Guidelines for Wind Energy and Wildlife Resource Management in Nebraska

The Nebraska Wind and Wildlife Working Group

November 2013 version

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Objective

These guidelines are non-regulatory statewide recommendations designed to help developers assess and minimize potential environmental impacts that could result from development of wind energy facilities. However, not all recommendations will be applicable to all wind energy development projects, which are reviewed and discussed on a project-by-project basis. Additionally, site-specific recommendations may be made that are not included in this document. These guidelines do not supersede site-specific recommendations provided by the Nebraska Game and Parks Commission (NGPC) or the U.S. Fish and Wildlife Service (USFWS) during the environmental review process.

This is a living document and will be updated when new information for recommendations becomes available. The document is available at: http://snr.unl.edu/renewableenergy/wind/tools.asp#stateguidelines. Please contact Caroline Jezierski, the Nebraska Wind Energy and Wildlife Project Coordinator, at windwildlife@unl.edu if you have any questions.

Introduction

Wind energy is a renewable energy source for which the potential environmental impacts of development and operation need to be considered. Wind energy is seen as a "green" energy source because during the operation of a wind energy facility there are no emissions of greenhouse gases or other pollutants. In general, the conservation community supports the development of wind energy. However, no energy source has yet been found to be without some degree of environmental costs and wind energy is no exception. The purpose of these guidelines is to provide consistent statewide guidance for the development of wind energy projects that avoid, minimize, and mitigate impacts to wildlife and their habitats in Nebraska.

Nebraska has great wind energy development potential. Nebraska ranks third nationally in terms of wind resources to generate electrical energy, with wind energy potential to produce more than 3.5 million gigawatt hours per year (United States Department of Energy 2010). The current Governor and State Legislature consider wind energy development in Nebraska a high priority. With much open land, low population densities in areas where wind turbines are likely to be placed, and relatively high average wind velocities, Nebraska seems destined to be a national focal point for wind energy development and exportation.

Hundreds of species of wildlife use Nebraska year-round or during migration or breeding seasons; several of these species and their habitats are considered at-risk and may be more sensitive to development. Nebraska has 14 federally and 27 state plant or animal species that are listed as endangered or threatened (http://outdoornebraska.ne.gov/wildlife/programs/nongame/pdf/E_T_Species_List.pdf). The Nebraska Natural Legacy Project State Wildlife Action Plan (Schneider et al. 2011) identifies at-risk species and categorizes them as Tier I or Tier II. Tier I species are those that are most imperiled, globally or nationally, and occur in Nebraska. The Tier II list contains those species that are at-risk within Nebraska while apparently doing well in other parts of their range. Biologically Unique Landscapes (BULs) have been identified by the Nebraska Natural Legacy Project as areas with the greatest potential for at-risk species and natural community

conservation. Nebraska supports a diverse array of species that should be considered when developing wind energy.

The Nebraska Wind and Wildlife Working Group is a consortium of state and federal agencies, non-governmental conservation organizations, and public utilities that formed to develop guidance for wind energy development in the state. The group works closely with wind developers and consultants who have developed or are looking to develop wind energy in Nebraska. The group consists of representatives from the NGPC, the USFWS, the Nebraska Energy Office, The Nature Conservancy, Audubon Nebraska, the Nebraska Wildlife Federation, the Nebraska Sierra Club, and other interested parties. Collectively the group represents a great diversity and depth of expertise in wildlife management and conservation in Nebraska. The group has no rule-making or regulatory authority; rather it works cooperatively to discuss mutual concerns, learn of the latest developments, and coordinate action as warranted. The group supports the development of wind energy in Nebraska when the planning and siting process avoids or minimizes impacts to wildlife populations and natural areas.

Wildlife Concerns

Wind energy development impacts wildlife populations in two ways: (1) direct impacts, such as individuals colliding with infrastructure; and (2) indirect impacts, such as loss and degradation of habitat.

Direct Impacts

Direct impacts (i.e., mortality) occur when birds and bats collide with or when bats come in close proximity to moving turbine blades, towers, or transmission lines servicing wind farms. Although numerous variables (including location of turbines, time of year, weather, scavenger removal rates, etc.) make it difficult to determine trends from multiple wind farms, some patterns have emerged.

Recent studies show direct impacts may increase significantly when turbines are placed in or near major migration corridors or natural features used during daily animal travel (e.g. mountain passes, large river valleys, and saddles or the edge of ridge-tops and bluffs) (Drewitt and Langston 2008, Kunz et al. 2007), or at migration stopover sites or frequently visited areas such as wetlands and lakes. Because birds and bats tend to follow or congregate along these natural landscape features, wind turbines placed near these features have potential for causing an increase in bird and/or bat mortalities.

Nebraska has several important areas used by migrating birds, most notably the principle spring staging area for migratory waterfowl within the Central Flyway. Millions of waterfowl and other water birds semiannually migrate through the Central Flyway between their breeding grounds and wintering grounds. In Nebraska, nearly one-half million Sandhill cranes (*Grus canadensis*) roost along the Central Platte River and feed in the meadows and crop fields adjacent to the river for six to eight weeks during the spring migration. The federal and state listed endangered whooping crane (*Grus americana*) also migrates through Nebraska. The central Platte River is one of the five geographic areas designated in the Central Flyway as critical habitat for

whooping cranes. Rivers and wetlands outside of the Platte River valley (e.g., Rainwater Basin, Central Table Playas, the South, Middle, and North Loup Rivers, the Niobrara River, and the Republican River) are also used by whooping cranes as they migrate through the state. Given the rarity of some migratory species in Nebraska, the mortality of a few individuals could have a significant negative impact on the species' populations; for these reasons, direct impacts of winds energy development on migratory bird species are of great concern in Nebraska.

Bats are likely to experience higher direct mortality rates than birds at many wind farms (Howe et al. 2002, Kunz et al. 2007, Kuvlesky et al. 2007, Molvar 2008). Resident bats in Nebraska are usually associated with trees or wooded areas and wetlands, where the insects on which they feed are abundant. However, bats commonly feed over grasslands and agricultural fields as well. Recent studies have shown tree-roosting migratory bats are at a higher risk of direct impacts from wind turbines; three particularly susceptible species are the eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), or silver-haired bat (*Lasionycteris noctivagans*) (Arnett et al. 2008, Kunz et al. 2007). All three of these species are present in Nebraska, as well as ten other documented bat species. Several trends have been identified about bats' susceptibility to direct mortality by wind turbines, including: 1) fatality rates differ among species, 2) most individuals are killed in late summer and early fall, most likely during their migration, and 3) most fatalities occur during nights with low wind speeds (Arnett et al. 2008, Cryan and Barclay 2009, Kunz et al. 2007). Currently there is no clear reason why so many bats are being killed by turbines and until such reasons are known, extra vigilance should be used when siting turbines near areas of potential bat stopover and roosting habitat.

Indirect Impacts

Indirect impacts, such as habitat loss and/or degradation from wind turbines and their associated infrastructure, can affect all species in the impacted area, including plants and non-flying animals that are not subject to turbine collision mortality. These impacts represent an environmental cost that may be greater than direct impacts. Development of infrastructure can impact species through loss of habitat due to construction of roads, tower sites, turbine pads, and other infrastructure within the wind farm. Habitat loss can result from the physical removal of suitable habitat from the area or through species' responses to the change in the habitat which can result in species being displaced from otherwise suitable habitat near a turbine or other wind farm infrastructure. These avoidance behaviors could result in a large area of intact grassland becoming fragmented into smaller use areas, each fragment being too small to sustain a population of that species over the long term.

Roads and Fill Pads

Small roads, such as those constructed in a wind farm, have been shown to negatively impact a number of bird species (Ingelfinger and Anderson 2004). Vehicle traffic along roads can disturb wildlife within visual or audible range of the road and create dust that can coat nearby vegetation. Roads increase habitat fragmentation and habitat edges which many species avoid. Roads also facilitate the spread of invasive plants thus changing the plant composition, altering the habitat, and potentially making it unsuitable for some wildlife species, thereby displacing those species. Turbine pads and other infrastructure development that require placing fill on a previously unfilled location can have similar impacts to the habitat as roads.

Turbine Avoidance

Certain species avoid vertical structures in grasslands. A number of studies have demonstrated the negative reaction of birds to the presence of wind towers (Stewart et al. 2005), including several grassland bird species (Leddy et al. 1999).

Long-Term and Cumulative Impacts

Few studies have addressed the long-term (more than five years post-construction) effects of wind farms or cumulative impacts that several wind farms in close proximity may have on native species. Preliminary studies indicate the long-term and/or cumulative impacts may negatively impact birds; however, more research is needed to evaluate the magnitude of these impacts (Langston and Pullan 2003, Stewart et al. 2005). Because grassland birds as a group have suffered the steepest declines in population over the past 30 years among all North American birds, and given that Nebraska is home to some of the largest, least degraded grasslands in the Great Plains, habitat loss and degradation from widely distributed wind farms poses a credible and potentially large environmental cost in our state.

Wind Energy and Wildlife Guidelines

The purpose of these guidelines is to provide consistent statewide guidance for the development of wind energy projects that avoid, minimize, and mitigate impacts to wild animals and plants and their habitats in Nebraska. The guidelines include recommendations for: 1. Pre-construction Site Assessments; 2. Practices to Avoid and Minimize Impacts to Wildlife; 3. Post-Construction Surveys and Operational Monitoring; 4. Mitigation for Permanent Habitat Impacts; and 5. Research to further assess and minimize impacts to animals, plants, and their habitats.

1. Pre-construction Site Assessments

The construction of a wind project may impact wildlife through direct mortality and through the loss or degradation habitat. It is therefore critical to establish the presence or absence of various species and important natural communities well in advance of construction activities. The primary purposes of pre-construction assessments are to: 1) collect information suitable for predicting the potential impacts of the project on animal and plant species and their habitats and 2) design the project layout (e.g., turbine and road locations) so that impacts on biological resources are avoided and/or minimized.

The site-specific components and the duration of the assessment should depend on the size of the project, the availability, quality, and extent of existing and applicable information in the vicinity of the project, the habitats potentially affected, the likelihood and timing of occurrence of endangered, threatened, and other special-status species at the site, the magnitude of impacts to species (e.g., bats, passerines, etc.), and other factors. **Before initiating any surveys, the project proponent is strongly encouraged to contact the NGPC and the USFWS to discuss details of survey methods.** A review of the current National Wind Coordinating Collaborative report, *Comprehensive Guide to Studying Wind Energy/Wildlife Interactions*, is strongly

recommended (http://www.nationalwind.org/assets/publications/Comprehensive_Guide_to_Studying_Wind_Energy_Wildlife_Interactions_2011_Updated.pdf).

An initial assessment of the proposed project site should determine which species and habitats will need on-the-ground surveys. The results of the information review and baseline studies should be reported to the NGPC and the USFWS in a timely fashion. To allow comparison of results among projects and to maximize the benefits of pre-construction assessments, the use of standard protocols is strongly encouraged. For specific avian protocols, please see *Wind Energy and Nebraska's Wildlife: Avian Assessment Guidance for Wind Energy Facilities* (http://outdoornebraska.ne.gov/wildlife/pdfs/avianassessment3.pdf).

The following pre-construction surveys and associated timeframes are recommended for all projects; however, alternate timeframes can be established on a project-by-project basis if the NGPC and the USFWS are consulted early and often in the planning process.

1.1 Whooping Crane Desktop Assessment

It is currently not known how whooping cranes will respond to wind energy development, but there are concerns that whooping cranes may collide with wind turbines and associated infrastructure. Whooping cranes are state and federally listed as endangered and are a Tier I species in every ecoregion of Nebraska. Since 1956, numerous whooping crane mortalities or serious injuries have occurred as a result of collisions with power lines (U.S. Fish and Wildlife Service 2009). There are also concerns that whooping cranes may avoid areas with wind turbines. If this is the case, whooping cranes will lose crucial stopover habitat if wind energy facilities are developed in the species' migration corridor. Currently, the risks of collision and habitat loss are difficult to quantify because of high uncertainty. Project proponents are encouraged to acknowledge this uncertainty and to prepare for a range of scenarios ranging from no effect to large numbers of mortalities and/or habitat loss if their project occurs within the main migration corridor. This preparation should begin with a rapid (or desktop) risk assessment. This assessment should use information about: 1) whooping crane migration ecology; 2) location of the proposed project site relative to the whooping crane migration corridor; and 3) a GIS analysis of wetland and habitat resources located within and adjacent to the proposed project site. For further information, please view the USFWS (2009) document: *Whooping Cranes and Wind Development- An Issue Paper* (ftp://wiley.kars.ku.edu/windresource/Whooping_Crane_and_Wind_Development_FWS_%20April%202009.pdf).

1.2 Nesting Raptor Surveys

A minimum of two years of pre-construction nesting raptor surveys are recommended during the breeding season within the project area as well as a two mile buffer around the project area. Surveys should determine the location and species of active nests that could potentially be disturbed by construction activities and identify species and active and potentially active nest sites with the highest likelihood of being impacted by the operation of the facility. All raptors are federally protected under the Migratory Bird Treaty Act, and eagles are also protected under the Bald and Golden Eagle Protection Act. Several raptors have been identified as Tier I or Tier

II at-risk species in the Nebraska Natural Legacy Project State Wildlife Action Plan (Schneider et al. 2011). If projects occur in areas where certain species of raptors occur that are susceptible to collisions with wind turbines, then a larger buffer around the project area will need to be surveyed. If the project occurs in areas where golden or bald eagles occur during anytime of the year, it may be recommended to follow the USFWS Eagle Conservation Plan Guidance, Module 1 – Land-based Wind Energy, Version 2 (http://www.fws.gov/migratorybirds/PDFs/Eagle%20Conservation%20Plan%20Guidance-Module%201.pdf).

1.3 Breeding Bird Surveys

A minimum of two years of pre-construction breeding bird surveys are recommended to estimate the use of the project area by avian species/groups of interest during their breeding season. Surveys for grassland nesting birds identified as Tier I or II are highly recommended. These species may be at risk for collisions with turbines or associated structures or suffer from habitat loss due to avoidance of otherwise suitable habitat that is in proximity to turbines or associated structures.

1.4 Prairie Grouse Surveys

Nebraska has two species of prairie grouse: the greater prairie-chicken (*Tympanuchus cupido*) and the sharp-tailed grouse (*Tympanuchus phasianellus*). The greater prairie-chicken is a Tier I species in all ecoregions of Nebraska. A minimum of two years of pre-construction surveys are recommended to determine the presence of prairie grouse, lek locations, and the number of males and females at each lek. A one-mile buffer should be added to the project area to ensure all potentially affected leks are located. Aerial surveys using fixed-wing aircraft are strongly encouraged and can be combined with the nesting raptor surveys.

1.5 Bat Surveys

Because of the potential long-term impacts to bat populations caused by excessive bat fatalities, two years of pre-construction surveys are recommended for all new wind energy facilities in Nebraska. We recommend these surveys in all areas because the species most often killed are long-distance migrants; as a result, even stop-over sites of low-quality habitat have the potential to result in a high number of bat fatalities.

An assessment of potential bat habitat along with passive acoustic surveys during the spring, summer, and fall are strongly encouraged for all projects in areas of potential roosts, hibernacula, and migratory pathways. At a minimum, acoustical detection units should be placed on all meteorological towers and on each ‘corner’ or ‘side’ of the project area. Consultations with the NGPC and the USFWS to review data from the habitat assessment and the acoustic survey(s) will determine if further bat surveys, including active sampling (mist nets and/or harp traps), are needed. Appropriate survey methods, survey periods, and locations will depend on local habitat and environmental conditions, and vary by species and/or life stage.

Additional bat surveys are recommended in the following cases: 1) use of the site by bat species is estimated to be high, and/or 2) there are limited or no relevant data regarding seasonal use of

the project site (e.g., data from nearby areas of similar habitat type), and/or 3) areas where low density or migrating species may be affected.

1.6 Endangered and Threatened Species Surveys

Early consultation (at least two years prior to construction) with the NGPC and the USFWS is highly recommended to determine if focused surveys for state and/or federally listed endangered and threatened (E&T) species are needed. The NGPC's Natural Heritage Program maintains range maps, habitat information, and a database of documented occurrences for all listed species in the state. Both the NGPC and the USFWS will conduct environmental reviews of proposed project sites to determine known occurrences, potential suitable habitat, and need for surveys for E&T species. Consultation with the NGPC and the USFWS for species specific survey protocols is also highly recommended.

1.7 Plant Community Surveys

The Nebraska Natural Legacy Project (Schneider et al. 2011) identifies numerous at-risk plant communities within the state (e.g., tallgrass prairie, oak woodland, saline wetland), which contain significant biological diversity. An assessment should be conducted to determine if any rare or high quality plant communities occur in the project area. Further loss, degradation, and fragmentation of remaining occurrences of these rare communities should be avoided. Early identification of these communities within a project area can aid in designing infrastructure to avoid or minimize impacts. The Natural Heritage Program maintains a classification of plant communities in the state and a database of documented occurrences of communities, and can provide community survey recommendations.

2. Practices to Avoid and Minimize Impacts to Wildlife

Proper siting and design of wind energy projects can avoid and minimize many of the impacts to wildlife. The following recommendations have been collected from a variety of sources, including the *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines* (http://www.fws.gov/windenergy/docs/WEG_final.pdf) and recommendations from the National Wind Coordinating Collaborative.

2.1 General Siting Recommendations

2.1.1 The *Wind Energy and Nebraska's Wildlife* map was developed to delineate areas where potential adverse impacts of wind turbines on wildlife and habitat in Nebraska are most likely to occur (http://outdoornebraska.ne.gov/wildlife/pdfs/wildlifewind.pdf). **Wind energy developers and planners are encouraged to refer to this map as an initial step when considering new sites. However, potential adverse impacts to wildlife and habitats will be greatly influenced by site-specific factors that cannot be captured in a statewide map. Wind energy projects in areas mapped as low-sensitivity may have significant impacts due to specific siting of infrastructure.** Conversely, there may be some sites within areas mapped as high-sensitivity where wind development would be appropriate when coupled with conservation measures. In general, higher sensitivity areas have a higher probability of impacts to wildlife and it is recommended that projects be sited outside of these areas. Consultation with

the NGPC and the USFWS biologists is recommended at the earliest stages of project development to aid in selecting suitable sites.

2.1.2 Possible cumulative regional effects of multiple wind energy projects should be considered by all parties involved in the development process. While one project alone may result in few concerns for wildlife, multiple projects across one landscape could substantially multiply adverse effects (Langston and Pullan 2003).

2.2 Site-Specific Recommendations

Siting wind energy facilities on previously altered landscapes, such as areas of cultivation, near towns, or urban and industrial areas is recommended. Avoid siting wind energy facilities in areas of contiguous intact native habitat and areas of concentrated wildlife use.

2.2.1 Existing roads and utility corridors should be utilized to the greatest extent practicable and new access roads and utility corridors should be configured to avoid high quality habitats and minimize habitat fragmentation. Access roads and utility corridors should have alignments that minimize stream crossing and wetland impacts. For more information on wetland habitats in Nebraska see *Guide to Nebraska's wetlands and their conservation needs* (http://outdoornebraska.ne.gov/wildlife/programs/wetlands/pdf/wetlandsguide.pdf).

2.2.2 State and Federally owned and managed wildlife or recreation properties (e.g., State Parks, Wildlife Management Areas, State Recreation Areas, Waterfowl Production Areas, National Wildlife Refuges, etc.) should be avoided entirely both for biological (rare landscapes, extensive wildlife breeding, and migrating activities, etc.) and aesthetic reasons. A one-mile buffer is recommended around all state owned and managed wildlife and recreation properties. In some cases, a larger buffer may be recommended depending on the location and wildlife use of the area.

2.2.3 Site turbines and other infrastructure away from occurrences of rare plant communities (e.g., tallgrass prairie, oak woodland, saline wetlands) and avoid siting turbines in a manner that will effectively fragment or split larger patches of native habitats.

2.2.4 Place turbines outside of recognized bird and bat concentration areas or migration pathways, which may include such features as: lakes, wetlands, forests, river valleys, ridge tops or bluff tops, native prairie, known roosting areas, and areas with frequent incidence of fog, mist, or low clouds. Although there is no consistent data on the amount of buffer needed between turbines and these habitats, a separation distance of at least one mile is recommended as a minimum distance. In some cases, a greater separation distance may be recommended based on the species typically using specific lakes, rivers, wetlands, or other natural features.

2.2.5 Avoid placing turbines at locations where they would have a direct or indirect impact on documented occurrences of fish, wildlife, or plants protected under the federal Endangered Species Act, the Bald and Golden Eagle Protection Act, and/or the Nebraska Nongame and Endangered Species Conservation Act. Site turbines in areas where impacts to migratory birds would be minimized in accordance with the Migratory Bird Treaty Act. Information regarding the species protected under these laws may be obtained by contacting the

Environmental Services Division with the NGPC in Lincoln and the USFWS in Grand Island.

Avoid roost habitat areas with documented repeated use by migrating whooping cranes. Examples of such areas include the Rainwater Basins, the central Platte River, the Loup rivers, the Niobrara River, the Central Table Playas in Custer County, and the eastern Sandhill wetlands. If a proposed wind energy project falls within the whooping crane migration corridor, a specific risk assessment should be conducted and a contingency plan should be developed (see section **1.1 Whooping Crane Desktop Assessment**). Additional measures should be taken to minimize the likelihood of whooping cranes colliding with all above ground power lines associated with the wind energy facilities.

Develop an Avian Protection Plan (APP) using the APP Guidelines developed by the Avian Power Line Interaction Committee and the USFWS to help identify and minimize risks to all migratory and resident birds (http://www.aplic.org/uploads/files/2634/APPguidelines_final-draft_Aprl2005.pdf).

2.2.6 Place turbines away from habitat known to be occupied by prairie grouse or other species that exhibit extreme avoidance of vertical features. If such habitat cannot be avoided, construction should not take place within ½ mile of leks during the lekking season.

2.2.7 Decommission, minimize, and restore roads not needed for facility operations. Use site-appropriate native species when replanting or seeding areas that have been disturbed.

2.3 Infrastructure Design Recommendations

2.3.1 Use free-standing (i.e., no guy-wires) support towers for turbines and meteorological towers. Any existing guy wires should be marked with recommended bird deterrent devices according to the document *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* by Avian Power Line Interactive Committee (http://www.aplic.org/uploads/files/2643/SuggestedPractices2006(LR-2).pdf).

2.3.2 Use tubular support towers with pointed tops which greatly reduce opportunities for birds to perch or nest upon the structures; lattice support towers should be avoided when possible. Avoiding placement of permanent external ladders or platforms on tubular towers also reduces nesting and perching.

2.3.3 Space turbines widely apart, preferably in arrays parallel to normal bird migration routes (typically north-south) which can reduce avian collisions. Depending on local landscape features, number of turbines installed, and other factors, turbine spacing recommendations may vary.

2.3.4 Bury electric power lines within the wind farm (collection lines). Any above ground power lines (e.g., from the wind farm to the power grid), riser poles, transformers, and conductors should comply with the document *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* by Avian Power Line Interactive Committee (http://www.aplic.org/uploads/files/2643/SuggestedPractices2006(LR-2).pdf). This includes marking all above ground power lines with bird flight diverters.

2.3.5 Taller turbines, having a top-of-rotor sweep exceeding 199 feet, may require lights for aviation safety. The minimum amount of pilot warning and avoidance lighting necessary should be used, and unless otherwise required by the Federal Aviation Administration, only red or dual red and white strobe or flashing lights should be used. These should be minimized in number, intensity, and number of flashes per minute. Steady burning red or white lights should *not* be used, as they attract more night-migrating birds than do strobes.

2.3.6 Adjust tower heights if the rotor-sweep zone poses high wildlife collision risks.

2.3.7 Minimize the number and intensity of lights associated with operation and maintenance facilities and substations located within half a mile of the turbines. Use lights with motion sensors that are hooded downward. All internal turbine nacelle and tower lights should be turned off unless the structure is occupied. Lights should only be illuminated when needed by personnel at the site.

2.3.8 Employ the above guidelines when older facilities are upgraded or retrofitted.

2.4 Operation Recommendations

2.4.1 Increase turbine cut-in speeds (the lowest wind speed at which a wind turbine begins producing power) during periods of low wind speed during months when bats are present.

2.4.2 Feather or change the pitch angle of the turbine blades below cut-in speed as a standard practice. It is highly recommended that all turbines be programmed to feather blades when they are not producing electricity. Feathering blades has been found to effectively reduce bat fatalities (Baerwald et al. 2009).

2.4.3 Curtail turbine operations by shutting turbines down in areas of high bird use to minimize fatalities during migration periods.

2.4.4 Advise wind energy facility personnel to be aware of wildlife in the area, reduce vehicle speed when wildlife are present, and avoid disturbing wildlife.

3. Post-Construction Surveys and Operational Monitoring

Mortality of birds and bats is expected to result from wind energy projects. However, it is anticipated that significant impacts to wildlife can be avoided or minimized if these guidelines are employed. Post-construction surveys and monitoring studies, including monitoring for carcasses *and* conducting surveys (i.e., breeding bird, prairie grouse, and bat acoustic surveys) should be conducted to determine the estimated direct and indirect impacts of the wind farm on birds and bats. These data are essential for both identifying potential measures to mitigate the impact of operations at existing sites as well as assessing potential risks associated with future developments.

In general, post-construction surveys and monitoring of birds and bats (or other relevant species) should be conducted for a minimum of two years following initiation of project operations; however, longer-term monitoring is encouraged and would provide more reliable data (Erickson et al. 2007, Parker and Wiens 2005). Project proponents should work with the NGPC and the USFWS to develop and/or determine acceptable survey and monitoring protocols for use. Use of standard protocols is encouraged and would allow for a comparison of results among projects. For specific avian protocols, refer to *Wind Energy and Nebraska's Wildlife: Avian Assessment Guidance for Wind Energy Facilities* (http://outdoornebraska.ne.gov/wildlife/pdfs/avianassessment3.pdf).

Project operators are encouraged to develop incidental fatality reporting protocols to coincide with regular on-going operational activities.

4. Mitigation for Permanent Habitat Impacts

Permanent impacts to habitat are those anticipated to persist and cannot be restored within and/or beyond the life of the project. Permanent impacts may include new permanent roads, operations and maintenance facilities, turbine pads, impervious areas and/or areas devoid of native vegetation resulting from project operations, and areas excluded from species' use due to avoidance of turbines (displacement).

Project-specific mitigation packages should be negotiated in consultation with the NGPC and the USFWS who will use the following principles to develop a suitable mitigation package, when warranted.

4.1 Basic Mitigation Recommendations

4.1.1 Mitigation habitat should be of like kind (e.g., tallgrass prairie for tallgrass prairie) and of equal or higher habitat value than the impacted area.

4.1.2 Mitigation habitat should be in the same geographical region as the impacted habitat.

4.1.3 The functions and values of the mitigation package should meet the extent of the impact on habitat.

4.1.4 Wind project developers are responsible for ensuring that mitigation habitat is given legal protection through acquisition in fee, a permanent conservation easement, or other enforceable means and managed in perpetuity. A wind developer may choose to work through a land trust to ensure perpetual protections.

4.1.5 Mitigation dollars will be used as specified in 4.1.1 – 4.1.4 unless an alternative agreement is made by all parties involved.

4.1.6 Research and mitigation are not interchangeable.

4.2 Specific Mitigation Recommendations

4.2.1 The standard for habitat mitigation is a 1:1 ratio. However, in cases of rare habitat types (e.g., tallgrass prairie, wetlands, etc.), the ratio would be higher.

4.2.2 No mitigation would usually be required for impacts to highly disturbed sites such as cropland and industrial or urban areas. If a highly disturbed site is utilized by a sensitive species (e.g., mountain plover nesting in crop fields) or is adjacent to habitat used by sensitive species (e.g., a crop field adjacent to a sandbar utilized by piping plovers or a crop field adjacent to a wetland used by whooping cranes), wind energy development on the site may adversely impact the sensitive species and/or the habitat. Mitigation will be necessary if development occurs in these locations.

4.2.3 In areas where whooping crane habitat is impacted, mitigation for acres lost should follow the USFWS guidelines as suggested in *Whooping Cranes and Wind Development - An Issue Paper* (ftp://wiley.kars.ku.edu/windresource/Whooping_Crane_and_Wind_Development_FWS_%20April%202009.pdf).

4.2.4 Where appropriate, mitigation acreage for indirect impacts (i.e., displacement) should be calculated as a 180 meter radius buffer around each turbine.

5. Research

Much uncertainty remains regarding predicting risk and estimating impacts of wind energy development on wildlife and habitat. It is in the interest of wind developers, wildlife agencies, and conservation organizations to support research to better understand these impacts so they can be avoided or minimized. Because the results of current and future research activities will directly impact future costs, siting recommendations, and survey protocols, it would greatly benefit wind proponents to play an active role in research. **Proponents can be involved by providing researchers with access to wind farm properties, trying new technologies which minimize impacts to wildlife, providing funds for research, and making their organization's research data available.** The Nebraska Wind and Wildlife Working Group encourages cooperation among wind proponents, local agencies, and universities to engage in productive research projects.

Standard pre-and post-construction assessment surveys and standard fatality operational monitoring are separate from research-oriented studies, but both types of studies could provide valuable information about wind – wildlife interactions. Data collected during standard pre- and post- construction surveys at a number of wind energy facilities could be used to test specific research hypotheses about impacts to a particular species, community, or landscape. By sharing data collected during pre- and post- construction surveys, wind proponents can facilitate these studies at no additional financial cost. Research studies, such as assessing the indirect impacts

(e.g., displacement, cumulative impacts, etc.) on wildlife or identifying bat migration routes, could provide information for future projects and potentially help to minimize the uncertainty of wind energy impacts on wildlife. Funding for research studies is needed, but through collaboration across stakeholder groups, the resources needed could be shared. For example, a wind proponent could provide funding for a research project that could be carried out by a graduate student who seeks additional funding through grants.

Current research priorities for Nebraska include: appropriate buffer distances (indirect impacts) for prairie grouse, assessing the cumulative impacts of multiple wind farms in an area, locating bat migration corridors within the state, and establishing long-term post-construction survey and monitoring efforts to explore the potential long-term impacts of wind energy development on wildlife. Other valuable research activities could focus on ways to design and operate turbines and power lines that may reduce bird and bat strikes, effective ways to mark power lines, and technologies to document bird or bat strikes on turbines or power lines.

Other Considerations

These guidelines focus on the potential impacts of wind energy development on wildlife and natural habitats. However, other issues should be considered including, but not limited to, impacts on historic and cultural resources, water quality, noise pollution, and human health concerns. Wind energy developers should work with the State Historic Preservation Office, the Nebraska Department of Environmental Quality, and others to address these issues.

Related Links

The Nebraska Wind Energy and Wildlife Project - http://snr.unl.edu/renewableenergy/wind/

NGPC – Nebraska Wind and Wildlife - http://outdoornebraska.ne.gov/wildlife/windwildlife.asp

USFWS Ecological Services – Wind Power Development in Nebraska – http://www.fws.gov/nebraskaes/Wind%20Power%20Development%20in%20Nebraska.html

American Wind Wildlife Institute (AWWI) - http://www.awwi.org/

Bats and Wind Energy Cooperative (BWEC) - http://www.batsandwind.org/

National Wind Coordinating Collaborative (NWCC) – Wildlife Workgroup - http://www.nationalwind.org/issues/wildlife.aspx

National Renewable Energy Laboratory (NREL) Wind-Wildlife Impacts Literature Database (WILD) - http://www.nrel.gov/wind/wild/

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