Wind Turbine Interactions with Wildlife and their Habitats

A Summary of Research Results and Priority Questions

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This fact sheet summarizes what is known about the adverse impacts of land-based wind power on wildlife in North America and the status of our knowledge regarding how to avoid or minimize these impacts.

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BACKGROUND: BIG HORN WIND FARM, PHOTO BY IBERDROLA RENEWABLES, INC., NREL 15188 • INSET, L-R: EASTERN MEADOWLARK, PHOTO BY MATTHEW PAULSON, FLICKR • AMERICAN BALD EAGLE, PHOTO BY USFWS, FLICKR • HOARY BAT, PHOTO BY J. N. STUART, FLICKR

SMOKY HILLS WIND FARM, PHOTO BY DRENALINE, WIKIPEDIA

INTRODUCTION

Wind energy's ability to generate electricity without carbon emissions will help reduce the potentially catastrophic effects of unlimited climate change on wildlife, and wind energy provides several other environmental benefits including substantially reduced water withdrawals and consumption, mercury emissions, and other sources of air and water pollution associated with burning fossil fuels (e.g., NRC 2010). Adverse impacts of wind energy facilities to wildlife, particularly to individual birds and bats have been documented (Arnett et al. 2008; Strickland et al. 2011). Impacts to wildlife populations have not been documented, but the potential for biologically significant impacts continue to be a source of concern as populations of many species overlapping with proposed wind energy development are experiencing long-term declines owing to habitat loss and fragmentation, disease, non-native invasive species, and increased mortality from numerous anthropogenic activities (e.g., NABCI 2009; Arnett and Baerwald 2013).

This fact sheet summarizes what is known about the adverse impacts of land-based wind power on wildlife in North America and the status of our knowledge regarding how to avoid or minimize these impacts. A precursor of this fact sheet, "Wind Turbine Interactions with Birds, Bats, and their Habitats: A Summary of Research Results and Priority Questions," was first produced by the Wildlife Workgroup of the National Wind Coordinating Collaborative (NWCC) in 2004 and then updated in 2010. In January 2012 the American Wind Wildlife Institute began facilitating the NWCC, and this updated fact sheet continues the tradition of previous fact sheets in reflecting the latest assessment of wind energy impacts on wildlife based on a review of the available literature.

BLUE-WINGED TEAL, PHOTO BY ANDREA WESTMORELAND, FLICKR

The amount of research in the peer-reviewed literature has grown substantially since 2010, reflecting the continued interest in understanding wind-wildlife interactions. This interest was underscored by the recent AWWI-NWCC Wind Wildlife Research Meeting IX that featured more than 100 oral and poster presentations. Much of the research presented at this meeting has not been published, and there is also a large amount of literature of wind-wildlife research consisting of unpublished reports documenting impacts of wind energy projects funded by wind energy companies or contracted by state and federal agencies. In order to maintain the highest level of scientific rigor for this fact sheet, we have emphasized research that has been published in peer-reviewed journals and un-published reports that have undergone expert technical review.

Recognizing the active work in this field of research, this fact sheet will become a "living, web-based document" that will be updated on a more frequent basis as new results become available. This version of the fact sheet has undergone, and all future updates will undergo, expert review before being posted on the AWWI and NWCC websites. Literature citations supporting the information presented are denoted in parentheses; full citations can be found online here.

Organization of this Fact Sheet

Individual birds and bats may collide with wind turbines, causing death. Potential adverse wildlife impacts also include direct and indirect habitat loss from the construction and operation of wind energy facilities; indirect effects include displacement by avoidance of otherwise suitable habitat, or demographic impacts, such as reduced survival or reproductive output (e.g., Arnett et al. 2007; Kuvlesky et al. 2007; NAS 2007; Strickland et al. 2011). This fact sheet organizes statements about what is known and what remains uncertain regarding the adverse impacts of wind energy on wildlife in the following categories:

- Direct Mortality
- Cumulative Impacts of Mortality — population level consequences of collision fatalities
- Avoidance and Minimization of Collision Fatalities
- Direct and Indirect Habitat-Based Impacts

Within each section, statements are ordered in decreasing level of certainty. Our level of certainty reflects the "weight of the evidence" that comes from multiple studies on a question of interest. One published study, although informative, is usually insufficient for drawing broad conclusions. For example, fatality monitoring for birds and bats has been conducted for many years and has become a routine procedure at new facilities[1]. However, although more information is available on direct impacts to individuals, substantial uncertainty remains about our ability to predict risk or our understanding of the population-level consequences.

[1] To demonstrate adherence to the 2012 USFWS Land-based Wind Energy Guidelines, project operators are requested to conduct a minimum of two years of post-construction fatality monitoring.

Since the previous version of this fact sheet, installed wind energy capacity in the United States has grown rapidly, increasing from approximately 35,000 megawatts (MW; one MW equals one million watts) in early 2010 to more than 60,000 MW at the end of Q3 in 2013. Land-based wind turbines have grown substantially in power output over the years; name-plate capacity of turbines installed at new projects ranges from 1.5-2.5 MW. Today's turbine towers range in height from 200–260 feet (60-80 m) and turbine blades create a rotor swept area of 75-90 m (250–300 feet) in diameter, resulting in blade tips that can reach over 130 m (425 feet) above ground level. Rotor swept areas now exceed 0.4 ha (one acre) and are expected to reach nearly 0.6 ha (1.5 acres) within the next several years. The speed of rotor revolution has significantly decreased from 60-80 revolutions per minute (rpm) to 11–28 rpm, but blade tip speeds have remained about the same; ranging from 220-290 km/hr (140-180 mph) under normal operating conditions. Most modern wind energy facilities have fewer machines producing the same or more electricity than early facilities; current projects have wider spacing between turbines and cover thousands of acres.

WOODWARD MOUNTAIN WIND RANCH, PHOTO BY TODD SPINK, NREL 11283

DIRECT MORTALITY

Results from the number of studies reporting collision fatality monitoring at operating wind energy facilities has increased substantially over the years, and approximately 100 studies that were conducted at all seasons are available (e.g., Strickland et al. 2011; Arnett and Baerwald 2013; Loss et al. 2013). Protocols for carcass searching also have become more standardized, thereby facilitating comparisons of more recent results. There remains much uncertainty as to underlying patterns in collision fatalities in both birds and bats. Some of this uncertainty reflects the lack of data from some regions of the country. For example, we are aware of only one publicly available fatality report from the southwestern U.S., and the northern and eastern regions of the country are underrepresented relative to the Midwest/Prairie region and the Intermountain West. We also do not know whether publicly available reports accurately reflect what is occurring at the majority of facilities from which data are not currently available.

This first section briefly outlines what is known and where there is remaining uncertainty about the patterns of collision fatalities focusing in the continental U.S. We first examine patterns that apply to both birds and bats and then describe patterns for birds and bats separately.

BLACK THROATED BLUE WARBLER, PHOTO BY KELLY COLGAN AZAR, FLICKR

LITTLE BROWN BATS, PHOTO BY USFWS, FLICKR

Fatalities of birds and bats have been recorded at all wind energy facilities for which results are publicly available.

We assume that most bird and bat collisions are with the rotating turbine blades (Kingsley and Whittam 2007; Kunz et al. 2007a; Kuvlesky et al. 2007; NAS 2007; Arnett et al. 2008; Strickland et al. 2011), although collisions with turbine towers is also possible. Fatality rates for most publicly available studies range between three to five birds per MW per year (for all species combined and adjusted for detection biases); a single facility of three turbines in Tennessee reported approximately 14 bird fatalities per MW per year, but a fatality survey conducted after the facility expanded estimated 1.1 birds per MW per year (e.g., Strickland et al. 2011; Loss et al. 2013). There is little variation in bird fatalities across regions for all species combined, although fatalities at sites in the Great Plains appear to be lower than sites in the rest of the U.S., and fatalities in the Pacific region may be significantly higher (Loss et al. 2013), but it is unknown to what extent these differences reflect the sample bias discussed earlier.

Bat fatality rates can be substantially higher than bird fatality rates, especially at facilities in the Upper Midwest and eastern forests: two facilities within the Appalachian region reported fatality levels of greater than 30 bats/MW per year, but there are reports as low as one to two bats/MW per year at other facilities in the eastern U.S. (Hein et al. 2013). Studies have not found a consistent pattern of fatalities across landscape types: fatality rates can be equally high in agricultural, forested landscapes, or in a matrix of those landscape types (e.g. Jain et al. 2011). Fatality rates average substantially lower at facilities in the western U.S., but, in general, there is greater variation in bat fatalities within regions than among regions (Arnett et al. 2013a; Hein et al. 2013).

The lighting currently recommended by the Federal Aviation Administration (FAA) for installation on commercial wind turbines does not increase collision risk to bats and migrating songbirds.

The number of bat and songbird fatalities at turbines using FAA-approved lighting is not greater than that recorded at unlit turbines (Avery et al. 1976; Arnett et al. 2008; Longcore et al. 2008; Gehring et al. 2009; Kerlinger et al. 2010). The FAA regulates the lighting required on structures taller than 199 feet in height above ground level to ensure air traffic safety. For wind turbines, the FAA currently recommends strobe or strobe-like lights that produce momentary flashes interspersed with dark periods up to three seconds in duration, and they allow commercial wind facilities to light a proportion of the turbines in a facility (e.g., one in five), firing all lights synchronously (FAA 2007). Red strobe or strobe-like lights are frequently used.

The effect of turbine height and rotor swept area on bird and bat collision fatalities remains uncertain.

There are conflicting reports on whether bird and bat collisions increase with tower height or rotor swept area on a per MW basis (Baerwald and Barclay 2009; Barclay et al. 2007; Strickland et al. 2011; Arnett and Baerwald 2013; Loss et al. 2013a). Taller turbines have much larger rotor-swept areas, and it has been hypothesized that collision fatalities will increase owing to the greater overlap with flight heights of nocturnal-migrating songbirds and bats (Johnson et al. 2002; Barclay et al. 2007). The vast majority (>80%) of avian nocturnal migrants typically fly above the height of the rotor-swept zone (<500 feet; <150 m) (Mabee and Cooper 2004; Mabee et al. 2006).


GRASSHOPPER SPARROW, PHOTO BY SHEILA GREGOIRE, FLICKR

It is unknown whether collision risk at single towers is comparable to risk at individual towers within large wind energy facilities.

Construction of single utility-scale turbines (1.5-2 MW) is growing rapidly in some regions of the country, especially where opportunities for large utility-scale projects are limited or municipalities often supply their own electricity (e.g., Massachusetts). There are no published data of fatality monitoring at these single turbines, and monitoring at these projects is often not required.


PEETZ TABLE WIND FARM, PHOTO BY MARGUERITE KELLY, NREL 14112

GOLDEN-CROWNED KINGLET, PHOTO BY ZANATEH, FLICKR

Birds

A substantial majority of bird fatalities at wind energy facilities are small songbirds.

Collisions of small songbirds (<31 cm in length) account for approximately 60% of fatalities at U.S. wind facilities (Loss et al. 2013); small songbirds comprise more than 90% of all landbirds (Partners in Flight Science Committee 2013). Most songbird species are migratory resulting in spring and fall peaks of bird casualty rates at most wind facilities (Strickland et al. 2011).

Diurnal raptors and pheasants also are relatively frequent fatalities, particularly in the western U.S. where these species are more common. These groups are far less abundant than songbirds, and the relatively high fatality rates for raptors and pheasants suggest a higher vulnerability to collision. The vulnerability to collision of native game birds, e.g., sage grouse and prairie chickens, is uncertain. Fatalities of waterbirds and waterfowl, and other species characteristic of freshwater, shorelines, open water and coastal areas (e.g., ducks, gulls and terns, shorebirds, loons and grebes) are recorded infrequently at land-based wind facilities (e.g., Kingsley and Whittam 2007; Gue et al. 2013). The infrequent fatalities of coastal birds is somewhat different than that reported at a single facility in the Netherlands (Winkelman 1992), but this could be owing to the limited information from coastal wind facilities, particularly in the United States (Kingsley and Whittam 2007; NAS 2007).

Newer, larger (≥500 kW) turbines may reduce raptor collision rates at wind facilities compared to older, smaller (40 - 330kW) turbines.

Numbers of raptor fatalities appear to be declining as a result of the repowering at Altamont; smaller low-capacity turbines are being replaced with taller, higher-capacity turbines (Smallwood and Karas 2009). Larger turbines have fewer rotations per minute, and this difference may be partly responsible for the lower raptor collision rates (NAS 2007). In addition, smaller turbines that use lattice support towers offer many more perching sites for raptors than large, modern turbines

GOLDEN EAGLE, PHOTO BY ELSIE.HUI, FLICKR on tubular support towers, thus encouraging higher raptor occupancy in the immediate vicinity of the rotor swept area of the turbines (NAS 2007). Fatalities could also be lower on a per MW basis because fewer, larger turbines are needed to produce the same energy as smaller turbines. It is difficult to separate the importance of these individual factors in the observed reduction in raptor collision rates.

Bats

Migratory tree-roosting bat species are vulnerable to colliding with wind turbines.

Twenty one species of bats have been recorded as collision fatalities, but fatalities reported to date are concentrated in three migratory tree-roosting species, the hoary bat, the Eastern red bat, and the silver-haired bat, which collectively constitute greater than 70% of the reported fatalities at wind facilities for all North American regions combined (NAS 2007; Kunz et al. 2007a; Arnett et al. 2008; Arnett and Baerwald 2013; Hein et al. 2013).

It is unclear to what extent this conclusion reflects sample bias as we have few reports from the southwestern U.S., especially Texas and Oklahoma where there is high installed wind capacity and a very different bat fauna. Higher percentages of cave dwelling bats have been recorded at wind energy facilities in the Midwest (e.g., Jain et al. 2011), and the few available studies indicate that Brazilian free-tailed bats can constitute a substantial proportion (41–86%) of the bats killed at facilities within this species' range (Arnett et al. 2008; Miller 2008; Piorkowski and O'Connell 2010). However, because the free-tailed bat is a very abundant species where it occurs, it is uncertain whether this species is at greater risk than other species.

Bat fatalities peak at wind facilities during the late summer and early fall migration.

Several studies have shown a peak in bat fatalities in late summer and early fall, coinciding with the migration season of tree bats (Kunz et al. 2007a; Arnett et al. 2008; Baerwald and Barclay 2011; Jain et al. 2011), although fatalities during spring migration has been observed for some species at some facilities (Arnett et al. 2008).

Some bat species may be attracted to wind turbines.

High fatalities of migratory tree bats observed within the range of these species may be explained by the possibility that they are attracted to turbines (e.g., Horn et al. 2008). Attraction may result from sounds produced by turbines, a concentration of insects near turbines, and bat mating behavior (Kunz et al. 2007a; Cryan 2008; Cryan and Barclay 2009). Analysis of bat carcasses beneath turbines found large percentages of mating readiness in male hoary, eastern red and silver-haired bats, indicating that sexual readiness coincides with the period of high levels of fatalities in these species (Cryan et al. 2012).

EASTERN RED BAT, PHOTO BY MATTHEW O'DONNELL, FLICKR

Barotrauma does not appear to be an important source of bat mortality at wind energy facilities.

While direct collision with turbine blades is thought to be responsible for most of the bat fatalities observed at wind facilities (Horn et al. 2008), Baerwald et al. (2008) suggested that a large percentage of observed bat fatality may be due to barotrauma, i.e., injury resulting from suddenly altered air pressure. Fast-moving wind turbine blades create vortices and turbulence in their wakes, and it has been hypothesized that bats experience rapid pressure changes as they pass through this disturbed air, potentially causing internal injuries leading to death. However, forensic examination of bat carcasses found at wind energy facilities suggests that the importance of barotrauma as a proportion of bat mortality, is substantially less than originally hypothesized (Rollins et al. 2012; see also Grodsky et al. 2011).

HOARY BAT, PHOTO BY DANIEL NEAL, FLICKR

Weather patterns may influence bat fatalities.

Bat occupancy is influenced by nightly wind speed and temperature (Weller and Baldwin 2012), and some studies indicate that bat fatalities occur primarily on nights with low wind speed and typically increase immediately before and after the passage of storm fronts. Weather patterns therefore may be a predictor of bat activity and fatalities, and mitigation efforts that focus on these high-risk periods may reduce bat fatalities substantially (Arnett et al. 2008; Baerwald and Barclay 2011; Weller and Baldwin 2012; Arnett and Baerwald 2013).

Bat fatalities may not be male-biased in migratory tree bats.

Examination of external characters of bat carcasses collected at wind energy facilities indicated that the sex ratio of migratory tree bats was skewed towards males (e.g., Arnett et al. 2008), although other studies had shown female-bias or no bias (e.g., Baerwald and Barclay 2011). Bats can be a challenge to age and sex from external characters especially when carcasses have decomposed or have been partially scavenged. Molecular methods used to sex bat carcasses indicate that sex ratios in fatalities of tree bats are not male-biased, although male bias in fatalities may persist in other species (e.g., evening bat, Korstian et al. 2013).

CUMULATIVE IMPACT OF BIRD AND BAT COLLISIONS

The estimated total number of bird collision fatalities at wind energy facilities is several orders of magnitude lower than other leading anthropogenic sources of avian mortality.

Several recent estimates indicate that the number of birds killed at wind energy facilities is a very small fraction of the total annual human-related bird mortality and two to four orders of magnitude lower than mortality from other factors, including feral and domestic cats, power transmission lines, buildings and windows, and communication towers, (NAS 2007; Longcore 2012; Calvert et al. 2013; Loss et al. 2013a,b).

Fatality rates at currently estimated values are unlikely to lead to population declines in most bird species.

For songbird species current turbine-related fatalities constitute a very small percentage of their total population size, even for those songbird species that are killed most frequently (<0.02%; Kingsley and Whittam 2007; Kuvlesky et al. 2007; NAS 2007). As wind energy development expands, the potential for biologically significant impacts to some populations of species, such as raptors, may increase (NAS 2007; Johnson and Erickson 2010).

The status of bat populations is poorly known and the ecological impact of bat fatality levels is not known.

Bats are long-lived and some species have low reproductive

HORNED LARK, PHOTO BY KENNETH COLE SCHNEIDER, FLICKR

DILLON WIND POWER PROJECT, PHOTO BY IBERDROLA RENEWABLES, INC., NREL 16105

rates, making populations susceptible to localized extinction (Barclay and Harder 2003; Jones et al. 2003). There is concern that bat populations may not be able to sustain the existing rate of wind turbine fatalities (Kunz et al. 2007a; NAS 2007; Arnett et al. 2008) and/or increased fatalities as the wind industry continues to grow. Because population sizes for the most vulnerable bat species are poorly known, it is impossible to determine whether current fatality levels represent a significant threat to these species (NAS 2007; Kunz et al. 2007a; Arnett et al. 2008; Arnett and Baerwald 2013).

The ecological implications of White-Nose Syndrome and collision fatalities for bats are not well understood.

White-Nose Syndrome (WNS) is a fungus-caused disease that is estimated to have killed more than six million bats in North America (Frick et al. 2010; Turner et al. 2011; Hayes 2012). Cave-dwelling bat are most at risk, and it is unknown whether WNS will be a significant source of mortality in migratory tree bats that are most vulnerable at wind energy facilities. These species rarely occur in caves and their solitary nature may not facilitate the spread of fungal spores (e.g., Foley et al. 2011). Because cave-dwelling bats form a higher percentage of fatalities at Midwestern wind energy facilities, there is concern about the added mortality of wind turbine collisions to WNS-vulnerable bat species in this region. Fatality rates in these species actually could decline, because population sizes are being reduced by WNS, although the relationship between bat abundance and collision risk has not been established.

AVOIDING AND MINIMIZING BIRD AND BAT FATALITIES

Substantial effort is made to estimate collision risk of birds and bats prior to the siting and construction of wind energy facilities under the premise that high-activity sites will pose an unacceptable risk to these species and should be avoided. Wind energy companies are also employing a variety of operational techniques and technologies, such as radar, to minimize fatalities of vulnerable species such as bats and raptors at operating wind energy facilities.

For example, there is interest in relating differences in bat fatality rates among wind facilities to landscape characteristics (e.g., topography, landscape types, proximity to landscape features such as mountain ridges or riparian systems). Relating fatality rates to features within the immediate area of a turbine could be useful in siting wind energy facilities and locating turbines within a site to avoid higher-risk areas (Kunz et al. 2007a; Kuvlesky et al. 2007; NAS 2007; Arnett et al. 2008).

SILVER-HAIRED BAT, PHOTO BY LASSENNPS, FLICKR

Curtailing blade rotation at low wind speeds results in substantial reductions in fatality of bats.

An examination of ten separate studies (Baerwald et al. 2009; Arnett et al. 2011; Arnett et al. 2013b) showed reductions in bat fatalities ranging from 50 to 87%. These studies indicate that reductions in bat fatalities were achieved with modest reductions in power production under the conditions at the facilities where experiments were conducted. Further study to identify times when bat collision risk is high could optimize timing of curtailment and minimize power loss (e.g., Weller and Baldwin 2012).

The use of ultrasonic transmitters may deter bats away from rotor swept area and reduce bat fatalities, but further testing and enhancement of the technology is needed.

Experimental trials have shown that ultrasonic devices can reduce bat activity and foraging success, and similar devices operating at wind turbines have shown some reduction in bat fatalities over control turbines (Arnett et al. 2013a). The signal from ultrasonic devices attenuated rapidly with distance and was sensitive to humidity levels.

Siting individual turbines away from topographic features that attract concentrations of large raptors may reduce raptor collision fatalities at wind energy facilities.

Some analyses have indicated a relationship between raptor fatalities and raptor abundance (e.g., Strickland et al. 2011; Carrete et al. 2012; Dahl et al. 2012), although studies also suggest that standard activity surveys for raptors may not correlate with fatality rates (Ferrer et al. 2012). Large raptors are known to take advantage of wind currents created by ridge tops, upwind sides of slopes, and canyons that are favorable for local and migratory movements (Bednarz et al. 1990; Barrios and Rodriguez 2004; Hoover and Morrison 2005; de Lucas et al. 2012a; Katzner et al. 2012).

RED-TAILED HAWK, PHOTO BY KELLY COLGAN AZAR, FLICKR

Selective shutdown of high-fatality turbines may be an effective strategy for reducing fatalities of some raptor species.

Some of the highest raptor fatality rates have been observed in southern Spain where raptors congregate to cross the Straits of Gibraltar to Africa during migration (Ferrer et al. 2012). Mortality of griffon vultures at a facility in that area was reduced substantially (mean of 50.8%) by selective shutdown of turbines where the greatest number of fatalities was observed (de Lucas et al. 2012a).

The relationship among collision risk, species abundance and behavior in bird species is complex and not well understood.

Certain species that forage for prey in close proximity to turbines (e.g., red-tailed hawk and golden eagle) appear to have higher fatality rates, while other species that actively fly around wind turbines such as common raven appear to avoid collisions with turbines (Kingsley and Whittam 2007; Kuvlesky et al. 2007; NAS 2007). High prey density (e.g., small mammals) is presumed to be a principal factor responsible for high raptor use and high raptor collision rates at the Altamont Pass wind resource area (Kingsley and Whittam 2007; Kuvlesky et al. 2007; NAS 2007; Smallwood and Thelander 2008).

The ability to predict collision risk for birds and bats from activity recorded by radar and acoustic detectors, respectively, remains elusive.

The use of radar and bat acoustic detectors is a common feature of pre-construction risk assessments for siting wind energy facilities (Strickland et al. 2011). To date, studies have not been able to develop a quantitative model enabling reasonably accurate prediction of collision risk from these surveys (e.g., Hein et al. 2013). Predicting bat collision risk using pre-construction activity measures would be further complicated if bats are attracted to wind turbines (see above).

Can wind turbines be designed so that they are easier for birds to see and avoid?

Mitigation methods based on avian vision have been proposed to reduce bird collisions with wind turbines. It has been hypothesized that towers and blades coated with ultraviolet (UV) paint may be more visible to birds, making them easier to avoid. In the only known test, Young et al. (2003) compared fatality rates at turbines with UV coatings to turbines coated with standard paint and found no difference. Few data are available on the effectiveness of these and other potential methods for making turbines more visible to birds.


WHOOPING CRANES, PHOTO BY GILLIANCHICAGO, FLICKR

DIRECT AND INDIRECT HABITAT-BASED EFFECTS OF WIND ENERGY DEVELOPMENT ON BIRDS

Operating wind energy facilities can reduce abundance of some grassland bird species near turbines, but the effect is not consistently observed in all studies.

Studies have shown that the displacement of grassland bird species in response to wind energy development is species-specific and the displacement response of individual species may be inconsistently observed (Hatchett et al. 2013; Loesch et al. 2013; Stevens et al. 2013).

It has been suggested that high site fidelity in bird species may reduce displacement effects in the short-term and displacement would become more pronounced over time, but this has yet to be demonstrated (Strickland et al. 2011). It is also unknown whether bird species will habituate to wind energy facilities and whether disturbance effects diminish over time. In one study, abundance of some species

GREATER PRAIRIE-CHICKEN, PHOTO BY WILDRETURN, FLICKR

declined during construction of the wind energy facility, but the effect disappeared after the facility became operational (Pearce-Higgins et al. 2012).

There is concern that prairie chickens and greater sage grouse will avoid wind energy facilities because of disturbance or because they perceive turbine towers as perches for avian predators.

Research indicates that close proximity to roads, utility poles or lines, trees, oil and gas platforms, and/or human habitations causes displacement in prairie grouse species (Robel 2004; Kingsley and Whittam 2007; Kuvlesky et al. 2007). It is hypothesized that similar effects would result from wind energy development, but few published studies have tested this hypothesis with respect to wind energy facilities. An extensive and comprehensive multi-year study of greater prairie-chicken in a fragmented Kansas landscape showed little or no response to wind energy development as measured by a variety of demographic parameters, and there was little or no response in nesting females (Winder et al. 2013a; Winder et al. 2013b). Lek persistence was lower in proximity to turbines, but this effect was not statistically significant (Sandercock et al. 2013). Similar studies on greater sage-grouse are underway in Wyoming, but results were not available at the time this fact sheet was published (http://www.nationalwind.org/sagegrouse.aspx).

It is unknown whether wind energy facilities act as barriers to landscape-level movements by big game and other large terrestrial vertebrates.

There is very little information to evaluate the hypothesis that wind energy facilities act as barriers to wildlife. Studies of desert tortoise indicate that wind energy has no negative effect on site use (Lovich et al. 2011; Ennen et al. 2012). Other species for which barrier effects are a concern but for which published research specific to wind energy is not available include pronghorn, mule deer, black bear, and elk (Lovich and Ennen 2013).

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About AWWI

The American Wind Wildlife Institute is a partnership of leaders in the wind industry, wildlife management agencies, and science and environmental organizations who collaborate on a shared mission: to facilitate timely and responsible development of wind energy while protecting wildlife and wildlife habitat. We envision a future where wildlife and wind energy thrive, allowing all of us — wildlife and habitat included — to reap the climate change mitigation benefits that wind energy makes possible.

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