Wind Turbine Interactions with Wildlife and their Habitats: A Summary of Research Results and Priority Questions

What's New in the 2017 Edition?

The updated, June 2017 edition of *Wind Turbine Interactions with Wildlife and their Habitats: A Summary of Research Results and Priority Questions* reflects the latest assessment of wind energy impacts on wildlife based on a review of the available literature including new, peer-reviewed studies published since the previous edition of June 2016. The new studies mostly confirm and refine previous findings.

References to the new studies and corresponding new information are highlighted in the excerpts below:

DIRECT MORTALITY

Birds and Bats

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

[…] Fatality estimates of individual studies vary in how raw counts are adjusted for known sources of detection error and sampling intensity (Huso et al. 2016). Our understanding of these sources of error is improving, but comparisons or aggregations of fatality estimates, especially if they include older studies (2006 or earlier), should be interpreted cautiously.

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

Some studies have suggested that bird and bat fatalities increase with tower height (Barclay et al. 2007; Baerwald and Barclay 2009; Loss et al. 2013). However, tower height was found to not affect levels of bat fatalities at Canadian facilities (Zimmerling and Francis 2016), and studies on birds suggest that the relationship between tower height and bird collisions is more nuanced (Smallwood and Karas 2009). […] there is no evidence to date that nocturnal migrants form a disproportionately high number of collision fatalities during migration (Welcker et al. 2017).

Birds

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

[…] Searcher efficiency trials indicate that small birds have significantly lower detection rates than large birds (Peters et al. 2014), and the true proportion of passerine fatalities of all collision fatalities is uncertain. Most small passerine species are migratory, resulting in spring and fall peaks of bird fatality rates at most wind facilities (Strickland et al. 2011; Erickson et al. 2014).

Diurnal raptors are relatively frequent fatalities, particularly in the western U.S. where these species are more common. Because these groups are far less abundant than passerines, there is concern that the potential relatively high fatality rates are reflective of a higher vulnerability to collision. These higher raptor fatality estimates may be partially due to the higher searcher efficiencies for large birds as described above (Peters et al. 2014). […]

Repowering with newer, larger (≥ 1 MW) turbines may reduce raptor collision rates at wind facilities compared to older, smaller (40 - 330kW) turbines.
The number of raptor fatalities on a per MW basis appear to be declining substantially (67 – 96% depending on the species) at the Altamont Pass Wind Resource Area as a result of repowering: smaller, low-capacity turbines are being replaced with taller, higher-capacity turbines (Smallwood and Karas 2009; ICF International 2016). […]

POPULATION-LEVEL CONSEQUENCES OF COLLISION FATALITIES

Fatality rates at currently estimated values do not appear likely to lead to population declines in most bird species.
[…] However, detailed demographic modeling indicates a potential for population-level impacts at current or projected levels of collision fatalities of certain raptor species (Carrete et al. 2010; Bellebaum et al. 2013; Hunt et al. 2017).

The status of bat populations is poorly understood and the ecological impact of bat fatality levels is not known.
[…] Detailed demographic modeling indicates a potential for population-level impacts at current or projected levels of collision fatalities for hoary bats (Frick et al. 2017).

AVOIDANCE AND MINIMZATION OF COLLISION FATALITIES

Siting

The relationship between bird behavior and bird collision risk, especially in the vicinity of the rotor swept area, is complex and not well understood.
[…] Bayesian models of raptor collision risk have been developed to predict fatalities based on observed raptor activity in the area and estimated collision probability (New et al. 2015).

Operations

Curtailing blade rotation at low wind speeds results in substantial reductions bat fatalities.
[…] Further study to identify times when bat collision risk is high could optimize timing of curtailment and minimize power loss (Weller and Baldwin 2012; Martin et al. 2017).

HABITAT-BASED IMPACTS ON BIRDS

Operating wind energy facilities can reduce abundance of some bird species, but the effect is not consistently observed in all studies.
Studies have indicated displacement of bird species in response to wind energy development, with some species showing consistent decreases in abundance in proximity to turbines, while other species showed no effect (Hatchett et al. 2013; Loesch et al. 2013; Stevens et al. 2013; Shaffer and Buhl 2016).

It has been suggested that high site fidelity in some grassland bird species may reduce displacement effects in the short-term and displacement would become more pronounced over time, but this effect was not apparent in a 10-year study of grassland birds (Shaffer and Buhl 2016). It is also unknown whether bird species will habituate to wind energy facilities and whether disturbance effects diminish over time (see Shaffer and Buhl 2016).[…]

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.
[…]
A multi-year study of greater sage-grouse in Wyoming found that many demographic and habitat use factors, including selection of nest sites and nest, brood, and female survival were not influenced by proximity to turbines (LeBeau et al. 2017a). However, selection of brood rearing and post-rearing habitat was negatively influenced by ground disturbance related to roads and turbine pads (LeBeau et al. 2017a). Negative trends in male lek attendance were not detected (LeBeau et al. 2017b).

It is unknown whether wind energy facilities act as barriers to landscape-level movements by big game and other large terrestrial vertebrates.
[…] Proximity to a wind energy facility did not affect winter survival of pronghorn in Wyoming (Taylor et al. 2016). Development and operation of a wind energy facility in Oklahoma had no measurable impact on radio-collared Rocky Mountain elk (Walter et al. 2006). Long-term studies of desert tortoise at a California wind energy facility have found no negative effects on tortoises using the area encompassed by the facility (Lovich et al. 2011; Ennen et al. 2012); survival of tortoises was higher within the area of the facility than in an adjacent undisturbed area (Agha etal. 2015)

Full citations for the new studies are:

Agha M, Lovich JE, Ennen JR, Augustine B, Arundel TR, Murphy MO, Meyer-Wilkins K, Bjurlin C, Delaney D, Briggs J, Austin M, Madrak SV, and Price SJ. 2015. Turbines and Terrestrial Vertebrates: Variation in Tortoise Survivorship Between a Wind Energy Facility and an Adjacent Undisturbed Wildland Area in the Desert Southwest. *Environmental Management* 56(2): 332-341.

Bellebaum J, Korner-Nievergelt F, Dürr T, and Mammen U. 2013. Wind turbine fatalities approach a level of concern in a raptor population. *Journal for Nature Conservation* 21: 394-400.

Carrete, M., J. A. Sanchez-Zapata, J. R. Benitez, M. Lobon, and J. A. Donazar. 2010. Large scale risk-assessment of wind-farms on population viability of a globally endangered long-lived raptor. *Biological Conservation* 142: 2954-2961.

Frick WF, Baerwald EF, Pollock JF, Barclay RMR, Szymanski JA, Weller TJ, Russell AL, Loeb SC, Medellin RA, and McGuire LP. 2017. Fatalities at wind turbines may threaten population viability of a migratory bat. *Biological Conservation* 209: 172-177.

Hunt WG, Wiens JD, Law PR, Fuller MR, Hunt TL, Driscoll DE, and Jackman RE. 2017. Quantifying the demographic cost of human-related mortality to a raptor population. *PloS ONE* 12(2): e0172232.

Huso M, Dalthorp D, Miller TJ, and Bruns D. 2016. Wind energy development: methods to assess bird and bat fatality rates post-construction. *Human-Wildlife Interactions* 10(1): 62-70.

ICF International. 2016. Final report Altamont Pass Wind Resource Area bird fatality study, monitoring years 2005–2013. Prepared for Alameda County Community Development Agency, Hayward, CA. ICF 00904.08. ICF, Sacramento, CA, U.S.A.

LeBeau CW, Johnson GD, Holloran MJ, Beck JL, Nielson RM, Kauffman ME, Rodemaker EJ, and McDonald TL. 2017a. Greater sage-grouse habitat selection, survival, and wind energy infrastructure. *The Journal of Wildlife Management* 81(4): 690-711.

Lebeau CW, Beck JL, Johnson GD, Nielson RM, Holloran MJ, Gerow KG, and McDonald TL. 2017b. Greater sage-grouse male lek counts relative to a wind energy development. *Wildlife Society Bulletin* 41(1): 17-26.

Martin CM, Arnett EB, Stevens RD, and Wallace MC. 2017. Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. *Journal of Mammalogy* 98(2): 378-385.

New L, Bjerre E, Millsap BA, Otto MC, and Runge MC. 2015. A collision risk model to predict avian fatalities at wind facilities: An example using Golden Eagles, Aquila chrysaetos. *PloS ONE* 10(7): e0130978.

Peters KA, Mizrahi DS, and Allen MC. 2014. Empirical Evidence for Factors Affecting Searcher Efficiency and Scavenging Rates at a Coastal, Terrestrial Wind-Power Facility. *Journal of Fish and Wildlife Management* 5: 330–339.

Shaffer JA and Buhl DA. 2015. Effects of wind-energy facilities on breeding grassland bird distributions. *Conservation Biology* 30(1):59-71.

Taylor KL, Beck JL, and Huzurbazar SV. 2016. Factors Influencing Winter Mortality Risk for Pronghorn Exposed to Wind Energy Development. *Rangeland Ecological Management* 69: 108–116.

Walter WD, Leslie Jr DM, and Jenks JA. 2006. Response of Rocky Mountain elk (Cervus elaphus) to wind-power development. *The American Midland Naturalist* 156: 363–375.

Welcker J, Liesenjohann M, Blew J, Nehls G, and Grünkorn T. 2017. Nocturnal migrants do not incur higher collision risk at wind turbines than diurnally active species. *Ibis* 159(2): 366-373.

Zimmerling JR and Francis CM. 2016. Bat mortality due to wind turbines in Canada. *The Journal of Wildlife Management* 80(8): 1360-1369.