AMERICAN WIND WILDLIFE INSTITUTE

ISSUE BRIEF

November 8, 2018

Bats and Wind Energy

Background About Bats

Bats play an important ecological role for ecosystems and for people. Bats are the second most diverse order of mammals, numbering well over 1,000 species worldwide, with 47 bat species in the U.S. and Canada. Most of these species are voracious consumers of insects including many agricultural and forestry pests.[1,2] "Pest control" services provided by bats, which reduce the number of insect pests and the amount of pesticides required to control them, have been valued at more than $3.7 billion USD/year.[3,4,5] Other bat species are critical plant pollinators.[6,7]

Bats face numerous threats, including climate change, habitat loss and degradation, persecution, white-nose syndrome (WNS) and other diseases, and fatalities at wind energy facilities.[8,9] Some of these threats, such as climate change and habitat loss and degradation, affect all species, whereas others, such as WNS, affect species with certain ecological and behavioral characteristics (e.g. hibernation in cold caves). Bats are long-lived and reproduce slowly. Most species typically only having one to two pups a year, and not every year, which limits their ability to sustain such threats and puts them at increased risk of population decline.

White-Nose Syndrome

White-nose syndrome (WNS) is a fungus-caused disease that is estimated to have killed more than six million bats in North America.[10,11,12] It has resulted in one species, northern long-eared bat, being listed under the U.S. Endangered Species Act, and other species, such as little brown bat, have been petitioned for listing. The northern long-eared bat, the little brown bat, and the tri-colored bat are all listed as endangered in Canada.

Cave-hibernating bats are most affected. The fungus has been found on individuals of two species of tree bats – eastern red bat and silver-haired bat – but the disease has not been confirmed in these species.[13,14] Because some bats that represent a higher percentage of fatalities at wind facilities, such as little brown bat, are also affected by WNS, there is concern about the effect of the additional mortality from wind turbine collisions.

Bats and Wind Turbines

Wind energy is a major component of the strategy to reduce carbon emissions and mitigate the significant risk to wildlife from a rapidly changing climate. Like all energy sources, wind energy can have adverse impacts to wildlife. Bat collision fatalities represent one of the major wildlife conservation challenges as wind energy expands and increases its contribution to mitigating the impacts of climate change.[15]

Since the early 2000s, surveys at wind facilities have shown that some bat species, such as migratory tree bats, can collide with wind turbines and be killed in large numbers, particularly in the Midwestern and Appalachian regions of the U.S.[16] Uncertainties remain about the impact of wind energy on bats, and substantial efforts are underway to accurately measure impacts, understand why certain bat species are at high risk

Facilitating timely and responsible development of wind energy while protecting wildlife and wildlife habitat of collision, and develop strategies to avoid and minimize these impacts.

Estimates of the number of bats killed annually vary, but all suggest that hundreds of thousands of bats are killed every year across Canada and the U.S.[17,18,19,20] Twenty five of 47 bat species in the continental U.S. and Canada have been found as fatalities at wind energy facilities,[17,21] and two additional species are reported from wind facilities in Canada. According to an analysis of data in the American Wind Wildlife Information Center (AWWIC) database, which includes public and confidential proprietary wind-wildlife data that has not before been available for analysis, three migratory tree bat species account for 72% of all fatalities: hoary bats (32%), eastern red bats (24%), and silver-haired bats (16 %). Overall, eight species account for 96% of all recorded bat fatality incidents in AWWIC.[21]

Fatality rates vary considerably among and within regions. AWWIC data shows the highest fatality rates in the Midwest region with a median of 6.2 bats per megawatt per year (bats/MW/year), and studies within this region reported as many as 32 and as few as 0.4 bats/MW/year. The fewest fatalities were reported from the Pacific region with a median of 0.7 bat fatalities per MW per year, with some studies in that region reporting no fatalities. Fewer than 5.3 bats/MW/year were reported in 75% of studies. The median fatality estimate for all regions is 2.7 bats/MW/year.[21]

Numerous hypotheses have been proposed for the high level of collision fatalities in some regions and several of these suggest that bats are attracted to turbines.[22,23,24,25] Several factors might attract bats, including sounds produced by turbines, a concentration of insects near turbines, and bat mating or roosting behavior.[22,23,25] Infrared imagery has shown bats exploring the nacelles of wind turbines from the leeward direction, especially at low wind speeds. Previous assessments of variation in fatality estimates found a relationship between turbine tower height and fatalities.[26] No relationship between these variables was observed in the AWWIC data, although we are still investigating.

Risk exposure for individual species, i.e., presence in the rotor-swept area, may reflect abundance of bats as well as foraging behavior. Many bat species in the U.S. are considered rare,[25] and their absence or low frequency of fatalities may reflect the species' rarity. Alternatively, a species may be abundant, but its behavior rarely takes it into the collision risk zone. Variation in bat morphology and its influence on foraging behavior has been hypothesized as a factor influencing collision risk in bats.[26]

It is uncertain whether fatalities at wind facilities put bat populations at risk because estimating bat population sizes is challenging at best, and extremely difficult for the three migratory tree bat species most frequently killed by wind turbines. A recent study suggests that hoary bat populations may decline as much as 90% over 50 years assuming current fatality levels and the absence of any conservation measures.[28]

Researchers are also investigating whether bats are affected by habitat-based impacts and barotrauma (injury due to sudden pressure changes) at wind facilities. More research is needed as there have been few efforts to evaluate the barotrauma hypothesis empirically, and there have been few direct studies evaluating the effects of land transformation on bats.

Legislation Protecting Bats

In the U.S., bats as a group have no federal protection although several species are listed under the Endangered Species Act. Of those species, only the Hawaiian hoary bat and the Indiana bat have been recorded as fatalities at wind facilities, and such fatalities have been recorded infrequently. Other federally-listed species include gray bats, Florida bonneted bats, Virginia big-eared bats, Ozark big-eared bats, and Mexican long-nosed bats. In Canada, additional species are protected including the tri-colored bat and the little brown bat; both species have been reported as fatalities at wind facilities in the U.S.

Reducing Bat Fatalities from Wind Turbines

A growing body of collaborative scientific research is focusing on improving our ability to predict and therefore effectively avoid and minimize collision risk to bats.

Avoidance

Substantial effort is made to estimate collision risk of bats prior to the construction and operation of wind energy facilities. To date, studies have not been able to develop a quantitative model enabling reasonably accurate predictions of collision risk from these surveys.[29] Predicting bat collision risk using pre-construction activity measures would be further complicated if bats are attracted to wind turbines. Wind energy companies can apply the tiered approach as outlined in the Land-Based Wind Energy Guidelines issued by the U. S. Fish and Wildlife Service in 2012. This approach, developed with input from multiple stakeholders, outlines a series of steps companies can take to identify potential risk to species of concern as defined in the Guidelines.

An alternative approach to predicting bat collision risk at future projects would be to model variation in fatality estimates from operating projects within the same region. If at-risk bat species are attracted to turbines, or land transformation from project construction increases bat activity in a project's vicinity, then evaluating post-construction fatality data has logical appeal. This approach has been tested and appears to show promise.[30]

Minimization

Curtailing the movement of turbine blades in low wind speeds has been shown to reduce bat fatalities substantially. For example, curtailing blade rotation when wind speeds are less than 5.0 meters per second reduces all-species bat fatalities by 50% or more on average [31,32,33] Restricting turbine operation at low wind speeds, however, reduces power production and has an economic impact on the project. "Smart curtailment" approaches are being developed, where variables in addition to wind speed that could predict collision risk are incorporated into curtailment rules.[34,35]

Feathering turbine blades (turning them parallel to the wind) below cut-in speed may also reduce bat fatalities because without feathering, blades continue to turn at potentially lethal speeds for bats below manufacturer's cut-in speed. In 2015, member companies of the American Wind Energy Association agreed to voluntarily feather turbine blades below cut-in speed in an effort to reduce bat collision fatalities.[36]

Acoustic devices to reduce bat fatalities by deterring them from entering the rotor-swept zone while allowing turbines to operate normally are being developed and tested. Unpublished preliminary results of initial tests at operating wind facilities in different regions of the U.S. have shown mixed outcomes in reducing bat fatalities overall and in reductions for specific species, and more testing is underway. Other approaches such as the use of ultraviolet light and adding a rough texture to the surface of turbine towers are also being evaluated as possible bat deterrents.[37,3]

The Future

Significant expansion of installed capacity of wind energy is considered necessary to offset carbon emissions and avoid the worst effects of climate change on global biodiversity. Predictions of the cumulative risk to bats from this future development will be influenced by where wind energy is installed and by advances in mitigation strategies implemented to reduce this risk. We can predict which species will be at risk and where they will be at risk based on the anticipated regional expansion of wind energy as describe in DOE's Wind Vision, projections from the data contained in AWWIC, and our knowledge of seasonal timing of risk.

Such projections require making several assumptions, but the Midwest and Southwest Regions are anticipated to constitute approximately 60% of the installed capacity in the U.S. by 2030, and in the absence of mitigation would lead to increased impacts to several bat species, including Mexican free-tailed bat, hoary bat, and eastern red bat. New species may also be at risk. For example, the southeastern U.S., where there is currently very little wind energy development, is predicted to grow to ~9 GW installed by 2030.[15] This region has several species, including the federally endangered gray bat, that might have greater exposure to collision risk if more wind energy is developed there. Efforts over the past decade have substantially increased our understanding of the options for avoiding and minimizing current and future impacts, and much research is underway. There is still much to be learned about bat behavior and responses to wind turbines, and it remains uncertain whether the cumulative impacts from wind energy have adverse population-level effects on at-risk bat species. Further research to is needed to improve our understanding of the conditions increasing collision risk and of how to avoid and minimize that risk to enable siting and operating of wind energy projects while reducing impacts to bats to the extent practicable.

Resources on Bats and Wind Energy

- American Wind Wildlife Institute
  - Bats and Wind Energy White Paper
  - Bat Technical Report
- Bats and Wind Energy Cooperative
- Species profile: Hoary bat
- Species profile: Eastern red bat
- Species profile: Silver-haired bat

Bats in this Issue Brief

Species	U.S. Endangered Species Act Status	Distribution in Canada and the U.S.	Long-distant migrant?	Known or hypothesized WNS risk	Percentage of fatalities at wind energy facilities
Eastern red bat (*Lasiurus borealis*)	No	Central and Eastern North America	Yes	Low†	24%**
Florida bonneted bat (*Eumops floridanus*)	Endangered	Florida	No	Low	0
Gray bat (*Myotis grisescens*)	Endangered	Midwest and Eastern U.S.	No	High*	0
Hawaiian hoary bat (*Lasiurus cinereus semotus*)	Endangered	Hawaii	No	Extremely Low	<0.01%
Hoary bat (*Lasiurus cinereus*)	No	Most of Canada and the U.S.	Yes	Low	31.9%**
Indiana bat (*Myotis sodalis*)	Endangered	Midwest, Eastern, and Northeastern U.S.	No	High*	<0.01%
Little brown bat (*Myotis lucifugus*)	*Listed in Canada*	Most of Canada and the U.S.	No	High*	5.1%**
Mexican free-tailed bat (*Tadarida brasiliensis*)	No	Southern U.S.	Yes	Low	10%**
Mexican long-nosed bat (*Leptonycteris nivalis*)	Endangered	Southern Texas	Yes	Low	0
Northern long-eared bat (*Myotis septentrionalis*)	Threatened	Most of Canada and the Eastern U.S.	No	High*	<0.5%
Ozark big-eared bat (*Corynorhinus townsendii ingens*)	Endangered	Arkansas, Oklahoma, and Missouri	No	High†	0
Silver-haired bat (*Lasionycteris noctivagans*)	No	Most of Canada and the U.S.	Yes	Low†	16.1%**
Tri-colored bat (*Perimyotis subflavus*)	*Listed in Canada*	Eastern Canada and Midwest and Eastern U.S.	No	High*	1.7%**
Virginia big-eared bat (*Corynorhinus townsendii virginianus*)	Endangered	West Virginia, North Carolina, Kentucky	No	High†	0

* species known to be heavily affected by WNS
† species on which the fungal pathogen *Pseudogymnoascus destructans* has been detected, but no diagnostic sign of WNS has been documented
** data from AWWIC, for U.S. only

Literature citations supporting the information presented are denoted by footnote numbers; full citations can be found online at https://awwi.org/resources/bats-and-wind-energy-issue-brief/.