

ISSUE BRIEF

Bats and Wind Energy

Background About Bats

Of the 47 bat species that occur in Canada and the U.S., all but two are voracious consumers of insects, including many agricultural and forestry pests.^{1,2} Pest control services provided by bats reduce both the number of pests and the amount of pesticides required to control them, and these services have been valued at more than \$3.7 billion USD/year.^{3,4,5} The other two bat species, mostly prevalent in the Southwestern U.S., feed on the nectar of agave cactuses commonly used to produce tequila and are critical pollinators for these plants.^{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., hibernating in cold caves). Bats are long-lived and reproduce slowly, 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.



MEXICAN FREE-TAILED BATS EXITING BRACKEN BAT CAVE, PHOTO BY USFWS HEADQUARTERS, FLICKR

Bats and Wind Turbines

Throughout the 1990's, wind energy facilities did not report bat fatalities for a variety of reasons: 1) no bat fatalities occurred at facilities, 2) studies at facilities were designed to detect birds and no bats were found, or 3) bats were found at facilities but not reported as there were no reporting requirements for bats. In 2003, a large

number of bat fatalities were found at the Mountaineer Wind Energy Center in West Virginia, and high levels of bat fatalities were subsequently reported at wind energy sites across North America.

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.^{10,11,12,13} Fatality rates vary considerably among regions and facilities; observed rates have gener-

ally been highest in the deciduous forests of the Northeast and lowest in the open range desert of the Great Basin/Southwest. However, the cumulative numbers of bat fatalities may be greatest in the Great Plains and the Midwest forest agricultural regions, where the amounts of wind power generating capacity are higher.¹⁰

Three species of migratory tree-roosting bats make up approximately 80% of all fatalities: hoary bats (38%), eastern red bats (22%), and silver-haired bats (19%).¹⁰ However, in some regions, high fatality rates of other species such as little brown *Myotis* and Mexican free-tailed bats have been reported.

Numerous hypotheses have been proposed for fatalities and several of these suggest that bats are attracted to turbines.^{14,15,16,17} Several factors might attract bats, including sounds produced by turbines, a concentration of insects near turbines, and bat mating or roosting behavior.^{14,15,17} Infrared imagery has shown bats exploring the nacelles of wind turbines from the leeward direction, especially at



EASTERN RED BAT, PHOTO BY LYCAENIDAE, NM, FLICKR

low wind speeds.¹⁸ Bat fatalities appear to be positively correlated with turbine height, indicating that increasing turbine height over the past 15 years has resulted in some increase in the number of bat fatalities observed.¹⁹

Migratory tree-roosting bats, the species most frequently killed by wind turbines, forage for insects in mid-air at relatively high altitudes, putting them in the vicinity of rotating turbine blades. By contrast, many of the species currently listed as endangered or at risk are non-migratory, flying and foraging close to the ground, frequently gleaning insects off of vegetation. As such, these species may be at low risk of being killed in high numbers by wind turbines.

It is uncertain whether fatalities at wind facilities put bat populations at risk because very little is known about bat population sizes (particularly of the three species most frequently killed by wind turbines). A recent study suggests that based on estimated hoary bat population levels and fatalities at wind turbines, assuming the absence of any conservation measures, hoary bat populations may decline as much as 90% over 50 years.²⁰ As highlighted further below, the conservation and wind energy community have anticipated the challenge and are working on effective solutions.

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, the Indiana bat, and the northern long-eared Myotis, 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, Rafinesque's big-eared bats, and lesser and Mexican long-nosed bats. In Canada, additional species are protected including the tri-colored bat and the little brown Myotis.



CHILL HOARY BAT IN HAND, PHOTO BY ERIN BAERWALD



TRI-COLORED BAT, PHOTO BY DAVE THOMAS, FLICKR

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.

Prior to the construction and operation of wind energy facilities, substantial effort is made to estimate collision risk of bats through bat activity surveys. However, to date, studies have not been able to develop a quantitative model enabling reasonably accurate prediction of collision risk from these surveys.²¹ Predicting bat collision risk using pre-construction activity measures would be further complicated if bats are attracted to wind turbines (see above). 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.

Curtailling the movement of turbine blades in low wind speeds has been shown to reduce bat fatalities substantially. For example, increasing the turbine cut-in speed to at least 5.0 m/s has been shown to reduce bat fatalities by 50% or more.^{22,23,24} Feathering turbine blades 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 the American Wind Energy Association announced that its member wind energy companies would voluntarily feather turbine blades below cut-in speed in an effort to reduce bat collision fatalities.

Acoustic devices to reduce bat fatalities by deterring them from entering the rotor-swept zone of turbines are currently being developed and tested. Preliminary results are promising, and several different approaches are being evaluated. The use of ultraviolet light is also being evaluated as a bat deterrent.

The Future

As turbine technology advances and turbines become more efficient in extracting energy from wind, wind energy development could expand into areas previously untapped, such as the Southeastern United States. These advancements may have various consequences for bats:

- Wind energy production will occur in low wind speeds, when fatality rates of bats are the greatest. Because of the mild climate, bats may be active year-round and migratory species may overwinter in the region; therefore there is a potential for fatalities year-round.
- There will be increased overlap with high-risk species, such as hoary bats and Mexican free-tailed bats, and facilities will come into contact with additional species whose foraging behaviors will put them at risk, such as the Florida bonneted bat, the northern yellow bat, the southern yellow bat, and the Seminole bat.
- The Southeastern United States is home to three species of conservation concern, the Florida bonneted bat (federally listed as endangered), Rafinesque's big-eared bat (USFWS species of concern and Threatened or Endangered at state level) and the southeastern *Myotis* (USFWS species of concern and Imperiled or Vulnerable at state level).
- Further research to both improve our understanding of the conditions increasing collision risk and avoiding and minimizing that risk is warranted.

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.^{25,26,27} It has resulted in one species, northern long-eared *Myotis*, being listed, and other species, such as little brown *Myotis*, have been petitioned for listing under the U.S. Endangered Species Act. The northern long-eared *Myotis*, the little brown *Myotis*, and the tri-colored bat are all listed as endangered in Canada.

Cave-dwelling bats are most at risk of WNS, and it is unknown whether WNS will be a significant source of mortality in the migratory tree-roosting bats that are most frequently killed at wind energy facilities. Migratory tree-roosting bats may remain active year-round, and they rarely occur in caves and do not roost in large colonies, behaviors that may limit the spread of fungal spores between individuals.²⁸ Because cave-dwelling bats, such as little brown *Myotis*, represent a higher percentage of fatalities at midwestern wind energy facilities, there is concern about the effect of the additional mortality of wind turbine collisions to populations of WNS-vulnerable bat species in this region. Fatality rates at wind energy facilities in these species may be declining because population sizes are being reduced by WNS, although the relationship between bat abundance and collision risk has not been established.



SILVER-HAIRED BAT IN HAND; PHOTO BY ERIN BAERWALD

Resources on Bats and Wind Energy

[American Wind Wildlife Institute](#)

[Bats and Wind Energy Cooperative](#)

[Species profile: Hoary bat](#)

[Species profile: Eastern red bat](#)

[Species profile: Silver-haired bat](#)

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

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 in North America
Eastern red bat (<i>Lasiurus borealis</i>)	No	Central and Eastern North America	Yes	Low†	22%
Florida bonneted bat (<i>Eumops floridanus</i>)	Endangered	Florida	No	Low	0
Gray bat (<i>Myotis grisescens</i>)	Endangered	Midwest and Eastern U.S.	No	High*	0
Hawaiian hoary bat (<i>Lasiurus cinereus semotus</i>)	Endangered	Hawaii	No	Extremely Low	<0.01%
Hoary bat (<i>Lasiurus cinereus</i>)	No	Most of Canada and the U.S.	Yes	Low	38%
Indiana bat (<i>Myotis sodalis</i>)	Endangered	Midwest, Eastern, and Northeastern U.S.	No	High*	<0.01%
Lesser long-nosed bat (<i>Leptonycteris yerbabuenae</i>)	Endangered	Southern Arizona and New Mexico	Yes	Low	0
Little brown Myotis (<i>Myotis lucifugus</i>)	Listed in Canada	Most of Canada and the U.S.	No	High*	7%
Mexican free-tailed bat (<i>Tadarida brasiliensis</i>)	No	Southern U.S.	Yes	Low	3%
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)	Endangered	Southern Texas	Yes	Low	0
Northern long-eared Myotis (<i>Myotis septentrionalis</i>)	Threatened	Most of Canada and the Eastern U.S.	No	High*	<0.5%
Northern yellow bat (<i>Lasiurus intermedius</i>)	No	Southeastern U.S.	No	Low	<0.1%
Ozark big-eared bat (<i>Corynorhinus townsendii ingens</i>)	Endangered	Arkansas, Oklahoma, and Missouri	No	High†	0
Rafinesque's big-eared bat (<i>Corynorhinus rafinesquii</i>)	Species of Concern	Southeastern U.S.	No	High†	0
Seminole bat (<i>Lasiurus seminolus</i>)	No	Southeastern U.S.	No	Low	<0.5%
Silver-haired bat (<i>Lasionycteris noctivagans</i>)	No	Most of Canada and the U.S.	Yes	Low†	19%
Southeastern Myotis (<i>Myotis austroriparius</i>)	Species of Concern	Midwest and Southeastern U.S.	No	High†	0
Southern yellow bat (<i>Lasiurus ega</i>)	No	Gulf Coast of Texas	Unknown	Low	<0.01%
Tri-colored bat (<i>Perimyotis subflavus</i>)	Listed in Canada	Eastern Canada and Midwest and Eastern U.S.	No	High*	5%
Virginia big-eared bat (<i>Corynorhinus townsendii virginianus</i>)	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

AWWI combines the power of science with the voice of collaboration to facilitate timely and responsible development of wind energy while protecting wildlife and wildlife habitat.

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