National Wind Wildlife Research Plan 2020-2023

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AWWI is a partnership of leaders in the wind industry, science, conservation organizations, and wildlife management agencies who collaborate on a shared mission: to facilitate timely and responsible development of wind energy while protecting wildlife and wildlife habitat.

Find this document online at www.awwi.org/resources/national-wind-wildlife-research-plan-2020-2023

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Executive Summary

An expanded role for wind-generated electricity is a leading component of the strategy for reducing future climate change impacts on wildlife and their habitat. Wind energy development and operation, like all human activity, can have adverse impacts on wildlife and habitat. Wind-wildlife stakeholders including industry, government, academic, and the conservation/science community have made great strides towards understanding and minimizing wind energy's wildlife impacts, but uncertainties remain.

In 2017, AWWI published a National Wind Wildlife Research Plan to identify and prioritize key areas where additional, strategically targeted research investments are needed to advance: 1) Understanding of the nature and magnitude of the impacts of wind energy on wildlife and habitat; and 2) The development, evaluation, and widespread application of strategies to avoid, minimize, and compensate for those impacts when necessary to conserve healthy wildlife populations.

This updated Plan is a refresh of the 2017 document and includes an updated synthesis of research priorities based on the state-of-the-science for wind-wildlife impacts and efforts to avoid, minimize, and compensate for those impacts. This Plan outlines specific topics where additional, focused research investments are needed, and highlights AWWI's focus and the anticipated outcomes over the next 3-5 years, aiming to ensure that priorities are appropriate to the pace and scale of research to achieve the development of wind energy needed over the next 10-20 years to mitigate climate change while minimizing the wildlife impacts of this development.

Priority research questions outlined in this Plan focus on topics related to bats, eagles, migratory birds, and habitat-sensitive species including prairie grouse where: 1) Concern exists but more data is needed to answer questions about risk and address regulatory issues; 2) Minimization is needed in light of population-level impacts; 3) Research can be structured to promote data pooling; and 4) Substantial progress can be made in 3-5 years with current resources.

AWWI's specific priorities leverage AWWI's expertise, resources, and extensive network of partnerships, and will support development and evaluation of risk minimization technologies and strategies for raptors and bats; improve understanding of impacts and risk factors for birds, bats, and grouse; and identify and evaluate management practices and offset options for key species, resulting in improved siting and minimization strategies that improve conservation and reduce mitigation costs.

Introduction

An expanded role for wind-generated electricity is a leading component of the strategy for **reducing the impacts of future climate change on wildlife and their habitat.** Recent published reports indicate our window of opportunity to influence the magnitude of future climate change is closing rapidly as the signal of a warming climate and its associated impacts to wildlife and human systems becomes increasingly clear.[1& 2]

Achieving carbon emission reductions necessary to meet international climate accord goals and limit catastrophic impacts to biodiversity and habitat requires both decarbonizing the electricity supply and electrifying other sources of high emissions, such as transportation and home and commercial heating. As a result, electricity generation would need to approximately double by 2050 while its carbon intensity would need to be reduced by 90-97%. Wind energy would be a key part of the strategy to achieve this reduction. Some scenarios suggest that wind energy in the U.S. will need to expand 10-fold or more over current levels by 2050, a substantially higher increase than that estimated by the DOE Wind Vision.[3]

Wind energy development and operation, like all human activity, can have adverse impacts on wildlife and habitat. In the three decades since the earliest efforts to monitor avian interactions with wind turbines, **industry, government, academic, and nonprofit stakeholders have made great strides towards understanding and minimizing wind energy's wildlife impacts** by defining common metrics and protocols, creating risk-assessment guidelines, and collaborating to prioritize research questions and test possible solutions.

However, uncertainties remain, and in 2016, the AWWI Board of Directors asked staff to prepare a National Wind Wildlife Research Plan that would ensure the responsible growth of land-based wind energy development that contributes to emission reduction goals.[4] The goal of AWWI's National Wind Wildlife Research Plan, released in 2017, was to identify and prioritize key areas where additional, strategically targeted research investments are needed to advance:

- Our understanding of the nature and magnitude of the impacts of wind energy on wildlife and wildlife habitat
- The development, evaluation, and widespread application of strategies to avoid, minimize, and compensate for those impacts when necessary to conserve healthy wildlife populations

The current Plan is a refresh of the original National Research Plan released in 2017. This edition of the Plan includes an updated synthesis of research priorities based on what was known about the impacts of wind energy on wildlife and the status of efforts to avoid, minimize, and compensate for those impacts. The refreshed Plan reflects input from interviews with AWWI's Science Advisors, research priority documents produced by other organizations and agencies, and informal discussions with AWWI Partners and Friends and other wind-wildlife stakeholders.

The 2017 Plan identified **specific areas of research where AWWI would focus over the next three years.** This refresh, published in 2020, is intended to ensure that our priorities are appropriate to the pace and scale of research needed to meet the challenge of reducing greenhouse gas emissions via increased deployment of wind energy while mitigating[5] impacts to wildlife and wildlife habitat.

In addition, since the Plan's release in 2017, investment in research by all wind-wildlife stakeholders, including organizations and initiatives such as the Bats and Wind Energy Cooperative, National Renewable Energy Laboratory, and Electric Power Research Institute, has increased and substantial progress has been made. Other events that support a refresh of our research priorities include:

- The American Wind Wildlife Information Center (AWWIC) has completed its pilot phase and has substantially increased the amount of data available for analysis. Publicly released reports are further informing our understanding of risk and impacts to birds[6] and bats[7]
- The U.S. Department of Energy has completed two successful Funding Opportunities that have leveraged millions of dollars for research to improve the efficacy of minimization strategies for eagles and bats
- The Wind Wildlife Research Fund, administered by AWWI, was launched by the wind industry in 2019, providing increased coordination and investment in wind wildlife research

We begin this Plan with a brief review of what we know about adverse wind-wildlife impacts and how to avoid and minimize them, identifying key areas of uncertainty and knowledge gaps. A more detailed summary of the state of knowledge concerning impacts of wind energy on wildlife is included in Appendix A.

We then outline the areas of research and specific topics where additional, focused research investments are needed, highlighting the specific areas of research on land-based wind energy where AWWI will focus and the anticipated outcomes over the next three to five years. We focus on this time horizon and research objectives that we have determined will enable us to achieve the necessary development of wind energy over the next 10-20 years while minimizing the impacts of this development.

In addition to these species-focused topics, AWWI will continue to examine how to balance the need for rapid growth in wind energy deployment with the uncertainties surrounding the environmental impacts of this deployment, specifically asking for each topic when uncertainty has been reduced to the desired level for decision-making.[8] We will also continue monitoring the potential for unforeseen impacts that develop as wind energy expands, including the impacts of range shifts of species of concern occurring in response to warming and the implications of those shifts for risk assessment. Finally, offshore wind energy development is poised to grow rapidly and AWWI will contribute to applying the lessons learned from the study of land-based wind energy development as well as addressing the unique aspects of the offshore environment.

AWWI will continue to work closely with industry, state and federal government agencies, researchers, and conservation organizations to accomplish national research objectives, and to facilitate the transformation of research results into policy and practice to achieve conservation outcomes and realize the potential of wind energy in the U.S.

Avoiding and Minimizing Adverse Impacts

The following summary is taken from "Impacts to Wildlife of Wind Energy Siting and Operation in the U.S.," published in the scientific journal *Issues in Ecology* in fall 2019 and available online.[9] This report, written by an expert group of scientists, summarizes what we know about impacts of wind energy to wildlife and provides a set of research recommendations. More details on the state of the science are also available in Appendix A.

Concerns can be grouped broadly as **direct** or **indirect** impacts. For the purposes of this document, we define **direct impacts** to include fatalities resulting from collisions with turbine blades or towers. **Indirect impacts** result from the effects of the construction and operation of a wind energy facility on a species' use of habitat. These impacts may include displacement of a species from suitable habitat, or demographic effects due to fragmentation of a species' habitat or disturbance from the construction and operation of a wind facility.

Collision fatalities of birds and bats are the most visible and measurable impact of wind energy production. Current estimates suggest most bird species, especially songbirds, are at low risk of

population-level impacts. Raptors as a group appear more vulnerable to collisions. Population-level impacts on migratory tree bats are a concern, and better information on population sizes is needed. Although recorded fatalities of cave-dwelling bat species are typically low at most wind energy facilities, additional mortality from collisions is a concern given major declines due to white-nose syndrome (WNS). Assessments of regional and cumulative fatality impacts for birds and bats have been hampered by the lack of data from areas with a high proportion of the nation's installed wind energy capacity. Efforts to expand accessibility of data from all regions are underway, and this greater access to data along with improvements in statistical estimators should lead to improved impact assessments.

Habitat impacts of wind energy development are difficult to assess. An individual wind energy facility may encompass thousands of acres, but only a small percentage of the landscape within the project area is directly transformed. If a project is sited in previously undisturbed habitat, there is concern for indirect impacts, such as displacement of sensitive species. Studies to date indicate displacement of some species, but the long-term population impacts are unknown.

National Wind-Wildlife Research Priorities – AWWI's Focus

In our first drafting of AWWI's research priorities released in 2017, we reviewed the results of recent priority-setting exercises conducted by federal agencies and other stakeholders. We also asked experts in wind-wildlife issues from state and federal agencies about the wind-wildlife impacts of greatest concern to them, and for each impact, how well we understand its relative significance for species sustainability, the underlying risk factors, and ways to avoid or minimize the impact.

Our refresh of this Plan builds on the common themes that arose from our earlier review and reflects updates based on our expansion of knowledge since that Plan was released. Research questions were updated while continuing to focus on **bats, eagles, migratory birds, and habitat-sensitive species including prairie grouse**.

In developing our list of research priorities, we applied the following **guidelines**:

- Research supported by AWWI should focus on species or groups of species where:
    - Sufficient concern exists regarding the level of impact but corroborating data is needed
    - Data is needed to address regulatory issues
    - Predicted or assumed population-level impacts require action to minimize these impacts and prevent the need for additional regulatory protections in the future
- Substantial progress can be made on a research topic in 3-5 years and with the resources available to AWWI and its collaborating organizations
- Research can be structured to promote data pooling to increase the rate at which results are incorporated into best practice

Approach

All research on these priorities will involve **collaboration with our wind-wildlife partners**, including state and federal agencies, conservation and science organizations, academic scientists, and the wind industry. Additional research topics that we believe are important in the context of AWWI's research priorities, but not a specific focus for AWWI, are listed below each table of our objectives. For example, there are many research questions reflecting important gaps in our knowledge of basic biology for most species of concern. This research is most appropriately led by organizations other than AWWI, although we will contribute to these efforts as appropriate.

Bats

Challenge: The need to substantially reduce bat collision fatalities while minimizing power losses remains the greatest conservation issue for wind energy development.

AWWI Research Objectives:

Bats *(Listed in order of priority)*	Outcomes
Support development and evaluation of minimization technologies and strategies including deterrence and smart curtailment	Reduced bat fatalities with minimally reduced power production
Improve understanding of factors promoting risk using innovative approaches and analysis of data contributed to the American Wind Wildlife Information Center (AWWIC)[10]	Improved siting and avoidance of high-risk areas leading to reduced bat fatalities
Use AWWIC to **develop more accurate estimates of impacts to bats**, including effects of improvements in turbine technology	Improved understanding of variation in impacts of wind energy on bats and of the effectiveness of mitigation efforts

Additional Important Research Objectives:

- **Support bat population estimation modeling** to develop population-based fatality reduction targets, especially for migratory tree bats

Bald and Golden Eagles

Challenge: In 2016 the U.S. Fish & Wildlife Service (Service) updated the Eagle Rule to improve the implementation of its eagle take permitting program under the Bald and Golden Eagle Protection Act (BGEPA). Since the 2017 National Research Plan, the number eagle take permits are being issued by the Service has grown substantially. Although the Service's *Eagle Conservation Plan Guidance*[11] has not been updated since the release of the 2016 Eagle Rule, the document continues to provide guidance for applicants pursuing Eagle Take Permits and avoid legal liability. Specific tools for avoiding, minimizing, and compensating for eagle take as outlined in the Guidance are needed.

AWWI Research Objectives:

Bald and Golden Eagles *(Listed in order of priority)*	Outcomes
Develop and evaluate potential best management practices (BMPs) for avoiding and minimizing take, including technologies intended to minimize impacts	Cost-effective, scientifically accepted technologies and strategies that minimize eagle take and are consistent with the 2016 Eagle Rule; reduced need for compensatory mitigation
Create and evaluate quantifiable and verifiable **options for offsetting eagle take**	Cost-effective, practical, scientifically accepted compensatory mitigation practices available for use in permit applications

Additional Important Research Objectives:

- **Enhance take prediction models** for bald and golden eagles to provide more accurate take predictions
- **Assess eagle population trends** and anthropogenic sources of mortality, yielding continued updates to take thresholds and compensatory mitigation requirements

Habitat-Sensitive Species, Including Prairie Grouse

Challenge: The presence of turbines and other site disturbances are assumed to reduce habitat quality for habitat-sensitive species, including prairie grouse, grassland birds, and other terrestrial vertebrates.[12] Evaluating potential habitat effects requires expensive, detailed studies that run for several years, and that are replicated at multiple wind facilities.

AWWI Research Objectives:

Habitat-Based Impacts *(Listed in order of priority)*	Outcomes
Conduct research that identifies species sensitive to wind energy development and evaluates the impacts	Improved understanding of wind energy's potential impacts that supports development of solutions for mitigating those impacts
Identify and test novel options, including habitat management, for offsetting negative effects of wind energy on habitat-sensitive species	Expanded mitigation options to reduce impacts and facilitate development in low risk, high wind resource areas

Migratory Birds

Challenge: Multiple published studies by different research groups have shown that, for most species of migratory birds, collision fatalities do not appear to pose a substantial threat to populations of these species. Whether this holds true as turbine height increases is an important uncertainty that should be addressed. Future research should focus on those species where uncertainties about impacts to populations remain high or where the consequences appear more significant, including for California condor, whooping crane, and raptors.

AWWI Research Objectives:

Migratory Birds *(Listed in order of priority)*	Outcomes
Support development and evaluation of measures to mitigate collision impacts for target avian species	Expanded BMP options to reduce hazards to target species such as raptors and listed avian species
Use AWWIC to **develop more accurate estimates of avian impacts**, especially for species of conservation concern, and to evaluate effects of improvements in turbine technology	Improved understanding of potential avian impacts leading to more effectively targeted mitigation

Conclusion

We are now at a pivotal point. This Plan outlines a suite of research topics that, if funded and completed over the next three years, will **provide all concerned stakeholders with additional credible, cost-effective solutions to wind-wildlife challenges.** It will take a continued infusion of funds for these solutions to be effective in conserving wildlife populations and economic enough for the wind industry to stay competitive. Federal funding continues to make a meaningful contribution and will be a critical component of the research community's ability to achieve the goals in this Plan, much less the future. The creation of the Wind Wildlife Research Fund is adding additional investment and coordination of research objectives among wind-wildlife stakeholders.

We recognize that – nationally and for AWWI – this is an ambitious list and cannot be achieved without considerable resources[13] and the continued participation of our partners in the wind industry, state and federal government agencies, researchers, and conservation and science organizations. Drawing on AWWI's demonstrated experience and success in supporting and facilitating collaborative research and leveraging resources, this Plan will help us address key wind-wildlife questions, facilitating the transformation of research results to policies and practices that will achieve conservation outcomes and enable the U.S. to realize the benefits of its wind energy potential.

Appendix A: Avoiding and Minimizing Adverse Impacts – Current Knowledge

Concerns about adverse impacts of wind energy to wildlife can be grouped broadly as **direct** or **indirect** impacts. For the purposes of this document, we define **direct impacts** to include fatalities resulting from collisions with turbine blades or towers. **Indirect impacts** result from the effects of the construction and operation of a wind energy facility on a species' use of habitat. These impacts may include displacement of a species from suitable habitat, or demographic effects due to fragmentation of a species' habitat or disturbance from the construction and operation of a wind facility.

Collision Fatalities

Bats

Twenty-five of the 47 species of North American bats have been reported as collision fatalities at wind energy facilities in the U.S. and Canada. Concern about possible population-level effects of fatalities is greater for some bat species than for birds because:

- Cumulative estimates of bat fatalities for North America are typically higher for bats than birds
- Fatalities are concentrated in fewer species, notably three species of migratory tree-roosting bats that account for approximately 70% of the observed fatalities nationwide[14]
- Little is known about population sizes of these tree-roosting species
- Several species of cave-dwelling bats have declined substantially in the eastern U.S. from White Nose syndrome, and the disease is spreading to western states
- As a group, bats are longer-lived with relatively high adult survival and lower reproductive potential than most bird species, and thus may be at greater risk from additional mortality

Bat fatalities at wind facilities peak in late summer and early fall in the northern latitudes of the U.S., coinciding with the mating season and the predominately southward migration of tree-roosting bats and movement of cave-hibernating bats to hibernacula. A much smaller peak in fatalities has been observed at some wind facilities during spring migration. We have been unable to predict collision risk from pre-construction measurements of bat activity. Bats may be attracted to wind energy facilities, especially in forested landscapes.

Birds

Nearly 300 species of birds have been reported as turbine collision fatalities in the U.S., but the number of bird species that may be at population-level risk from fatalities is likely much smaller. Raptors as a group appear to be most vulnerable to collisions relative to their abundance, and there is concern regarding the potential population effects of fatalities on some raptor species. Available evidence suggests that raptor abundance in the vicinity of a wind energy facility may predict collision risk;[15] other attributes, such as flight behavior, are thought to be important but are poorly understood at present.

Most nocturnal migrants fly above the height of the current rotor-swept zone (~140 m). Higher capacity and taller wind turbines are under development to take advantage of wind speeds at higher altitudes, and there is concern that taller turbines will increase collision risk of night migrants.

Avoiding & Minimizing Collision Fatalities

Siting

Project siting is the first strategy to avoid or minimize collision impacts.[16] For example, landscape features that concentrate prey or create favorable conditions for raptor nesting, feeding, and flying influence raptor abundance and collision risk. Similarly, topographical features affect raptor behavior, which may put them at greater risk of collision if wind turbines are sited in these areas. Avoiding bat hibernacula and known roosting areas also is hypothesized to be important. To date, however, scientists have been unable to relate pre-construction activity of bats or most bird species to collision risk.

Operations

There has been increased interest in operational strategies and technologies that minimize fatalities at operating projects. In some locations, operations are being curtailed at certain times during migration. There has also been exploration of deterrence methods to cause birds and bats to avoid operational turbines.

- *Curtailment:* Multiple, controlled experiments reducing turbine operations at low wind speeds have demonstrated substantial reductions in bat fatalities, but there are concerns about power loss and associated loss of revenue. Informed curtailment – where turbines are shut down when target species are observed by human or automated detection systems – is being applied at some facilities in the western U.S. to reduce eagle collision risk, and its effectiveness is now being evaluated experimentally. Studies to increase the efficiency of curtailment for bats focus on other variables, such as temperature, to refine curtailment practices to periods of peak fatality risk.
- *Deterrence:* Ultrasonic deterrence methods to reduce bat fatalities has undergone preliminary testing, and results indicate significant reductions in Mexican free-tailed bat and hoary bat fatalities at test turbines. Several projects are evaluating different approaches to acoustic deterrence, and other researchers are evaluating the use of low intensity ultraviolet light as a bat deterrent. Acoustic deterrents for birds, particularly raptors, have also been developed and used at European wind energy facilities and currently are undergoing testing in the U.S.

Habitat-Based Impacts

Studies on habitat impacts from wind energy development are relatively few and show mixed effects, with species varying in their sensitivity to the transformation and disturbance associated with siting and operating wind facilities. Species' responses have ranged from no detectable effect to statistically significant reductions in use of suitable habitat as a function of distance to roads, turbines, and other wind facility infrastructure. In the U.S., research has focused on birds of grasslands and shrublands because these species have seen substantial population declines due to climate change, altered fire and grazing regimes, the spread of invasive plants, disease, and habitat loss due to agriculture, energy development, and residential development. A few studies have looked at potential impacts to grassland and shrubland species, as summarized below:

- Greater prairie-chicken showed increased female survival and no negative effects on nest site selection or nest survival in proximity to wind turbines. The persistence of leks (i.e., the areas used in mating displays) appeared to decrease in proximity to wind turbines, and females shifted habitat use to areas further away from turbines.[17 &18]
- Selection of brood rearing and post-rearing habitat by female greater sage-grouse were negatively influenced by ground disturbance related to roads and turbine pads, but no negative effect on nest site selection or nest, brood, and female survival, or lek attendance was detected.[19,20]

- Some species of grassland birds declined in abundance in proximity to wind turbines, while others did not decline, or responded inconsistently.[21]
- Pronghorn and elk have shown no negative effects of proximity to wind turbines.[22, 23]
- Habitat use and survival of desert tortoise at a California wind energy facility has shown no negative effects.[24]

Mitigating Habitat Impacts

The species-specific response to wind energy facilities makes generalizations for mitigating habitat impacts difficult. Careful project siting can help avoid or minimize habitat impacts. Limiting noise and human activity at a facility may help reduce disturbance to sensitive species. Additional research is needed to determine how best to offset impacts, for example through habitat management or restoration.

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[1] https://www.ipcc.ch/sr15/
[2] https://www.audubon.org/climate/survivalbydegrees
[3] http://deepdecarbonization.org/wp-content/uploads/2015/11/US_Deep_Decarbonization_Technical_Report.pdf
[4] AWWI recognizes the future importance of offshore wind as part of a renewable energy strategy and may work on offshore wind energy if there is a unique and useful role for AWWI to play.
[5] Unless otherwise qualified, mitigation encapsulates avoidance, minimization, and compensatory mitigation.
[6] https://awwi.org/resources/awwic-bird-technical-report/
[7] https://awwi.org/resources/awwic-bat-technical-report/
[8] Allison, TD, Root, TL, and Frumhoff, PC. 2014. Thinking globally and siting locally – renewable energy and biodiversity in a rapidly warming world. Climatic Change.
[9] https://awwi.org/resources/issues-in-ecology/
[10] AWWI is collecting post-construction fatality data in its American Wind Wildlife Information Center to enable more detailed and representative analyses of bird and bat fatalities at wind energy facilities.
[11] U.S. Fish & Wildlife Service. 2013. Eagle Conservation Plan Guidance, Module 1 – Land-based Wind Energy, Version 2. Available www.fws.gov/migratorybirds/pdf/management/eagleconservationplanguidance.pdf
[12] https://awwi.org/resources/issues-in-ecology/
[13] An estimated $4-6 million per year over current levels of research investment.
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[23] 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.
[24] 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 (USA). *Environmental Management* 56(2): 332.