ISSUE BRIEF

RESPONSIBLE WIND POWER AND WILDLIFE

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EXECUTIVE SUMMARY

Land-based wind power (referred to throughout as wind power) is a critical factor in the ongoing transformation of America's energy markets. After a century of relying heavily on coal, which pollutes the environment throughout all stages of its lifecycle, a shift is occurring to cleaner energy. This is due to a boom in renewable energy sources such as wind and solar, as well as a shift to more natural gas, which is cleaner burning during combustion but poses serious concerns about methane emissions[1] – a potent greenhouse gas – associated with its production that increase it over lifecycle emissions. This transformation is critical to achieving the carbon pollution reductions needed to protect wildlife and people from dangerous levels of climate change. Even with a substantial increase in other renewable sources like solar, to achieve the emissions reductions in the time needed to keep warming levels safe for wildlife, significantly more wind power will be needed.[2]

However, the build out of wind power presents the potential for adverse impacts to some species of wildlife and habitat. As recently highlighted in Fall 2018 reports by the United Nation's Intergovernmental Panel on Climate Change (IPCC) and by the U.S. multi-federal agency National Climate Assessment, given the increasingly limited time frame to address climate change, it is critical that wildlife risks from wind power development, as well as other renewable energy sources needed to mitigate climate change, be successfully addressed so this vital transformation can be achieved.
This is because we must protect wildlife from all development impacts in order to maintain healthy and thriving wildlife populations. Particular to wind, a failure to address wildlife risks could lead to a regulatory or economic slowdown in the wind power production that is needed to tackle climate change.

Wind power is currently booming. In fifteen years, it has gone from a de minimis amount to over 6 percent of our power supply. In 2017, about 54,000 land-based turbines provided about 254 million megawatt hours (MWh), close to the amount of power from hydroelectric dams in America, and enough electricity to power 27 million homes.[3] The U.S. wind industry grew 9 percent in 2017, adding over 7,000 megawatts of new capacity. While final year end numbers aren't out, strong growth has continued through 2018.[4] Wind power delivers more than 10 percent of the electricity produced in 14 states and over 30 percent in Iowa, Kansas, Oklahoma, and South Dakota.[5]

This energy transformation, and wind power's role in it, holds great promise. Securing a clean energy future is critical to maintaining a safe and stable climate for people and wildlife. For example, over the long term, climate change could significantly alter ranges for nearly half of U.S. birds within this century.[6] More immediately, reducing reliance on coal means fewer coal byproducts such as mercury pollution, acid rain, ozone pollution, and haze. Clean energy sources, like wind power, also reduce risks to public health, wildlife, and the outdoor economy. Additionally, wind power is providing jobs, tax revenue, and income to rural areas, strengthening local economies, and improving quality of life for American families.

While wind power offers many benefits, it can also pose risks to wildlife, especially some birds and bats. Since little research was available on wind-wildlife interactions in the early days of wind power development, a few early wind farms, like the Altamont Pass Wind Resource Area, built in the 1980s, resulted in unacceptably high numbers of raptor deaths due to poor siting and the use of small turbines that may have increased the chances for casualties. More recently, Duke Energy Renewables was prosecuted in 2013 for fatalities of 163 protected birds at a site in Wyoming, including golden eagles, and PacifiCorp Energy settled over claims of bird fatalities at four sites in Wyoming in 2014. Incidences like these, the enforcement of wildlife protection laws designed to safeguard species like eagles, and conservation concerns have encouraged additional operational changes and new technologies to be put in place to protect wildlife.

Red-tailed hawk and turbines, Puget Sound Energy Wild Horse Wind Facility. Photo: Jennifer Diaz, Puget Sound Energy

These examples highlight the need to ensure that wind power projects are responsibly developed. This means avoiding and minimizing adverse impacts to wildlife, and compensating for impacts that cannot be avoided or minimized. It also means keeping in place strong laws and rules that protect wildlife. As wind power becomes a major source of electricity in the United States, it is important that, as with all energy development, the environmental impacts are evaluated and addressed.

Research by the National Renewable Energy Laboratory estimated that almost three-quarters of wind power's technical potential might be affected by wildlife issues.[7] If they are not properly addressed, these wildlife issues could lead to significant harm to some species or present regulatory and economic hurdles to achieving the wind power development necessary to reduce carbon emissions in time to avoid catastrophic warming levels.

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This issue brief looks at the growth of wind power, its benefits and risks to wildlife, and explores how any adverse impacts can be minimized.

The issue brief finds that:

- Wind power is a fast-growing energy technology that reduces pollution, does not use water, creates jobs, and — if done responsibly — offers critical benefits to wildlife by offering clean energy solutions to the climate crisis.

- Wind power does however pose risks to wildlife, particularly some birds and bats, associated with siting (where projects are built), construction, and operation.

- While more study is needed, wind power's threats to most bird species do not appear to be having significant population-level impacts, and in many instances are far less than other existing human-caused and energy related threats.

- There is indication that wind power may pose population-level concerns to some bat species, pointing to the need for successful mitigation strategies and additional research.

- Many wildlife impacts from wind power can be minimized and compensated for. Wind companies are working with conservation groups and wildlife agencies to address these challenges through responsible siting, operating, and construction practices as well as proper oversight of wind power projects.

- It is critical to continue investing in research and science to understand risks and to develop tools and practices that avoid, minimize, and compensate for wind-wildlife risks.

Given the escalating threat of climate change and the limited time frame for meaningful action, we are challenged with the need to develop wind power both at the pace and scale needed to address climate change and in a sustainable and mindful manner that protects wildlife. Broad stakeholder cooperation and the ability to manage and reduce wildlife risks in real time will be necessary to develop wind at the pace needed to avoid catastrophic climate impacts to wildlife and biodiversity. To achieve this, **this issue brief concludes by setting forth the following principles to guide responsible wind power development:**

- Responsible wind power is a key solution to addressing the threat of climate change to people and wildlife. Unless substantial wind power and other renewable energy development occur in a rapid and timely manner, there will be significant and irreversible impacts to wildlife and biodiversity. As such, wind power companies, conservation groups, wildlife agencies, and other stakeholders should continue to work collaboratively to reduce or avoid risks to wildlife from wind power.

- Wind power projects, like all energy projects, should continue to undergo thorough environmental reviews and adhere to strong wildlife protections laws. Environmental reviews should examine the direct, indirect, and cumulative impacts on wildlife and habitat.

- While there is generally not evidence of population level impacts to species, as the industry grows, it is important that decisions regarding wind power project siting, construction, and operation should be guided by the best available science and technology, comprehensive input from all stakeholders, and the latest landscape-scale planning efforts. This guidance must endeavor to avoid, minimize, and compensate for wildlife risks when appropriate.

- Sufficient funding should be dedicated to resolving conflicts between wind power and wildlife, and to developing advanced technologies and practices that reduce impacts to wildlife.

- Wildlife impacts should continue to be monitored prior to and post construction to inform strategies for avoiding, minimizing, and offsetting potential impacts to wildlife from wind power; these strategies should be periodically reviewed and evaluated for effectiveness, and the data informing these strategies should be made available for review.

Photo: Flickr

WIND POWER, CLIMATE CHANGE, AND WILDLIFE

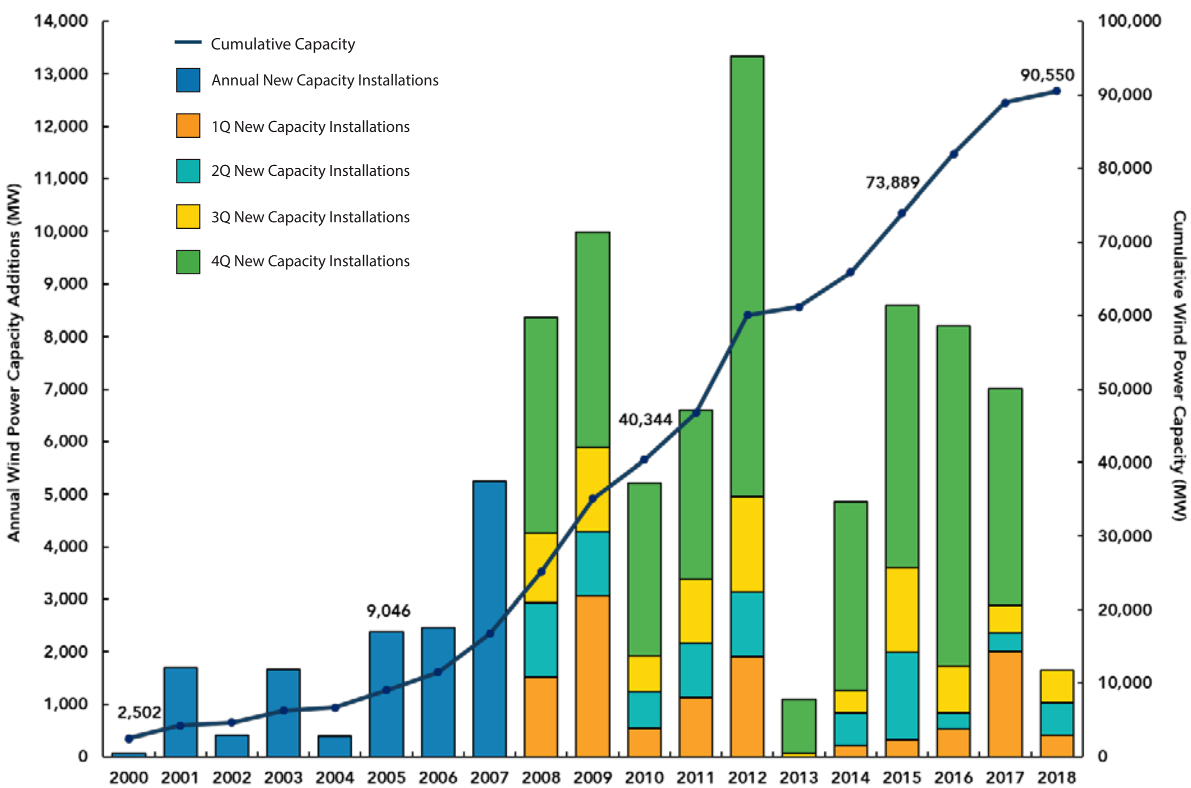
As was made clear by the most recent IPCC report, a rapid transition from burning fossil fuels to harnessing renewable energy resources is critical to securing a stable climate for wildlife and habitat, which are facing increasing short and long-term threats from climate change.[8] Renewable energy and wind power generation are key to achieving the carbon pollution reductions needed to avert warming levels that will be catastrophic to people, wildlife, habitat, and America's outdoor heritage.

However, all types of energy generation have environmental costs associated with them. The possibility of significant impacts to some species of wildlife and habitat from wind power development is a serious concern, especially as wind power expands and becomes a rapidly increasing source of electricity in the United States. As the much-needed expansion of wind power occurs, it is critical that its impacts on wildlife are evaluated and addressed. Wind power must avoid, minimize, and compensate for adverse impacts on wildlife to the extent practicable. Striking a balance between impacts to wildlife and the urgent need to switch to wind and other renewable energy sources requires cooperation among industry, scientists, and the government agencies charged with wildlife protection. This issue brief discusses wind power's risks to wildlife and how these risks can be reduced or avoided.*

In 2017, renewable resources (solar and wind power) made up the largest share of new additions to electricity capacity for the fourth year in a row.[9] Wind development has brought private investment to rural America, attracting more than $145 billion in new projects over the last decade[10] and it is one of the fastest growing employment sectors in the Midwest and Great Plains.[11] Wind power is already bringing strong economic activity to rural and rust belt areas, with the wind industry supporting approximately 100,000 jobs as of 2017.[12]

Compared to fossil fuels, the pollution reduction benefits of wind are substantial. Wind does not emit harmful pollution like greenhouse gases, nitrogen oxides (which lead to smog, acid rain, and other problems), mercury, and sulfur dioxide.[13] Acid rain, in particular, has very significant impacts on fish and wildlife, rendering lakes and ponds virtually lifeless[14] and has been linked to songbird declines.[15] Wind power also does not require substantial water withdrawals, unlike power derived from thermal power plants (coal, natural gas, nuclear) or concentrated solar operations.[16] Existing wind power projects avoided 189 million metric tons of carbon dioxide emissions in 2017 (the equivalent of 40 million cars) and helped avoid the use of 95 billion gallons of water, or 292 gallons per person in the United States.[17]

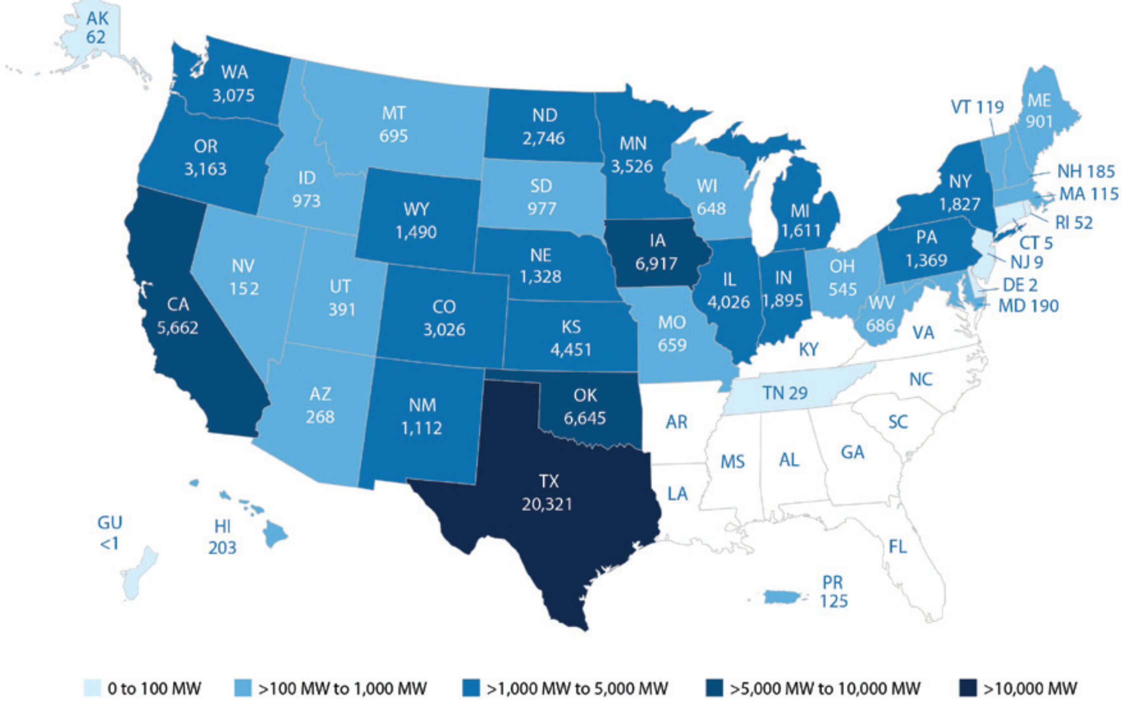
A responsible shift to wind power will help reduce pollution emissions and lead to a more stable climate as well as cleaner air and water—benefitting both



Note: Utility-scale wind capacity includes installations of wind turbines larger than 100-kW for the purpose of the AWEA U.S. Wind Industry Quarterly Market Reports. Annual capacity additions and cumulative capacity may not always add up due to decommissioned and repowered wind capacity. Wind capacity data for each year is continuously updated as information changes. AWEA did not track quarterly activity prior to 2008.

U.S. Annual and Cumulative Wind Power Capacity Growth. *https://www.awea.org/resources/publications-and-reports/market-reports/2018-u-s-wind-industry-market-reports/3q2018_public*

* Additional detailed information can be accessed at: https://awwi.org/what-we-do/science-for-policy-and-practice/#section-reporting-the-facts.



Map of Installed Wind Capacity per State. American Wind Energy Assn 2017 (https://www.awea.org/wind-energy-facts-at-a-glance)

wildlife and people through improved health and greater enjoyment of the outdoors. Rapid and accelerating climate change poses a host of threats to wildlife, resulting from such climate-related impacts as rising sea levels, increased flooding and drought, warming and acidifying ocean waters, melting sea ice, and more variable and extreme weather events. Many wildlife species already are experiencing contractions or shifts in their ranges due to warming conditions and other factors.[18] Indeed, shrinking and shifting ranges due to climate change could imperil nearly half of U.S. birds within this century.[19] Further, climate change affects the natural cycles that wildlife depend on, such as timing of insect hatchings, flower blooms, and migration, which can in turn affect species that rely on co-evolved interactions for their survival such as food source supply and pollination.[20] A rapidly changing climate is also exacerbating other threats to wildlife, such as disease, invasive species, and habitat loss and degradation.[21]

A 2014 study by the National Audubon Society showed the high risk that human-induced climate change poses to North America's bird species. The study found that 314 of 588 species modeled would lose more than half of their 2010 geographic range by 2080 due to likely climate change scenarios. For 126 of these species (21.4 percent), this loss occurs without proportional range expansions, leading the study to conclude that these species are climate endangered. For 188 species (32 percent), range loss resulting from climate change is coupled with the potential for the species to extend their range to new areas due to climate shifts, making these species climate threatened.[22] Among the most affected birds species are bald and golden eagle, brown pelican, osprey, tundra swan, and piping plover. Additionally, several states may lose their state birds as climate change reduces their range, including the common loon in Minnesota, Baltimore oriole in Maryland, mountain bluebird in Idaho and Nevada, purple finch in New Hampshire, and ruffed grouse in Pennsylvania.[23]

Scientists are already seeing wildlife impacts consistent with a warming climate.[24] Impacts include moose population declines in the Northeast due to exploding tick populations caused by warmer and shorter winters, and trout populations stressed by warming waters and low flows in the Southeast and West. Additionally, polar bears and walruses are suffering from the loss of Arctic ice, while pika and wolverines are being impacted from warming of mountain habitats, and sea turtles and shorebirds are losing habitat from sea-level rise.[25]

Climate change also poses enormous threats to people and communities, including loss of life and property through more extreme weather events, floods, droughts, megafires, sea-level rise and erosion, and other related events.[26] These events have major economic consequences too. A recent government report found that climate-related events cost the federal government $350 billion over the last decade.[27]

Scientists agree that if we fail to keep global temperatures from rising 1.5 degrees Celsius (or in a worst case scenario, 2 degrees Celsius), even more severe and irreversible impacts could occur due to extreme climate destabilization.[28] To avoid this, the U.S. must eliminate virtually all of its carbon pollution emissions by mid-century.[29] To reach that goal the U.S. will need to generate a substantial amount of electricity from wind power.

Wind power is a nearly carbon-free energy source that can displace, and is displacing, high-carbon sources like coal, petroleum, or natural gas.[30] While coal has alarmingly high climate impacts, natural gas is largely made up of methane and has lower carbon emissions than other fossil fuels when burned. As natural gas has become cheaper, it has begun to displace coal, but methane is itself a super-potent greenhouse gas in the short-term that can be released intentionally or leaked from oil and gas wells and associated infrastructure, and its lifecycle emissions may be high.[31]

Replacing fossil fuel energy sources with wind power comes with reductions in carbon pollution as well as other pollutant reductions that provide more immediate benefits to wildlife and human health such as cleaner air and water. Between 2007 and 2015, increases in wind power combined with other power generation improvements and reductions in emissions from other sectors contributed to cleaner air in several ways: carbon dioxide emissions fell 20 percent, sulfur dioxide emissions fell 72 percent, nitrogen oxide emissions fell 50 percent, and particulate matter fell 46 percent.[32] Wind power's share of this contribution is considerable.

Bull Elk and turbines, Puget Sound Energy Wild Horse Wind Facility. Photo: Jennifer Diaz, Puget Sound Energy

In 2013, wind power capacity nationwide was about three-quarters of what it is currently. But even by 2013 benchmarks, it accounted for carbon dioxide reductions equivalent to eliminating 270 million barrels of oil, sulfur dioxide reductions equivalent to taking 12 uncontrolled coal plants offline, nitrogen oxide reductions equivalent to the emissions of 10 uncontrolled coal plants, and reduced water consumption by 116 gallons for every person in the United States.[33]

Additionally, wind generation preserves water resources,[34] an increasingly important feature in a world impacted by climate change. Conventional power plants draw large amounts of water for steam with which to run the power plants and then to cool down the plants and reactors.[35] These plants withdraw large amounts of water for power generation. This can stress habitat, and the plants then discharge their waste water which pollutes waterways and harms wildlife. By contrast, wind power virtually eliminates these concerns. Wind power also largely avoids emissions of toxic substances like mercury, which are airborne from coal power plants and fall out into waterways. Mercury harms wildlife[36] and has left some freshwater and saltwater fish unsafe to eat for people and for fish-eating birds like loons and other species.[37]

Overall, wind and solar power have saved Americans an estimated $88 billion dollars in environmental and health costs over an eight year period.[38]

Wind power is a vital piece to addressing climate change through carbon pollution reduction. The more wind power we rapidly put on line to replace carbon intensive sources of energy, the faster we reduce harmful carbon emissions. Wind power will continue to grow due in large part to its increasing cost competitiveness. Even if there are substantial rollbacks or repeals of federal policies that are designed to encourage cleaner energy, like the Clean Power Plan or tax incentives, and even if natural gas prices remain low — wind power still wins. According to the Department of Energy's 2015 *Wind Vision* report, by 2050, wind power is projected to make up 35 percent of installed capacity in the U.S.[39]

While DOE's *Wind Vision* predicts a substantial increase that will reduce long-term climate impacts, even more wind power is needed to adequately address climate change concerns.[40] This means that, in order to avoid catastrophic levels of warming, we must encourage a rapid and responsible development of renewable energy with land-based wind comprising a substantial portion of that build out.

To ensure this occurs in a way that protects wildlife and habitat, it is important that wind companies, wildlife agencies, and conservationists work together. These stakeholders need to continue monitoring and studying existing wind farms and working collaboratively to further develop practices that reduce impacts on wildlife, including appropriate siting. Establishing frameworks that encourage collaboration on wind power development to safeguard wildlife and habitat is the best way to move forward with the responsible development of wind power at the pace and scale needed to address the climate crisis.

As an example of stakeholder collaboration, the American Wind Wildlife Institute (AWWI) is an independent, science-based nonprofit organization that brings together national conservation and science organizations, state and federal permitting agencies, and wind power companies to advance solutions to wind-wildlife challenges. AWWI works to assess and understand risks of wind power to wildlife and helps develop and evaluate best management practices and cutting edge solutions to minimize those risks to facilitate responsible wind power development while conserving wildlife.

Bald eagle. Photo: NREL

WIND POWER AND RISKS TO WILDLIFE

The growth of the wind industry has been immense. In the last 15 years, there has been a 20-fold increase in wind power generation in the U.S., which now has more than 54,000 operating utility scale turbines and utility scale projects in 41 states plus Guam and Puerto Rico.[41] Wind provides enough power to supply 27 million homes and it saw a 9 percent growth rate in 2017.[42] Wind turbine towers in the U.S. tend to range in height from 260 to 330 feet, with blades ranging in length from 200 to 260 feet, meaning modern turbines are approximately 460 feet with a rotor swept area of 1.1 to 3.3 acres.[43] Wind power developments can encompass thousands of acres of land.[44]

Like any form of development, wind power presents the potential for significant impacts to some species of wildlife and habitat. However, these impacts can be minimized or reduced by carefully siting wind turbines, developing new technologies, implementing changes in wind farm operations, and compensating for impacts to wildlife by offsetting fatalities or restoring affected habitat. Additionally, given that wind power development on this scale is still relatively new, risks to wildlife must be continually assessed and solutions developed to address issues that emerge. These risks are compounded by the fact that many species of concern are facing other threats, such as habitat loss and fragmentation, invasive species, disease, and impacts from other human activities. Fortunately, there has been great progress over the past few decades in reducing the risks that wind power can pose to wildlife, with techniques to avoid, minimize, or compensate for these impacts through the use of proper siting, best management practices, and development of innovative technologies to reduce or eliminate risks. With these safeguards in place, the risks from wind power are generally much lower than the risks from most other energy sources, especially the fossil fuel sources that wind aims to replace.

Like any form of development, wind power presents the potential for significant impacts to some species of wildlife and habitat. However, these impacts can be minimized or reduced by carefully siting wind turbines, developing new technologies, implementing changes in wind farm operations, and compensating for impacts to wildlife by offsetting fatalities or restoring affected habitat.

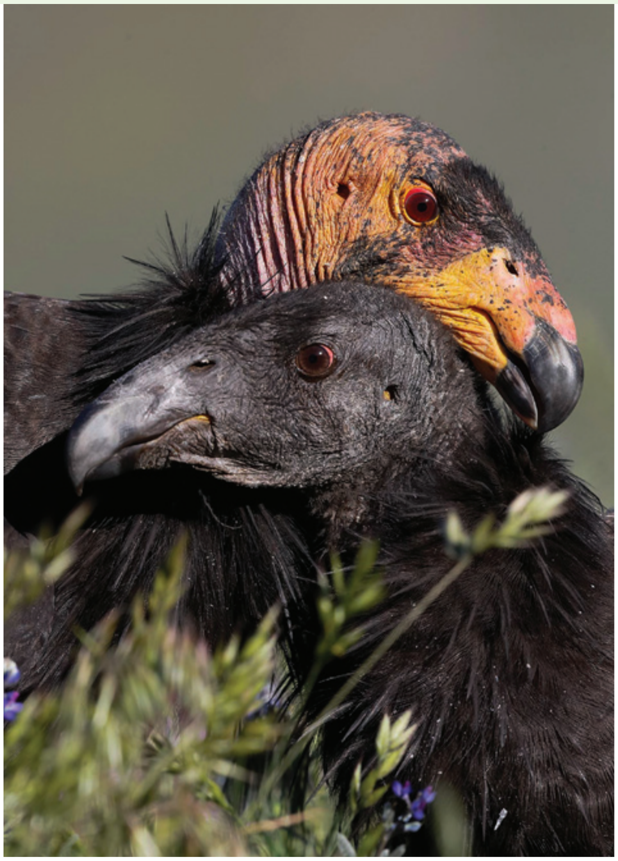
A primary concern associated with wind power is direct impacts, like collisions of birds and bats with wind turbines that can lead to direct fatalities, as well as the dangers from the associated infrastructure such as transmission lines. Indirect impacts like habitat fragmentation and disturbance may also pose some risk to some species. Many species need large tracts of undisturbed, uninterrupted habitat for vital life functions like nesting, and fragmentation of these habitats can allow for invasive species to take hold or give predators the upper hand.[45] Land conversion due to construction of turbine pads, roads, transmission lines, and other related developments may affect habitat-sensitive species through displacement, disturbance, or other changes to the area that make it difficult for species to thrive. For example, there is evidence that infrastructure to support higher elevation wind farms may allow foxes and coyotes access to the habitat of martens, a type of weasel. If foxes and coyotes are able to compete in habitat areas used by marten that were previously inaccessible to these canine species, the marten populations may find it more difficult to compete for resources.[46] And as noted later, wind energy infrastructure in grassland areas can provide perches for raptors in ways that may increase predation on ground-dwelling birds and mammals. More research is needed to determine the extent of potential adverse effects to certain species from indirect impacts such as habitat fragmentation and disturbance.

Some features of wind turbines do not seem to have notable impacts. For instance, with the exception of red bats, Federal Aviation Administration-required lighting on taller towers does not appear to impact species more than unlit towers.[47]

It is important to note that there is still uncertainty regarding the impacts of wind power to wildlife, including direct fatalities like bird and bat collisions. Some of this uncertainty is because limited data exists for certain regions of the country, some is because the wind power industry is still relatively young and there is much yet to learn, and some is because there are knowledge gaps in biology, behavior, and life history for some species. Furthermore, monitoring of fatalities at wind development sites is imperfect, with variance in sampling intensities and how counts are adjusted for error.[48] While many wind companies have made fatality data available to researchers on a proprietary basis, much of this data is not publicly available, though American Wind Wildlife Institute is currently working with collaborators to incorporate private data to better analyze and understand risk.

There is also evidence that installing wind projects in areas with significant topographical features, like hills or mountains, can result in significantly more habitat fragmentation than projects sited on flatter lands due to expansion of roads and cutouts.[49]

Finally, while this issue brief focuses on impacts to birds and bats, it is worth noting that wind power may impact other wildlife. For instance, it is unknown whether wind power facilities act as barriers to landscape-level movements by big game and other large terrestrial vertebrates. Studies of pronghorn, Rocky Mountain elk, and desert tortoise have found no significant impacts.[50] There are other species, however, for which energy infrastructure of any type, including wind turbines and associated access roads and transmission lines, may impede movements.



California condor. Photo: Loi Nguyen/Audubon Photography Awards

IMPACTS TO BIRDS

About 250 species of birds have experienced wind power-related fatalities in the U.S.[51] Most of these fatalities involve passerine species (perching birds such as songbirds), which are the nation's most abundant type of birds. Most passerine species migrate in the spring and fall, which correlates with peaks in bird fatality rates recorded at most wind facilities.[52] Of the more than 5 billion passerines in North America, a recent estimate is that 134,000-230,000, or less than 0.01 percent, collide annually with wind turbines.[53] For all bird species combined, bird fatalities from collisions with wind turbines are estimated to range from 214,000 to 368,000 annually,[54] but could be as much as half a million birds.[55]

Current data suggests that fatal collisions with wind turbines do not appear to be causing population declines in passerines.[56] Raptors, which include hawks, falcons, and eagles, may be more vulnerable to turbine collisions than passerine species.[57] The comparatively high raptor mortality counts may in part be due to the easier detectability of these larger birds.[58] Because raptors are often slow to mature and reproduce, there is cause for concern, and modeling for some raptor species has indicated a potential for population-level impacts.[59] Wind impacts on golden eagles are a particular concern. Unlike bald eagles, whose populations have soared since the banning of DDT and the passage of the Endangered Species Act in 1973, golden eagle populations appear to be declining and are currently limited by a variety of human threats.[60] Siting appears to have a great influence on the incidence of raptor fatalities, and fatalities are especially a concern where raptors tend to gather in larger numbers, like upwind sides of slopes as well as ridgetops and canyons favorable for raptor migratory movements.[61]

Bird fatality rates do not appear to vary significantly across different landscapes, such as agricultural lands, grasslands, or forest types.[62] Similarly, there do not appear to be major regional differences in fatalities, though they appear lower in the Great Plains region and higher in the Pacific region.[63] There have been instances, such as Altamont Pass in California, where local raptor fatalities have been high.[64]

In general, as the number of wind farms grow, so does the possibility of collision and disturbance. Also, the trend towards taller turbines may lead to more bird deaths,[65] though research on this is still inconclusive as most birds migrate at altitudes above the height of most towers.[66] Studies indicate that higher flying nocturnal migrating birds are not disproportionately impacted and appear to circumvent collision more effectively.[67] In fact, taller and larger turbines may actually serve to limit fatalities by reducing the overall number of turbines and opportunities for collision at a site.[68]

Certain groups of birds, such as shorebirds and waterfowl, do not experience many fatalities.[69] Indeed, waterfowl fatalities are very low even in places like the Prairie Pothole region of the upper Great Plains that have high duck populations.[70]

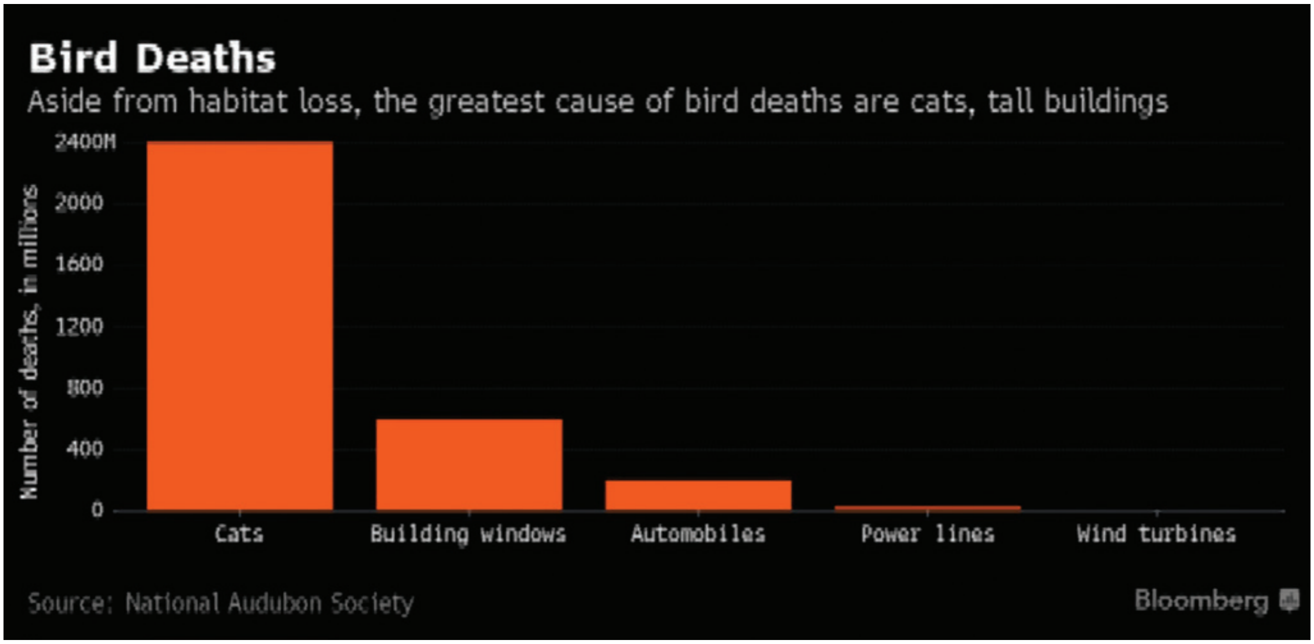
Comparing threats

Although many birds are killed each year by wind installations, it is worth putting these deaths in the context of other leading causes of avian mortalities. Domestic and feral cats, windows and buildings are major threats to song birds, while power transmission lines are frequent causes of raptors deaths.[71] Recent comprehensive reviews of bird fatalities from wind turbines are in the range of a quarter to half million annually.[72] This compares to more than 30 million bird deaths from power lines (collision and electrocution), 200 million from automobiles, almost 600 million from buildings and windows, 67 million from pesticides on U.S. agricultural lands,[73] and up to 2.4 billion from cats. Total mortality from wind installations is thus relatively low compared to other major human-related causes.[74†]

Golden eagle.

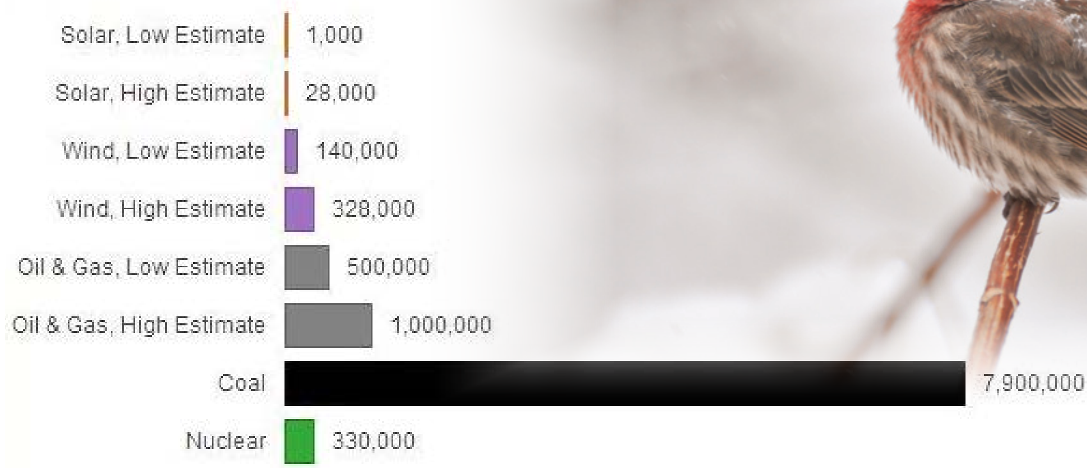
Wind power also results in far fewer bird deaths than other sources of energy it is serving to displace and offset, as shown by the 2014 graph below. Coal, oil, and natural gas-fired power plants can cause bird fatalities as well as habitat loss and displacement throughout their fuel cycle. For example, birds can be killed during the process of extracting oil, gas, and coal as habitat is destroyed and water polluted, especially in the case of mountaintop removal mining for coal.

Open oil pits, coal ash ponds, and oil spills also pose risks to birds. Birds can be killed at power plants from onsite collisions and electrocution with operating plant equipment, in addition to collisions with transmission lines. Finally, there are avian impacts from the acid rain, mercury pollution, and climate change that results from fossil fuel-based energy production.[75]



† These numbers represent a range. For instance, the National Audubon Society conducted a survey of 14 studies to estimate that the number of bird deaths from power lines (electrocution and collision) is between 12 and 64 million birds, with between 8 and 57 million killed by collision and 0.9 and 11.6 million killed by electrocution. Loss, SR, Will, T, and Marra, PP. Direct Mortality of Birds from Anthropogenic Causes. Annual Review of Ecology, Evolution, and Systematics. Vol. 46:99-120. Dec.2015. https://www.annualreviews.org/doi/pdf/10.1146/annurev-ecolsys-112414-054133.

Purple finch.
Photo: Margaret Morse



Estimated bird deaths by different energy types (U.S. News and World Report 2014) [77]

Small-scale solar, such as rooftop solar panels, does not likely have a measurable impact on birds. Utility-scale solar power, like large photovoltaic sites and concentrated solar power, may have significant impacts on some bird species, but more research is needed.[76]

In summary, the number of bird fatalities from wind power is comparatively small relative to other human-related hazards, and to fossil fuel energy sources. For most avian species, especially songbirds, wind power does not appear to be causing population-level declines, although continued research and monitoring will be important.[78]

IMPACTS TO BATS

Bats are incredibly important to ecosystems as they are avid insectivores and eat crop pests. Bats' economic value as pest control agents in North America is estimated at more than $3.7 billion a year for agricultural value alone.[79] Bats are also under stress, with many of the 1,300 bat species worldwide in decline or threatened. These declines are due in large part to disease, as well as anthropogenic causes including pesticides and habitat destruction, and, for some species, possibly wind development.[80]

As with birds, we are still learning about wind power's impacts on bats, but research suggests that the impacts to some species of bats may be significant and more difficult to address.[81] Bats are long-lived and can have low reproduction rates, so any significant number of fatalities is a concern. Bats tend to fly at lower altitudes than birds when migrating, possibly because they also feed as they travel. While very little is known about population sizes of the three species most frequently killed by wind turbines, making it difficult to estimate population-level impacts, there are indications that impacts from wind power may present population-level concerns for some species. For example, a recent study modeled the impacts of collision fatalities on hoary bat, a migratory tree bat, with the authors concluding that these fatalities could affect the species' population stability.[82]

At least 24 species of bats have been recorded as collision fatalities in the U.S. and Canada. The majority of fatalities reported to date are hoary bat, eastern red bat, and silver-haired bat, which are migratory tree-roosting species. These species collectively constitute about 70 percent of the reported fatalities at wind power facilities in North American regions combined, but fatalities have also seen among cave dwelling bats, like tri-colored bats and little brown myotis (little brown bats).[83] While cave-hibernating bats do not migrate south to escape the winter, they can travel hundreds of miles to and from breeding colony locations and wintering sites. Nevertheless, while they are generally considered non-migratory, fly and forage close to the ground, and do not appear to be affected by wind power development as heavily as tree bats, many cave bat populations have been devastated in recent years by white nose syndrome. We should not discount additional impacts to these species from other sources such as wind power.[84] This may be of heightened concern in the Midwest, where cave-dwelling bat fatalities from white-nose syndrome appear to be higher than in other regions.[85]

Bat fatalities can vary widely both between and within regions.[86 §] Bat fatalities peak at wind facilities in the northern U.S. during the late summer and early fall migration. Bat fatality rates vary from region to region much more substantially than bird fatalities, with bat fatalities in eastern forest regions highest.[87] On average, bat fatalities seem to be lower in the Western U.S.,[88] while two facilities within the Appalachian region reported fatality levels of greater than 30 bats per megawatt per year.[89] However, there are also reports as low as one to two bats per megawatt per year at other facilities in the eastern U.S.[90] and further assessment is needed before concrete trends can be identified.

The risk to bats appears to be mostly from collision. Recent studies appear to show that barotrauma – injury or death resulting from the rapidly changing air pressure caused by fast spinning blades – is a far less substantial threat than some initial studies indicated.[91]

Bat white nose syndrome.

Bats may be attracted to wind turbines due to sounds produced by the turbines, insects that may concentrate around turbines, or mating behaviors.[92] Bat activity is also determined in part by wind speed and temperature, with bat activity highest at higher temperatures and lower wind speeds.[93] Bat fatalities have also been shown to increase before and after the passage of storm fronts.[94] As turbine designs evolve to operate at lower wind speeds, this could present further risks to bats. Increased knowledge of how weather, temperature, bat behavior, and other factors shape the risk that wind turbines present to bats is paramount to developing best practices and minimization measures to manage and reduce these impacts to sustainable levels.[95]

NON-TURBINE-COLLISION IMPACTS TO WILDLIFE

- **Land transformation and habitat fragmentation:** The amount of land altered by wind farms (acres of surface disturbance per megawatt) varies between farms. These changes come from maintenance roads and the pads where wind turbines are installed. Turbine size, configuration, land cover, and topography affect the amount of disturbance. These disturbances can alter and fragment habitat.[96] Habitat fragmentation presents long-term, significant impacts to many species, and it should be an important consideration in deciding where to site wind farms and how to design access roads. However, unlike mining and drilling for fuels like coal and natural gas, which provide a finite supply from any one land base and often destroy large land areas, wind production can provide more or less indefinite power from the same land base with a smaller footprint.[97] Additionally, the footprint and overall land usage of wind sites is generally much smaller than that of other types of energy development.[98]

§ The American Wind Wildlife Institute has recently compiled a detailed technical report of nationwide bat fatality data at wind sites that provides a comprehensive review of data collected at wind sites across the country. Allisson, T, Butryn, R. AWWI Technical Report: A Summary of Bat Fatality Data in a Nationwide Database. July 2018. https://awwi.org/wp-content/uploads/2018/07/AWWI-Bat-Technical-Report_07_25_18-FINAL.pdf.

- **Impacts to ground-dwelling birds:** The potential impacts of wind energy development to ground-dwelling birds, such as lesser and greater prairie-chicken and greater sage-grouse, are most notably habitat loss, fragmentation, and reduction in quality habitat due to infrastructure, roads, and human activity. This can add to the considerable effects on these declining species from impacts from other human activities that cause habitat loss and disturbance such as oil and gas drilling, climate change, and invasive species of grasses. Other potential impacts include behavioral changes, increase in predator populations, such as increasing raptor perches, and noise effects from road traffic and other activity.[99] The level of impact varies by location and species. According to a 2018 sage-grouse review by the U.S. Geological Survey, the scope and scale of wind development research results are not yet sufficient to predict effects with desired certainty.[100] Further research is needed to increase our understanding of the relationship between wind energy development and sage-grouse and prairie-chicken populations.

- **Transmission and distribution lines:** In order to build-out wind power at the scale needed to combat climate change, the U.S. will need to add capacity for additional transmission and distribution lines. Transmission and distribution lines are not unique to wind power development, as they carry power from several sources, but they can pose collision and electrocution risks to birds. The roads that access transmission lines can fragment habitat. Clearing the base of transmission line structures of vegetation can further alter habitat. It can, however, create habitat for other species, like shrubland birds, but also lead to habitat risks like erosion.[101] The best way to minimize and avoid impacts to birds from transmission and distribution lines is to site wind projects in areas near existing lines and pairing new lines to the extent possible with previously installed lines. However, when additional lines are needed, siting power lines away from high bird use areas such as rivers, lakes, and wetlands may reduce risk of collision, and markers may also be added to the lines to make it easier for birds to see them.[102]

Sage Grouse. Photo: Conservation Media

Photo: Flickr

PROTECTIONS FOR WILDLIFE

U.S. FISH AND WILDLIFE SERVICE'S LAND-BASED WIND ENERGY GUIDELINES (WEG)

Fortunately, there are measures to avoid, minimize, and compensate for wildlife risks from wind power. In 2012, the U.S. Fish and Wildlife Service developed Land-Based Wind Energy Guidelines (WEG) in collaboration with representatives from the wind industry, conservation, and science communities.[103] The WEG, which are voluntary but are employed by many wind power companies to help address wildlife concerns, use a tiered approach for assessing potential impacts to wildlife and habitat. The first three tiers are pre-construction and set up a process where developers work to identify, avoid, and minimize risks to wildlife prior to building a project. This process is meant to identify the risks, evaluate the risks, determine whether the site is appropriate for development, and what mitigation or other measures are needed to ensure risks to wildlife are appropriately addressed.[104] Since pre-construction evaluation does not always effectively predict post-construction impacts, the final two tiers are meant to assess and monitor the site post-construction to ensure that actions taken to avoid and minimize impacts are successful, or determine whether additional measures are needed.[105]

The WEG also suggest best management practices for site construction and operation. These include:

- Avoiding siting in areas where risks to birds and bats cannot be mitigated;
- Minimizing the impacts of roads, power lines, and other associated infrastructure, including burying power lines when possible to avoid bird conflicts and not locating lines in frequent bird flight paths;
- Implementing measures to minimize habitat fragmentation such as reducing the number of new roads, fences, and other disturbances that fragment habitat;
- Using native species and other tactics to reduce the establishment of non-native invasive species;
- Avoiding guy (stabilizing) wires on facility infrastructure when possible;
- Locating turbines in places that do not separate birds and bats from frequently used places like roosts, feeding areas, or nests;
- Using buffer zones to protect habitat or high-risk areas;

- Minimizing the impacts of lighting;
- Employing practices to reduce the attraction of predators.[106]

The WEG also provide guidance for collaboration, research, and best management practices that avoid, minimize, and offset impacts.

FEDERAL LAWS PROTECTING WILDLIFE

Wind power projects must comply with laws that protect wildlife. Five primary federal wildlife laws apply to these projects: the Endangered Species Act, the National Environmental Policy Act, the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Federal Land Policy and Management Act. Wind developers must also comply with all state protections, many of which also protect habitat areas, natural resources, and state threatened and endangered species.

Endangered Species Act

The Endangered Species Act (ESA) prohibits the take of species that have been listed as either endangered or threatened with being extinct.[107] Under the ESA, "take" means either killing or harming, intentionally, incidentally or inadvertently. The ESA also protects habitat for these species.[108] A project that might affect protected species and require federal permitting or other federal action must undergo consultation with a federal wildlife agency — the U.S. Fish and Wildlife Service (USFWS) for terrestrial species and the National Marine Fisheries Service for marine species — before it can proceed. The wildlife agency must determine that the project will not jeopardize the species. The agency may allow for certain incidental (or inadvertent) takes of listed species that may occur as a result of the action being taken (like constructing and operating a wind farm) and require that measures to protect the species be put in place.[109] Projects that do not require a federal permit to build or operate must get a separate protective permit to incidentally (or inadvertently) take any species or they will be in violation of civil or criminal law if they harm or kill protected species.[110]

National Environmental Policy Act

Whenever a federal permit or a major federal action is at issue for a wind power development, projects must also be reviewed for their impacts to the environment, including wildlife, under the National Environmental Policy Act (NEPA). While NEPA does not impose specific substantive requirements on a project, it does require a look at reasonable alternatives — including siting alternatives — as well as direct, indirect and cumulative impacts to wildlife, habitat, and species.[111]

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA)[112] prohibits "take" (defined broadly as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb") of eagles without a permit.[113] BGEPA is comprehensive and covers intentional as well as inadvertent, or incidental, takes such as those that occur with wind blade strikes. The USFWS established a permitting system to allow for incidental (inadvertent) take for applicants that engage in measures to avoid and minimize takes, offset remaining unavoidable eagle take, and monitor takes.[114] While wind power companies are not required to obtain an eagle take permit, the take of an eagle without a permit can result in criminal prosecution.[115] Thus, there is strong incentive for wind power companies to obtain permits and put protective measures in place.

As part of its charge to protect eagles, the USFWS developed the **Eagle Conservation Plan Guidance** for wind farm developers in 2013.[116] This document provides in-depth, voluntary guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind power facilities. The measures recommended in the guidance are not mandatory in order to obtain an eagle take permit, and other measures can be proposed by wind power

Golden eagle.

companies seeking a permit. Indeed, new and improved effective measures are continuously being studied, implemented, and refined.

In 2016, the USFWS extended the maximum permit duration for incidental take from 5 to 30 years.[117] Permitted takes must be "compatible with the preservation" of the species which is defined as "consistent with the goals of maintaining stable or increasing breeding populations in all eagle management."[118] Permittees are required to monitor project impacts and consult every five years with the USFWS to ensure compliance,[119] and permits can be modified or revoked if compliance measures are not being met.[120]

Migratory Bird Treaty Act

Most native U.S. birds are protected under the Migratory Bird Treaty Act (MBTA). The MBTA makes it illegal to "kill" or "take" a migratory bird, nest, or egg, except as permitted under regulations.[121] The language of MBTA is broad, stating that "it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill . . . any migratory bird . . . nest, or egg . . . ."[122] Despite this broad and seemingly clear language, courts have differed in interpreting the scope of a "take" as defined by the MBTA. Unlike the ESA and BGEPA, the MBTA does not distinguish between purposeful take and "incidental" (inadvertent) take that occurs as a result of otherwise lawful activity. Some courts have found that the MBTA covers industrial activities that inadvertently kill migratory birds,[123] but other courts have found that it only applies to "deliberate acts done directly or intentionally to migratory birds."[124]

Until very recently, presidential administrations from both parties have taken the more protective approach and applied the MBTA to both incidental (or inadvertent) takes of birds from major industrial activities such as industrial waste pits, oils spills, power lines, and wind farm operations as well as purposeful takes. However, in a significant departure from this practice, in December 2017, the Department of Interior's Office of the Solicitor released a Solicitor's Opinion formally reversing the Department of Interior's interpretation of MBTA as protecting birds from incidental or inadvertent takes. The recent memorandum determined that "take" only refers to "affirmative actions that have as their purpose the taking or killing of . . . birds."[125] Under this new opinion, the Department of Interior will apply the MBTA to bird deaths that occur due to "affirmative and purposeful actions, such as hunting and poaching."[126]

If this opinion stands or is codified in regulations, it could have serious negative consequences for bird protections. For most development on private land, the federal government has little leverage to ensure practices like the WEG are put in place to protect birds and other wildlife. However, the prospect of

Until very recently, presidential administrations from both parties have taken the more protective approach and applied the MBTA to both incidental (or inadvertent) takes of birds from major industrial activities such as industrial waste pits, oils spills, power lines, and wind farm operations as well as purposeful takes.

American pika. Photo: Ben-Knoot

possible prosecution under the MBTA for incidental or inadvertent bird takes has been an important incentive for companies to take protective measures for developments on private lands and prosecutors often take into consideration whether or not a company has taken the right steps to protect wildlife in making prosecutorial decisions

Federal Land Policy and Management Act

The Federal Land Policy and Management Act (FLPMA) directs the Department of Interior's Bureau of Land Management (BLM) to manage the public lands "in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use."[127]

Pursuant to FLPMA, the Interior Department implements these requirements through land management plans, known as resource management plans (RMPs).[128] Under the FLPMA planning process, BLM must provide opportunities for public participation and comment, develop a NEPA analysis addressing the impacts of the changes, publish notice of the proposal in the Federal Register, and coordinate its effort with other Federal agencies, state and local governments, and Indian tribes.[129] Wind development on federal lands would have to occur in compliance with FLPMA and applicable RMPs that consider wildlife and environmental concerns, and provide for public input.

IndentiFlight technology. Photo: IdentiFlight International

PROTECTIONS FOR BATS

Conservationists, the wind power industry, and wildlife agencies have been working to try to get ahead of the issues concerning bat fatalities. Researchers are gathering data on a number of issues in a variety of regions to better understand the risks to bats from wind power operations and how bats interact with wind turbines. They are also looking into solutions, including how technological methods and operational changes can reduce or avoid risk to bats.[130]

There is hope for reducing bat fatalities from wind power. One method that has already been identified —changing wind turbine speed operations at times of highest risk to bats (which also tends to be at lower wind speeds and under certain meteorological conditions)—can reduce bat fatalities by 44-93 percent.[131] Significant bat fatalities can also be reduced through operational changes at times when bat activity and presence may be higher, such as the late-summer and fall migration season and when wind speeds are low. Likewise, by feathering the blades (pitching them parallel to the wind so they are moving slowly) below manufacturer's cut-in, bat fatalities can be reduced by an average of 35 percent.[132] Technological solutions like acoustic deterrents and ultraviolet illumination of turbines (which may help bats better identify them) also show promise, and there are currently several technologies undergoing evaluation and in development.[133‡]

‡ To learn more about advances in technology to reduce risk to bats from wind power, see this list of presentations for Department of Energy-funded projects: https://www.nationalwind.org/status-findings-developing-technologies-bat-detection-deterrence-wind-facilities/) and recent National Renewable Energy Laboratory funding awardees: https://www.nrel.gov/news/program/2018/nrel-announces-new-technology-development-and-innovation-project-selections.html.

There is still much to learn about risk and solutions for bats, and continued research is needed to more adequately understand the risk to bats and develop measures that will ensure these risks are reduced to the extent practicable. A major priority should be investment in studies and solutions to bat and wind conflicts. It should be noted that threatened and endangered bats are legally protected by the Endangered Species Act. State laws can apply to protect bats as well.

TECHNOLOGIES AND PRACTICES TO REDUCE IMPACTS

Technologies and practices are continually being developed and refined to further reduce impacts to birds and bats from wind power facilities. Technological solutions generally include one or more of the following components:

1) Detection: some technologies detect approaching wildlife using cameras, radar, thermal imaging, or acoustic monitoring with sophisticated software or artificial intelligence that assesses and informs of heightened risk. These detection systems may have further capabilities to respond automatically or notify the wind facility's operator of the heightened risk.

2) Curtailment: new technologies are being developed or refined to automatically shut down wind turbines when risk of collision is determined to be high for key species based on environmental factors or based on detection by a detection technology.

3) Deterrent: some technologies deploy audible or visual deterrent signals designed to discourage wildlife from approaching or draw the animal's attention to the turbine. There is ongoing research on all stages of the development of technology solutions, from studies of eagle physiology to better understand how they respond to visual and auditory signals, to full evaluations of commercially-available technology solutions to reduce risk to wildlife at commercial wind facilities.

Photo: IdentiFlight International

After Duke Energy Renewables was prosecuted for bird deaths in 2013, it installed a new technology called IdentiFlight in 2016 that is designed to identify eagles and temporarily shut down (or curtail) turbines that pose a risk to eagles. The technology is still being evaluated, but if it proves effective it could provide a way to better protect raptors of concern in a manner that is cost effective to wind operators. Findings of an initial evaluation suggest that this system can be effective means of detecting birds in flight and identifying eagles.

Radio monitoring systems that already exist on most wild California condors, which were extinct in the wild in the 1980s but have climbed to a wild population of 290 birds since reintroduction, are being used to curtail wind turbines when the birds get within a certain distance of a turbine. The radio collars on the birds communicate with antennae at wind operation sites. When a condor is detected, employees use a device to determine the position of the bird and ensure that any turbines that might present a threat to the condor is turned off until the birds moves out of the range of potential harm.

As part of its Land-Based Wind Energy Guidelines,[134] the U.S. Fish and Wildlife Service recommends that wind power developers implement Bird and Bat Conservation Strategies (BBCS). A BBCS outlines the steps a developer can take to apply the Guidelines to reduce impacts to wildlife.

Similar efforts are underway to identify operational changes or other techniques that could reduce wildlife impacts at wind power facilities, such as prey management and carcass removal to reduce eagle activity within or in the vicinity of a wind power facility, and improving siting practices.[135]

These enhanced practices are already looking promising. In before-after, control-impact comparisons of the adjusted annual fatality rates based on overall detection rates, the repowering of the Vasco Winds project reduced fatalities 75 percent to 82 percent for golden eagles; 34 percent to 47 percent for red-tailed hawks; 48 percent to 57 percent for American kestrels; and 45 percent to 59 percent for burrowing owls. Annual fatality rates were reduced between 56 percent and 65 percent for all raptors combined and 64 percent to 66 percent for all birds combined.[136] Repowering involves the removal or replacement of turbines and their associated infrastructure using modern turbine technologies and designs.[137]

Federal funding has been critical to developing solution to wildlife risks from wind power. The Department of Energy's Wind Energy Technology Office[138] has provided millions of dollars in grants to researchers, wind companies, non-profit organizations, and technology developers for work developing solutions to wildlife risks from wind power. This important funding must be continued and increased.

Siting considerations are also important to reducing impacts. As the Wind Energy Guidelines suggest, avoiding high impact areas such as those that provide rare habitat, or large, intact areas of habitat can avoid many impacts. Further research and monitoring is also extremely important. Much is still not known about how certain species groups, such as bats, interact with wind development. The more we know about bat and other species' behavior, the more effective mitigation and siting strategies can be in reducing those impacts.

WHAT ABOUT OFFSHORE WIND?

The waters off our coasts have a tremendous amount of untapped wind power potential, available in close proximity to some of the nation's largest urban energy markets. America's first offshore wind power project, the Block Island Wind Farm, consists of five turbines three miles off the coast of Block Island, Rhode Island. The project was completed by Deepwater Wind in 2016 and now generates enough energy for 17,000 homes. This is just the beginning, as states along the Atlantic including Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Maryland have committed to enough offshore wind development to collectively power over three million homes, with six projects expected to come online in the next four years. The U.S. Department of the Interior has awarded leases to developers for areas of federal water all along the East Coast from Massachusetts to North Carolina. An exciting new energy chapter for America has begun.

As offshore wind power advances in America, is it is critical that this new renewable energy resource be developed in a responsible manner that avoids, minimizes, and compensates for potential impacts to coastal and marine wildlife. Offshore wind power development has rapidly grown in Europe since the world's first offshore turbines were installed in 1991, with over 4,000 turbines operational today. This provides nearly three decades of lessons to draw from as offshore wind power expands in the U.S. Additionally, ocean planning, research, and outreach efforts by both state and federal governments have produced valuable data and stakeholder input needed to inform and guide America's growth of offshore wind power, given the unique marine resources and wildlife on this side of the Atlantic.**

** For the current status of U.S. offshore wind development and NWF's efforts to promote responsibly developed projects: visit our campaign website at offshorewind.nwf.org.

Big Horn Wind Farm. Photo: Iberdrola Renewables, NREL

PRINCIPLES FOR RESPONSIBLE ENERGY

National Wildlife Federation and National Audubon Society recommend federal agencies, states, municipalities, and renewable energy companies adopt the following principles for responsible wind power:

- Responsible wind power is a key solution to addressing the threat of climate change to people and wildlife. Unless substantial wind power and other renewable energy development occur in a rapid and timely manner, there will be significant and irreversible impacts to wildlife and biodiversity. As such, wind power companies, conservation groups, wildlife agencies, and other stakeholders should continue to work collaboratively to reduce or avoid risks to wildlife from wind power.

- Wind power projects, like all energy projects, should continue to undergo thorough environmental reviews and adhere to strong wildlife protections laws. Environmental reviews should examine the direct, indirect, and cumulative impacts on wildlife and habitat.

- While there is generally not evidence of population level impacts to species, as the industry grows, it is important that decisions regarding wind power project siting, construction, and operation should be guided by the best available science and technology, comprehensive input from all stakeholders, and the latest landscape-scale planning efforts. This guidance must endeavor to avoid, minimize, and compensate for wildlife risks when appropriate.

- Sufficient funding should be dedicated to resolving conflicts between wind power and wildlife, and to developing advanced technologies and practices that reduce impacts to wildlife.

- Wildlife impacts should continue to be monitored prior to and post construction to inform strategies for avoiding, minimizing, and offsetting potential impacts to wildlife from wind power; these strategies should be periodically reviewed and evaluated for effectiveness, and the data informing these strategies should be made available for review.

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