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Impact of wind energy on wildlife: synthesis

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Humankind on Earth is desperate for energy. Fossil fuels including coal, oil, and natural gas have served as the main energy source since oil's discovery by Colonel Drake in Titusville, Pennsylvania during 1857, with the first well drilled in 1859 (Hubbert 1949). However, 2 issues have become gravely important regarding our use of fossil fuels. It is estimated that there are <44 years of oil remaining, with primary oil fields already showing declines in production (BP 2015). Secondly, continued fossil fuel consumption will only exacerbate effects of global climate change (Baes et al. 1977). Therefore, the search for new sources of renewable energy not based on fossil fuels has begun. One promising source is wind energy. Consequently, we invited the key scientists, knowledgeable on wind energy impacts on wildlife, to contribute to this Special Topic volume. We hope that you agree after reading these papers that wind energy development is an important energy source, but also a profoundly important mortality factor for 2 ecologically important types of wildlife: our avifauna and chiropterans.

Some key themes consistently arise from our contributors that warrant mention. First, the validity of methodologies regarding estimating detection probabilities, and thus mortality from wind turbines, is in its infancy. There is much evidence that most models underestimate mortality of birds and bats. We are reminded of the quote of the highly distinguished statistician George E. P. Box: "Remember that all models are wrong; the practical question is how wrong do they have to be to not be useful" (Box and Draper 1987). Models are only as good as the information that is fed into them. Thus, more research is needed to evaluate current predictive models and to develop better methods based on sound statistical theory and animal ecology, especially behavior. This is most evident when threatened, endangered, and/or species of concern may be present. However, this and other anthropogenic impacts on birds and bats are pervasive, and with a few exceptions (e.g., waterfowl), even our most common species are in precipitous decline. Also, sampling methodologies and models must be standardized to estimate carcass detection and mortality and to allow impacts to be compared across locations, regions and biomes. Second, although a most arduous task, it is imperative that sound population data on birds and bats be obtained, given that biologists agree that current magnitude of estimated losses are staggering and likely will have an impact. Third, data on bird and bat mortality at wind energy facilities is considered the property of wind energy companies and not shared publicly, and this is disturbing to many. Fourth, monitoring and reporting of mortality is mostly conducted by wind energy companies, not by "independent" outside sources. We are not in any way claiming impropriety here, but for such data to be recognized, used, and be credible to the citizenry (especially to our legislative bodies), monitoring and reporting of mortalities should be conducted by independent and objective entities. In this way, no appearance of a conflict of interest call be implied. Fifth, the process of siting wind energy projects is tenuous at best and doesn't seem to be well linked to what species are present, not to mention projected mortality. More objective methodologies are needed to evaluate those species (resident and migratory) that may be present and at what temporal framework (resident, temporary), and be soundly integrated with potential impacts of planned wind energy fields. Furthermore, proposed projects that represent high levels of risk should be rejected or charged appropriate

levels of compensatory mitigation to make up for the losses to our public trust resources.

It is clear from reading the contributions herein that much more research is needed to develop effective mitigation for wind energy development. Many of the mitigation methods often cited as reducing bird and bat kill have not been tested systematically for their efficacy. It is 1 thing to imply that radar and temporary shutdowns, ultrasonic deterrents, or alternative lighting will reduce bird and bat deaths, respectively, and quite another to verify their effectiveness through testing and experimentation. Furthermore, we think it would be a useful exercise to consider what level of bird and bat mortality would be acceptable for wind energy development to proceed. This, of course, may vary by species and conservation status, and by the cumulative impacts of all other sources of mortality. However, because any wind energy project will result in the deaths of some birds, what per-megawatt loss would be acceptable and allow us to ensure that birds and bats will continue to exist and thrive in the face of continued energy development, either traditional or alternative?

Lastly, although our authors did not discuss this, we also feel that long-term studies are needed to evaluate the subtle but profoundly important ecological changes that the presence of wind energy turbines may create. What are the impacts of such turbines on atmospheric moisture, distribution of rainfall, temperature gradients, etc.? All of these ecological factors play important roles in the types of biomes maintained across continents. We must be assured that our biomes are not impacted, and this will require long-term monitoring and evaluation.

Harnessing the energy of the wind is indeed a promising energy source. However, as our authors have noted, we do not want to rush into wind energy development without ensuring that we do our best to minimize impacts to our natural resources. We only need to look at the promise of clean energy that hydroelectric dams represented before their considerable environmental impacts were fully understood to realize that this is an important question. Our colleagues in their papers have shown that we should be more proactive regarding ecological impacts as we move forward with "green energy" development, including energy from wind turbines, underwater turbines harnessing energy of water currents, and solar energy. We should also realize that climate change is merely a symptom of exponential human population growth and consumption, both of which are the major drivers of a myriad of environmental problems, including pollution, forest loss, and species extinctions. In order to have a future for the world's wildlife, we'll need to address these issues as well.

Literature cited

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