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Special Topic: Wildlife and wind energy: are they compatible?

Introduction

MICHAEL HUTCHINS, Bird-Smart Wind Energy Campaign, American Bird Conservancy, 4301 Connecticut Ave. NW, Suite 451, Washington, D.C., 20008 USA *MHutchins@abcbirds.org*
BRUCE D. LEOPOLD, Mississippi State University, 211 Hickory Drive, Starkville, MS 39759, USA

THE WORLD IS HUNGRY for energy, and with growing concerns about the exacerbating effects of burning fossil fuels on climate change, there has been a profound demand for and, thus, rapid growth of clean, renewable energy sources, such as solar and wind. The United States is one of the world's leaders in wind energy development. As of September 2014, there were 46,600 operational wind turbines, having a total generating capacity of 62,300 mW. An additional 1,254 mW came online in 2014, and there are currently 13,600 mW under construction (Today's Energy Solutions 2014). In addition, the U.S. Department of Energy recently revised its original estimate of 20% of electrical energy being produced by wind by 2030 to a projected 35% by 2050 (Jackson 2015). This would mean tens of thousands of new turbines, many of which may be 152 to 213 m high, with blades as long as a football field, traveling at up to 274 km per hour. It would also mean hundreds of kilometers of new power lines and towers to carry this power into the national grid (Wernau 2014), both of which pose a substantial risk to wildlife, primarily birds, through collision and electrocution (Manville 2005, Loss et al. 2014).

While this rapid development of a clean, renewable energy resource may help our nation address anthropogenic climate change (Vasi 2011), it is also having a non-trivial impact on wildlife, particularly our ecologically important birds and bats (Smallwood 2013, Zimmerling et al. 2013, Loss et al. 2014, Erickson et al. 2014). Birds and bats are either struck by the wind turbine blades or, in the case of bats, injured or killed by the air-pressure changes associated with them (Baerwald et al. 2008). Some species, such as raptors, nocturnal migratory songbirds and tree-dwelling, migratory bats are at greater risk than others, but many species are affected (Smallwood 2013). Less understood are additional potential effects of associated disturbance and habitat alteration, which may cause wildlife to abandon an area or change habitat-use or migratory patterns (Zimmerling et al. 2013). This comes at a time when our nation's bird and bat populations are under siege from many threats, including feral cats (*Felis catus*), collisions with buildings, pesticides, and disease. The cumulative impacts have been devastating, and even our most common species are in decline (Thogmartin 2012, North American Bird Conservation Initiative 2014).

It is important, therefore, that wildlife professionals, natural resource managers, elected representatives, local planning boards, and the public begin to develop a deeper understanding of wind energy, the risks it entails to wildlife, and potential solutions. If one listens to certain media or to the wind industry and its allies, one would conclude that wind energy's impact on birds and bats is minimal (Koch 2014, American Wind Energy Association [AWEA] 2015) and that the industry knows how to effectively mitigate its effects (AWEA 2015). One would also conclude that loss of birds and bats is a small price to pay to address climate change, which also is a serious threat to wildlife (AWEA 2015). Conversely, diehard opponents of renewable energy have sometimes over-exaggerated its impacts (DuChamp 2014). However, it seems that the truth is somewhere in between, as it nearly always is. That makes it even more important that the debate remain science-based and unencumbered by the confounding influences of politics, money, or emotionalism. The goal of this special issue of *Human–Wildlife Interactions* is to provide an overview of a broad spectrum

of topics related to wind energy development and wildlife, ranging from how we can assess risks pre-construction and monitor impact post-construction to effective mitigation to policy and regulation. All of these areas remain in an early state of evolution, and, therefore, we thought this would be a good time to take a snapshot of our current knowledge.

In the first paper, we asked authors Douglas Johnson, Scott Loss, Shawn Smallwood, and Wallace Erickson to compare current approaches to measuring avian fatalities at wind energy facilities. Similarly, we then asked Cris Hein and Michael Shirmacher to review our current knowledge of the impact of wind energy on bat populations. In the third paper, we asked Edward Arnett and Roel May to provide an overview of our current knowledge on mitigating wildlife impacts at wind energy facilities. In the fourth paper, Todd Katzner, Victoria Bennett, Tricia Miller, Adam Duerr, Melissa Braham, and Amanda Hale provide an overview of methods used to assess risks to birds and bats, pre-construction. Similarly, M. Wing Goodale and Iain J. Stenhouse present a conceptual model for determining the vulnerability of wildlife to offshore wind energy development. This latter topic is a key issue leading to proper turbine siting, which many see as the most effective form of mitigation (Marques et al. 2014). Placing wind turbines away from sensitive, high-use areas for birds and bats would greatly help to reduce wildlife mortality. In the sixth paper, Manuela Huso, Dan Dalthrop, T. J. Miller, and Dawn Bruns discuss methodological challenges to assessing bird and bat mortality at wind energy facilities after they are constructed. Last, Michael Hutchins, Darin Schroeder, and Mike Parr provide an overview of the American Bird Conservancy's Bird-Smart Wind Energy Campaign, including a discussion of relevant policy issues and what can be done to find solutions. We conclude with a synthesis of the key issues raised by the authors, particularly those that were covered in the papers.

It is important that we find solutions to the current challenges surrounding wind energy development in the United States and globally. Wind energy may be 1 key to a sustainable future in energy production, but it is not without its drawbacks. Some politicians and conservation organizations have seemingly embraced wind power completely, without posing difficult questions about its impact on wildlife or its regulation or operation; this probably is due to their legitimate fears about climate change. However, for the future of our wildlife, we must make sure that green energy development is truly green, and that means minimizing its impact on our native wildlife and their habitats (Hutchins and Bies 2010). This can only happen through open and honest discussion and through science-based approaches to risk assessment, siting, valid evaluation of impacts, effective mitigation, and improved regulation. We hope that this special issue contributes to these goals.

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MICHAEL HUTCHINS is director of Bird Smart Wind Energy Campaign for the American Bird Conservancy.

He earned his Ph.D. degree in animal behavior at the University of Washington–Seattle, in 1984, studying an introduced population of Rocky Mountain goats in Olympic National Park. Previously, he served as director of the William Conway Endowed Chair, Department of Conservation and Science, at the Association of Zoos and Aquariums for 15 years, and Executive Director and CEO of The Wildlife Society for 7 years. He has authored more than 250 articles and books on various topics in wildlife science, management, and conservation, and has traveled widely to pursue his passion for wildlife and habitat conservation.

BRUCE D. LEOPOLD received his B.S. degree from Pennsylvania State University in 1977, majoring in forest science.

He then received his M.S. degree in forestry with a minor in wildlife management from Mississippi State University in 1979. He later attended the University of Arizona and received his Ph.D. degree (1984) in wildlife ecology, studying desert mule deer ecology in Big Bend National Park, Texas. He began employment at Mississippi State University as an assistant professor in 1987, and in 2000, he was named head of the Department of Wildlife and Fisheries. Also during this time, he was co-director of the Berryman Institute. In 2012, he became executive director of the Center for Resolving Human–Wildlife Conflicts at Mississippi State University. In July, 2015, he retired from Mississippi State University. He is a member of The Wildlife Society, the Society of American Foresters, Phi Kappa Phi, Xi Sigma Pi, and the Boone and Crockett Club. His research interests include predator–prey relationships, habitat management and quality assessment, wildlife biometry, population ecology, wildlife population monitoring, computer applications, forest-wildlife management, and resolving human–wildlife conflicts. He is author or co-author of 163 peer-reviewed journal articles, and numerous other publications. Currently, he is co-editing a textbook on North American wildlife policy and law.