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ESSAY

Thinking globally and siting locally – renewable energy and biodiversity in a rapidly warming world

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Abstract Increasing greenhouse gas emissions are projected to raise global average surface temperatures by 3°–4 °C within this century, dramatically increasing the extinction risk for terrestrial and freshwater species and severely disrupting ecosystems across the globe. Limiting the magnitude of warming and its devastating impacts on biodiversity will require deep emissions reductions that include the rapid, large-scale deployment of low-carbon renewable energy. Concerns about potential adverse impacts to species and ecosystems from the expansion of renewable energy development will play an important role in determining the pace and scale of emissions reductions and hence, the impact of climate change on global biodiversity. Efforts are underway to reduce uncertainty regarding wildlife impacts from renewable energy development, but such uncertainty cannot be eliminated. We argue the need to accept some and perhaps substantial risk of impacts to wildlife from renewable energy development in order to limit the far greater risks to biodiversity loss owing to climate change. We propose a path forward for better reconciling expedited renewable energy development with wildlife conservation in a warming world.

1 Introduction

Rapid, large-scale expansion of low- and zero-carbon renewable energy sources is essential for limiting the magnitude of global warming and its impacts on wildlife (Clemmer et al. 2013). Expansion of renewable energy leads to concerns in the conservation community over harm to wildlife populations from injury and death of individual birds and bats or from fragmentation of species' habitat (e.g., Arnett & Baerwald 2013; Kiesecker et al. 2011).

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Threats to wildlife can be reduced by strategic siting and operation, yet the threat of global extinctions rises the longer it takes to reduce carbon emissions (e.g., Warren et al. 2013). Consequently, efforts to expand renewable energy at the needed scale should factor in both (a) the potential for direct harm to species' local populations and (b) the reduction in global biodiversity loss from limiting global warming.

Here we present core issues of this challenge in order to motivate a needed dialogue across conservation and renewable energy communities about determining the acceptable level of uncertainty in the impacts of renewable energy development on wildlife in a world facing high-magnitude warming. We focus on wind energy, but our broader argument applies to other sources of renewable energy. Difficult choices need to be made, and time is of the essence for a dialogue that addresses how to ensure the conservation of wildlife with the need for rapid and deep cuts in greenhouse gas emissions.

2 Threat of climate change

Even if we stabilized atmospheric concentrations of heat-trapping gases at today's levels through immediate and deep reductions in emissions, surface temperatures would continue to rise for decades as excess heat now contained in the deep ocean is released to the atmosphere. Adapting to further climate change is unavoidable, but the risks of potentially catastrophic warming can be reduced through deep and sustained cuts in emissions.

The U.S. and other nations agreed to take actions to limit warming below a 2 °C increase in global average surface temperature above pre-industrial levels (Copenhagen Accord 2009), but actions and pledges by major emitters have fallen far short of what is needed to achieve this goal (World Bank 2012). Future warming most likely will exceed the 2 °C target (Sanford et al. 2014).

The Intergovernmental Panel on Climate Change (IPCC) reports that a "large fraction" of species around the globe "face increased extinction risk under projected climate change during and beyond the 21st Century" particularly when the synergistic effects of climate change with other anthropogenic impacts such as habitat loss and fragmentation and invasive species are taken into account. (Scholes et al. 2014). According to the IPCC, the risk of extinction owing to climate change is projected to increase regardless of the scenario used to project future climate change, but the fraction of species at risk will be greater as the magnitude of temperature change increases. For example, most of the world's biodiversity is concentrated in the tropics. Under medium to high magnitude warming, tropical species (characteristically, with quite limited physiological tolerance to changes in climate) will experience monthly average temperatures that exceed historic bounds before 2100 (Mora et al. 2013).

3 Need for significant renewable energy expansion

Limiting the magnitude of warming to ~2 °C will require swift and deep reductions in heat-trapping emissions. Assuming comparable actions by other nations, the U.S. would have a carbon budget equivalent to emitting no more than ~170-200 Gigatons of carbon dioxide between 2012 and 2050, a level consistent with the goal of reducing U. S. emissions by 83 % below 2005 levels by mid-century (NRC, 2010). A large proportion of these reductions will come from the power sector, and meeting this emissions goal will require extensive expansion of renewable energy (Fawcett et al. 2009; Clemmer et al. 2013). Staying within the U.S. carbon budget, for example, will require expansion of land-based wind energy from 60 GW in

2012 to 330–440 GW in 2050, and offshore wind expansion from zero currently to 25–100 GW; estimates for solar energy in 2050 range from 160–260 GW for photovoltaic and 20–80 GW for concentrated solar (Clemmer et al. 2013).

4 Potential wildlife impacts of renewable energy expansion

All forms of low-carbon electricity production have environmental impacts, and the potential impacts of wind energy and solar energy development on wildlife have been the subject of multiple reviews (e.g., NRC, 2007; Arnett et al. 2008; Strickland et al. 2011; Lovich & Ennen 2013). Collision fatalities of birds and bats have been reported at all wind energy facilities where data are publicly available (Strickland et al. 2011); raptors and bats appear to be relatively more vulnerable to collision. Projections of fatality levels under aggressive build-out scenarios raise the concern that reported fatality levels are not sustainable for some of these species (e.g., Johnson & Erickson 2011; Arnett & Baerwald 2013). Concern has been expressed about the large land area needed to achieve emissions reduction targets described above (McDonald et al. 2009). Disturbances associated with renewable energy development may cause displacement of sensitive species from otherwise suitable habitat or lead to demographic decline due to effects on breeding success or survival, but the few studies evaluating these effects have not produced definitive or consistent results either within or among species (e.g., Pearce–Higgins et al. 2012; Lovich & Ennen 2013; Sandercock et al. 2013).

Uncertainty regarding the magnitude of impacts to wildlife from renewable energy development have been influential in siting decisions to date (e.g. BLM 2013) and growing concerns about this potential but unknown risk threaten to undermine the pace and scale of renewable energy development needed to achieve emissions reduction targets.

5 Proposed framework

We opened this paper with a simple proposition: efforts to expedite renewable energy expansion while protecting biodiversity need to factor in both (a) the potential adverse impacts of renewable energy siting and operation and related transmission on wildlife and (b) the reduction in extinction risk from avoided emissions and high-magnitude warming. A framework to achieve these objectives includes

1. Continuing efforts to strategically locate and operate renewable energy projects to minimize impacts to wildlife from such development
2. Understanding the potentially far greater risks to global biodiversity from increased extinction owing to unlimited climate change, and
3. Acknowledging that research will not eliminate uncertainty regarding wildlife impacts in advance of the scale of development needed to limit global warming.

Several initiatives are underway to avoid and minimize wildlife impacts of wind energy development, which may constitute up to 50 % of the total renewable energy development by 2050 (e.g., Mai et al. 2012). The U. S. Fish and Wildlife Service released voluntary guidelines for siting land-based wind energy and for developing eagle conservation plans, thus, providing a legal framework for companies to avoid and minimize impacts to species vulnerable to wind energy development (USFWS 2012; USFWS 2013b).

In 2008 the American Wind Wildlife Institute (www.awwi.org), a partnership among the wind industry, scientific community, and conservation organizations, was formed to foster research and develop tools to promote timely and responsible wind energy development that minimizes impacts to wildlife and wildlife habitat. To address specific concerns about bats, the Bat Wind Energy Cooperative (http://www.batsandwind.org/), a collaboration of the wind industry, Bat Conservation International, and the Department of Energy, was formed in 2003 and has tested mitigation strategies that may reduce bat fatalities by 50 % or more (e.g., Arnett et al. 2013). The multi-partner Sage Grouse Collaborative was established in 2010 and implemented a research framework to determine the impact of wind energy development on this species at multiple sites (National Wind Coordinating Collaborative NWCC 2010).

Incorporating the risks of climate change into siting decisions could lead to decisions that do not appear to be precautionary with respect to biodiversity impacts when only the first of our propositions, avoidance and minimization of local impacts, is considered. For example, in December 2013 the Service finalized an amendment to the 2009 Eagle Rule that extended the duration of programmatic take permits up to 30 years (USFWS 2013a). By allowing a 30-year permit length under certain conditions, the Service made the Eagle Rule more compatible with the long-term assurances requested by the wind industry because of the need to secure funding and lease agreements for developing projects. This revision has been opposed by some in the conservation community because of concerns that longer permit lengths are not compatible with our level of knowledge about eagles or the threat of wind energy development to eagle populations (e.g. American Bird Conservancy 2013).

The predicted and devastating impacts of climate change on biodiversity need to be incorporated into the risk calculus of renewable energy development in ways that they are not today. Even as the conservation community partners with the wind industry to minimize impacts of siting renewable energy, it will be necessary to accept some, and perhaps substantial uncertainty about the risk to wildlife populations if we are to limit the greater risks of global extinctions from unlimited climate change.

Aggressive renewable energy development is essential to both limiting climate change and protecting wildlife. Achieving the needed expansion of renewable energy in the face of concerns about wildlife risks will require (1) a shared understanding among key stakeholders of the scale and pace of renewable energy siting needed to help limit the wildlife impacts of climate change, (2) application of the best available science to renewable energy siting – science that informs an understanding of both the local near-term wildlife risks of siting and the longer-term, global extinction risks of climate change, and (3) a policy framework and timely process for siting decisions that supports renewable energy expansion while taking the full suite of risks and uncertainties into account. We intend this paper to catalyze a series of structured dialogues among industry, wildlife conservation advocates and policymakers in support of this goal.

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