Upscaling Individual Effects of Wind Energy to Population Impacts on Wildlife

POPULATION IMPACTS OF WIND ENERGY DEVELOPMENT

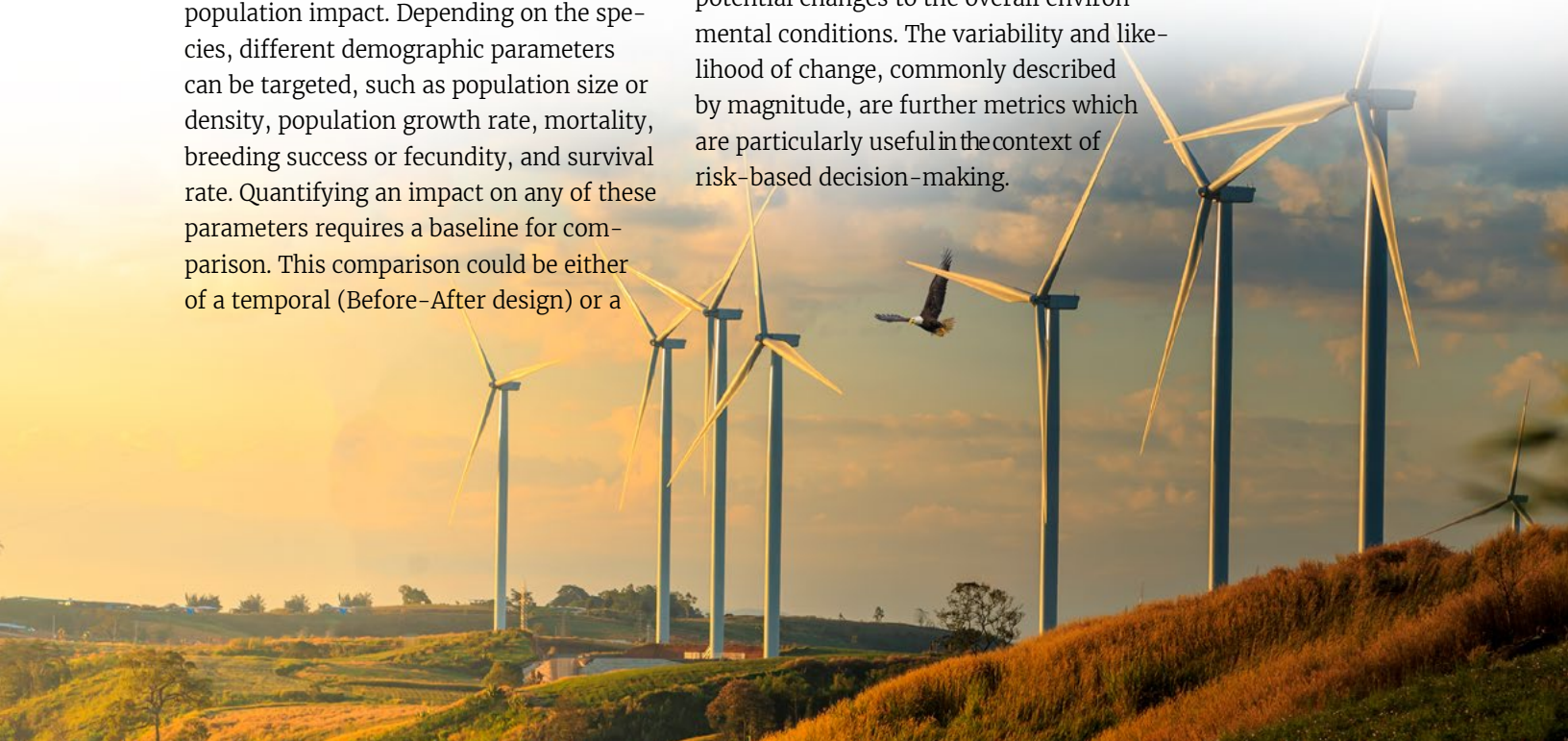
Wind energy (both land-based and offshore) provides significant benefits such as climate change mitigation, associated benefits to human health, and energy diversification. However, adverse interactions with wildlife have been documented at many facilities worldwide, especially for birds, bats, and marine mammals. Depending on the magnitude of effect on the fitness of an individual, coupled with the number of affected individuals, these interactions may or may not ultimately lead to reduced survival, reduced reproduction, and increased mortality at the population level. Licensing frameworks generally focus on assessing the effects on individuals within a rather restricted temporal and spatial range. Yet from a conservation point of view, there is a need to upscale these effects to the level of the broader population that these individuals are part of. Such a shift in decision-making processes is an essential step to balance the costs of wind energy on wildlife with socio-economic benefits in a sustainable and socially acceptable way. The WREN nations prepared a white paper, based on the literature, to provide an overview of how population impacts are measured and predicted, and how impact thresholds can be established for decision-making.

EFFECTS VS. IMPACTS

It is important to distinguish between the effects wind energy developments have on individuals and how these ultimately impact populations. Effects relate to any change in the survival probability of an individual due to disturbance, barrier effects, and direct injury or mortality. Impacts occur when the vital rates (reproduction, mortality, survival) for the population these individuals are part of are changed.

ASSESSING POPULATION IMPACTS

For wind energy projects, one of the greatest challenges pertains to the definition, prediction, and detection of a population impact. Depending on the species, different demographic parameters can be targeted, such as population size or density, population growth rate, mortality, breeding success or fecundity, and survival rate. Quantifying an impact on any of these parameters requires a baseline for comparison. This comparison could be either of a temporal (Before-After design) or a spatial nature (Control-Impact design). A combination of these study designs (BACI-designs) generally allows for more robust conclusions since they better account for potential changes to the overall environmental conditions. The variability and likelihood of change, commonly described by magnitude, are further metrics which are particularly useful in the context of risk-based decision-making.



Various statistical and modeling techniques are available to predict impacts during pre-construction assessment, the most basic one being extrapolating available data across larger areas and time frames. More sophisticated approaches such as matrix population models allow forecasting of future population growth rates through linear algebra and can be used in population viability analyses to compute the risk of extinction of a population. More recently, individual-based models have been developed, which simulate processes such as birth, death, and movements of all individuals within the model domain in discrete time steps. Although very powerful, such models remain computationally intensive and require extensive datasets.

SETTING IMPACT THRESHOLDS

Once a significant change in demographic parameters has been detected, its relevance for the decision-making process has to be determined. While measured impacts for a population in good conservation status under limited development scenarios may be considered negligible, the cumulative impact as the number of wind-power plants increases may become unacceptable relative to the benefits of development. Ultimately, the central question that needs to be answered by decision-makers is how to set impact thresholds to assess whether an impact is deemed acceptable. Three distinct types of thresholds can be distinguished: ecological, utility, and decision. Ecological thresholds are triggered by a shift in the dynamics of a system (e.g. turning the growth rate of a population negative) and are usually estimated from population models.

Utility thresholds are triggered by a shift in the value of a management outcome. A good example is the maximum harvest rate achievable without depleting a population (e.g. using the method of Potential Biological Removal). Lastly, decision thresholds are the set of conditions that should prompt a management response. Generally, these decisions will be informed by ecological and/or utility thresholds.

No matter which methodological approach is taken to assess population-level impacts or how thresholds are set, a key consideration from a policy perspective is the reconciliation of precautionary approaches with risk-based approaches. Acknowledging the environmental and demographic stochasticity inherent in population dynamics along with the imperfect nature of any model is important when assessing potential impacts on species of concern.

RECOMMENDATIONS

The extent to which project-based thresholds can ensure population perseverance at larger spatial and temporal scales remains unclear. It has been suggested that the impacts of renewable energy are small relative to other anthropogenic activities. However, rapid and large-scale utilization of renewable energy resources challenges our ability to anticipate (and subsequently verify) the accumulated impacts on populations from wind-power plants and their related infrastructure over large geographical regions. The use of adaptive management, which aims to reduce scientific uncertainty while managing a given natural resource, may promote the adoption of assessments at the population level to balance the development of wind energy with the persistence of wildlife populations adequately.

You can find the full text of the population impacts assessment review online online on Tethys: WREN Individuals to Population white paper.

POPULATION DEFINITION

A population can be defined as "a group of individuals from the **same species** which live in the **same space** at the **same time** and reproduce". It is important to define the spatial and temporal boundaries of the population, as well as consider the conservation status and regional importance of the population from a national or biogeographic perspective. To reconcile differing interests of stakeholders, impacts should be assessed at a regional scale larger than a single wind energy development and an intermediate timeframe that allows for recovery after decommissioning (e.g. 50 years).

May, R., Masden, E.A., Bennet, F. & Perron, M. 2019. Considerations for upscaling individual effects of wind energy development towards population-level impacts on wildlife. Journal of Environmental Management, 230: 84-93. https://doi.org/10.1016/j.jenvman.2018.09.062 US Department of Energy (DOE). pp 46.

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WREN Working Together to Resolve Environmental Effects of Wind Energy

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