



Estimating risks to wildlife populations is important during planning and operation of wind energy facilities. Yet methods for evaluating the relative risks of alternative plans for wind farm design and management are still in early stages of development (Ram 2009). We present a proposed framework for assessing and managing wildlife risks at wind energy facilities.

Objective

Develop a risk assessment modeling framework for evaluating risks to wildlife by integrating 1) habitat analysis from a landscape perspective, 2) modeling to predict wildlife mortality from turbine encounters, and 3) population-level risk assessment and mitigation.

Why Population Modeling?

Population models can be used to extrapolate *observed* or *estimated* mortality, growth, and reproductive effects on individual organisms to population-level endpoints, such as abundance, population growth rate, age/size structure, and spatial distribution pattern (Pastorok et al. 2001; Forbes et al. 2010).

- Population models provide ecologically relevant endpoints and are already in use for evaluations under the Endangered Species Act (ESA) (Figure 1)
- Population models integrate multiple stressors (e.g., turbine strikes; human activity-disturbance of wildlife) to assess cumulative effects
- Population models are applicable to spatially explicit assessments using GIS and analyses of the distributions of individual organisms (e.g., individual-based models)
- Risk estimation based on population modeling yields value-relevant output (e.g., reduced wildlife population abundance, increased extinction risk) that can be used in cost-benefit analyses to support management decisions concerning siting of facilities and mitigation actions

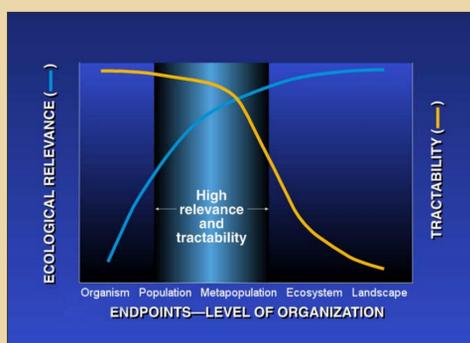


Figure 1. Evaluation of Modeling Endpoints Based on Ecological Relevance and Tractability

A Proposed Framework

Within our proposed risk assessment framework (Figure 2), key steps associated with wildlife risk estimation and mitigation include:

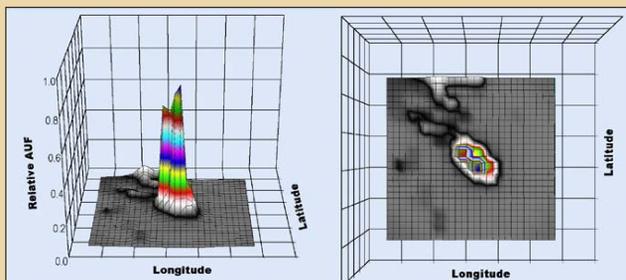
- Identifying wildlife species at risk, characteristics of wind energy facilities and other stressors, and value-relevant endpoints (e.g., reduced wildlife abundance, increased extinction risk)

- Characterizing wildlife use of habitat at landscape scales (Figure 3)
- Predicting wildlife movements with desired precision in a seasonal and spatial context
- Weighing various factors that affect wildlife encounter rates with turbines
- Developing reliable models to predict encounters and associated mortality rates
- Extrapolating rates of wildlife mortality, reproductive effects (if any), and habitat impacts to express risks in terms of value-relevant endpoints at the population level.

We propose a landscape-level GIS-based model to analyze the distribution and quality of habitats, wildlife corridors, meteorological data, and other factors to provide a basis for wildlife risk assessments at wind energy facilities.

Combining the output of a landscape-based analysis of encounters with population projection models allows extrapolation of estimated mortality rates to population endpoints and associated risk expressions. Once developed, this framework can be easily transferred among facilities.

Data-poor situations may be addressed by collection of critical site-specific data, sensitivity analysis of models based on alternative scenarios, and relative risk assessment.



Source: Mackay (2000)
Figure 3. Example Area Use Factor (AUF) for a Wildlife Species Based on Habitat Characteristics and Field Observations

Landscape Connectivity Model

We have developed a GIS-based model to evaluate habitat patches and connectivity (e.g., migration corridors) between them. Habitat patches are defined and quality indices are developed relative to the facility site and the region. Distance measures between patches may include 1) minimum edge-to-edge distance between patches, 2) radius-corrected centroid-to-centroid distance, and 3) centroid-to-centroid distance (Figure 4).

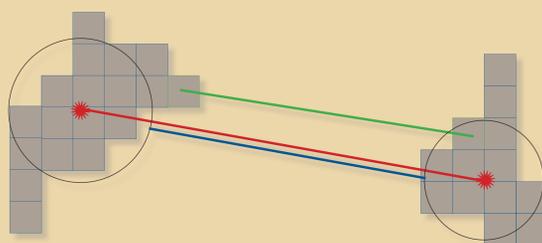


Figure 4. Analysis of Distance between Habitat Patches

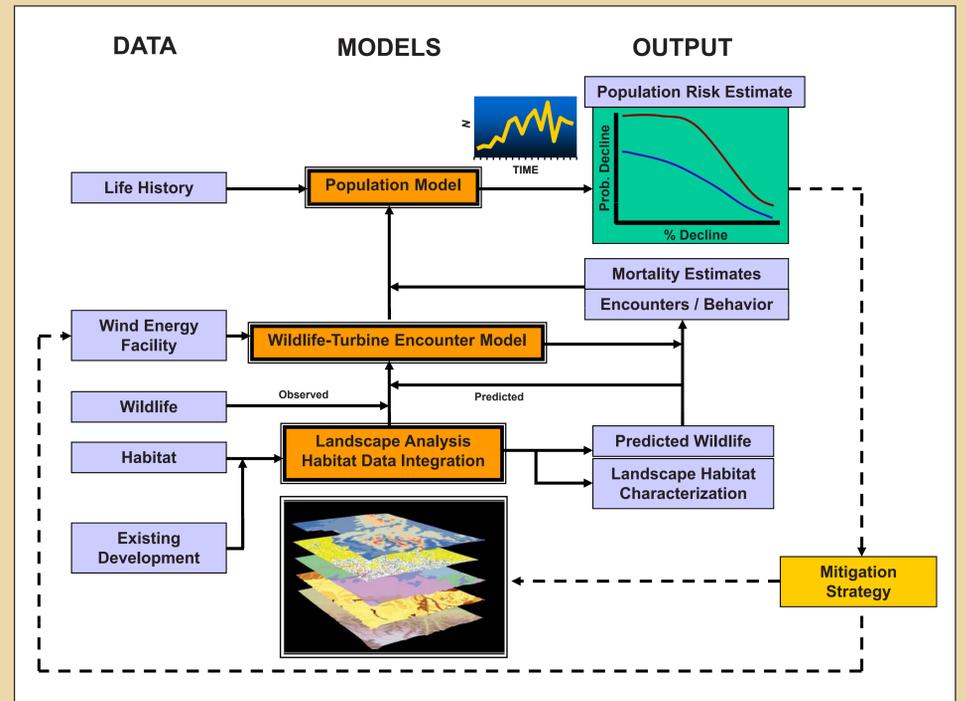


Figure 2. A Proposed Risk Assessment Modeling Framework for Evaluating Wind-Wildlife Interactions and Mitigation Strategies

Habitat patch values are analyzed relative to a landscape by considering four species-specific factors (Figure 5). Habitat values and connectivity can be incorporated into models of wildlife encounters with wind turbines as well as evaluations of plans for siting facilities.

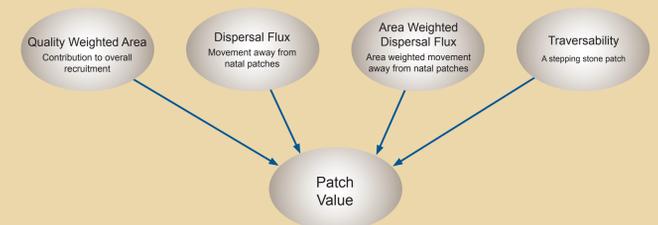


Figure 5. Four Factors Considered in Estimation of Habitat Patch Value

Conclusions

Endpoints resulting from a population-level risk analysis include increased extinction risk, which cannot be inferred directly from simple measurement of mortality rates, but is important for compliance with existing regulations (e.g., ESA). An evaluation of habitat patch connectivity is essential to estimating the distribution and movements of wildlife for input to encounter modeling and population risk assessment. Using a wildlife risk modeling framework to integrate empirical data and modeling results within an adaptive management framework will improve risk assessments and management decisions for wind power development and facility operation.

References

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