The Role of Population Modeling in Risk Assessment at Wind Energy Facilities

R.A. Pastorok
D.V. Preziosi
M.E. Behum
Integral Consulting Inc.

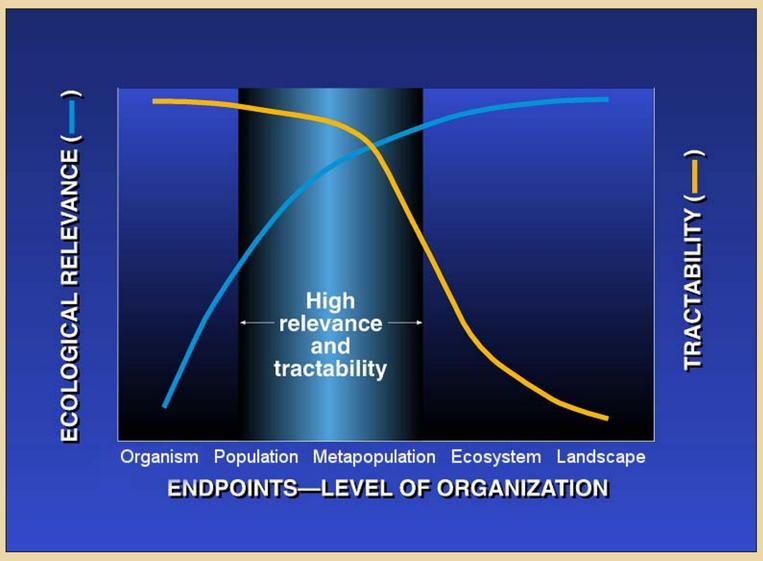
Population modeling is an important tool for assessing risk to wildlife populations subject to multiple stressors associated with wind energy facilities (e.g., interpreting increased fatality rates, habitat fragmentation). Our objective is to demonstrate ways in which population modeling can support risk management of wind energy developments at various spatial scales. Data on fatality rates alone without using population modeling can be a reasonable starting place for comparing potential impacts. As a sole indicator, however, fatality rate is a weak metric because a given level of fatality produces vastly different demographic impacts among species due to variation in life-history characteristics. We present a framework for incorporating population modeling into tiered risk assessments and risk management for the wind energy industry.

Why Conduct Population Modeling?

Population modeling provides a basis for ecologically relevant assessments. Moreover, population risk estimation is the basis for evaluations under the Endangered Species Act, which is relevant for the potentially most vulnerable species. Current approaches are limited because:

- Mortality estimates can be difficult to interpret without evaluating their population-level effects.
- Effects of life-history variation among species preclude simple criteria for allowable mortality.
- Population demographic responses are not directly related to fatality rate because of compensatory processes and multiple stressors acting on populations.

Therefore, population risk is not directly related to mortality or habitat fragmentation metrics.

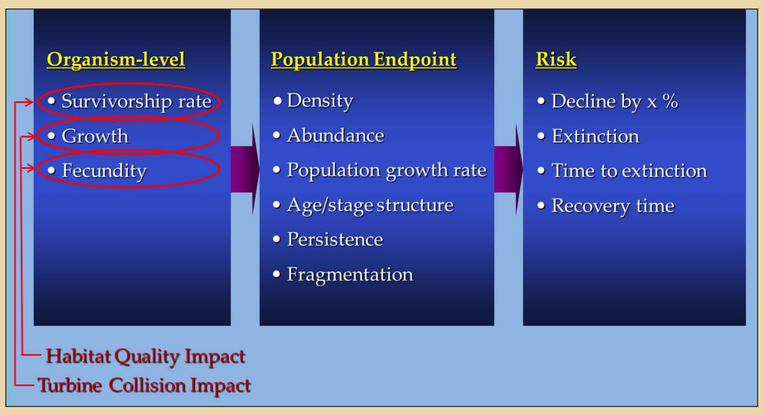


Population or meta-population modeling is preferred over modeling at other levels of organization because it:

- Provides an assessment at a relevant ecological scale
- Integrates multiple stressors and cumulative effects, e.g.,
  - Turbine impact mortality
  - Habitat loss
  - Reproductive effects
- Is amenable to spatially explicit assessments using GIS and individual-based models.

How is Population Modeling Used in Ecological Risk Assessment?

Population modeling integrates multiple stressors and extrapolates organism-level vital rates to population endpoints. Whether the application is at project, regional, or national scale, selection of population-level endpoints and the risk expression is critical.

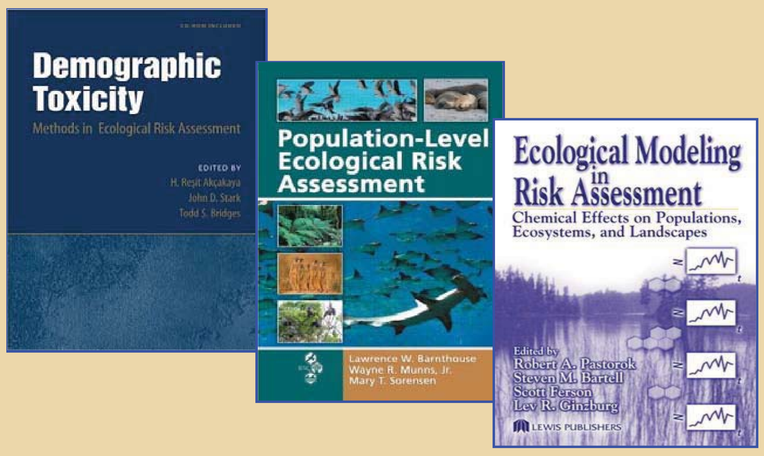


How Can Population Modeling be Used in Wind Energy Development?

Population modeling can be a valuable tool to:

- Identify vulnerable species
- Evaluate alternative plans for energy development
  - Different sites
  - Turbine design
  - Operational modes
  - Mitigation strategies
- Gain insight to mechanisms of population regulation, compensatory processes, and potential effects of management actions
- Evaluate relationships between avoidance of sites/ turbines and population demographics
- Assess relative importance of direct and indirect effects
- Conduct cumulative assessments at watershed, regional, or continental scale.

Population risk estimates are one metric entered into a weight of evidence approach for risk characterization. Guidance on modeling is available from applications in conservation biology and other fields.



Issues of Spatial-Temporal Scale

Population models are adaptable to different spatial-temporal scales and need not always be applied to a continental population. Problem formulation may specify comparative risk assessment or selection of relative risk metrics, such as reduction in carrying capacity, that help minimize the need for collecting new demographic data. Model applications may be at the scale of:

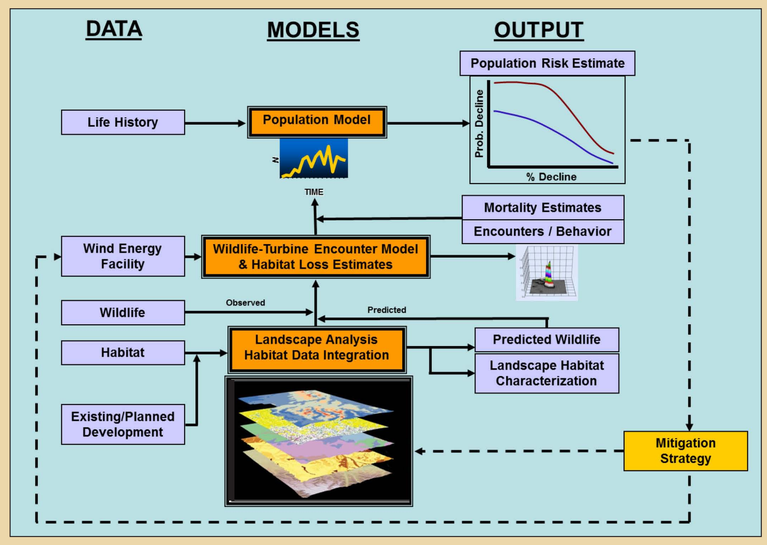
- Individual projects
- Watersheds
- Regions
- Continental populations.

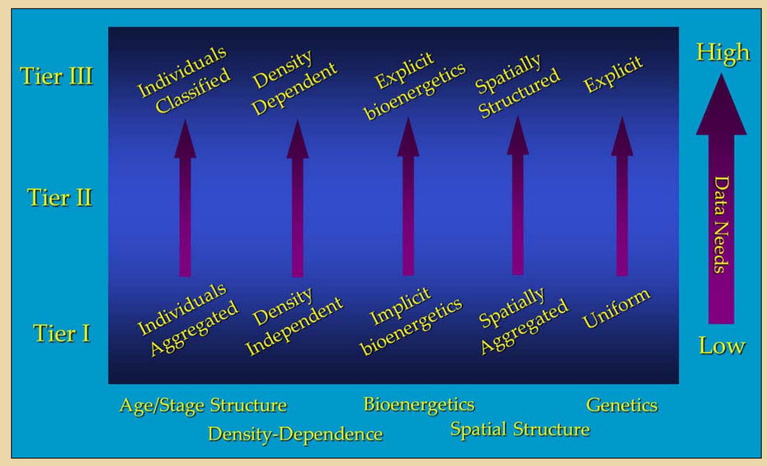
Proposed Framework for Wildlife Population Modeling at Wind Facilities

Elements of the proposed Population Modeling Framework include:

- Wildlife habitat analysis from a landscape perspective
- Characterization of wildlife-habitat relationships and interactions (e.g. avoidance or attraction) with the site and turbines
- Turbine encounter modeling to predict bird and bat mortality
- Life-history analysis and specification of population model(s)
- Increasing complexity/realism of models within a Tiered Risk Assessment
- Population-level risk analysis/mitigation.

Guidance for modeling also should include identification of resources, such as libraries of available models and data useful for parameterizing models.





Conclusions

- Population modeling can be a valuable tool in planning, design, and operational monitoring evaluations of wind energy developments.
- Available models can be readily adapted for comparative risk assessments, but site-specific applications may require some data collection and model validation.
- A variety of population models is available and guidance is needed to define which models are best for addressing specific issues.