An Individual-Based Model to Assess the Cumulative Impacts of Wind Energy Development on Greater Sage-Grouse

Kirk LaGory, Yuki Hamada, Paul Tarpey, Cory Weber
Environmental Science Division, Argonne National Laboratory, Argonne, IL 60439

Argonne NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Abstract

A spatially explicit individual-based model (IBM) was developed to estimate the cumulative effects of wind energy development on the greater sage-grouse *(Centrocercus urophasianus)* in Albany County, Wyoming. Seasonal habitat suitability maps were generated using geospatial data of environmental variables and information about the species' habitat usage as a template. The IBM incorporates the species' unique life history and habitat preferences for seven age-sex classes. The model estimates population size and distribution based on individuals' habitat selection and resultant reproduction and mortality rates that are based on the expected impact of infrastructure. Three wind development scenarios were used to demonstrate the model. The results suggest a strong relationship between the location and configuration of development, the habitat suitability, and the size and location of the sage-grouse population.

Introduction

In order to achieve the vision of 20% wind energy by 2030, issues associated with potential impacts on ecological resources resulting from wind energy development must be addressed. In particular, wind energy and associated transmission system development affect wildlife populations through direct mortality, habitat fragmentation, habitat degradation, and disturbance. Although individual projects may have little effect on the sustainability of wildlife populations, cumulative impacts can be significant.

Objective

Develop a landscape-based modeling framework that considers the cumulative impacts of prospective wind energy development in the western U.S. on critically important wildlife species to facilitatate smart development that minimizes ecological impact.

Species

Greater Sage-Grouse *(Centrocercus urophasianus)*

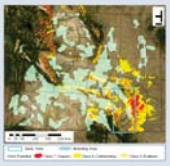
Photo Courtesy of DOE/NREL, Credit - Lulley Parker

- Sagebrush *(Artemisia spp.)*-obligate gallinaceous bird
- Once occupied much of the northwestern U.S.
- Significant population decline coincides with energy development in the western U.S.
- Characterized by complex life history (e.g., movements between seasonal ranges and strong site fidelity)
- Disrupting the annual life cycle could result in significant impacts on the species' range.

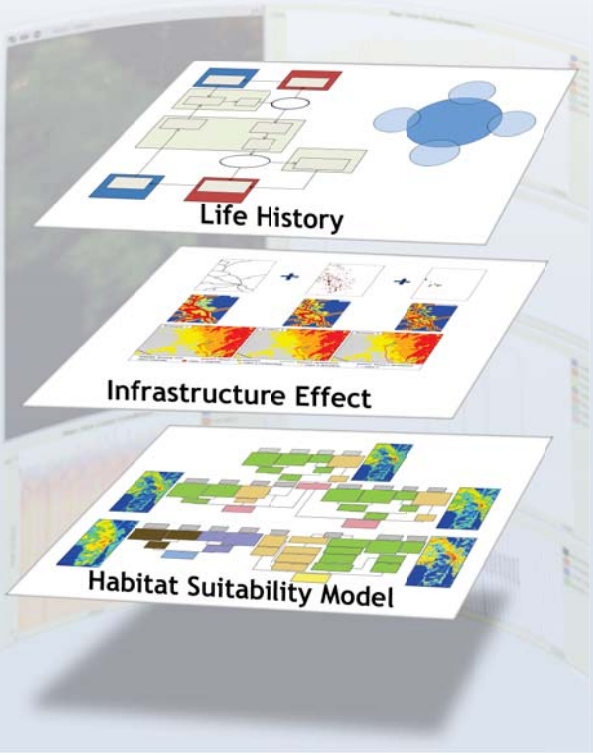
Study Area

Albany County

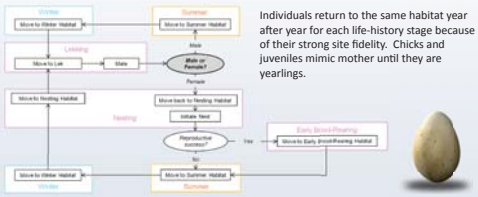
- One of the highest wind energy potential regions that overlaps with an important breeding habitat for sage-grouse
- Approximately 11,000 km^2
- Sagebrush-dominated shrubland/steppe mixed with grassland
- Support agriculture and oil and natural gas development



Greater Sage-Grouse Individual-Based Model



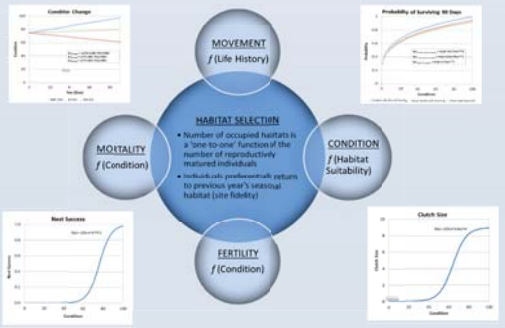
Life History of Greater Sage-Grouse



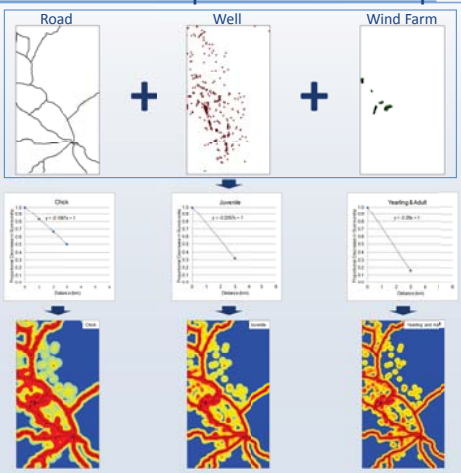
Individuals return to the same habitat year after year for each life-history stage because of their strong site fidelity. Chicks and juveniles mimic mother until they are yearlings.

Processes at the Individual Level

'Habitat Selection' is the core process in IBM. Four other processes revolve around Habitat Selection.

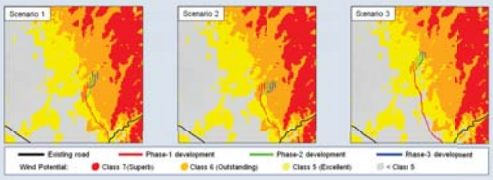


Infrastructure Impact on Survivorship

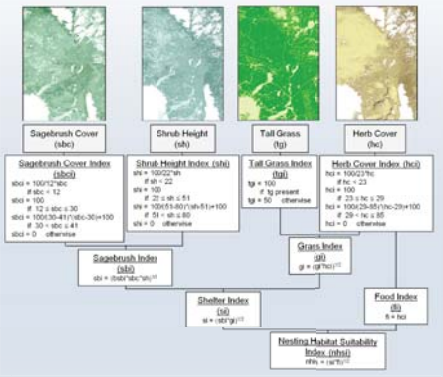


Wind Development Scenarios

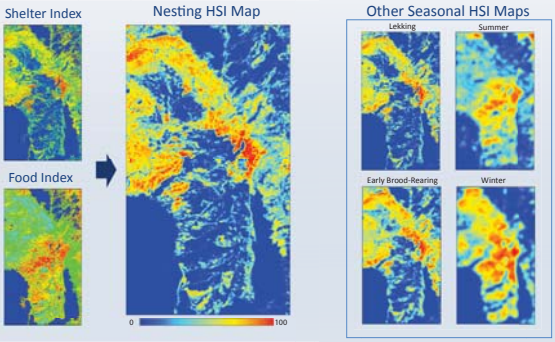
Wind development scenarios were patterned after existing wind farms in Albany County.



Habitat Suitability Model

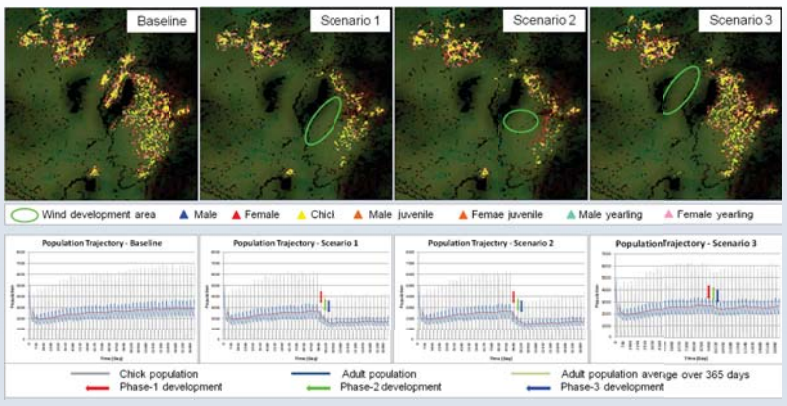


The habitat suitability index (HSI) consists of multiple key components, which are characterized using environmental variables. Boolean logic, piecewise linear functions, and geometric mean were used to compute HSI. Five distinct habitat suitability models were developed to generate habitat suitability maps.



Results

All scenario outputs indicate displacement of sage-grouse from the developed area due to decreased suitability and loss of habitat, which imposes a reduction in survivorship. Population is also reduced in surrounding areas, presumably because of the effects of infrastructure on survivorship and habitat suitability. Scenarios 1 and 2 (comparable location with varying turbine configuration) would result in similar population trajectories and spatial distributions. Scenario 3 (the equivalent configuration to Scenario 1 placed in a different location) would exhibit a very different population-level effect. This may suggest that, at least in these cases, location of development was more important than spatial configuration of infrastructure for determining development effects on sage-grouse.



Conclusion

Our IBM has the potential to provide users with valuable insights into the potential impacts of wind development on greater sage-grouse. The model provides information for planning and siting processes while proactively assessing impacts on wildlife species. This analysis would assist Department of Energy (DOE), wind energy developers, and permitting authorities in planning for dispersed but potentially extensive development in critically important wildlife areas.

Future studies include but are not limited to:

1. Applying the model for a larger area using an alternative platform,
2. Integrating impacts of multiple infrastructure types, and
3. Refining the model using information being collected on sage-grouse and related species.

Acknowledgments

The project was funded by DOE's office of Energy Efficiency and Renewable Energy (EERE), Water and Wind Power Program. Geospatial data utilized for habitat suitability models are courtesy of U.S. Geological Survey.

Argonne National Laboratory's work was supported by the U.S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Wind and Water Power Program, under contract DE-AC02-06CH11357.