A Habitat-Based Wind-Wildlife Risk Tool With Application to the Upper Great Plains Region

Greg Forcey, PhD
Pandion Systems, Inc
October 20, 2010
Objectives

• Develop spatial collision models based on biological and environmental variables
• Model output: maps of relative predicted collision mortality for each species
• Can be adapted to other geographic areas
• Increase understanding of wind turbine/wildlife interactions
This map shows the annual average wind power estimates at 50 meters above the surface of the United States. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.

**Wind Power Classification**

<table>
<thead>
<tr>
<th>Wind Power Class</th>
<th>Resource Potential</th>
<th>Wind Power Density at 50 m</th>
<th>Wind Speed at 50 m</th>
<th>Wind Speed at 50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Fair</td>
<td>300 - 400</td>
<td>6.4 - 7.0</td>
<td>14.3 - 15.7</td>
<td></td>
</tr>
<tr>
<td>4 Good</td>
<td>400 - 500</td>
<td>7.0 - 7.5</td>
<td>15.7 - 16.8</td>
<td></td>
</tr>
<tr>
<td>5 Excellent</td>
<td>500 - 600</td>
<td>7.5 - 8.0</td>
<td>16.8 - 17.9</td>
<td></td>
</tr>
<tr>
<td>6 Outstanding</td>
<td>600 - 800</td>
<td>8.0 - 8.8</td>
<td>17.9 - 19.7</td>
<td></td>
</tr>
<tr>
<td>7 Superb</td>
<td>800 - 1600</td>
<td>8.8 - 11.1</td>
<td>19.7 - 24.8</td>
<td></td>
</tr>
</tbody>
</table>

*Wind speeds are based on a Weibull k value of 2.0*
Wildlife Data

• Birds:
  – Breeding: North American Breeding Bird Survey
  – Winter: Christmas Bird Counts
  – Migration: eBird Data - Quality Controlled

• Bats:
  – Known habitat associations from the literature
  – Natureserve range maps
Environmental Data

• Weather
  – National Climate Data Center

• Topography
  – National Elevation Dataset

• Land Use
  – National Landcover Dataset 2001

• Forest Stand Age
  – Canopy Height and Biomass data

• Behavioral
  – Known seasonal behaviors from literature
General Approach - Birds

- For each species for each season

Bird Data

Hierarchical Model

Predicted Abundance Maps

Exposure Factors (behavior, topography, weather)

Seasonal Collision Model

- For each species

4 X Breeding Collision Model + 4 X Winter Collision Model + 4 X Migration Collision Model = Final Species Collision Model
Modeling - Birds

• Modeling bird abundance as function of land use
• Hierarchical spatial modeling approach within Bayesian framework
• Nuisance effects for time, space, and observer

\[
\log[\lambda(s)] = \sum_{k=1}^{n} \nu_k(s) + Z_k(s) + \omega_k(s) + \eta I(s) + \gamma_k(s) + \varepsilon_k
\]
Model Validation

- Compare model predictions with observed results
  - Using withheld data (~20% of total)
- Compare predictions to other mapped models
General Approach - Bats

• For each species for each season

- Bat Habitat Preferences
- Landcover
- Moving Window
- Maps of Preferred Habitat
- Exposure Factors (behavior, topography, weather)
- Seasonal Collision Model

• For each species

- 3 X Summer Collision Model
- 3 X Winter Collision Model
- 3 X Fall Migration Collision Model
- 3 X Spring Migration Collision Model
- Final Species Collision Model
Modeling - Bats

• Models are based on known habitat preferences
• Define habitat features that influence occurrence
  – Forest %
  – Forest Edge Density
  – Forest Stand Age
  – Open Water %
  – Distance to Water
  – Riparian Flyways
Modeling - Bats

• Moving window analyses quantify the landscape within a defined window size
  – 2-km and 10-km moving window sizes
  – Computationally intensive

• Resulting grids are specific to 1 land use variable each
Moving Window Results - Example
Modeling – Birds and Bats

• Behavior
  – Determine if species has behaviors that increase exposure (e.g., aerial foraging, courtship, nocturnal migration)

• Weather
  – Derive grids of weather variables thought to increase exposure (e.g., fog, rain, wind, temperature)

• Topography
  – Identify areas of high slopes
Acknowledgements

• DOE
  • Nick Johnson
  • Melissa Luken
• Technical Advisory Group
  • Wayne Thogmartin
  • Kevin Martin
  • Ted Weller
  • Jane Ledwin

• Pandion
  – Christian Newman
  – Crissy Sutter
  – Caleb Gordon
  – Jim Newman

• GIS Associates
  – Rich Doty
  – Carlos Fortich
  – Jason Teisinger

• Matt Krogh
• Tyson Waldo