An Evaluation of Study Design, Biases, and Limitations of Pre- and Post-Construction Studies

Wally Erickson
Outline

• Pre-Construction Studies
• Post-Construction Studies
Pre-Construction Studies

- Diurnal Avian Use Surveys
- Raptor Nest Surveys
- Radar Surveys
- Bat Surveys
Examples: Pre-Construction Objectives

• Quantify to the relative abundance of birds in the project area
• Use to predict a range of mortality anticipated from the project
• Document presence/absence of a rare species
• Collect quantitative data pre-construction that will be compared to post-construction data to estimate an impact from the project (e.g., displacement)
Avian Use Surveys

- Surveys focusing on quantitative measures of utilization primarily for large birds (raptors, waterfowl etc.)
  - Hawk-watch type surveys or point count surveys
  - Predict Impacts
  - Micro-siting
Annual Raptor Use

Raptors

Wind Energy Facility
Diurnal Avian Use Surveys

• Limitations
  – Viewshed differences
  – Distance bias
  – Use vs. abundance
  – Migrant vs. Resident
  – Different time durations

• Comparing similar metrics among sites is strength
Raptor Nest Surveys

• Ground vs. aerial
• Coniferous forest methods vs. open habitat
• Small sample sizes for effects at individual Projects
• Most studies are before/after designs
Nests move over time
Can compare sites in terms of nest density
Note: These data are preliminary and are not guaranteed to be accurate or complete. Please contact Jim Watson, WDFW (watsojww@dfw.wa.gov) before citing.
Marine Radar Methods

• **Strengths**
  – Sees at night
  – Accurate flight height information
  – Comparability among sites
  – Confirmation of broad-front migration

• **Weaknesses**
  – No true target identification
  – No species identification
  – No correlation with post-construction fatality
  – Technology Effects
    • Power of unit, automated vs. manual data collection, range, etc.
  – Detection bias 3-Dimensional
Marine Radar Studies for Wind Projects in the U.S.

Note: Map does not contain all radar studies conducted.
Radar Metrics

• Passage Rate – expressed as:
  number of targets / km of migratory front / hour.

• Target Flight Direction – expressed as:
  mean direction (compass bearing) of travel

• Target Altitude or Flight Height – expressed as:
  meters above ground level or above radar level

• Percent of targets occurring below 125 meters altitude.
Radar Assumptions

• A target is one or more migrating bird or bat.

• Insects and other non-avian/bat targets can be removed from the data set.
  – screened with either data from the radar or observer criteria

• Radar viewsheds between studies are similar.
  – both horizontally and vertically

• Equipment and settings produce similar returns.
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**Mean - East Studies**

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Predictability of Impacts from Radar Studies

- Few studies with radar and mortality
- All sites show targets migrating through
- Most sites show low % of targets at rotor heights and below
- Confirmation of broad-front hypothesis
- Mortality of migrants relatively low
  - No large events at wind projects
  - Comm. Tower research suggests structures < 500 feet not very risk
  - Turbines are getting larger
Bat Emergence
NEXRAD

Reflectivity

Radial Velocity

dBZ

Knots
Nexrad Applications

- Investigate broad front hypotheses
- Relative comparisons of migration intensity
- Archived information – data from past
- Short-comings
  - 20 miles away from unit = 1000 ft above ground level
  - Target identification
Study Designs for Displacement/Avoidance Studies

- Impact/Reference Designs
- Before/After Designs
- Before/After Reference/Impact Designs
- Gradient Designs

![Graph showing Grassland Species](image)
• Reference/Impact Design
  – Assumes differences due to turbines, but differences in study areas confounded
Mountain Plovers at FCR

- Before/After Control Impact Design
Mountain Plover

- Mortality
- Initial Impression: Displacement
- Numbers inhabiting the wind plant site declined during construction:

![Graph showing estimated population size over time]

*Estimated Population Size*

*Construction Period*
However…

- Reference area numbers declined from 30 to 5 for the same period.
- Regional decline occurred during late 1990s at the Pawnee National Grasslands, Colorado (Fritz Knopf, USGS, pers. comm.).
GRASSLAND SONGBIRD DISPLACEMENT - Stateline

- Before/After Gradient Design
- Transects in suitable habitat perpendicular to strings
- Small-scale impact detected
- Confounding between temporary habitat impacts and displacement
Bat Surveys
Bat Surveys

• **Anabat/Weaknesses**
  – Yet to be shown to be a predictor
  – No species information
  – Use vs. Abundance
  – Small sampling viewshed
  – Habitat differences from pre to post construction

• Fatality results from nearby facilities “best” method for predicting impacts

• Bat call rates **may be** useful in predicting fatality rates in the absence of fatality data

• Mist-netting shows limited use – most fatalities are migratory species
Fatality Monitoring Objectives

- determine whether overall avian and bat fatality rates or raptor fatality rates are low, moderate, or high relative to other projects
- Determine whether raptor mortality is low, moderate or high
- Determine whether predicted mortality is a reasonable estimate
- Determine whether a wind project has a fatality problem
# Approximate search hours

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<th># Turbines</th>
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<th>non-migration</th>
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Values under migration and non-migration represent the interval between searches in days
Assumes 2 hours per search
• Negative correlation: fatalities and wind speed

\[ r = -0.60 \] for MEYERSDALE

\[ r = -0.30 \] for MOUNTAINEER
Variance in Fatality Estimates

- Turbine to turbine variation in observed fatality
  - General has been low
- Scavenging rates
- Observer detection

\[ m = \frac{C}{\pi} \]
Potential Biases in Field Methods

- Some casualties or injured specimens may land or move outside the search area
  - Solution 1: ignore, if a small percentage
  - Solution 2: estimate the percentage

Arrows indicate direction of possible bias.
Example Carcass Search Plot

130 m

87 m

63 m

Turbine Transects

Sampled Area

Unsampled Area

W N E S
Distribution of Distances from Bird Fatalities to Nearest Turbine

Nine Canyon
62 m rotor diameter
92 m to tip of blade

Distribution of Distances from Bat Fatalities to Nearest Turbine

Nine Canyon
62 m rotor diameter
92 m to tip of blade

Estimate <10% missed based on this distribution
Caution: Flat, mostly songbirds

Estimate <5% missed based on this distribution
Caution: Flat
Distribution of Bat Fatalities
Distribution of Bat Fatalities

![Bar chart showing distribution of bat fatalities in different categories. The chart compares fatalities in two distance categories (<40 m and >40 m). The categories are divided into humans (CA, MT, MY) and dogs. The chart indicates a higher percentage of fatalities in the <40 m category.]
Reference or Background

Mortality
Studies of Reference Mortality

• Buffalo Ridge, MN
  – Estimates of fatality rate at plots without turbines 1/3 of estimate at turbines

• Other examples, Montana site (Harmata, NREL), San Gorgonio, Buffalo Mountain
Potential Biases in Trials

- Experimental carcasses/trials may not represent wind turbine casualties
  - **Possible Problem:** Feather spots may be more or less visible than intact carcasses used in trials.
  - **Possible Problem:** Placement and number of carcasses not representative of real mortality (“scavenger swamping”)
  - **Possible Problem:** are small birds representative of bats? Thawed vs. Fresh
Feather Spots

Feather Spots considered as project-related fatalities
Variance in Fatality Estimates

- Turbine to turbine variation in observed fatality
  - General has been low
- Scavenging rates
- Observer detection

\[ m = \frac{\bar{C}}{\pi} \]
Probability of being Available and Detected

• Early formula \((m=(c*l/(t*p)))\) “ok” when interval greater than mean removal time
  – Modification used (remove \(l/t\))
• When mean removal time greater than interval, detection distribution assumption important
Fatality Monitoring Process
Detection Rates by Age of Carcass
Recommendations

- Do removal trials early to determine if changes to search interval are necessary
- If searcher efficiency low and scavenging high relative to search interval, estimates will be highly uncertain
- Need to do more trials with bats

\[ m = \frac{c}{\pi} \]
Searcher Efficiency - Dogs

- 71% - Mountaineer
- 82% - Meyersdale
- On average, ~2-4 times better than human observers
- In low visibility habitats, even higher