Birds, bats, and habitat

Amanda Hale

*Texas Christian University*

a.hale@tcu.edu

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In partnership with NextEra Energy Resources, we have been investigating wind-wildlife issues since 2008.

Wolf Ridge Wind, LLC in north-central Texas

- 75 1.5-MW turbines
- Field and lab studies underway since 2009
Impacts to wildlife

Direct
- Habitat loss
- Collision mortality

Indirect
- Contribute to habitat loss and fragmentation
- Disrupt migratory paths
- Displace wildlife
- Alter nesting success
Impacts to habitat

• Habitat impacts vary from site to site
• Turbines are typically sited 5 to 20 rotor diameters apart, so the turbines and associated infrastructure occupy a small fraction of the total wind facility
  – Less than 3.5 acres per MW are disturbed during construction
  – Less than 1 acre per MW are disturbed permanently
• Remainder of the land can be used for a wide range of activities
Direct effects on birds

- Collisions have been documented globally
- ~170 studies conducted at nearly 100 wind project are publically available for the U.S. & Canada
  - Reported fatalities for about 250 bird species
- Studies are not a random sample of all wind facilities or even of wind turbines within a single facility
  - Are the publically available data representative of what is really occurring?
- Fatality rates from most studies range from 3 to 5 birds per MW per year
  - For all species combined and adjusted for detection biases
Direct effects on birds

• Songbirds comprise more than 60% of turbine fatalities in the U.S. and Canada
  – Fatality peaks during spring and fall migration

• Diurnal raptors are also frequent fatalities
  – Flight patterns and hunting behavior

• Species with small populations, delayed maturity, long lifespans, and low reproductive rates are of most concern

• Cumulative effects are unknown
How many birds are killed?

- 68 studies, monopole turbines
- 140,438 – 327,586 annual bird collisions with turbines in U.S.
How many songbirds are killed?

- 116 studies in the U.S. and Canada; lattice and monopole turbines
- 133,993 – 229,765 annual songbird fatalities
- Fatality rates varied by biome
- Compared fatality rates to estimated population sizes
  - Black-throated Blue-warbler (*Dendroica caerulescens*) had the greatest estimated population effect (0.029-0.043% annual loss)
Wind turbine-bird mortality in context

Collisions with buildings
365 – 988 million birds killed annually in the U.S. (Loss et al. 2014)

Free-ranging cats
1.4 – 3.7 billion birds killed annually in the U.S. (Loss et al. 2013)

Collisions with communication towers
6.8 million birds killed annually in the U.S. and Canada (Longcore et al. 2012)
Indirect effects on birds

• In the U.S., the focus has been on prairie-chickens, grouse, and grassland birds
• Most studies investigated displacement from wind turbines
• Increasingly more data are available on breeding performance, nesting success, and adult survival
• Responses appear to be species-specific and site-specific
• Mechanisms are poorly understood
• High-site fidelity and the potential for habituation are a challenge
• Cumulative effects remain unknown
Greater Prairie-chickens and Greater Sage-grouse

• These species are sensitive to disturbance from roads, utility poles or lines, trees, oil and gas infrastructure, etc.

• Wind facility studies to date have shown neutral, negative, and positive responses

Greater Prairie-chicken (*Tympanuchus cupido*)

(Winder et al. 2013, 2014, 2015; Smith et al. 2017)

Greater Sage-grouse (*Centrocercus urophasianus*)

(LeBeau et al. 2014, LeBeau et al. 2017)
Large numbers of bat are killed at wind energy facilities world-wide

- In the U.S. and Canada most observed fatalities are migratory tree bats

  - 650,104 – 1,308,378 cumulative bat fatalities from 2000 to 2011 (Arnett & Baerwald 2013)
  - >600,000 bat fatalities in the U.S. in 2012 (Hayes 2013)
Increasing evidence that bats are attracted to wind turbines

Attraction hypotheses:

1. Wind turbines provide one or more resources
2. Bats misperceive turbines to be a resource
3. Bats just find wind turbines intriguing

• Videos show bats exploring and contacting monopoles, nacelles, and wind turbine blades
• Flight patterns are suggestive of foraging, roost investigation, mating behavior, and drinking behavior

Cryan et al. 2014
Management techniques to reduce impacts to wildlife

1. Pre-construction
   – Risk assessment
   – Siting

2. Post-construction
   – Evaluation of the impacts
   – Effective mitigation

3. New and improved regulations
Risk assessment and siting

• Macro-siting
  – Avoid high-risk sites for species or habitats of conservation concern
  – Avoid core areas for species at risk
  – Develop wind energy in disturbed landscapes

• Micro-siting
  – Avoid placing individual turbines near particular landscape features (along ridges or near wetlands) or known resources for target species (e.g., golden eagle nest)
  – Effectiveness is not well understood
  – Largely untested
Attraction may help explain why predicting risk to bats has been unsuccessful to date

- Pre-construction bat activity does not predict bat fatalities
- Ecological impact assessments fail to reduce risk of bat fatalities

n = 12 wind farms (Hein et al. 2013)

n = 29 wind farms (Lintott et al. 2016)
Strategies to minimize fatalities for birds

**Repowering:**

- Replace several small turbines with fewer, larger turbines

- Repowering the Altamont Pass Wind Resource Area in California could reduce mean fatality rates for raptors by 54% and for all birds by 65% (Smallwood and Karas 2013)

Photo by Steve Boland
Selective shutdown or curtailment:

- High raptor fatality rates have been observed in southern Spain near the Strait of Gibraltar (important migratory route)

- Selective shutdown of high-fatality turbines reduced Griffon Vulture mortality by 50% (de Lucas et al. 2012)
Strategies to minimize fatalities for birds

Golden Eagle (*Aquila chrysaetos*) fatalities at the Top of the World Windpower Project:

Several measures to reduce impacts:

- Carrion removal
- Tested radar technology to detect eagles
- Tested visual and sound deterrent devices to deter eagles from turbines

Current approach:

- Selective shutdown when eagles are in the area
  - Human observers
  - Camera system with machine vision (IdentiFlight detection technology)
Current mitigation strategies for bats

- **Siting restrictions**
  - Limit where wind facilities can be built
  - Setbacks from important bat habitats

- **Operational minimization**
  - Limit wind turbine blade rotation on low wind speed nights
    (e.g., Baerwald et al. 2009, Arnett et al. 2011)
  - Reduce bat fatality rates 50-93%
    (reviewed in Arnett et al. 2013)

**Downside:** Limit wind energy production
Efforts to improve mitigation strategies for bats

1) Refine operational minimization
   • Target when bats are active in the area
     – Not just wind speed, look at other variables such as temperature, wind direction, etc.
       (e.g., Martin et al. 2017)
     – Real-time acoustic monitoring to know when bats are near turbines
     – Regional weather patterns

Goal: Improve fatality reductions while limiting financial costs
Efforts to improve mitigation strategies for bats

2) Technological solutions that are being tested

• Acoustic deterrents
  Broadcast ultrasonic sound from wind turbines to deter echolocating bats from entering the rotor swept zone
  (Arnett et al. 2013)

• Dim UV light illumination
  Affect how bats see turbines (Gorresen et al. 2015)

• Texture coating for wind turbine towers
  Alter how echolocating bats perceive the surfaces
  (McAlexander 2013, Bienz 2015)

Goal: Fatality reductions without power loss
Acoustic deterrents

- Bat Conservation International is testing a new ultrasonic bat deterrent device with NRG Systems and three wind energy partners
- 2017: Tests are underway at 3 wind facilities in North America
- Devices are mounted on turbine nacelles
Acoustic deterrents

- Using thermal cameras to observe bats at turbines with nacelle-mounted devices
- Monitoring fatality with and without the devices operating
- Predict a significant reduction in bat fatalities when the devices are operating
Texture coating for turbine towers

― "DE-EE0007033 Texturizing Wind Turbine Towers to Reduce Bat Mortality"

Tasks
• Texture coating development
• Behavioral experiments with wild-caught bats in a flight facility
• Bat surveys at wind turbine towers
Texture coating for turbine towers

• Completed texture coating application to 2 turbine towers.
Texture coating for turbine towers

• Field test 2017...... stay tuned!

Predict: Bat activity will be higher at smooth compared to texture-treated towers
Research needs and recommendations
Research priorities:

1. Improved estimates of collision mortality
   • We don’t understand the biological significance of these impacts
   • Need standard criteria for monitoring, estimating, and reporting fatalities at wind energy facilities

2. Improved risk assessment
   • Quantitative models linking risk factors to fatalities are generally lacking
   • For those predictive risk models that have been developed, they need to be empirically tested
3. Continued investment in developing effective mitigation strategies

- Invest in technologies and solutions to reduce collision fatalities
  
  Rigorous assessment of the effectiveness of these technologies

- Focus on species or populations of most concern

- Focus on elucidating the underlying mechanisms for adverse impacts
  
  What about their ecology or behavior that puts them at risk?
Research priorities:

4. Promote coordinated research efforts
   • Encourage stakeholders to work together

5. Data must be publically available
   • Peer-reviewed publications and sharing of results
   • Central repository and database
   • May require an “incentive-based” approach with new opportunities for industry and law enforcement agencies
Recommended FAA lighting

- FAA recommends strobe or strobe-like lights that produce momentary flashes interspersed with dark periods up to 3 sec in duration
- A proportion of turbines are lighted (e.g., 1 in 5), firing all synchronously
- Red lights are commonly used

Current Approach:
- Songbird and bat fatalities at turbines with FAA-approved lighting are not greater than at unlit turbines (Gehring et al. 2009, Kerlinger et al. 2010, Bennett & Hale 2014)