

Population Impacts to Bats from Wind Energy Development

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Bat Populations

Population Size

- Understanding population size is essential for proper management & sustainability of a species
 - Determine the extent & severity of an impact
 - Assess the effectiveness of mitigation
- Many bat species are experiencing declines & range contraction in response to natural & human-induced stressors
- Bats have low reproductive potential & require high adult survivorship to avoid declines

Jones et al. (2009), O'Shea et al. (2016), Frick et al. (2019), Barclay and Harder (2003), Podlustsky et al. (2005)

Can we get population estimates for bats? Depends

- Cave-hibernating species
 - Roost in relatively large colonies
 - Known locations
 - Relatively easy to get population estimates
- Migratory tree-roosting species
 - Roost individually or relatively small groups
 - Dispersed across the landscape
 - Difficult to estimate population size



Effective Population Size (Ne)

- Ne = size of the ideal population that would experience the same amount of genetic drift (loss of genetic variation due to chance) as the observed population
 - Ne almost always < Nc (Census population)
 - On avg, Ne ~11% of Nc across animal populations
 - Influenced by variance in reproductive success, unequal numbers of males and females, fluctuations in population size
 - Genetic monitoring over time can reveal changes in Ne that reflect changes in Nc

Ne – Migratory Tree Bats

- Eastern red bat
 - Ne: 100,000s to 1,000,000s
 - Multiple paternity is common
- Silver-haired bat
 - Ne: 100,000s
- Hoary bat
 - Ne 1,000s to 100,000s
 - Stable or decreasing population







Korstian et al. (2015), Vonhof & Russell (2015), Pylant et al. (2016), Sovic et al. (2016), Ammerman et al. (2019)

Bats & Wind Energy

Impact of Wind Energy Development

- Land-based Wind
 - Estimated 100,000s bats killed each year
 - 78% of mortality from 3 species
 - Eastern red bats (22%)
 - Silver-haired bats (18%)
 - Hoary bats (38%)
- Offshore Wind
 - Know bats are active offshore
 - No method to estimate impact, but several technologies in development





Population-level Impact from Wind Energy?

- Frick et al. (2017) assessed the potential population-level impact of wind turbines on hoary bats
 - Mortality and installed capacity static from 2014 data
 - Growth rate of λ = 1.01
 - Starting population size 2.25 million (median from expert elicitation)
 - Model indicated a <u>90% population decline by 2050</u>
- EPRI (2020) updated models with buildout & minimization
 - <u>38% reduction</u> necessary to manage extinction risk for <u>2.25 million bats</u>
 - <u>88% reduction</u> necessary to manage extinction risk for <u>1 million bats</u>

Population Size Matters

- The population size dictates our response
 - Is minimization warranted, & if so at what level?
- Currently, there is no method to estimate Nc for migratory bats
- Need for a weight of evidence approach
 - 2 approaches: acoustics & genetics/genomics



Thermal image of a bat flying near a wind turbine. Courtesy of S. Weaver

Acoustic Monitoring

Alternative Approaches for Acoustic Monitoring

- North American Bat Monitoring Program (NABat)
 - Spatially-balanced sampling design that allows inference to unsurveyed areas
 - Options for mobile or stationary monitoring
 - Uses presence data, collected over years, to assess trends in bat populations
 - <u>https://www.nabatmonitoring.org</u>





NABat Master Sample

Probabilistic Sampling (GRTS)

- 10 x 10 km grid cells
- Spatially balanced
- Randomized
- All cells assigned GRTS ranking
- Priority = top 5% in GRTS order
- Allows for substitution/replacement
- Inference to non-surveyed cells
- NABat is still interested in data from non-priority cells



*NABat Training Presentation (<u>https://www.nabatmonitoring.org/resources</u>)



Selecting Points



<u>Goal</u>: Detect all species present in 10 x 10 km cell

2-4 detectors per cell

- 1 per 5 km quadrant
- Cover all habitat types Minimum 4 consecutive nights

Post migration, pre-volant young

Revisit annually

*NABat Training Presentation (https://www.nabatmonitoring.org/resources)

Learn More

- National Wind Coordinating Collaborative webinar
 - <u>https://www.nationalwind.org/tools-for-collecting-archiving-and-</u> visualizing-bat-monitoring-data/



- Defenders of Wildlife webinar
 - <u>https://vimeo.com/443169070/f6ca160219</u>



Potential Benefits

- Data not associated with a specific project site
- Effort/cost for multiple years of NABat monitoring may be equivalent to 1 year of standard acoustic monitoring
- Industry could provide funding to NABat in lieu of conducting standard pre-construction acoustic monitoring
 - Industry funds leveraged with other funds
 - Reduces complications of a company monitoring for multiple years (i.e., development & operations can change between companies)

Genetics/Genomics

Population Genetics

- Population Genetics can...
 - Estimate genetic diversity
 - Decreases in predictable ways when populations decline
 - Estimate current & historical Ne
 - Identify evolutionarily unique subpopulations
 - i.e., management units
 - Detect bottlenecks
 - Monitor population declines



Next Steps for Ne

- Previous studies estimating Ne were limited
 - Geographically only used a portion of the species' range
 - Temporally samples from a narrow period of time
- Need data from entire range & compare Ne from different times (e.g., between 10-year intervals)
- Focus on genomics to obtain better estimates of mutation rates
 - Increases number of markers
 - Greater power to estimate Ne
 - Greater precision to detect subtle patterns of differentiation

Current Studies

- USGS
 - Examining genetic variation in hoary bats collected in 2009–2010 & 2017–2018
 - Also published the hoary bat genome: <u>https://www.ncbi.nlm.nih.gov/assembly/GCA_011751065.1</u>
- University of Maryland
 - Characterizing genetic diversity, Ne, population structure for 3 migratory tree-roosting bats using data across entire range

Conclusions

- No single method can provide precise population estimates for migratory bats
- No option for quick results, but short-term investments can support long-term success
- Multiple lines of evidence, even if indirect, will be required to assess the status of bat populations (Rodhouse et al. 2019)
- Consistent long-term & geographically broad data collection
- Offshore Wind Industry can play a role by supporting bat population research



Thank you

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