Wind Wildlife Research Fund

RESULTS SUMMARY

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The Role of Regional-Scale Weather Variables in Predicting Bat Mortality and Bat Acoustic Activity: Potential for Use in the Development of Smart Curtailment Algorithms

A proof-of-concept study supported by the Wind Wildlife Research Fund explored the development of decision support tools that could inform targeted, proactive curtailment using regional-scale variables to predict increases in bat presence and collision risk.

Reducing bat mortality at wind energy facilities is a priority for wind-wildlife stakeholders. Curtailment (shutting down turbines) under certain conditions has proven to be effective in reducing bat fatalities. To date, two curtailment strategies show both promise and limitations. The simplest strategy, "blanket" curtailment during low wind-speed conditions, typically results in reduced collision risk but also results in unnecessary loss of energy production if turbines are shut down when bats are not present. "Smart" curtailment uses other variables, e.g., temperature and real-time acoustic activity measurements, to guide curtailment decisions, but unplanned curtailment resulting in unplanned reductions in power generation can complicate electrical grid management strategies. This study applied an approach previously used for forecasting bird migration based on weather data (BirdCast), and developed models using statistical and machine learning approaches to see if regional scale meteorological variables could predict increases in bat acoustic activity and collision risk to better inform curtailment. Given the scale of movements exhibited by bats during migration, a regional approach to smart curtailment could help identify trends that small-scale smart curtailment algorithms are not able to detect .

Find this document online at: https://awwi.org/resources/wwrf-regional-scale-weather-variables-in-predicting-bat-mortality-and-acoustic-activity/

STUDY OBJECTIVES

The primary objective of this effort was to perform a preliminary, proof-of-concept regional-scale analysis that employed statistical and machine learning approaches to develop two models that predict:

1. Bat fatalities as a measure of bat collision risk based on weather and geographic data.
2. Bat acoustic activity as a measure of bat occurrence based on weather, landcover, and geographic data.

Because acoustic activity has not been shown to predict bat fatalities at the project-level, these responses were modeled separately.

This study shows how, by providing a more comprehensive data set than previously available, the American Wind Wildlife Information Center (AWWIC) can be leveraged to help develop, evaluate, and target solutions that minimize wind energy's impact on wildlife. Investigators queried publicly available and confidential post-construction fatality monitoring data from U.S. wind projects housed in AWWIC to conduct this analysis. Data from total of 71 different wind facilities were used in this analysis.

KEY TAKEAWAYS

- This effort supports further exploration of smart curtailment algorithms that account for weather variables at a regional scale and highlights the importance of temperature as a potential predictor of bat activity.
- The models performed well, with the acoustic activity model outperforming the mortality model. Authors suggest that the difference in model performance could be attributed to:
  - Higher temporal resolution in the acoustic activity data set
  - The inclusion of landcover predictor variables for the acoustic activity model
  - Larger sample size available for the acoustic activity model

- Large datasets are necessary to apply the machine learning methodologies used in this study, but there is much more acoustic activity data available than fatality data. Collecting fatality data is an expensive and labor-intensive effort that is limited to areas where fatalities are occurring.
- The use of bat fatality data in the development of smart curtailment algorithms is complicated by the low temporal resolution that these data provide. Models like the one developed here are likely to improve if each fatality event had a time stamp to which specific weather variables could be tied.

NEXT STEPS

- This study focused on the Great Lakes region. Results suggest there is value in expanding the analysis to regions beyond to both improve our understanding of which weather and habitat factors best predict collision risk and to tailor smart curtailment approaches for individual regions.
- Application of these models at operational wind energy facilities will require additional research guided by this proof-of-concept study.
- While an expanded fatality dataset could improve the predictive ability of the mortality model, fatality data with the appropriate temporal and spatial resolution may be too expensive or unrealistic to acquire. Therefore, the authors suggest shifting the focus to the more readily available acoustic vocalization data.
- A potential pathway for strengthening the activity model would involve querying more acoustic data to identify whether the nights with increased fatalities line up with broader regional increases in bat activity.

STUDY RESULTS

The models predicted heightened bat acoustic activity and bat mortality from different variables. The variables that contributed the most to the predictive ability for each model were:

For bat acoustic activity (vocalizations):

1. Surface temperature
2. Water as a % of land-cover (within 2 km)
3. Hour after sunset
4. Ordinal date
5. Hour before sunrise

For bat mortality:

1. Longitude
2. Ordinal date
3. Latitude
4. Surface temperatures
5. Air temperatures

The acoustic activity model explained 73% of the variation in bat echolocation calls collected from audio recordings. Predictive performance varied between taxonomically explicit models (53-74%), with different variables occupying the top positions for different species of bats. Temperature was the top predictor in three of four acoustic activity models, but this variable exhibited distinct variation by taxonomy. The bat mortality model explained 44% of the variation in bat fatality data, but there was not sufficient data to develop taxonomically explicit mortality models.

CITATION

Farnsworth, A., K. Horton, K. Heist, E. Bridge, R. Diehl, W. Frick, J. Kelly, P. Stepanian. 2021. The Role of Regional-Scale Weather Variables in Predicting Bat Mortality and Bat Vocalizations: Potential for Use in the Development of Smart Curtailment Algorithms. AWWI Technical Report. Washington, DC. Available at www.awwi.org.