RENEWABLE ENERGY WILDLIFE | RESEARCH FUND

RESULTS SUMMARY 2025

Understanding Differences Between Collision Risk of Male and Female Bats of Different Species to Inform Minimization Strategies

A study funded by the Renewable Energy Wildlife Research Fund to provide bat collision data to better inform curtailment strategies and/or inform deployment of acoustic deterrent technology.

PROJECT OVERVIEW

The proportions of adult females and males in a bat population (i.e., the sex ratio) can profoundly influence its growth, size, and risk of extinction. Female bats are particularly important for the population growth and stability of bats because (1) most species have a polygamous mating system, (2) females carry, nurse, and raise young, and (3) depending on species, females may have multiple pups per litter. Understanding of the seasonal timing and geographic location at which female bats are killed at wind-energy facilities could be used to improve curtailment strategies to further maximize operating time and energy production and/or inform deployment of acoustic deterrents. Despite progress in assessing the sex of bat carcasses from wind-energy facilities, there is a need to revisit results from previous studies as they were primarily based on morphological sex determinations which have since been shown to be inaccurate for bat carcasses.

STUDY OBJECTIVES

Our objective was to use DNA to assess the sex ratios of Brazilian free-tailed bat, eastern red, evening, hoary, northern yellow, silver-haired, and southern yellow bat carcasses obtained from wind-energy facilities in the United States (U.S.). In particular, we aimed to identify the seasonal times and geographic locations of greatest female fatalities.

ANALYSIS

We used molecular techniques to determine sex of carcasses of the seven bat species obtained from wind-energy facilities in ten states across the U.S. Tissue samples used in this study were either collected during post-construction bat mortality studies (PCM) conducted by the authors or PCM studies conducted by others and provided to the authors by wind energy operators and consultants prior to or as part of a solicitation effort for this study. Our final dataset included sex determinations from molecular analysis of DNA from 4,445 bat carcasses from ten states for every year from 2009 to 2022, except 2015.


EASTERN RED BAT

We compared overall differences in total number of females and males by species with a Fisher's exact test, and we used a series of species-specific generalized additive mixed models (gamm) with random effects and generalized additive models (gam) without random effects with package mgcv to identify temporal and spatial patterns in the sex ratio data.

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KEY PROJECT FINDINGS/TAKEAWAYS

- From empirical counts we found overall proportion of females was significantly higher for silver-haired and southern yellow bats.
- After model selection, we found significant temporal patterns in proportion of female fatalities by week for Brazilian free-tailed, eastern red, evening, hoary, and silver-haired bats, but for Hoary bats it was only significant in Texas.
- The timing of highest proportion of female fatalities varied by species with a bimodal pattern of highest proportion of female fatalities in spring and late summer/early fall for eastern red and silver-haired bats, and spring and late fall for evening bats. Female Brazilian free-tailed bat fatalities were highest in September, whereas proportion of female hoary bat fatalities in Texas occurred in late July/early August.
- We only had samples for evening bats in Texas, and thus modeled spatial variability by county, and found more females were killed in LaSalle, San Patricio, and Bee Counties than in Hidalgo County, Texas.
- Proportion of female hoary bats found was significantly higher in Indiana overall.
- We did not find a temporal or spatial pattern in proportion of female fatalities for northern or southern yellow bats. Samples for both species were only provided from Texas likely due to their restricted ranges in the U.S.



NEXT STEPS

- As of June 2025, two manuscripts have been published in PeerJ and Global Ecology and Conservation (GECCO). Citations included below.
- While we found some spatial patterns of female fatalities, we generally lacked samples from many states where wind energy sites exist. Thus, we hope to obtain more samples from a larger geographic area for all the species assessed to improve our knowledge on spatial patterns associated with higher female fatalities. We also encourage operators to allow for tissues samples to be preserved for further analyses.
- Spring appears to be an important season for female fatalities for three of the species, which coincides with pregnancy and parturition for these bat species. Thus, impacts to females during this time could be more concerning for their populations and was a previously unknown pattern. Additional research on these impacts is recommended.
- Sites not under a curtailment or other minimization strategy requirement in the U.S. could use the discovered patterns to implement such strategies targeted at females for the times and places of the species with significant patterns reported during this study.

CITATIONS

Manuscript 1

LiCari ST, Hale AM, Weaver SP, Fritts S, Katzner T, Nelson DM, Williams DA. 2023. Understanding fatality patterns and sex ratios of Brazilian free-tailed bats (Tadarida brasiliensis) at wind energy facilities in western California and Texas. PeerJ 11:e16580 https://doi.org/10.7717/peerj.16580

Manuscript 2

Sara P. Weaver, Amanda M. Hale, David M. Nelson, Sarah R. Fritts, Todd E. Katzner, Austin S. Chipps, Jennifer M. Korstian, Sarah T. LiCari, Juliet J. Nagel, Dean A. Williams. 2025. Spatiotemporal patterns in sex ratios of bat fatalities at wind energy facilities in the United States, Global Ecology and Conservation 61:e03672 https://doi.org/10.1016/j.gecco.2025.e03672.