Drone surveys using thermal and acoustic sensors advance bat abundance monitoring efforts.

Estimating Bat Occupancy and Relative Abundance Using Drone-based Surveys

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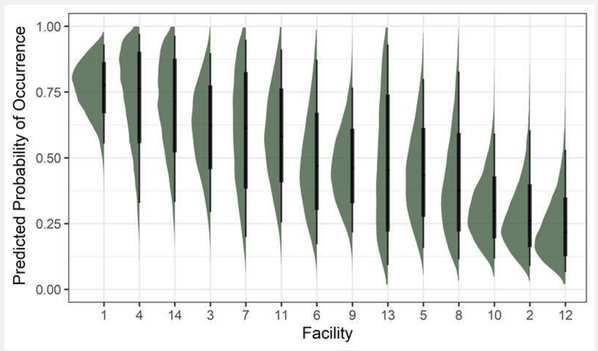
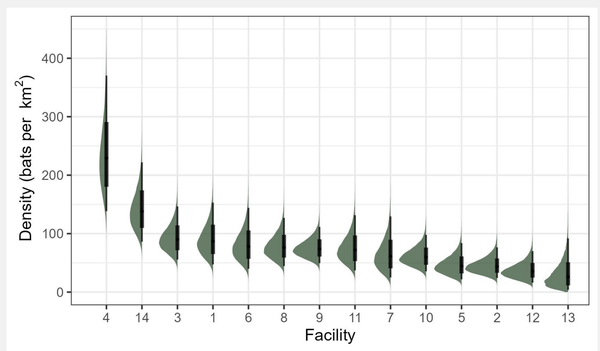
Occupancy

- *Bayesian occupancy model*



Relative Abundance

- *Bayesian N-mixture model*



Introduction

Objectives:

- Improve methods for detecting bats using drones
- Estimate bat occupancy and relative abundance

Methods

- Replication
  - Transects grouped into circular Drone Mission Units (DMUs)
  - Transects flown out and back
  - Thermal and acoustic detectors
- Two abundance models to allow comparison of results based on very different assumptions
  - **GLM:** detection probability constant across years
  - **N-mixture:** closure within 90 minutes in a DMU

Results

- Spatial and temporal replication allowed detection probability estimation
- Thermal imagery detected bats; acoustics missed bats
- Detection probability varied with time of night, temperature, and wind speed

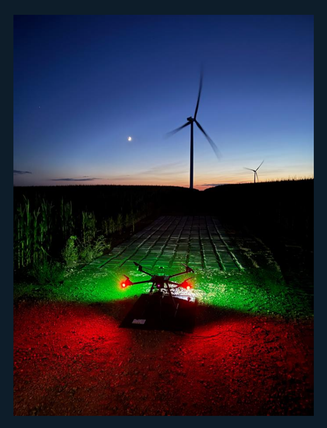
Discussion

Relative abundance may show a trend in abundance over time.

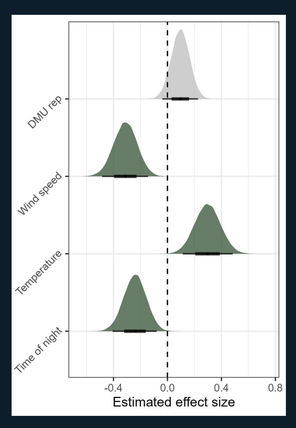
Advantages of drones for detecting bats:

- Incorporate visual detection to detect non-echolocating bats
- Minimize double-counting
- Survey airspace in the rotor-swept zone of the wind turbines
- Increase spatial coverage

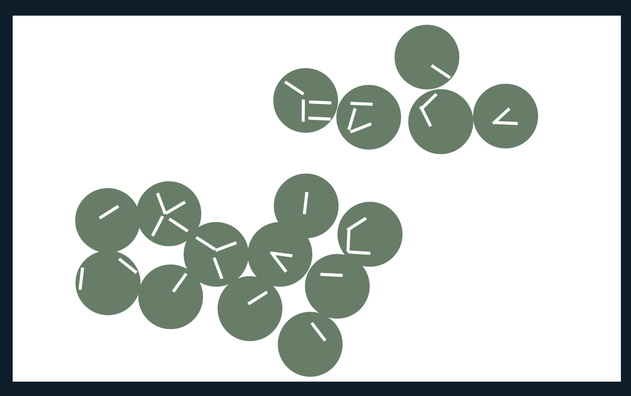
Extra Tables & Figures



Thermal and acoustic bat data were collected simultaneously during 0.5-kilometer flights using a custom-built, multi-rotor drone that was specifically engineered for collecting data on bat images and calls.



Acoustic detection probability coefficient estimates from the N-mixture model. Green indicates significant coefficient estimates. Detection probability increases with temperature, decreases with wind speed, and decreases throughout the night.



Drone Mission Units (DMUs), about 0.6-kilometer radius circles, provide spatial replication. We assume the bat population is closed during the 90 minutes in which the DMU is sampled, meaning if a bat is present in the DMU for one flight, it is present for subsequent flights in the DMU. This allows estimation of the detection probability.

Acknowledgements:

This work was supported by Electric Power Research Institute (EPRI), Persimia, LLC, MidAmerican Energy, and BHE Renewables

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