Patterns of Bat Activity and Mortality: Are Bat Activity and Fatality Best Predicted by Weather Measured On-site or Off-Site Regional Airports?

Rhett E. Good, CWB®

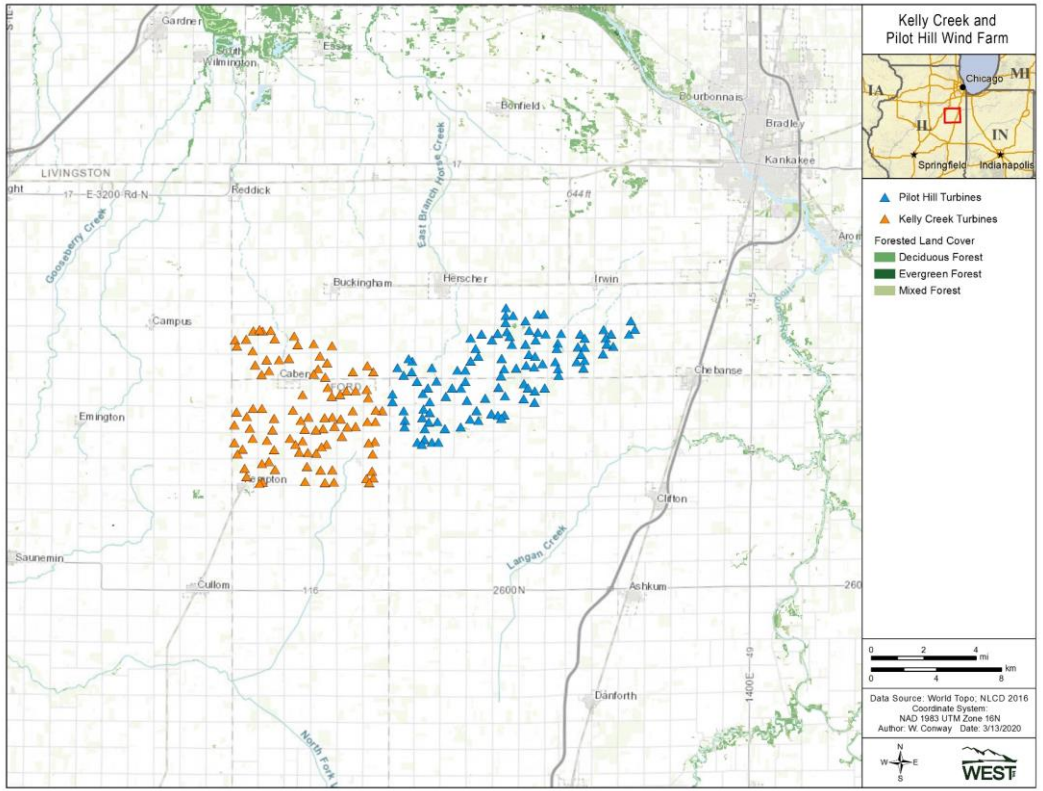
Presented by

WEST

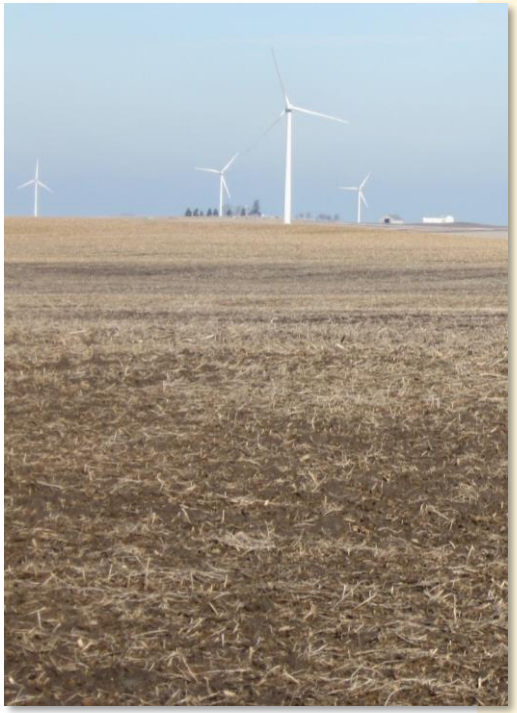
Western EcoSystems Technology, Inc.

west-inc.com

Project Description



Background



- Project located in corn and soy dominated areas; nearest significant forest is located 6-12 mi from the Project.
- No Indiana bats or northern long-eared were found in any search out of 1,865 total bat carcasses collected across both sites over 4 years
- Tree bat mortality unexpectedly high; 36-38 bats / turbine / year at Pilot Hill

Background

- Four years of prior research showed that using on-site weather data was not a great predictor of bat mortality
- Concurrent research on deterrents was being conducted and funded by EDFR; AWWI funding used to enhance ongoing research patterns of bat activity and mortality

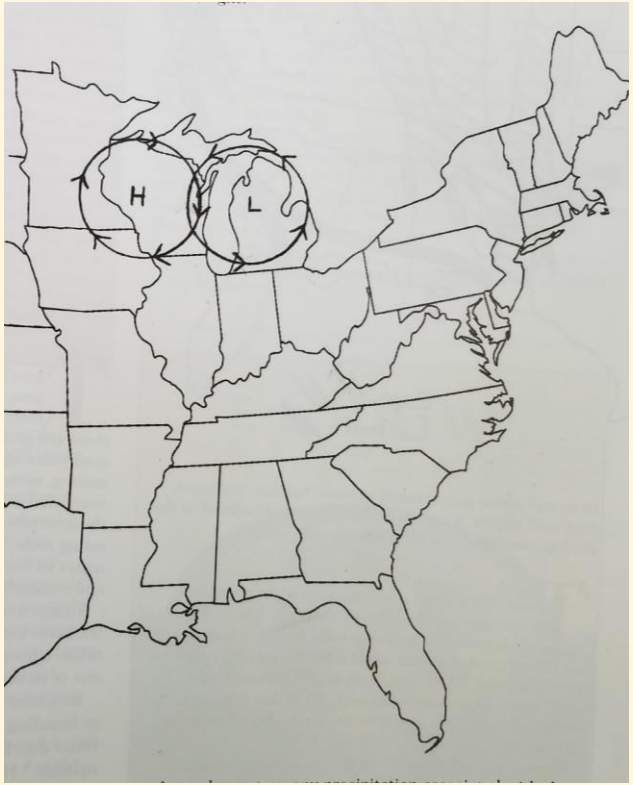
Field Methods

- Fifteen turbines were searched within 80 meters (m; 263 feet [ft]) of the turbine base at the PHWF; 10 of these were searched daily
- Anabat units mounted below nacelles at 13 turbines (9 at PHWF, 4 KCWF)

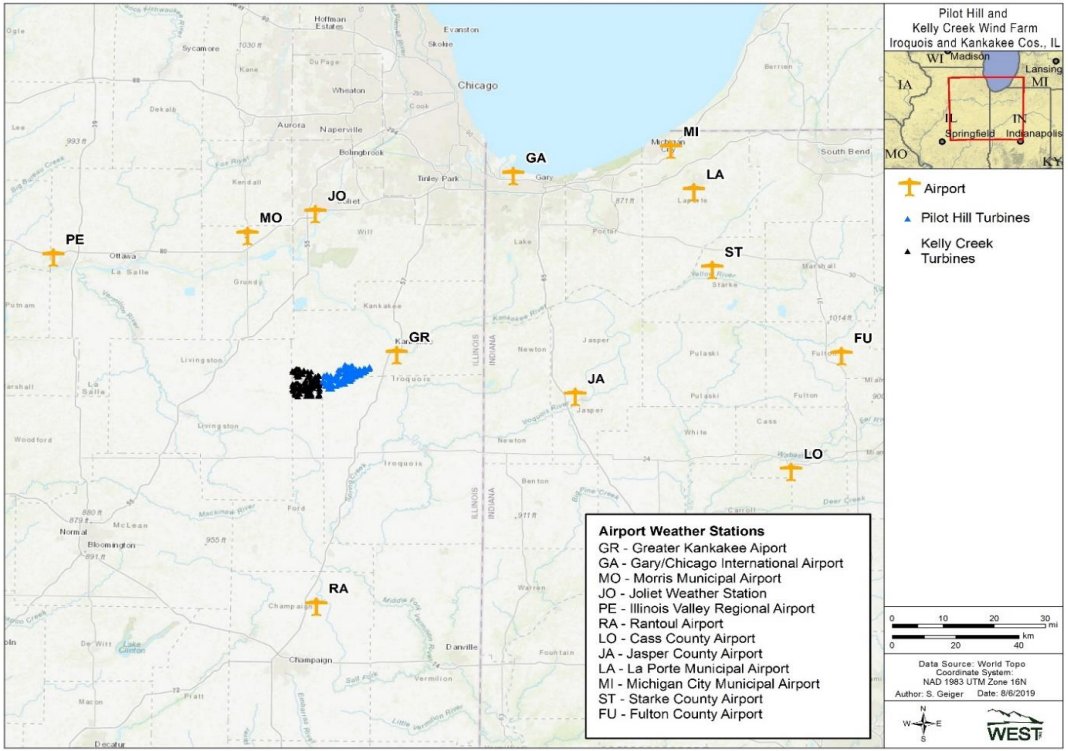
Objectives

- Determine if weather data collected at off-site locations would be a better predictor of bat activity and fatality than weather data collected on-site
- Identify if weather variables could be used to optimize curtailment by increasing energy production when bats were not present
- Determine if bat activity or fatality was concentrated in portions of the night

Can the Passage of Broad Weather Fronts Influence Bat Activity and Mortality?



Airport Weather Stations



On-site Predictor Variables

Table 3a. On-site predictor variables available for regression analysis.

Variable and Units	Use in the Model
Day of Study	as a continuous variable
Quadratic of Day of Study	as a continuous variable
Wind speed (meters per second [m/s])	as a continuous variable
Quadratic of Wind speed (m/s)	as a continuous variable
Air temperature (degrees Celsius)	as a continuous variable
Wind direction (compass degrees; measured at the meteorological tower)	Cardinal direction: N (315-45), E (45-135), S (135-225), and W (225-315)
Precipitation (millimeters)	as a continuous variable
Cumulative proportion of one night with no rain	as a continuous variable
Cumulative proportion of two nights with no rain	as a continuous variable
Cumulative proportion of three nights with no rain	as a continuous variable
Relative Humidity (percent)	as a continuous variable
Barometric Pressure (millibar)	as a continuous variable to account for barometric pressure changes from 1 hours, 2 hours, and 3 hours prior to the time stamps
Estimated Moonlight (Sunset to 1 AM)	as a continuous variable
Peak Moonlight (Sunset to Sunrise)	as a continuous variable

Off-site Predictor Variables

Table 3b. Off-site airport predictor variables available for regression analysis	
Variable and Units	Use in the Model
Barometric Pressure (millibar)	as a continuous variable to account for barometric pressure changes from 1 hours, 2 hours, and 3 hours prior to the time stamps with 0, 6, 12, 18 hour time lags
Wind Direction (compass degrees)	Cardinal direction: N (315-45), E (45-135), S (135-225) and W (225-315) with 0, 6, 12, 18 hour time lags

Statistical Methods

- Logistic regression used to predict migratory tree bat activity and fatality
- Activity data were divided into exploratory and validation data sets to test model performance; Fatality data performance measured using k-fold cross validation

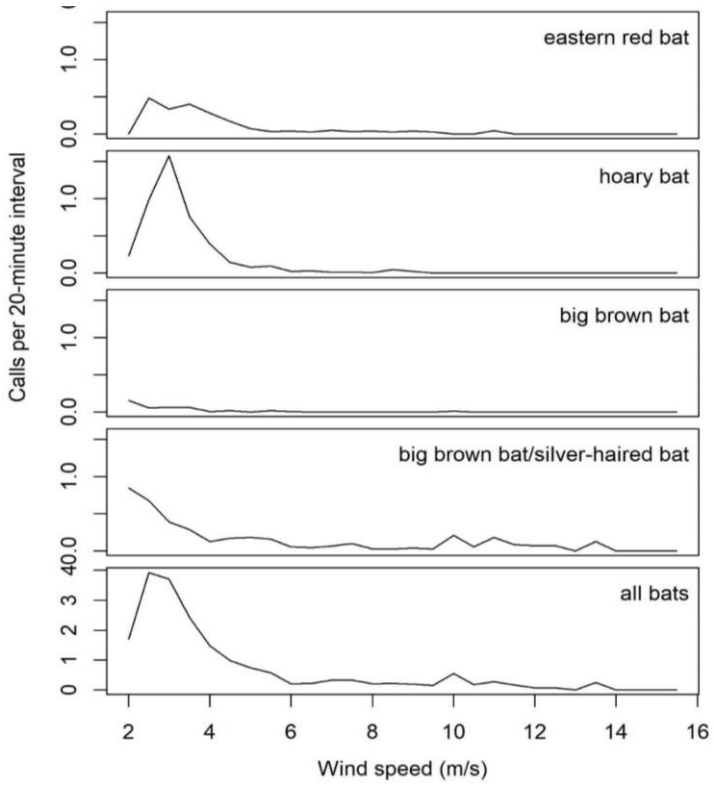
Pilot Hill Mortality Data – Previous Night Mortalities

- 85 eastern red bats
- 60 hoary bats
- 61 silver-haired bats
- 18 big brown bats
- 1 Seminole bat

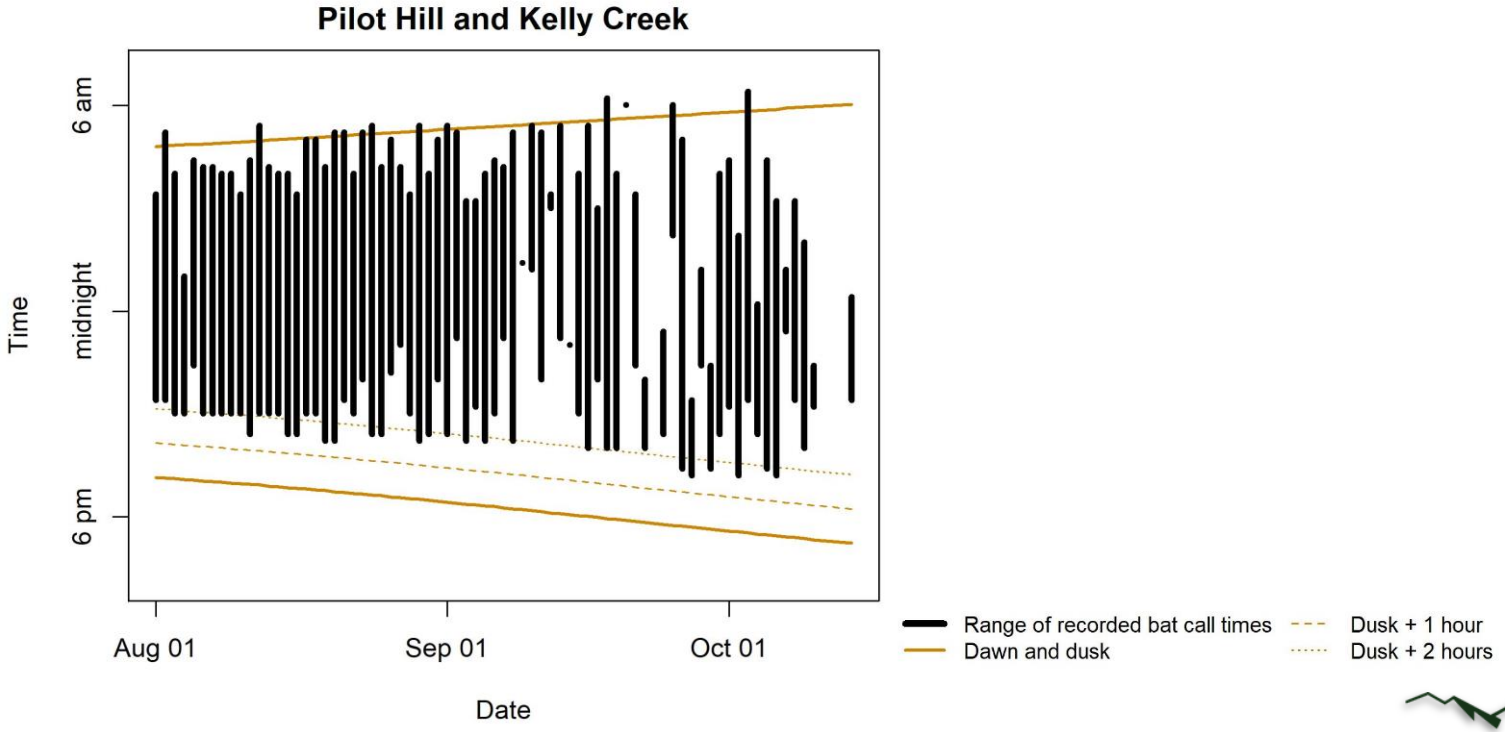
Acoustic Monitoring Methods

- Anabat detectors SD2 were adapted for recording bat calls <2 m from turbine blades, generator, and electronics
- Titley engineered a sharp cut-off noise filter that passed sounds above 19 kHz but sharply filtered noise below 18 kHz
- Anabats were installed in the nacelle bottom pointing to the lower rotor zone and tower

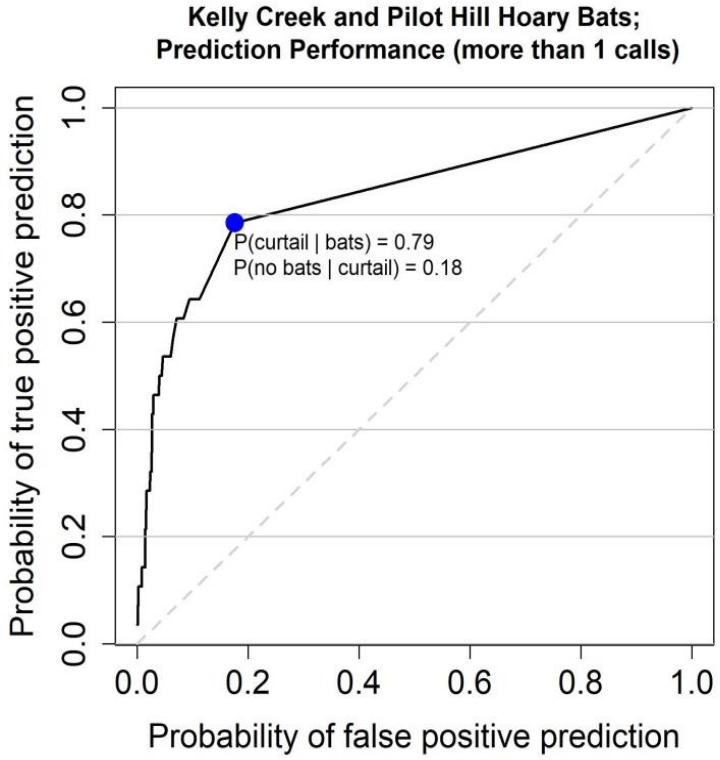
Bat Calls and Wind Speed



Bat Calls Relative to Sunset and Sunrise

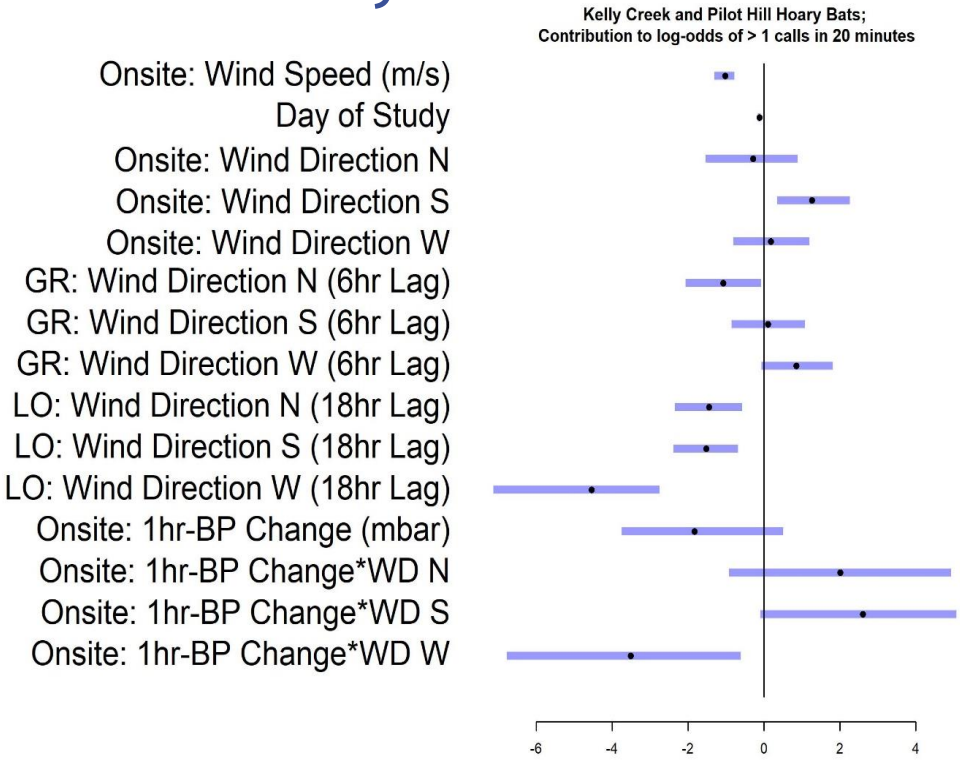


Model Performance – Hoary Bat Acoustic Activity



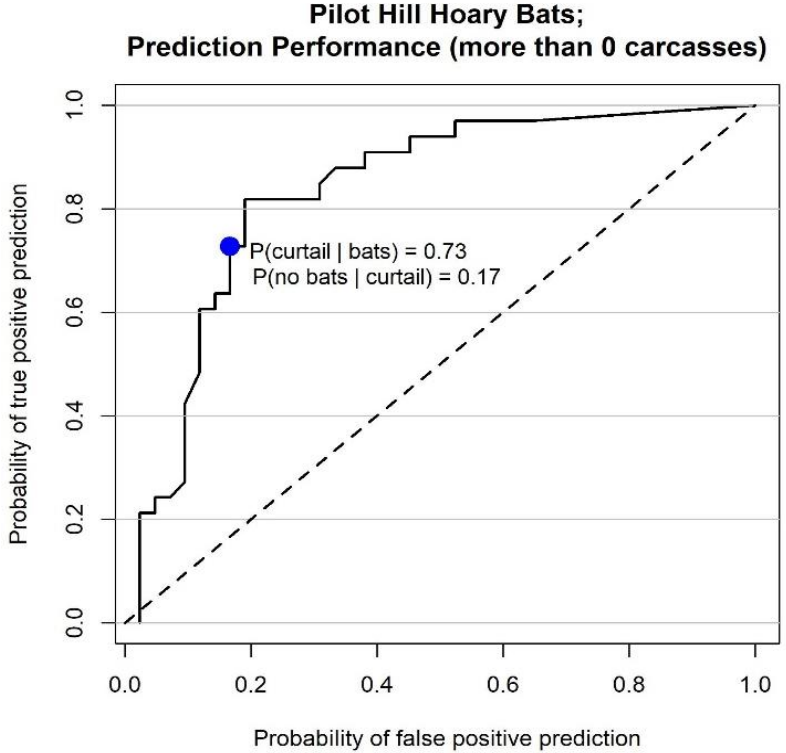
WEST

Modeling Results – Hoary Bat Acoustic Activity

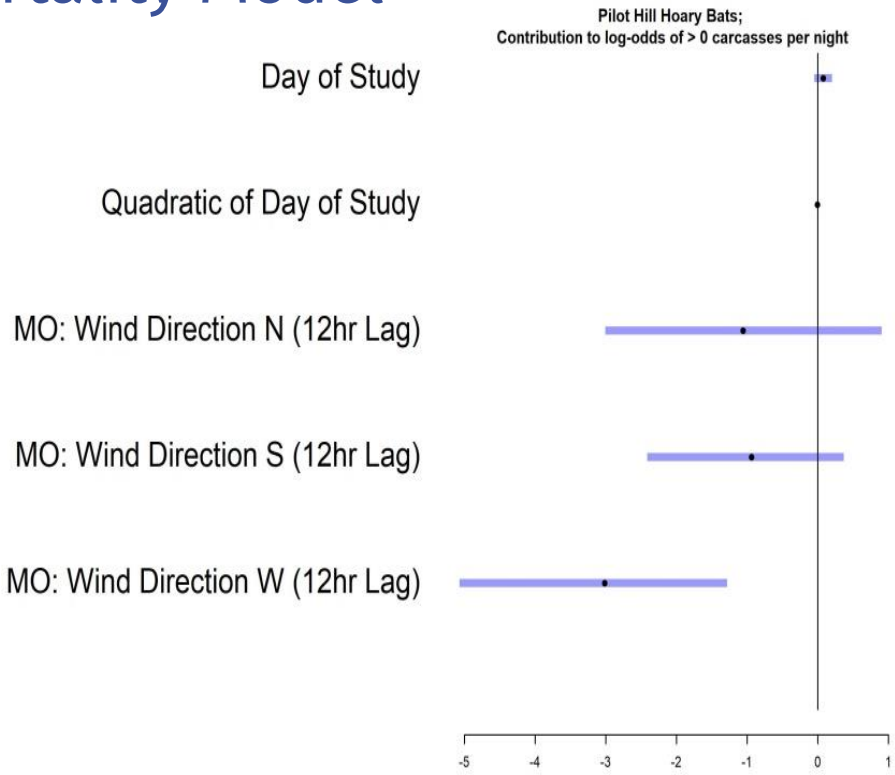


WEST

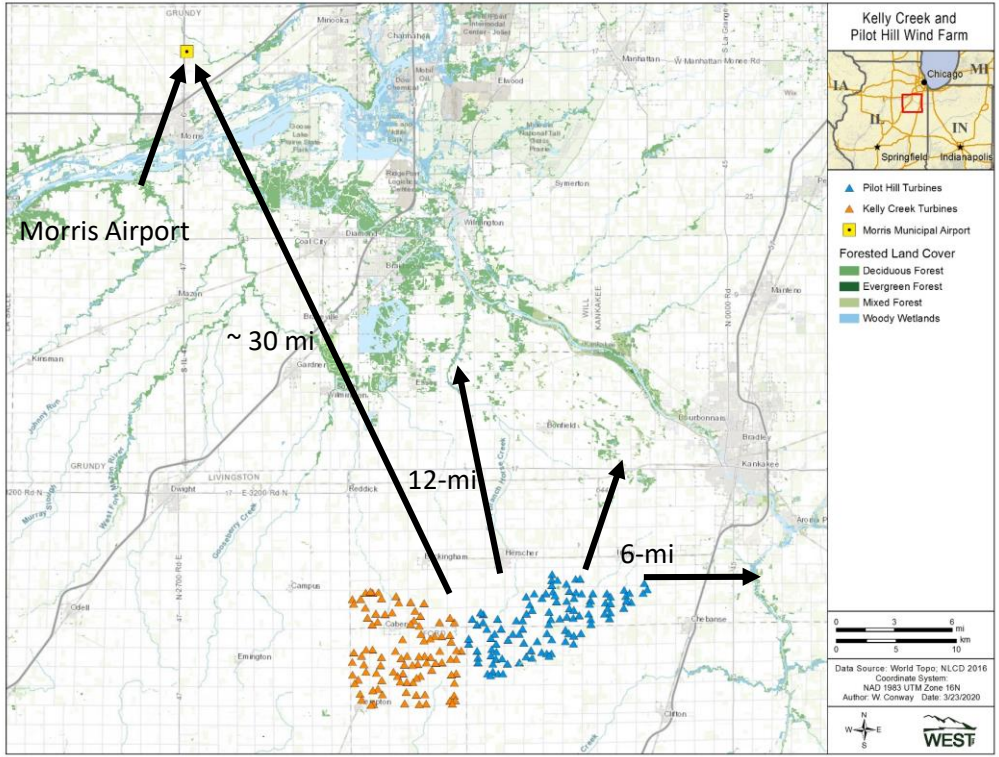
Hoary Bat Mortality Model Performance



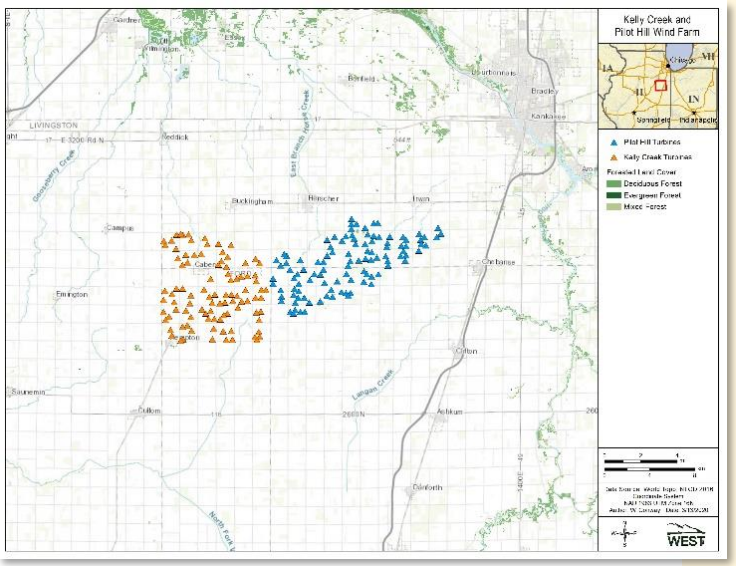
Hoary Bat Mortality Model



Morris Airport and Forest Proximity to Pilot Hill



Management Implications



- Curtailment can potentially be delayed 90-120 minutes after sunset for projects that are located long distances from roosting habitat
- Measuring the passage of weather fronts up to 100-mi from wind projects could potentially be used to design smarter curtailment, but needs further verification

WEST

Management Implications

- Tree bats are individual species that appear to be responding differently to weather cues
- Designing curtailment to meet pre-defined mortality thresholds can be optimized by accounting for relative composition of bat mortality

Next Steps

- Currently examining if similar patterns exist at two wind facilities within 100-mi under WWRF award
- If successful, regional tools predicting hoary bat mortality could be developed, which can be used to focus curtailment during periods of highest risk to hoary bats

Acknowledgements

- EDFR and the AWWI Technical Innovation Fund provided support for the study
- Mike Azeka provided overall vision and direction for the research, installed and maintained Anabats, and managed project logistics
- EDFR meteorologists provided data and guidance on appropriate weather metrics
- Goni Iskali served as Project Manager
- Paul Rabie, Rebecca Clark, Julie Bushey completed the stat analyses

Thank You!

Rhett Good, CWB®

rgood@west-inc.com