Assessing Changes in Bat Activity in Response to an Acoustic Deterrent — Implications for Decreasing Bat Fatalities at Wind Facilities

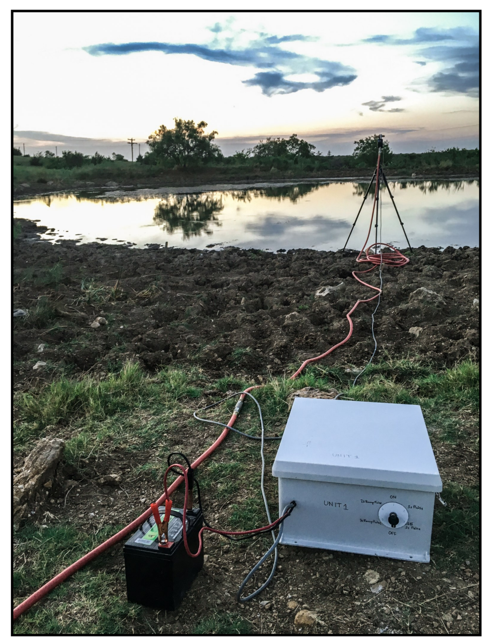
Cole Lindsey—M.S. Candidate in Biology, Department of Biology
Faculty Advisors: Dr. Amanda Hale (Department of Biology), Dr. Tory Bennett (School of Geology, Energy, and the Environment)

Summary

Wind energy is a renewable resource with many environmental benefits. However, bats can be killed when they fly into the path of spinning turbine blades. Estimates of bat fatalities at U.S. wind energy facilities exceed 500,000 per year. One potential way to reduce bat fatalities at wind energy facilities is with acoustic deterrents. At a wind farm in north-central Texas, we assessed changes in bat activity in response to an acoustic deterrent developed by General Electric. The deterrent reduced bat activity over ponds by up to 90%, indicating it has the potential to reduce bat fatalities when installed on wind turbines.

Acoustic Deterrent Developed by General Electric

Compressed nitrogen tanks and manifold supplying gas to the deterrent.



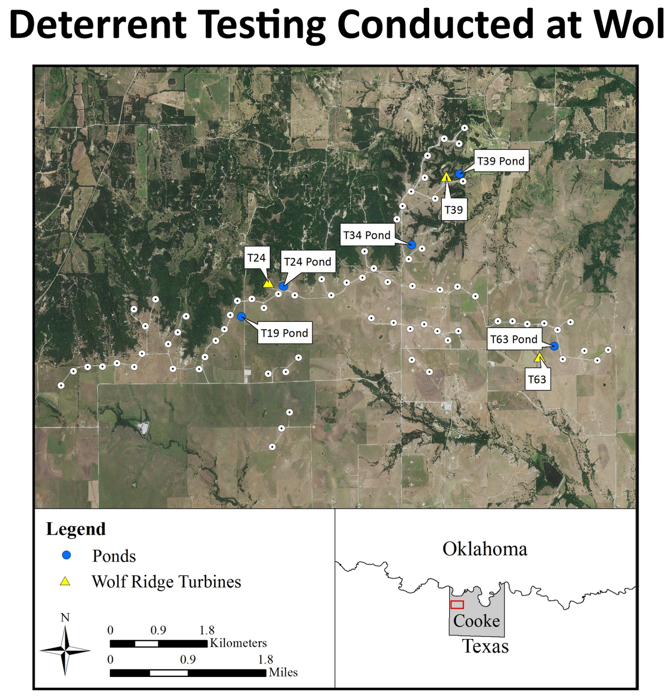
Control box used to change the deterrent signal.

Tripod mounted deterrent nozzle and electronic control valve.

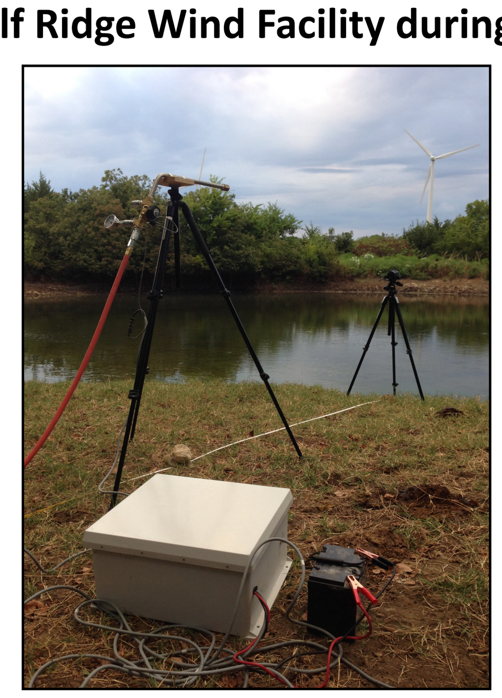
Benefits of the newly designed deterrent:

- Multi-directional high amplitude sound coverage
- Wide range of ultrasonic frequencies
- Weather resistant

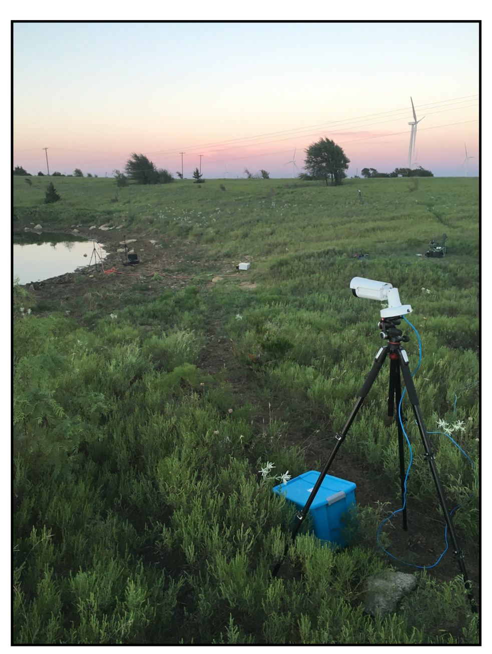
Deterrent Testing Conducted at Wolf Ridge Wind Facility during 2015 and 2016



Location of pond and turbine locations used for deterrent testing.



Night vision camera and deterrent deployed at a pond in 2015.



Thermal camera setup used for deterrent testing during 2016.

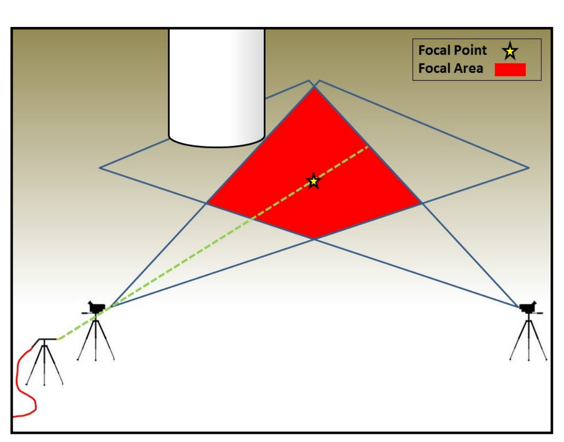


Diagram of overlapping camera views creating a focal area in which bat passes were counted during video analysis at ponds and turbines (shown here).

Summary of deterrent testing conducted during 2015 and 2016 at Wolf Ridge.

2015		2016	
Pond/turbine survey-nights	66	Pond survey-nights	81
10-minute trials	448	10-minute trials	601
Video bat passes	447	Video bat passes	492

Fun Facts from deterrent testing at Wolf Ridge during 2015 and 2016.

Feet of compressed gas hose used per night	750
Tanks of nitrogen used during the two field seasons	353
Hours of video analysis	>700
Number of bug bites	Too many!

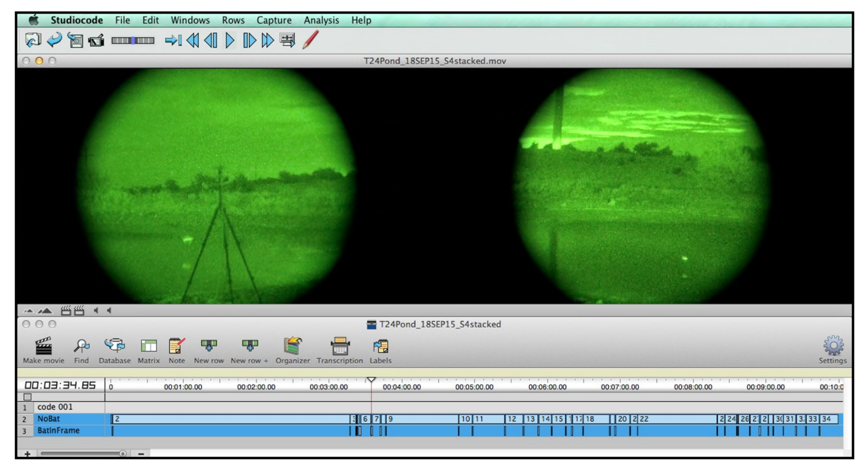
2015 Research Objectives

To determine if:

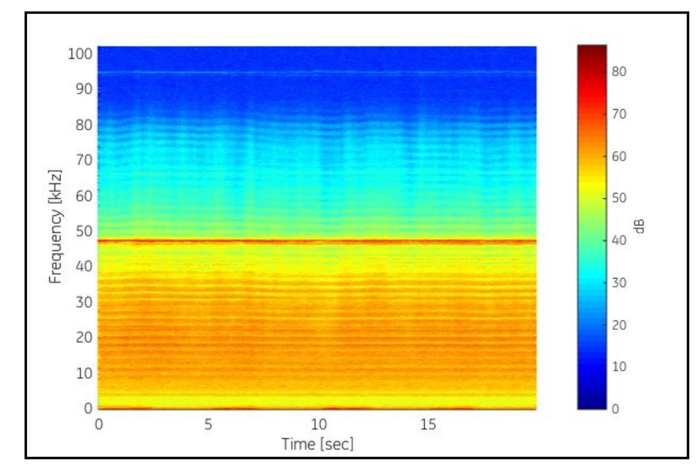
1) the deterrent changes bat activity and behavior.
2) the signal type used changes bat activity.
3) the distance from the deterrent changes bat activity.
4) the habitat type changes how bats respond to the deterrent.

2015 Methods

We evaluated three deterrent signals: Continuous On, Pulse 1 (1 sec. On 1 sec. Off), Pulse 2 (1 sec. On 2 sec. Off) compared to a Control. We tested the deterrent at three distances (10, 20, and 30 meters). Deterrent testing was conducted at wind turbines and closely associated cattle ponds. We recorded bat activity using night vision cameras and acoustic bat detectors.



Night vision video analysis at Wolf Ridge during 2015 using Studiocode software.



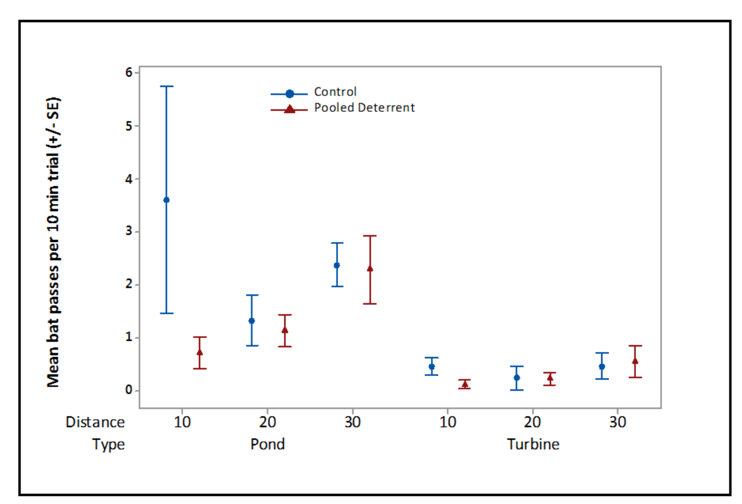
Deterrent sound used during 2015, Continuous On signal with constant pressure.

2015 Results

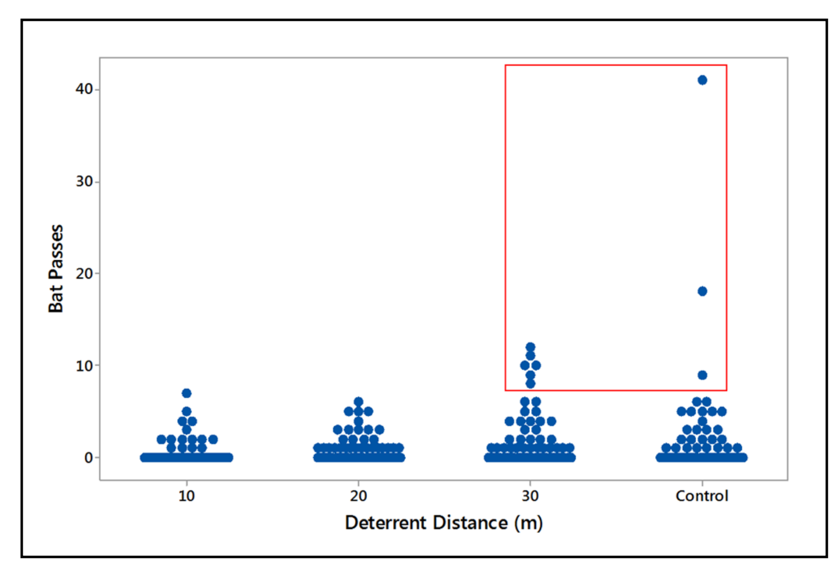
We used a General Linear Model (GLM), which showed the effectiveness of the deterrent did not change when using different signals at ponds ($F_{2,91} = 0.22$, $P = 0.80$) or turbines ($F_{2,89} = 0.17$, $P = 0.85$). The number of bat passes varied significantly with distance from the deterrent at ponds ($F_{2,91} = 5.68$, $P = 0.005$); there were fewer bats with the deterrent at 10 m compared to 30 m (Tukey test: $t = 3.35$, $P = 0.003$). The reduction in bat activity for the pooled deterrent compared to the control was not significant at ponds ($F_{1,39} = 0.12$, $P = 0.73$) or turbines ($F_{1,39} = 0.0$, $P = 0.96$).

Average reduction in bat passes for pooled deterrent signals compared to control by habitat type and deterrent distance (n = 11 survey nights each) at Wolf Ridge in 2015.

Habitat	Distance (m)	Control Bat Passes	Deterrent Bat Passes	Percent Reduction
Pond	10	3.6	0.7	80.4
	20	1.3	1.1	14.9
	30	2.4	2.3	3.5
Turbine	10	0.5	0.1	75.8
	20	0.2	0.2	4.0
	30	0.5	0.5	-19.1



Bat passes by habitat, distance, and deterrent treatment observed using night vision cameras at Wolf Ridge during 2015.



Trials with high levels of bat activity (≥8 passes) only occurred during control tests or with the deterrent at 30 m during deterrent testing at Wolf Ridge during 2015.

2015 Discussion

Although the deterrent appeared to reduce bat activity compared to the control, the results were not statistically significant, likely due to the inherently high variability in bat activity. However, the deterrent was effective at minimizing pulses of bat activity, which is important because bat fatalities often occur episodically. The reduction in effectiveness with distance is a challenge as turbine blades exceed 40-50 m; placing emitters on the turbine blades may be needed to achieve sufficient coverage of the rotor swept zone. The lack of difference among the three deterrent signals suggests that pulsing signals may be a viable alternative to signals that are continuously on, thereby conserving pressurized gas without decreasing effectiveness of the deterrent. The lack of difference between habitats suggests that future studies could be implemented at ponds (i.e., more bats to detect).

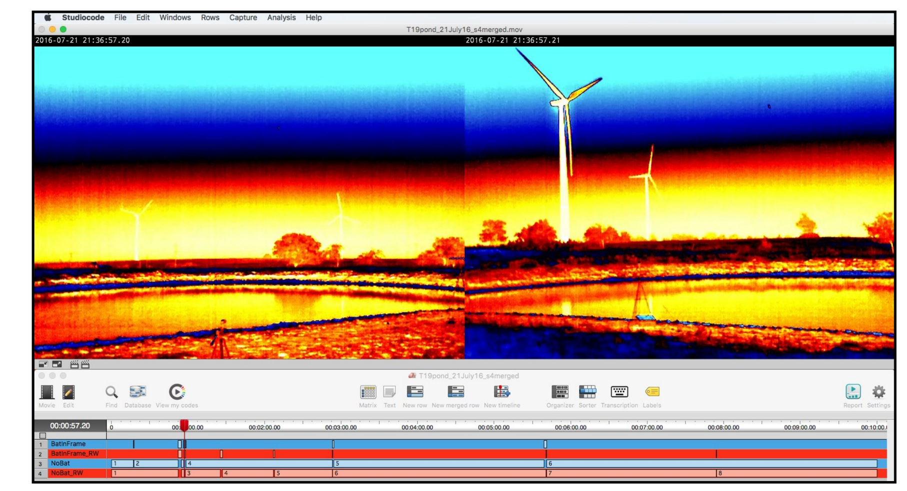
2016 Research Objectives

To determine if:

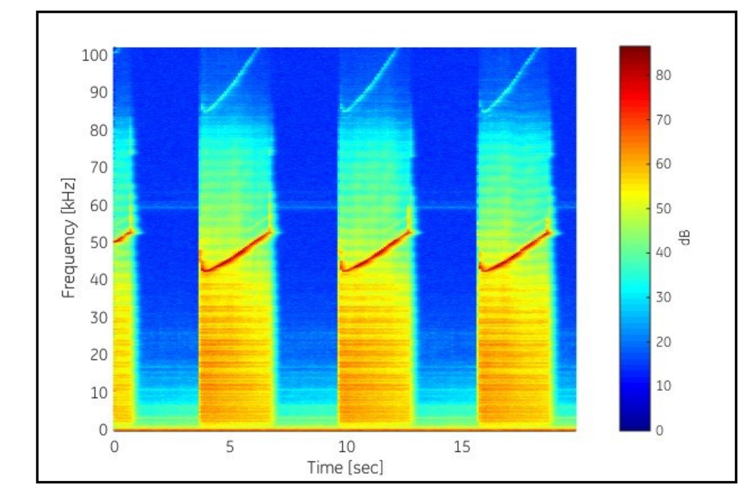
1) the deterrent changes bat activity and behavior.
2) the deterrent signal type used changes bat activity.
3) there is seasonal variation in how the bats respond to the deterrent.

2016 Methods

We evaluated three deterrent pulses: Continuous On, Pulse 3 (3 sec. on 3 sec. off with ramped pressure), and Pulse 4 (2 sec. on 2 sec. off with ramped pressure). All deterrent testing was conducted at ponds. Bat activity was recorded using thermal cameras and acoustic bat detectors. The focal area covered was from zero to 31 m from the deterrent.



Thermal video analysis of deterrent trials at Wolf Ridge during 2016 using Studiocode software.



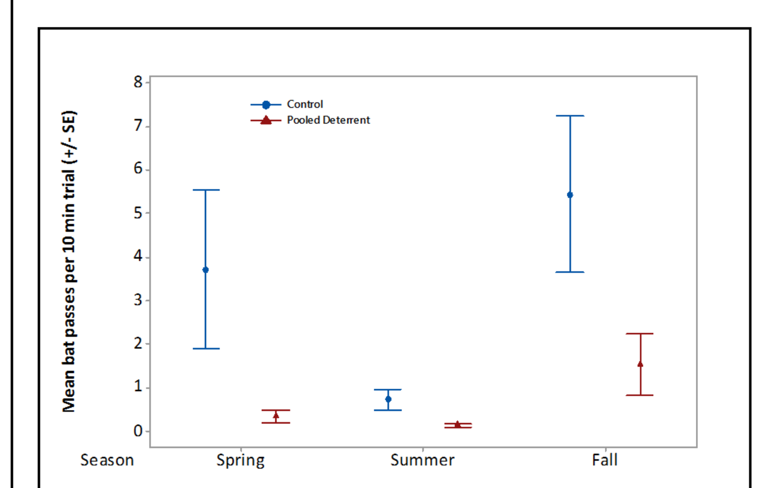
Deterrent sound used at Wolf Ridge during 2016, Pulse 3 signal with change in frequency due to ramped pressure.

2016 Results

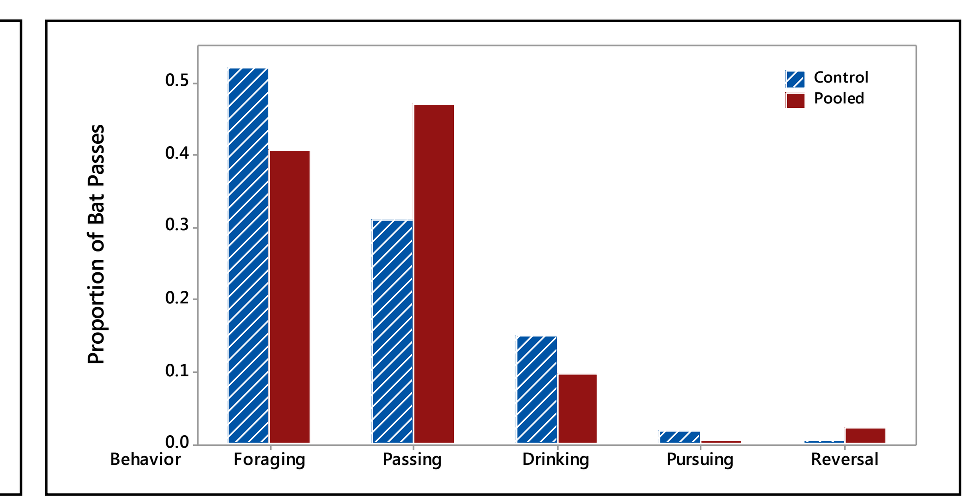
GLM results showed the number of bat passes was significantly lower during pooled deterrent trials compared to the control ($F_{1,148} = 9.99$, $P = 0.02$). Bat activity was higher in the spring and fall than during the summer. We found that the effectiveness of the deterrent in reducing bat activity did not vary among the three seasons ($F_{2,150} = 0.15$, $P = 0.86$). Bats exhibited significantly less "Foraging" behavior (Fisher's exact test: $P = 0.015$) and significantly more "Passing" behavior (Fisher's exact test: $P < 0.001$) while the deterrent was playing, compared to the control trials.

Average reduction in bat passes for pooled deterrent signals compared to control, by season, at Wolf Ridge during 2016.

Season	Control Bat Passes	Deterrent Bat Passes	Percent reduction
Spring	3.7	0.3	90.9
Summer	0.7	0.1	83.8
Fall	5.4	1.5	71.9



Bat passes by season and deterrent signal observed using thermal cameras at Wolf Ridge during 2016.



Behavioral analysis of bat passes observed with thermal cameras during 2016 deterrent testing at Wolf Ridge.

2016 Discussion

The deterrent significantly reduced bat activity, with reduction rates ranging from 72-91%, compared to the control. The deterrent changed bat flight behavior, with bats demonstrating significantly less complex foraging flight and more simple passing flight during deterrent tests compared to the control. We found no difference in the effectiveness of the pulsing deterrent signals. Overall, our data from 2015 and 2016 indicate that this deterrent may be effective at reducing bat fatalities at wind facilities, but a potential limitation is the reduction in effectiveness with distance.

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