

**Bat Evaluation Monitoring Studies at the
Fowler Ridge Wind Farm
Benton County, Indiana**

**Final Report
April 1 – October 15, 2019**



**Prepared for:
Fowler Ridge Wind Farm**

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EXECUTIVE SUMMARY

The Fowler Ridge Wind Farm (FRWF) collectively includes Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC. The FRWF consists of 420 wind turbines in four phases in Benton County, Indiana. Western EcoSystems Technology, Inc. conducted post-construction fatality studies of bats within Phases I, II and III in the fall of 2009 and 2010, when two Indiana bat carcasses were found. The FRWF worked with the US Fish and Wildlife Service and developed a Habitat Conservation Plan (HCP) for the Indiana bat, designed to minimize Indiana bat fatalities. The FRWF received an Incidental Take Permit (ITP) for Indiana bats in August 2014.

Monitoring the effectiveness of minimization measures is required by both the HCP and the ITP. Evaluation phase monitoring was conducted in Phases I, II and III during the fall of 2014 and 2015. Indiana bat mortality was below adaptive management thresholds in both years, so less intensive implementation phase monitoring began in 2016 for these phases and will continue unless adaptive management thresholds are exceeded in the future. Evaluation phase monitoring was completed during the fall of 2016 and 2017 for the FRWF Phase IV. Indiana bat mortality was also below adaptive management thresholds in both years for this phase, so implementation phase monitoring for Phase IV began in the fall of 2018 and will continue unless adaptive management thresholds are exceeded in the future.

Indiana bats were not believed to be at risk during the spring migration period (April 1 – May 15) when the original HCP was prepared and the ITP was issued. Recent evidence indicates a risk of Indiana bat take during the spring migration period as well, so in 2018, the HCP was amended to account for spring take of Indiana bats and an ITP amendment was granted. As per the amended HCP and ITP, the second year of spring evaluation phase monitoring was completed in 2019 at all phases of the FRWF.

Standardized carcass searches were completed weekly at 183 turbines during the spring (April 1 – May 15) and twice weekly at 114 turbines during the fall (August 1 – October 15), corresponding with migration periods of Indiana bats. Turbines were searched twice weekly during the fall because the average length of persistence for bat carcasses in the fall of 2018 was 6.8 days. The search area was restricted to the gravel roads and pads within 80 meters (262 feet) of each turbine included in the study. Searcher efficiency and carcass persistence trials were conducted during both seasons to adjust for detection and removal bias.

No Indiana bat or other *Myotis* species were found. A total of 128 bat carcasses of five species, 18 bird carcasses of 10 known species, and three individuals of unknown passerine species were found during searches and incidentally. Similar to previous years of monitoring, the most commonly found bat species were eastern red bats, silver-haired bats, and hoary bats. Four evening bats (state-listed as endangered) and three big brown bats were also found.

Bat fatality rates were calculated based on the number of carcasses found, the results of bias trials, and adjustments for bats that did not fall on roads and pads. The combined spring and fall bat fatality rate in 2019 was estimated to be 14.54 bat fatalities/turbine/study period (90% confidence interval: 10.86 – 18.41). The results of monitoring during 2019 provide evidence that operational strategies exceeded the objective of reducing bat fatality rates by 50%, compared to fatality estimates from turbines operating normally in 2010 and 2011. Within-season and end-of-season adjustments of minimization strategies were not required in 2019 because bat fatality rates were below adaptive management thresholds.

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INTRODUCTION

The Fowler Ridge Wind Farm (FRWF) collectively includes Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC. The FRWF consists of 420 wind turbines in four phases in Benton County, Indiana. A post-construction fatality study of bats was conducted by Western EcoSystems Technology, Inc. (WEST) within Phases I and III in 2009 (Johnson et al. 2010a, 2010b), when an Indiana bat (*Myotis sodalis*) carcass was found. Subsequent studies were conducted in 2010, 2011, 2012 and 2013 (Good et al. 2011, 2012, 2013 and 2014) under Scientific Research and Recovery Permits (TE15075A in 2010, TE15075A-2 in 2011, and TE73598A-0 in 2012 and 2013) within Phases I, II, and III. A second Indiana bat carcass was found in 2010 (Good et al. 2011). The results of this research were used by the FRWF to design a strategy for reducing Indiana bat fatality rates.

The FRWF worked with the US Fish and Wildlife Service (USFWS) and developed a Habitat Conservation Plan (HCP) for the Indiana bat designed to minimize Indiana bat fatalities by feathering turbine blades when winds were at 5.0 meters per second (m/s; 16.4 feet per second [ft/s]) or lower during the fall migration period. The FRWF received an Incidental Take Permit (ITP) for Indiana bats in August 2014 (TE95012A-0) based on the HCP. The HCP and ITP include requirements for monitoring the effectiveness of minimization measures. The first two years of evaluation phase monitoring at Phases I, II and III were completed in 2014 (Good et al. 2015) and 2015 (Good et al. 2016) during the fall migration season for Indiana bats. Because Indiana bat mortality was estimated to be below adaptive management thresholds during 2014 and 2015, as outlined in the HCP, implementation phase monitoring began in 2016 (Good et al. 2017) and will continue unless adaptive management thresholds are exceeded in the future (Good et al. 2018, Good et al. 2019).

Construction of Phase IV was completed in December 2015 and the required two years of evaluation phase monitoring were conducted in 2016 and 2017 during the fall migration season for Indiana bats. Indiana bat mortality was estimated to be below adaptive management thresholds at Phase IV during both years of evaluation phase monitoring, so implementation phase monitoring began in the fall of 2018. As with Phases I, II and III, Indiana bat mortality was estimated to be below adaptive management thresholds at Phase IV during 2018.

Indiana bats were not believed to be at risk during the spring migration period (April 1 – May 15) when the original HCP was prepared and the ITP was issued. Since that time, new evidence indicates Indiana bats may be at risk of take during the spring migration period as well (Pruitt and Reed 2018). The HCP was amended to account for spring take of Indiana bats and an amendment to the ITP was granted on March 22, 2018 (TE95012A-1). As per the amended HCP and ITP, two years of spring evaluation phase monitoring began in 2018 at the FRWF. To minimize Indiana bat take during the spring, turbines were feathered below a cut-in speed of 3.5 m/s(11.5 ft/s) on a nightly basis from sunset to sunrise from April 1 – May 15, 2018. This report describes the results of the 2019 spring and fall mortality monitoring required under the HCP.

STUDY AREA

The FRWF has a total energy capacity of 750 megawatts (MW). Phase I consists of 122 Vestas V82 1.65-MW turbines and 40 Clipper C96 2.50-MW turbines with a combined total of 301 MW of energy capacity. Phase II consists of 133 1.50-MW General Electric (GE) SLE turbines with a capacity of 199.5 MW. Phase III consists of 60 Vestas V82 1.65-MW turbines with a total of 99 MW of capacity. Phase IV consists of 65 Siemens SWT-2.3-108 2.30-MW turbines with a capacity of 150 MW. Turbine characteristics are listed in Table 1.

Table 1. Turbine characteristics at the Fowler Ridge Wind Farm, Benton County, Indiana.

Turbine Model	Megawatt	Turbine Height (meters)	Rotor Diameter (meters)	Standard cut-in speed (meters/second)
General Electric SLE	1.50	80	77	3.5
Vestas V82	1.65	80	82	3.5
Siemens SWT-2.3-108	2.30	80	108	3.5
Clipper C96	2.50	80	96	3.5

Phases I and III were constructed in 2008 and became operational during January 2009. Phase II was constructed in 2009 and became operational by December 31, 2009. Phase IV was constructed in 2015 and became operational in December 2015.

The FRWF is dominated by cultivated crops, consisting primarily of corn (*Zea mays*) and soybeans (*Glycine max*; Figures 1a and 1b). Within 0.80 kilometers (approximately 0.5 mile) of turbine locations, cultivated crops comprise 92.5% of the land use in the 67,894 acre study area (Table 2). After cultivated crops, the next most common land uses within the FRWF are developed areas (e.g., houses, buildings, and open space), which comprise 5.3% of the total, and pastures/hayfields, which comprise 1.5% of the total area. Forested areas, grasslands (herbaceous) and wetlands are rare within the study area (0.4%, 0.04% and <0.01%, respectively; National Land Cover Database [Yang et al. 2018, Multi-Resolution Land Characteristics 2019]).

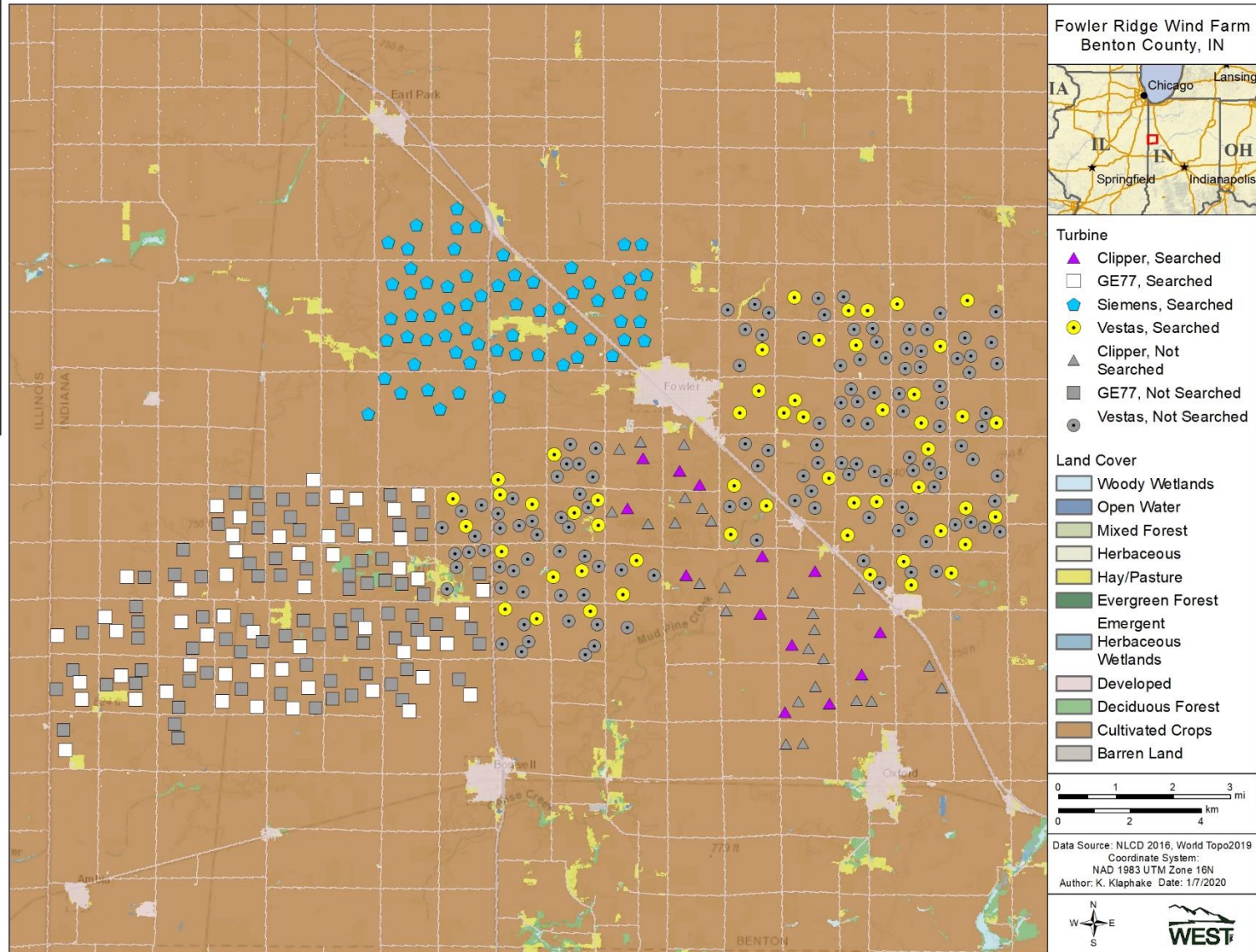


Figure 1a. Land cover types, and locations of Phase I-IV turbines searched from April 1 – May 15, 2019 at the Fowler Ridge Wind Farm, Benton County, Indiana.

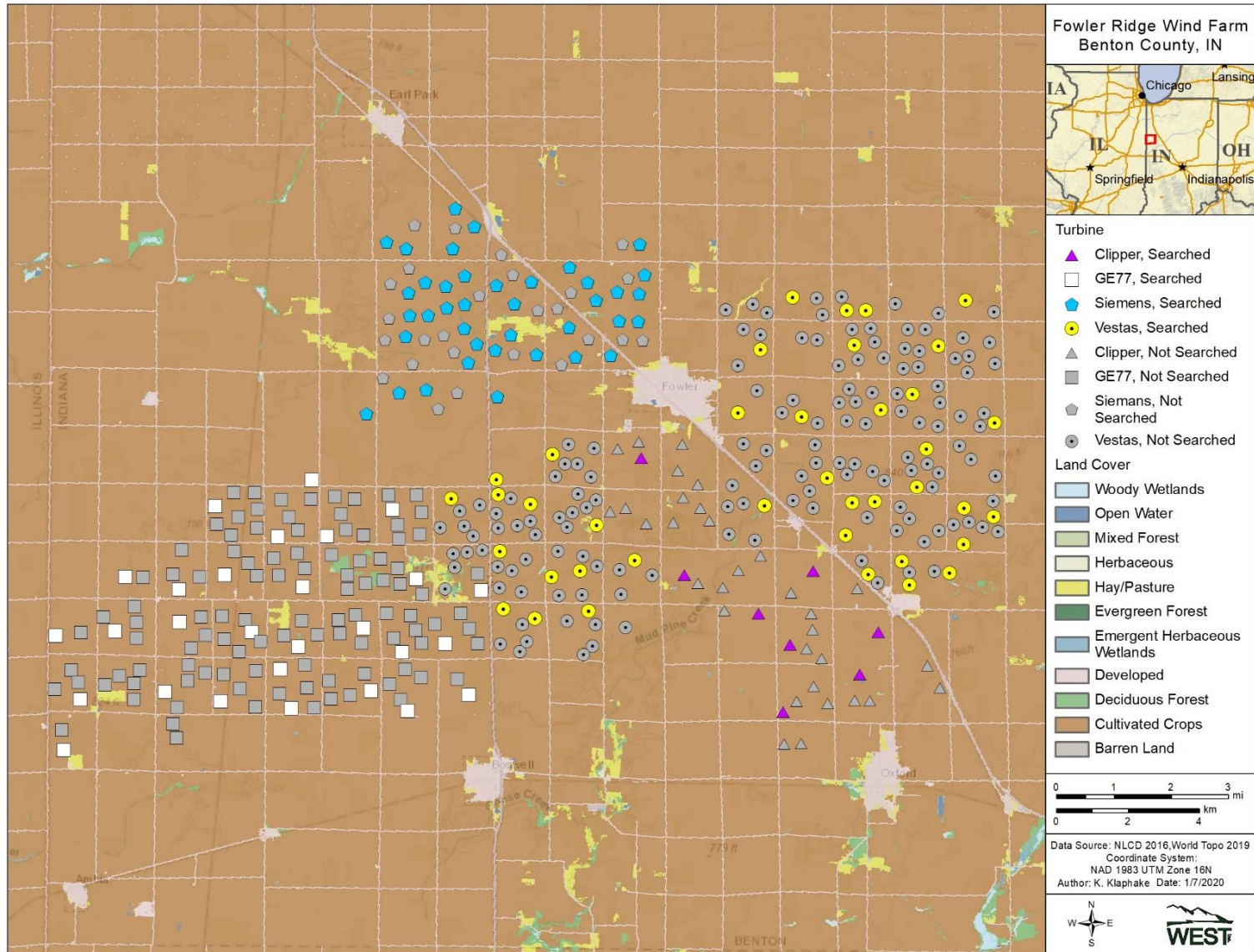


Figure 1b. Land cover types and locations of Phase I-IV turbines searched from August 1 – October 15, 2019 at the Fowler Ridge Wind Farm, Benton County, Indiana.

Table 2. Land cover types, coverage, and percent composition within 0.5 mile of turbine locations within the Fowler Ridge Wind Farm, Benton County, Indiana.

Land Cover Types	Coverage (acres)	Percent Composition
Cultivated Crops	62,810.0	92.5
Developed, Low Intensity	2,014.0	3.0
Developed, Open Space	1,557.0	2.3
Hay/Pasture	1,036.0	1.5
Deciduous Forest	280.0	0.4
Developed, Medium Intensity	95.0	0.1
Open Water	37.0	<0.1
Herbaceous	30.0	<0.1
Developed, High Intensity	19.0	<0.1
Barren Land	10.0	<0.1
Emergent Herbaceous Wetlands	4.0	<0.1
Woody Wetlands	2.0	<0.1
Total	67,894	100

Source: National Land Cover Database (Yang et al. 2018, Multi-Resolution Land Characteristics 2019)

METHODS

Standardized Carcass Searches

Most of the preceding monitoring efforts had been conducted from August 1 - October 15, as this encompassed the fall migration period for Indiana bats outlined in the *Draft Indiana Bat Recovery Plan* (USFWS 2007); the period of highest bat mortality at the FRWF (Good et al. 2011, 2012), and the period in which previous Indiana bat carcasses were found at the FRWF. As per the amended HCP and ITP, fatality monitoring now occurs during the spring migration period for Indiana bats as well. The first year of the two-year spring evaluation phase monitoring period was completed in the spring of 2018. The second year of spring evaluation phase monitoring was completed April 1 – May 15, 2019. All 65 turbines in Phase IV were searched, along with a subset of 118 turbines in Phases I, II and III during the spring (Figure 1a). All phases of the FRWF are in the implementation phase monitoring period of the HCP during fall migration, so a randomly chosen subset of turbines were searched August 1 – October 15, 2019, for a total of 75 turbines at Phases I, II and III and 39 turbines at Phase IV (Figure 1b).

Carcass searches were conducted along access roads and on turbine pads within 80 m (262 ft) of the selected turbines. The weekly search interval for the spring was determined by the mean carcass persistence time of 13.4 days recorded during spring monitoring at the FRWF in 2018 (Good et al. 2019). During the fall monitoring period, carcass searches were conducted twice weekly. This search interval was determined by the mean carcass persistence time of 6.8 days recorded during fall monitoring at the FRWF in 2019 (Good et al. 2019).

Technicians trained in proper search techniques conducted the carcass searches. Searches occurred along transects on the roads and pads of a sampled turbine within 80 m (262 ft) of the tower. Searchers walked at a rate of approximately 45 - 60 m per minute (about 148 - 197 ft per minute) along each transect, looking for bat and bird carcasses. Transects were spaced at approximately 5-m (16-ft) intervals, and searchers scanned the area on both sides out to

approximately 2.5 m (8.2 ft) for carcasses as they walked. All bat carcasses were recorded and collected. Bird carcasses were recorded, but left in the field. Searches began after 0700 hours each morning and were completed before sunset.

The condition of each carcass found was recorded using the following categories:

- Intact - a carcass that was complete, not badly decomposed, and showed no sign of being fed upon by a predator or scavenger
- Scavenged - a carcass in one piece that showed signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains), or a carcass that was heavily infested with insects
- Dismembered - a carcass that was found in more than one piece and the pieces were separated by more than five m (16.4 ft)
- Live/Injured - a bat or bird found alive
- Feather Spot (for bird carcasses only) – presence of 10 or more body feathers and/or at least two primary feathers, in one location indicating predation or scavenging

Data recorded for each carcass included date and time collected, turbine number, species, sex and age when identifiable, carcass location as Universal Transverse Mercator coordinates, distance and azimuth from turbine, condition (live, intact, scavenged, dismembered, feather spot), and any comments that may indicate cause of death. Digital photographs were taken of the carcass, any visible injuries, and surrounding habitat. Time since death for all carcasses was also estimated and recorded (e.g., last night, 2-3 days). Criteria used to determine time since death are listed in Appendix A.

Bat carcasses were collected under the Special Purpose Salvage Permit 18-044 from the Indiana Department of Natural Resources (IDNR) and the WEST and USFWS Native Endangered and Threatened Species Recovery permit TE234121-9. Any state or federally endangered or threatened carcasses were reported to the appropriate agency within 48 hours. All bat carcasses were verified by a permitted bat biologist and delivered to the USFWS Bloomington Field Office at the end of the study, along with any tissue and fur samples taken from each carcass. A copy of the completed data sheet for each bat carcass was kept with the carcass and tissue samples at all times.

Carcasses found in non-search areas (e.g., near a turbine not selected for standardized carcass searches or outside of the search boundary for a searched turbine) were recorded as incidental discoveries, collected, and documented in a similar fashion as those found during standard searches. In addition to carcasses, all injured bats and birds were recorded and treated as a fatality for the purpose of the analyses.

Turbine Operation Schedule

Turbine cut-in speeds were raised to 5.0 m/s at the FRWF from August 1 – October 15. Operational parameters were set so that the rotation of the turbine blades below cut-in wind speed

was feathered. Increasing cut-in speed and feathering turbine blades below cut-in speed were both implemented on a nightly basis from sunset to sunrise, and adjusted for sunset/sunrise times weekly. Turbines were monitored and controlled based on wind speed on an individual basis (i.e., the entire facility did not alter cut-in speed at the same time; rather, operational changes were based on wind speed conditions specific to each turbine). Turbines began operating under normal conditions when the 5- to 10-minute rolling average wind speed was above 5.0 m/s; turbines were feathered again if the 5- to 10-minute rolling average wind speed dropped below 5.0 m/s during the course of the night. From April 1 – May 15, turbine cut-in speeds were not raised from the manufacturer's cut-in speed of 3.5 m/s, but turbine blades were feathered below manufacturer's cut-in speed.

Bias Trials

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers to account for detection bias in the bat fatality estimates. When possible, freshly killed bats conclusively identified as non-*Myotis* or non-evening bat (*Nycticeius humeralis*) were used for searcher efficiency and carcass persistence trials. Big brown bat (*Eptesicus fuscus*) carcasses obtained from Indiana State University were used for bias trials when not enough fresh carcasses were available.

Multiple searcher efficiency trials were conducted in each season. Across both seasons, a total of 124 bats were placed from zero to six days prior to searches to estimate the overall probability that a bat carcass was available and detected (empirical pi) and the probability of detection (single search searcher efficiency rates). Bat carcasses were placed throughout each study season by a technician not involved in the carcass search effort, and were randomly placed within a turbine's searchable area. Searchers had no knowledge of the number, placement, or timing of carcasses placed at turbines. Data recorded for each trial carcass included date of placement, species, turbine number, the distance and azimuth from the turbine, and date the carcass was found. Carcasses were identified as bias trial carcasses through the placement of a small, indistinct black zip tie on the bat's forearm. Any trial carcasses placed zero days prior to a search (i.e. on a scheduled search day) were used for carcass persistence trials and were left in the field until scavenged, or up to 24 days. Searchers therefore had three chances in the spring and six chances in the fall of finding a carcass that persisted the full 24 days on subsequent search days. The first day the carcass was discovered by the searcher was recorded to estimate the overall probability that a carcass was available and detected.

Carcass Persistence Trials

The objective of carcass persistence trials was to estimate the average length of time (in days) a carcass persisted in the field (i.e., before a carcass was no longer available for detection). Carcasses could be removed by scavenging or rendered undetectable by typical farming or wind farm maintenance activities. Carcass persistence trials were conducted when carcass search studies occurred, using searcher efficiency trial carcasses that were placed on day zero of a search day.

Persistence trials were conducted during both spring and fall to incorporate the effects of varying weather and scavenger densities. Forty bat carcasses were monitored to estimate persistence rates. Carcasses were checked on days one, two, four, six, eight, 10, 12, 18, and 24 after placement to calculate average carcass persistence rates. Day one was defined as the day after a carcass was placed. Trial carcasses were left at the placement location until they were removed by scavenging or other means, completely decomposed, or the end of the carcass persistence trial, whichever occurred first. Any evidence of carcasses that remained at the end of the 24-day period was removed.

Statistical Analysis

Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, technicians were responsible for reviewing data for completeness, accuracy, and legibility. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the technician and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes were made in all affected steps.

Data Compilation and Storage

A Microsoft® SQL database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference.

Bat Fatality Rate Estimation

Fatality estimates for bats were calculated based on:

- Observed number of bat carcasses found on search plots that were estimated to have been killed during the monitoring period;
- Persistence rates combined with searcher efficiency, expressed as the estimated average probability a bat carcass is expected to be available for detection and was detected by the searchers during combined bias trials; and
- The search area adjustment factor for bat carcasses landing outside of searched roads and pads.

Carcasses found on a search plot were included in the fatality analysis if the bat was estimated to have perished during either monitoring period (i.e., on or after the evening of March 31 for spring surveys and July 31 for fall surveys), regardless of whether they were found during a scheduled search or incidentally at some other time. We assumed that all carcasses found incidentally on search plots would have been found at the next search if they had not been found incidentally. Those carcasses found during searches but not within the search area were not included in fatality estimates.

The probability of carcass availability and detection ($\hat{\pi}$) was calculated based on the results of combined bias trials measuring searcher efficiency and carcass persistence. Trial carcasses were placed in search areas throughout each monitoring period and left until they were either found by searchers or removed by some other means, such as scavenging. The ratio of the number found to the number placed was calculated for each number of days prior to the search the trial carcass was placed. The average of the ratios was used as an empirical pi estimate of the probability of availability and detection.

A correction factor (r) of 6.56 was used to adjust for carcasses that likely occurred outside of searched roads and pads for Fowler I-III, to determine total estimated bat mortality during the fall migration period. This area adjustment factor was an average of the road and pad correction factors from 2011 and 2012 at Phases I, II and III of the FRWF (Good et al. 2011, 2012).

The road and pad area of each turbine at Phase IV was smaller compared to Phases I, II and III, and required a different correction factor in order to accurately estimate bat fatality rates. A correction factor (r) of 26.38 was used to adjust for carcasses that likely occurred outside of searched roads and pads for Fowler IV, to determine total estimated bat mortality during the spring and fall migration period (Good et al. 2018).

The adjusted estimate for the number of fatalities per turbine was calculated as follows:

$$m = \frac{(\text{observed fatalities})}{(\text{number of search plots}) * \hat{\pi}} * r$$

Carcass Persistence Rates

Definition of Variables

The following variables were used to calculate carcass persistence rates:

- s the number of carcasses used in persistence trials
- s_c the number of carcasses in persistence trials that remain in the study area after 24 days
- t_j the time (in days) carcass j remains in the study area before it is removed, as determined by the persistence trials
- \bar{t} the average time (in days) a carcass remains in the study area before it is removed, as determined by the persistence trials

Mean carcass persistence time (\bar{t}) was calculated as the average length of time a carcass remained in the study area before it was removed in days:

$$\bar{t} = \frac{\sum_{j=1}^s t_j}{s - s_c}$$

Between Years Comparisons

Percent change in fatality rates between 2019 (spring and fall combined) and the baseline years (2010 and 2011) was calculated as the percent difference between estimates and compared to the anticipated 50% reduction in fatality rates due to applied minimization measures.

RESULTS

The following sections contain the results of studies conducted under ITP permit TE95012A-1. Per the requirements of this permit, information regarding the date, locations, and species of bats (and birds) encountered can be found in Appendix B.

Bat and Bird Carcass Surveys

A total of 3,539 surveys were conducted on roads and pads at 183 turbines from April 1 - May 15, and at 114 turbines from August 1 - October 15, 2019. Overall, 128 bat carcasses and 18 bird carcasses were found during the survey (Table 3; Appendix B). Turbine 639 was inaccessible from August 21 – September 23, 2019 due to county road closures. As a result, this turbine was searched when possible but was not included in the analyses for the fall. One bat carcass was found at this turbine with an estimated time of death prior to the fall monitoring period, so it was also excluded from the analyses.

Species Composition

No Indiana bats or other *Myotis* spp. were found during the study. The most commonly found bat species were eastern red bat (*Lasiurus borealis*; 61 carcasses; 47.7%), silver-haired bat (*Lasionycteris noctivagans*; 37 carcasses; 28.9%), hoary bat (*Lasiurus cinereus*; 23 carcasses; 18.0%). Four evening bat carcasses (3.1%) and three big brown bat (2.3%), carcasses were also found (Table 3). The evening bat is listed as state-endangered and every carcass was reported to the IDNR within 24 hours of its finding (IDNR 2019). One bat carcasses was heavily scavenged and was a suspected *Myotis* spp. A tissue sample was submitted for DNA analysis and it was identified as a silver-haired bat.

Eighteen bird carcasses found during the survey period represent 10 known bird species and three carcasses identifiable only as passerine species (Table 4). No eagles or any bird species listed as threatened or endangered by IDNR (IDNR 2019), or the federal Endangered Species Act (1973) were found (USFWS 2019). Bird fatality rates were not estimated.

Table 3. Total number and percent composition of bat carcasses found at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019.

Species	Included in Fatality Estimate		Found Outside Plot		Estimated Time of Death Outside Study Period		All Carcasses Found	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
		Composition*		Composition		Composition		Composition
eastern red bat	50	48.5	8	47.1	3	25.0	61	47.7
silver-haired bat	33	32.0	4	23.5	0	8.3	37	28.9
hoary bat	16	15.5	3	17.6	4	66.7	23	18.0
evening bat	2	1.9	1	5.9	1	0	4	3.1
big brown bat	2	1.9	1	5.9	0	0	3	2.3
Totals	103	100	17	100	8	100	128	100

*Totals may not add to 100% due to rounding

Table 4. Total number and percent composition of bird carcasses found at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019.

Species	Number	Percent Composition*
killdeer	4	22.2
unidentified passerine	3	16.7
common grackle	2	11.1
mourning dove	2	11.1
chimney swift	1	5.6
cliff swallow	1	5.6
common yellowthroat	1	5.6
golden-crowned kinglet	1	5.6
mallard	1	5.6
rock pigeon	1	5.6
vesper sparrow	1	5.6
Totals	18	100

*Totals may not add to 100% due to rounding

Estimated Time since Death

Most bat carcasses found on search plots and included in the analyses were estimated to have been killed the night before the search (54.4%; Table 5). More than 92% of bat carcasses had an estimated time of death of less than a week while less than 8% of bat carcasses had an estimated time of death beyond seven days (Table 5). Three bats were found injured and all were released, but one was subsequently found dead and collected; all three were included in the fatality estimates.

Table 5. Estimated time since death of bat carcasses found on search plots and estimated to have been killed at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019.

Estimated Time Since Death ^a	Number of Carcasses	Percent Composition
Last night	56	54.4
2-3 days	26	25.2
4-7 days	13	12.6
8-14 days	4	3.9
Greater than 14 days	0	0
Greater than 30 days	0	0
Unknown	1	1.0
Injured	3	2.9

^a: Estimated time since death criteria described in Appendix A.

Timing of Bat Carcasses

Most bat fatalities occurred from mid-August to mid-September (Figure 2). Eastern red bats comprised a large portion of the overall bat mortality during this time period (Figure 3). Silver-haired bat carcasses occurred later in the fall, and also comprised a significant portion of spring fatalities (Figure 4). Hoary bat fatalities occurred primarily in the fall (Figure 5).

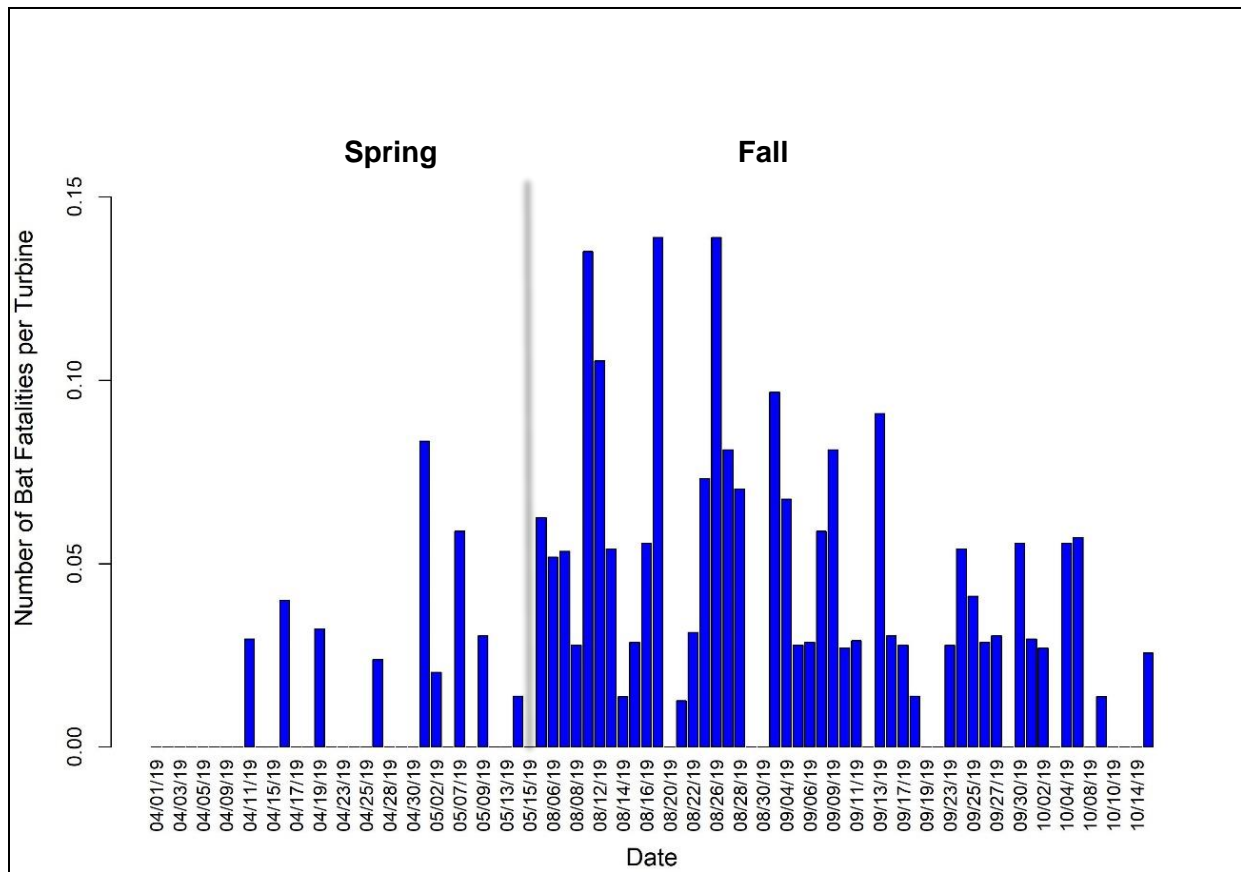


Figure 2. Timing of all bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

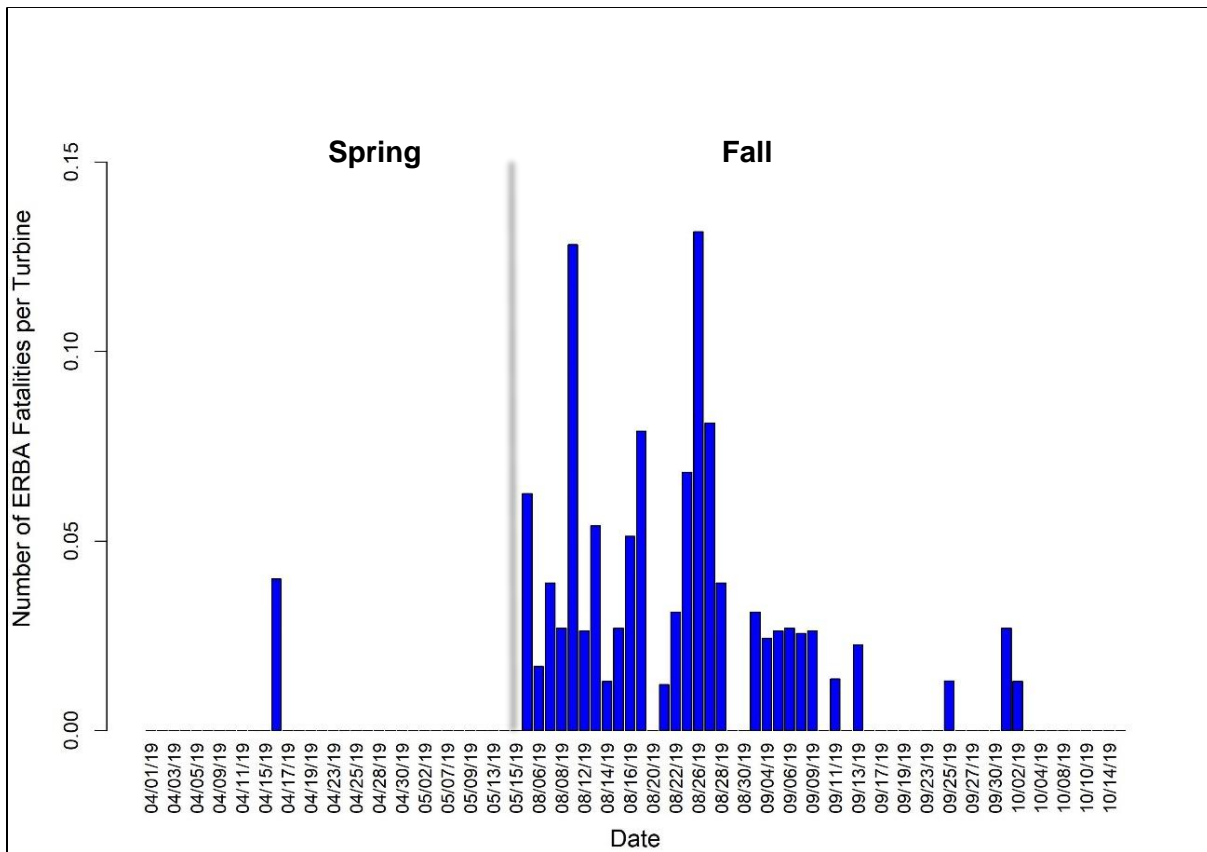


Figure 3. Timing of eastern red bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

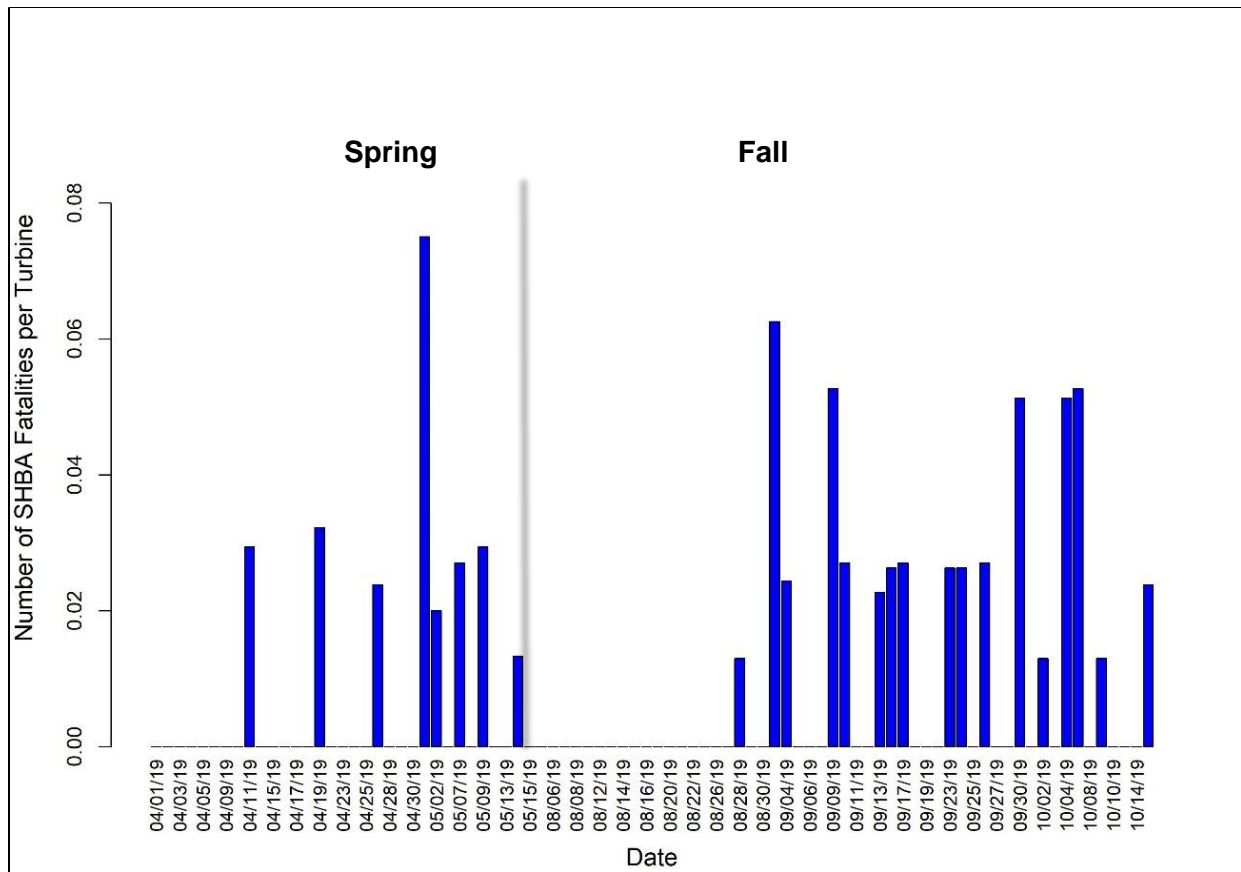


Figure 4. Timing of silver-haired bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

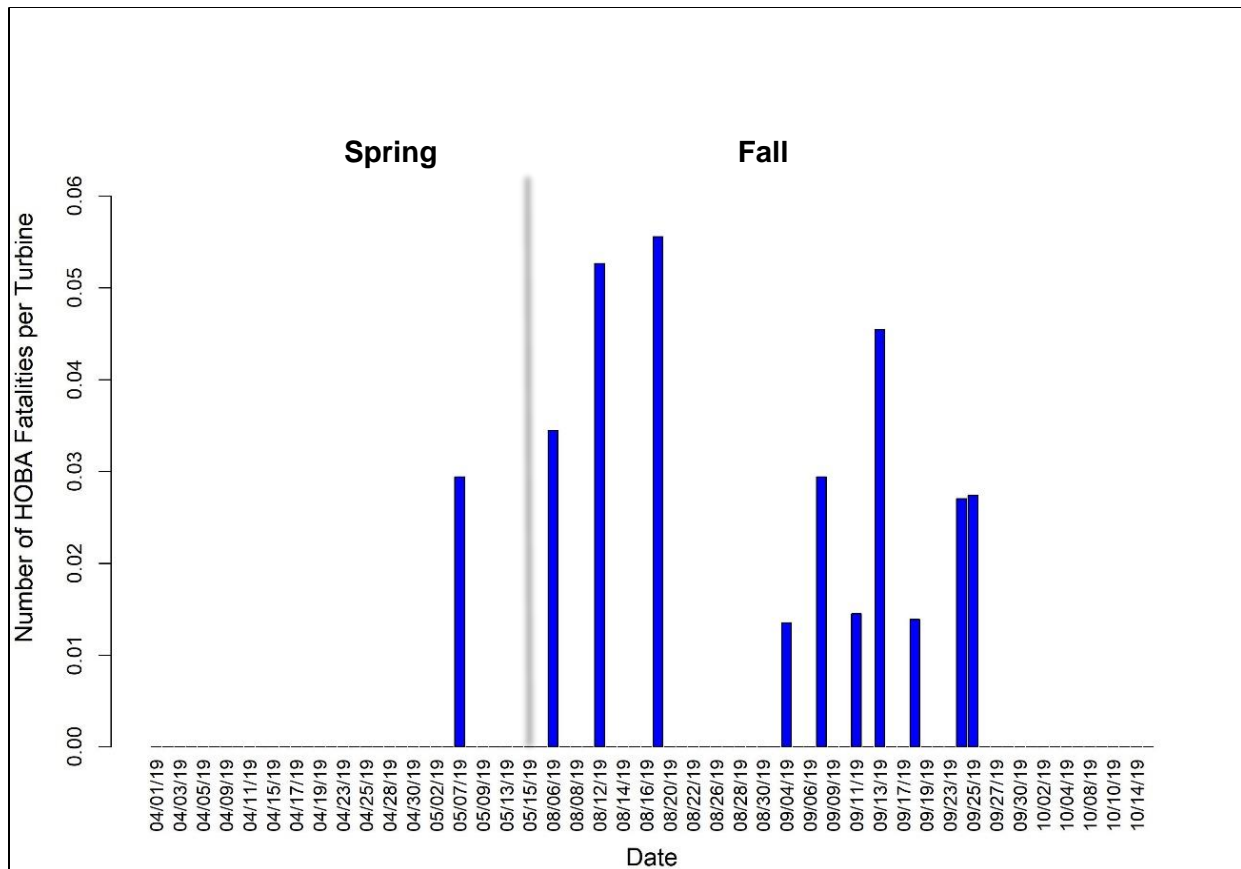


Figure 5. Timing of hoary bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

Distribution of Bat Carcasses

Over 92% of bat carcasses were found within 50 m (164.0 ft) of turbines, with the highest percentage (38.8%) of carcasses found between 0-10 m (0-32.8 ft), followed by 22.3% found between 20-30 m (65.6-98.4 ft; Table 6, Figure 6). This was a function of the amount of searchable area present because roads and pads comprise a higher percentage of the area closer to the turbines.

Table 6. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

Distance to Turbine (meters)	Number of Carcasses	Percent Composition
0 to 10	40	38.8
10 to 20	17	16.5
20 to 30	23	22.3
30 to 40	8	7.8
40 to 50	7	6.8
50 to 60	5	4.9
60 to 70	1	1.0
70 to 80	2	1.9

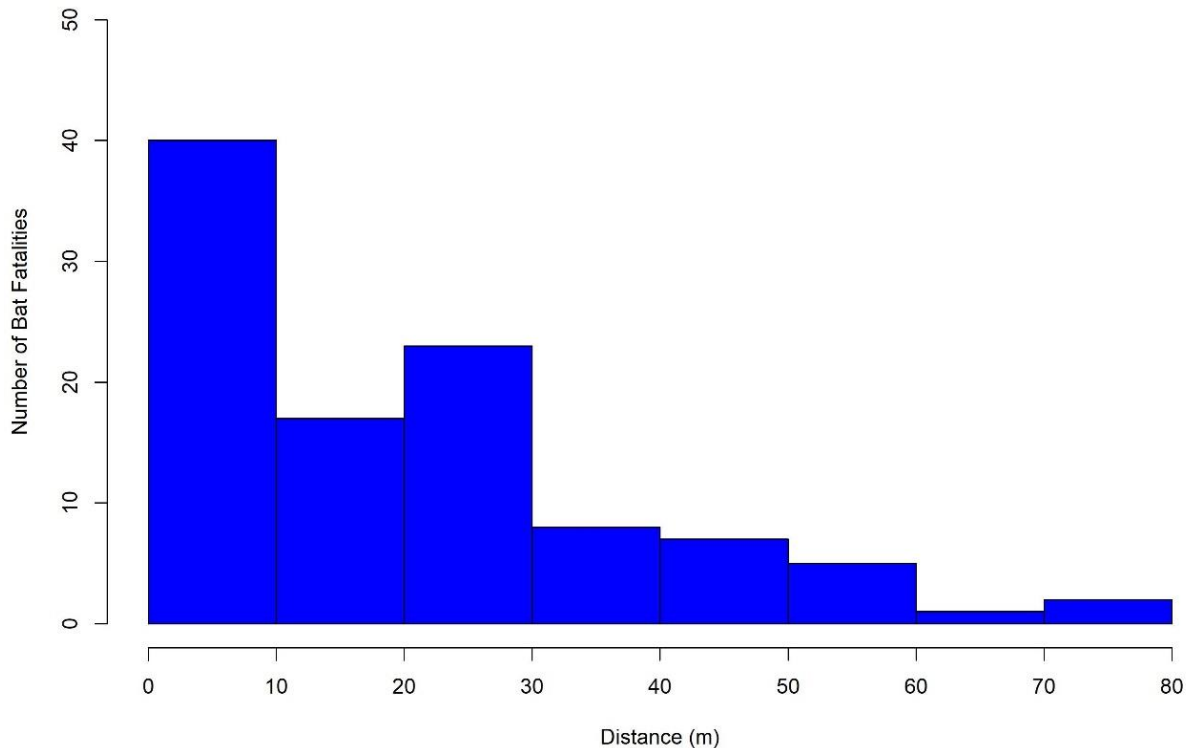


Figure 6. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in fatality estimates.

Bat Carcasses by Turbine Type

During the spring monitoring season, the highest observed fatality rate occurred at Siemens turbines (0.12 observed bat carcass per turbine) followed by Vestas turbines (0.06 observed bat carcass per turbine; Table 7). During the fall monitoring season, the highest observed fatality rate was at Clipper turbines (2.29 observed bat carcasses per turbine) followed by Siemens turbines (0.85 observed bat carcass per turbine; Table 7).

Siemens turbines are clustered in the northwestern section of the FRWR, while Clipper and Vestas turbines are found mostly in the eastern and southern sections (Figure 7). There are no obvious topographical or large-scale landscape features salient to bats in these portions of the FRWR that could help explain the higher fatality rates at these turbines.

Table 7. Total number of carcasses found, turbines searched, and unadjusted fatality rate by turbine type and season at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 15, 2019.

Turbine Type	Carcasses Found On Plot During Search or Incidentally	Number of Turbines Searched	Observed Fatalities per Turbine
Spring			
Siemens	8	65	0.12
Vestas	3	52	0.06
GE	1	53	0.02
Clipper	0	13	0
Total	12	183	0.07
Fall			
Clipper	16	7	2.29
Siemens	33	39	0.85
Vestas	27	39	0.69
GE	15	28	0.54
Total	91	113*	0.81

*Clipper turbine 639 was excluded from the analysis due to eight consecutive missed searches

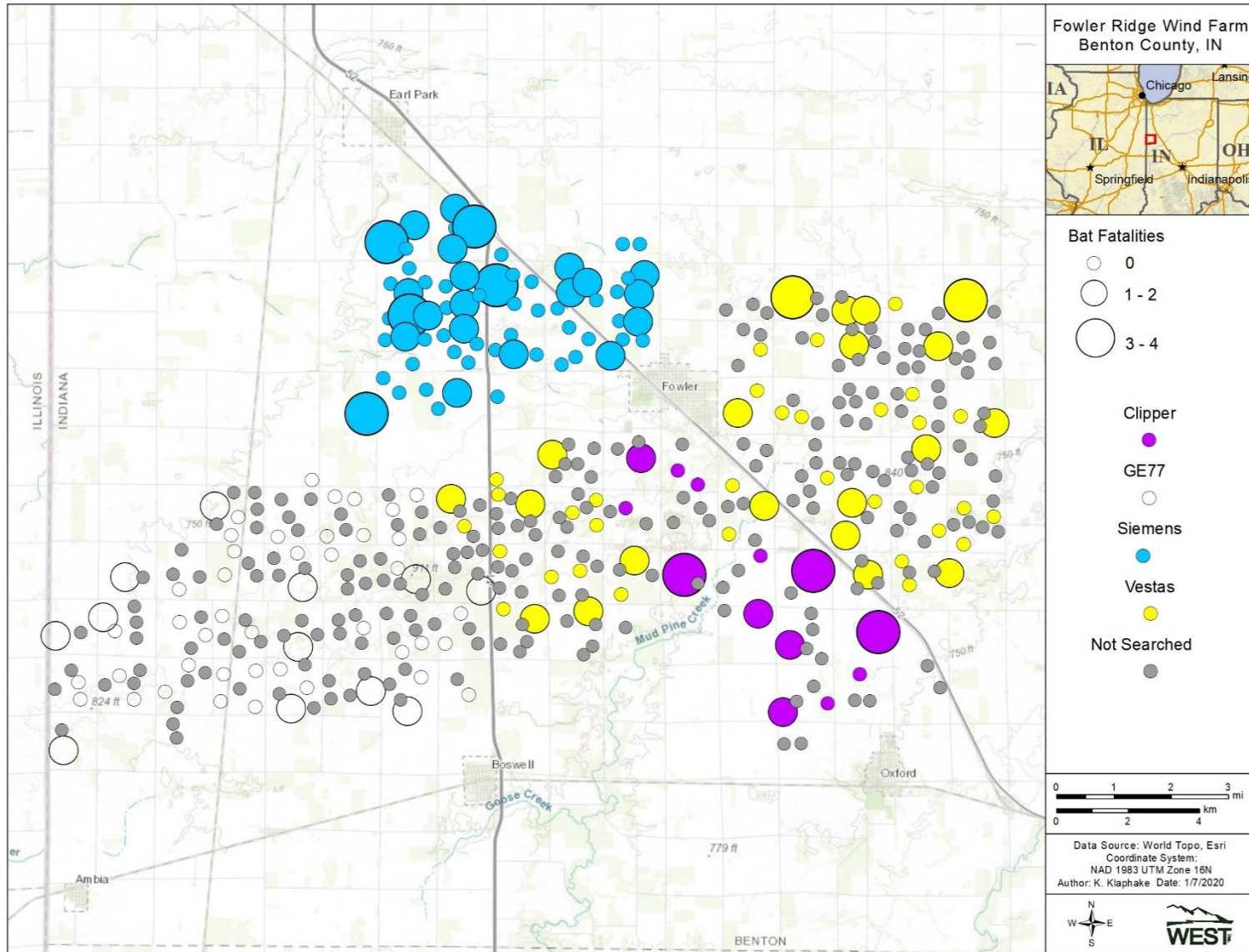


Figure 7. Number of bat carcasses found at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019 that were included in analyses.

Bias Trials

Searcher Efficiency Trials

During the spring season, 47 of the 70 carcasses placed for bias trials were found at the first scheduled search, with two additional bats found after multiple searches, resulting in an overall probability of a carcass being available and detected of 62.0% (Table 8). The percent found was calculated as an average across the percent found based on the number of days before a search. During the fall season, 32 of 54 bias trial carcasses placed were found at the first scheduled search, with three additional bats found after multiple searches, resulting in an overall probability of a carcass being available and detected of 59.4% (Table 8).

Table 8. Searcher efficiency based on empirical pi methodology for post-construction fatality monitoring at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2019.

Number of Days Prior to Search*	Number Placed	Number Found on First Search	Total Found	Percent Found
Spring				
0	20	19	19	95.0
1	11	11	11	100
2	8	5	6	75.0
3	8	4	5	62.5
4	12	4	4	33.3
5	7	3	3	42.9
6	4	1	1	25.0
Total	70	47	49	62.0
Fall				
0	21	18	19	90.5
1	8	7	7	87.5
2	8	1	2	25.0
3	9	3	4	44.4
4	8	3	3	37.5
Total	54	32	35	59.4

*Number of days prior to search in fall less than spring due to twice weekly searches.

Carcass Persistence Trials

Forty bats were used to measure carcass persistence rates, split between the spring and fall seasons. The average length of persistence for bat carcasses in 2019 was 8.52 days in the spring and 4.14 days in the fall. Carcass persistence in 2019 was lower than 2018 in both seasons (13.4 days in the spring, 6.8 days in the fall; Good et al. 2019). In 2017, the average carcass persistence in the fall was 10.7 days (Good et al. 2018).

Adjusted Fatality Estimates

Twelve of 15 bat carcasses found during the spring survey period were used in the analyses. Two were excluded because they were found outside the search plot at a normally searched turbine and one was excluded because it was an incidental find at a non-searched turbine. For the fall surveys, 91 bat carcasses were included in the analyses and 22 bat carcasses were excluded because they were incidental finds at non-searched turbines (n=13), found outside the search

plot at a normally searched turbine (n=1) or were estimated to have perished before July 31 (n=8; Appendix B).

An observed fatality rate of 0.07 bat per turbine was calculated for the spring (Table 9) and 0.81 bat per turbine in the fall (Table 10). The observed fatality rate was then divided by the empirical probability of availability and detection (0.62 for spring and 0.59 for fall). This value was multiplied by the road and pad correction factor (6.56 for Fowler I-III, 26.38 for Fowler IV) to obtain the per turbine adjusted fatality estimate for each type of turbine.

Table 9. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from April 1 to May 15, 2019.

Estimator	Point Estimate	Standard Deviation	90% Confidence Interval	
			Lower Limit	Upper Limit
Fowler I - III	6.56	-	-	-
Area adjustment Fowler IV	26.38	-	-	-
Observed fatalities per turbine	0.07	0.02	0.03	0.10
Empirical pi	0.62	0.06	0.53	0.71
Adjusted number of fatalities per turbine	1.14	0.38	0.56	1.82

Table 10. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from August 1 to October 15, 2019.

Estimator	Point Estimate	Standard Deviation	90% Confidence Interval	
			Lower Limit	Upper Limit
Fowler I - III	6.56	-	-	-
Area Adjustment Fowler IV	26.38	-	-	-
Observed fatalities per turbine	0.81	0.12	0.61	0.99
Empirical pi	0.59	0.04	0.52	0.67
Adjusted number of fatalities per turbine	13.40	2.23	9.86	17.24

The adjusted fatality estimate for the facility was weighted by the number of each turbine type present in the FRWF. The adjusted fatality estimate for the spring was 1.14 bat fatalities/turbine/study period, or 0.56 bat fatality/MW/study period (Table 11). The adjusted fatality estimate for the fall was 13.40 bat fatalities/turbine/study period or 6.74 bat fatalities/MW/study period (Table 12). The adjusted bat fatality rate per turbine was highest at Siemens turbines in both spring and fall (Tables 11 and 12).

Table 11. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from April 1 to May 15, 2019.

Turbine Type	Mean	90% Confidence Interval
Number of fatalities/turbine/year		
Siemens	5.24	2.06 – 9.34
Vestas	0.61	-
GE	0.20	-
Clipper	0	-
All Turbines	1.14	0.56–1.82
Number of fatalities/megawatt/year		
Siemens	2.28	0.90 – 4.06
Vestas	0.37	-
GE	0.13	-
Clipper	0	-
All Turbines	0.56	0.28-0.88

Table 12. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from August 1 to October 15, 2019.

Turbine Type	Mean	90% Confidence Interval
Number of fatalities/turbine/year		
Siemens	37.57	22.31 – 54.52
Clipper	25.23	8.94 - 44.69
Vestas	7.64	4.69 – 11.21
GE	5.91	3.15 - 9.21
All Turbines	13.40	9.86-17.24
Number of fatalities/megawatt/year		
Siemens	16.33	10.13 - 23.71
Clipper	10.09	3.58 - 17.88
Vestas	4.63	2.84 - 6.79
GE	3.94	2.10 - 6.14
All Turbines	6.74	4.35-8.08

End of Year Adaptive Management Threshold

The end of year adaptive management threshold, as described within the HCP, is 19.64 bat fatalities/turbine/year, which is based on the upper 90% confidence interval (CI) of the average of 2010 and 2011 spring and fall bat mortality estimates, reduced by 50% (39.28 bat fatalities/turbine/year ÷ 2). The 2019 fatality estimate with turbines feathered until wind speeds reached 3.5 m/s in the spring and 5.0 m/s in the fall was 14.54 bat fatalities/turbine/study period (90% CI 10.86-18.41), which was 63% lower than the end of year adaptive management threshold, and 54% lower than the mean spring and fall fatality estimate from 2010 and 2011 with turbines that operated at manufacturer cut-in speed. The end of year threshold for triggering adaptive management was not met in 2019 (Figure 8).

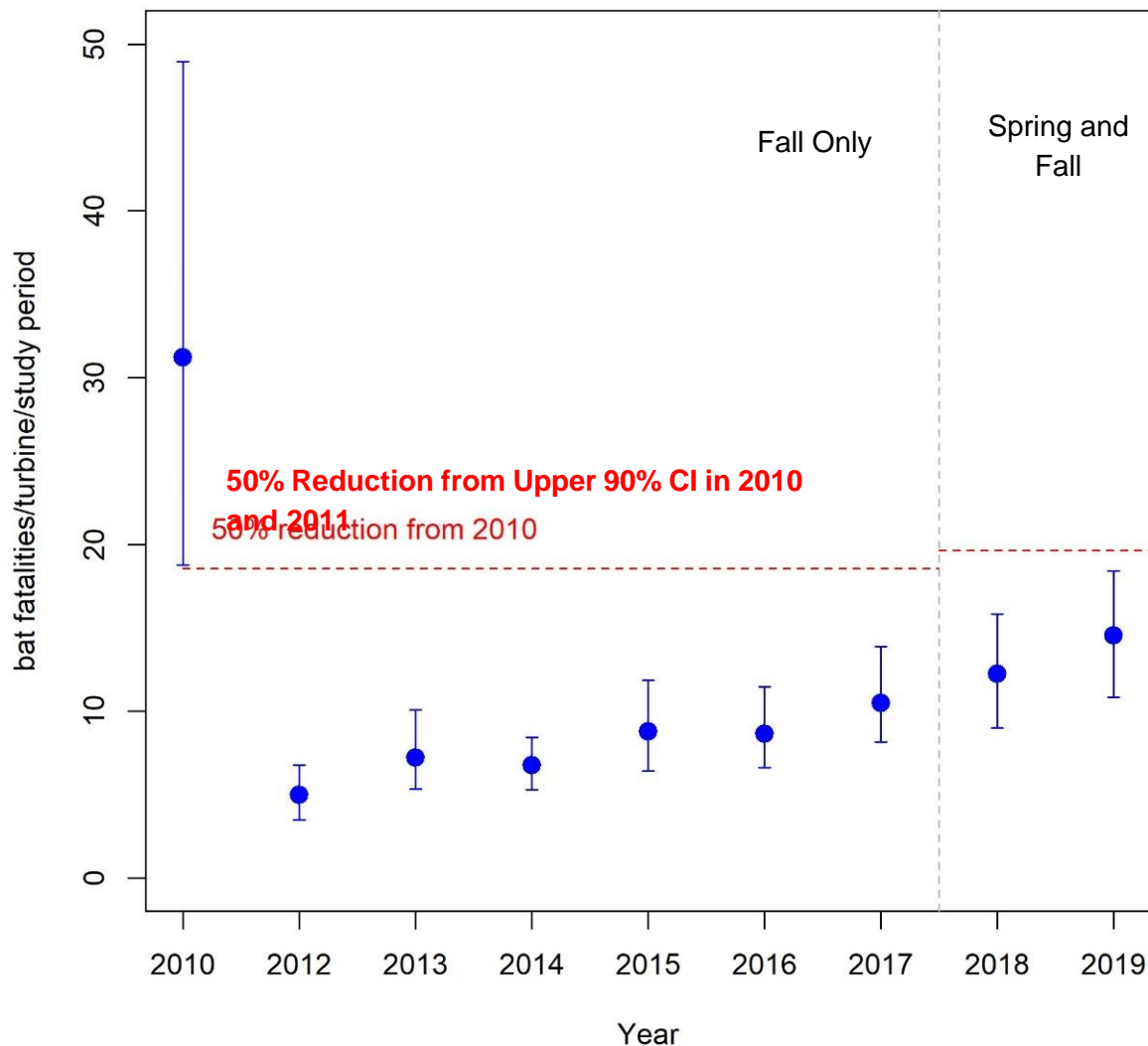


Figure 8. A comparison of estimated bat fatality rates and 90% confidence intervals for the Fowler Ridge Wind Farm. The 2010 and 2011 combined spring and fall estimate represents turbines operating at manufacturer cut-in speeds. The 2012-2017 estimates represent data collected at turbines feathered below 5.0 meters/second in the fall. The 2018-2019 estimates represent turbines feathered below 5.0 meters/second in the fall and 3.5 meters/second in the spring. The red dotted line from 2010 – 2017 represents the end-of-year adaptive management thresholds, which is a 50% reduction of the upper 90% confidence interval of bat fatality rates compared to the 2010 and 2011 combined fatality estimates.

Composition of Bat Species by Year

No Indiana bats have been found at the FRWF since ITP monitoring began; however, the total bat fatality rate has steadily increased since 2012. WEST plotted the relative fatality rates for the four most common bat species by year to determine if certain bat species were becoming more frequently found as fatalities, potentially explaining the increase in fatality rates. From 2012

through 2019, eastern red bats comprised the most fatalities every year, except 2017 when the number of silver-haired bats was higher (Figure 9). Big brown bats have consistently been the least found bat species during the same time period. The number of eastern red bat and silver-haired bat fatalities show an increase from 2012 to 2019, and to a lesser extent, hoary bats. Increases in fatality rates since 2016 appear to be largely driven by increasing numbers of eastern red bat and silver-haired bat fatalities.

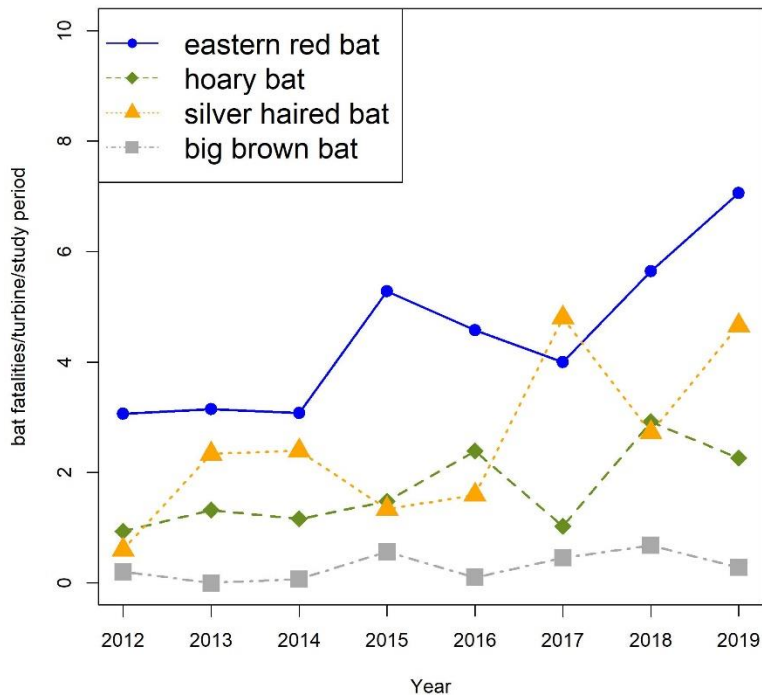


Figure 9. Composition of bat species found on search plots during scheduled searches at the Fowler Ridge Wind Farm from 2012 - 2019. The fatality rates by species were calculated by multiplying the total fatality rate for a given year by the percentage of each species comprising the total fatality pool.

Within Season Adaptive Management

The HCP includes an active adaptive management approach that facilitates responsiveness in management actions based on results from annual take compliance monitoring to ensure permit compliance. Within-season adaptive management thresholds were calculated to serve as an early indicator if adjustments to minimization efforts were necessary before the conclusion of the monitoring year. Per the HCP, within-season adaptive management thresholds were based on the predicted number of bat carcasses that would be found that would equal the upper quartile (i.e., 75th percentile) of estimated spring and fall bat mortality in 2010 and 2011 at control turbines with minimization measures in place, which equals 11.8 Indiana bats per year for the entire facility.

The HCP prescribes a sampling approach utilizing roads and pads to calculate fatality estimates. Per the HCP, to determine the number of bat carcasses of all species found that would equate to

the adaptive management threshold for within season Indiana bat mortality, bias correction factors from the previous year’s monitoring results were applied (Table 13a and Table 13b). The within-season adaptive management threshold for 2019 was 166 bat carcasses, spring and fall combined. A total of 103 bat carcasses were found on search plots that were estimated to have been killed during the study’s two monitoring periods.

Figure 10 illustrates the within-season tracking tool that was used to determine if mortality was approaching within-season adaptive management thresholds. The weekly 2019 estimated bat fatality rate shown in Figure 10 was a prediction calculated using the 2018 bias trial data. The final 2019 bat fatality estimate was based on 2019 bias trial results. Adaptive management thresholds were not exceeded at any time during the study, and no changes to minimization efforts were required during 2019.

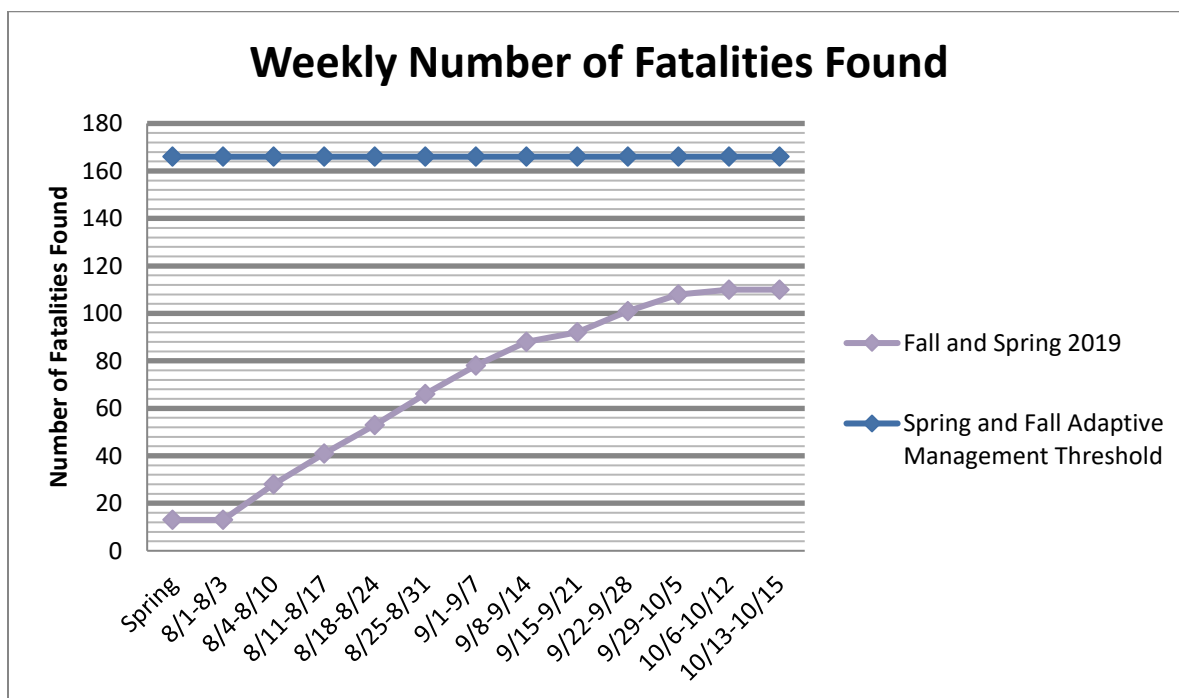


Figure 10. Weekly per turbine fatality rates (number of bat carcasses found per turbine) at the Fowler Ridge Wind Farm in 2019. This graph was used to determine if weekly fatality rates were approaching the 50% adaptive management threshold. Fatality rates for 2019 shown above were based on 2018 bias trial results.

Table 13a. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in spring 2019 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Descriptions of Data Sources
Adaptive management threshold for Indiana bats	0.60		Upper quartile (i.e., 75th percentile) of estimated spring bat mortality in 2010 and 2011 at control turbines with minimization measures in place
Percent of all fatalities that are Indiana bats	0.16		Percentage based on total number of Indiana bats found during searches over total bats found, as described within the Habitat Conservation Plan.
Estimated upper quartile of total fatalities during the period for which adaptive management thresholds are based		378	Calculated – 0.60//0.0016
Number of turbines	355	65	Fowler Phases I, II, III and IV
Estimated upper quartile of all bat fatality rates per turbine during the period for which adaptive management thresholds are based		0.90	Estimated by dividing the bat mortality count (378) by the number of operational turbines (420).
Empirical pi estimate		0.61	Estimated probability of carcasses being available and detected based on Fowler 2018 empirical bias trials from weekly road/pad searches; will be adjusted annually for subsequent years
Road and pad correction factor	6.56	26.38	Phases I, II and III estimated based on number of bats found on road and pads of cleared plots in relation to the total number of bats found at cleared plots in 2010 and 2011. Phase IV based on road and pad area searched measured at Phase IV and modeled carcass density distribution based on carcass distance data collected at Fowler from 2012-2016 on roads and pads
Predicted upper quartile of number of bats found per searched turbine during the period for which adaptive management thresholds are based	0.08	0.02	Predicted based on estimated fatality rate per turbine (0.90), multiplied by empirical pi (0.61), divided by road/and pad correction factor (6.56 or 26.38)
Total bats found in one spring season based on turbines searched	9.91	1.36	Predicted based on estimated number of bats found per turbine (0.08 or 0.02) multiplied by the number of turbines searched (118 or 65). Calculated value represents adaptive management threshold for 2019
Total Bats Found Threshold		11.27	Sum of expected bat mortality from Phases I, II, III and IV during the Spring

Table 13b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2019 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Descriptions of Data Sources
Adaptive management threshold for Indiana bats	11.22		Upper quartile (i.e., 75th percentile) of estimated fall bat mortality in 2010 and 2011 at control turbines with minimization measures in place
Percent of all fatalities that are Indiana bats	0.16		Percentage based on total number of Indiana bats found during searches over total bats found, as described within the Habitat Conservation Plan.
Estimated upper quartile of total fatalities during the period for which adaptive management thresholds are based	7,016		Calculated – 11.22//0.0016
Number of turbines	355	65	Fowler Phases I, II, III and IV
Estimated upper quartile of all bat fatality rates per turbine during the period for which adaptive management thresholds are based	16.7		Estimated by dividing the bat mortality count (7,016) by the number of operational turbines (420).
Empirical pi estimate	0.72		Estimated probability of carcasses being available and detected based on Fowler 2018 empirical bias trials from road/and pad searches every 3.5 days; will be adjusted annually for subsequent years
Road and pad correction factor	6.56	26.38	Phases I, II and III based on number of bats found on road and pads of cleared plots in relation to the total number of bats found at cleared plots in 2010 and 2011. Phase IV based on road and pad area searched measured at Phase IV and modeled carcass density distribution based on carcass distance data collected at Fowler from 2012-2016 on roads and pads. The road and pad correction factor used to estimate within-season thresholds is different than the factor used to calculate end-of-season fatality estimates. The end-of-season correction factor includes carcass distribution information collected during 2018; the within-season factor did not include 2018 data.
Predicted upper quartile of number of bats found per searched turbine during the period for which adaptive management thresholds are based	1.84	0.46	Predicted based on estimated fatality rate per turbine (16.7), multiplied by empirical pi (0.60), divided by road/and pad correction factor (6.56 or 26.38)

Table 13b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2019 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Descriptions of Data Sources
Total bats found in one fall season based on turbines searched	137.66	17.80	Predicted based on estimated number of bats found per turbine (1.80 or 0.45) multiplied by the number of turbines searched (75 or 39). Calculated value represents adaptive management threshold for 2019
Total Bats Found Threshold	155.46		Sum of expected bat mortality from Phases I, II, III and IV

End of Season Indiana Bat Take Estimate

The estimated number of Indiana bat fatalities that occurred during 2019 was calculated based on the overall estimated bat fatality rate during 2019, and the relative percent of Indiana bat carcasses compared to all bat carcasses found during the fall of 2009, 2010 and 2011 (0.16%). A total of 0.8 (90% CI 0.38-1.22) Indiana bat fatality were estimated to have occurred in the spring of 2019, and an estimated total of 9.0 (90% CI 6.62-11.58) Indiana bat fatalities in the fall. The total estimated number of Indiana bats was lower than the number that was predicted to occur as fatalities within the HCP after minimization (Table 14), and is within the 90% CI of Indiana bat fatalities predicted within the HCP. No CIs were provided in the HCP for the spring predicted number of Indiana bat fatalities. The end-of-year adaptive management threshold is equal to the upper bound of the 90% CI of Indiana bat mortality predicted within the HCP. Per the terms of the HCP, no changes to minimization efforts are required for 2020.

Table 14. The estimated number of Indiana bat fatalities compared to the number of predicted Indiana bat fatalities at the Fowler Ridge Wind Farm while operating under Incidental Take Permit TE95012A-0.

Year	Number of Operating Turbines	Estimated Number of Indiana Bat Fatalities	Predicted Number of Indiana Bat Fatalities to Occur within the HCP after Minimization		
			Lower 90% CI	Mean	Upper 90% CI
2014	355	4.1	7.0	8.6	10.6
2015	355	5.2	7.0	8.6	10.6
2016	420	5.8	8.8	10.9	13.4
2017	420	7.1	8.8	10.9	13.4
2018-Spring	420	0.7	-	0.70	-
2018-Fall	420	7.6	8.8	10.9	13.4
2019-Spring	420	0.8	-	0.70	-
2019-Fall	420	9.0	8.8	10.9	13.4

HCP=Habitat Conservation Plan; CI=confidence interval

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**Appendix A. Estimated Time of Death Information Sheet for Fowler Ridge Wind Farm
Benton County, Indiana**

Estimated Time of Death Information Sheet

Last Night

- **Eyes will be round and fluid filled, or slightly dehydrated**
 - Bat eyes dry much slower than bird eyes
 - Bird eyelids usually closed, open to check eyes
- **No decomposition, no smell**
- **No infestation beyond flies and eggs**
 - Possible to have very small maggots if carcass found after noon
- **Joints of body flexible**
 - Bat wing membranes flexible

2 – 3 Days

- **Eyes sunken or missing**
 - Bat eyes may still be intact
- **May be infested with small-medium sized maggots, beetles, flies, and ants**
- **Strong smell of decomposition**
- **Small holes in skin or body from insects (if no infestation noticed)**

4 – 7 Days

- **Eyes missing**
- **Internal scavenging evident**
 - Carcass may be full of large maggots (days 4-5) or only a shell with a few large maggots remaining (days 6-7) (during warm days)
- **Carcass may be hollow**
- **Fur may have begun to fall off and appear as “fluff” around bat**
 - Typically if carcass was rained on and then dried

7 – 14 Days

- **Mostly skin, feathers and bones**
- **Skin tightened to skeletal system**
- **Mostly devoid of insects**
 - Possibly a beetle, no maggots

Greater than 2 Weeks

- **Body desiccated (mummified in appearance)**

**Appendix B. Bat and Bird Casualties Found at the Fowler Ridge Wind Farm, Benton
County, Indiana between April 1 – October 15, 2019**

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 1 – October 15, 2019.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
4/2/2019	common grackle unidentified	410	Vestas	Yes	Yes	No
4/2/2019	passerine	125	GE	Yes	Yes	No
4/4/2019	mallard	S60	Siemens	Yes	No	No
4/11/2019	silver-haired bat	S1	Siemens	No	No	Yes
4/11/2019	silver-haired bat	S60	Siemens	Yes	No	No
4/16/2019	eastern red bat	224	Vestas	No	No	Yes
4/19/2019	silver-haired bat	S47	Siemens	No	No	Yes
4/26/2019	silver-haired bat	S11	Siemens	No	No	Yes
4/26/2019	common grackle	S27	Siemens	No	No	Yes
5/1/2019	silver-haired bat	85	GE	No	No	Yes
5/1/2019	silver-haired bat	S42	Siemens	No	No	Yes
5/1/2019	silver-haired bat	S56	Siemens	No	No	Yes
5/2/2019	silver-haired bat	S16	Siemens	No	No	Yes
5/6/2019	evening bat	322	Vestas	Yes	No	No
5/7/2019	silver-haired bat	285	Vestas	No	No	Yes
5/7/2019	chimney swift	245	Vestas	No	No	Yes
5/7/2019	hoary bat	226	Vestas	No	No	Yes
5/7/2019	silver-haired bat	629	Clipper	Yes	No	No
5/9/2019	silver-haired bat common	S1	Siemens	No	No	Yes
5/9/2019	yellowthroat	S31	Siemens	No	No	Yes
5/14/2019	silver-haired bat	S6	Siemens	No	No	Yes
5/14/2019	mourning dove	S21	Siemens	No	No	Yes
8/5/2019	hoary bat	388	Vestas	No	Yes	No
8/5/2019	eastern red bat	459	Vestas	No	No	Yes
8/5/2019	eastern red bat	398	Vestas	No	Yes	No
8/6/2019	hoary bat	17	GE	No	No	Yes
8/6/2019	hoary bat	20	GE	No	No	Yes
8/6/2019	eastern red bat	28	GE	No	No	Yes
8/6/2019	eastern red bat	457	Vestas	No	Yes	No
8/6/2019	hoary bat	639	Clipper	No	Yes	No
8/6/2019	hoary bat	622	Clipper	No	Yes	No
8/6/2019	evening bat	622	Clipper	No	Yes	No
8/7/2019	big brown bat	S52	Siemens	No	No	Yes
8/7/2019	eastern red bat	S18	Siemens	No	Yes	No
8/7/2019	hoary bat	S21	Siemens	No	Yes	No
8/7/2019	eastern red bat	S1	Siemens	No	No	Yes
8/7/2019	eastern red bat	309	Vestas	No	No	Yes
8/7/2019	eastern red bat	622	Clipper	No	No	Yes
8/7/2019	cliff swallow unidentified	624	Clipper	No	No	Yes
8/8/2019	passerine	83	GE	No	Yes	Yes
8/8/2019	eastern red bat	608	Clipper	Yes	No	No
8/8/2019	eastern red bat	17	GE	No	No	Yes
8/9/2019	eastern red bat	S57	Siemens	No	No	Yes
8/9/2019	eastern red bat	S59	Siemens	No	No	Yes
8/9/2019	eastern red bat	S38	Siemens	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 1 – October 15, 2019.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
8/9/2019	eastern red bat	S31	Siemens	No	No	Yes
8/9/2019	eastern red bat	S31	Siemens	No	No	Yes
8/12/2019	hoary bat	378	Vestas	No	No	Yes
8/12/2019	eastern red bat	448	Vestas	No	No	Yes
8/12/2019	eastern red bat	635	Clipper	Yes	No	No
8/12/2019	big brown bat	635	Clipper	Yes	No	No
8/12/2019	evening bat	631	Clipper	No	No	Yes
8/12/2019	hoary bat	285	Vestas	No	No	Yes
8/13/2019	eastern red bat	605	Clipper	No	No	Yes
8/13/2019	eastern red bat	82	GE	No	No	Yes
8/14/2019	eastern red bat	339	Vestas	No	No	Yes
8/15/2019	eastern red bat	28	GE	No	No	Yes
8/16/2019	eastern red bat	S43	Siemens	No	No	Yes
8/16/2019	eastern red bat	S60	Siemens	No	No	Yes
8/16/2019	hoary bat	S17	Siemens	Yes	No	No
8/19/2019	eastern red bat	371	Vestas	No	No	Yes
8/19/2019	eastern red bat	448	Vestas	No	No	Yes
8/19/2019	hoary bat	641	Clipper	No	No	Yes
8/19/2019	eastern red bat	631	Clipper	No	No	Yes
8/19/2019	hoary bat	260	Vestas	No	No	Yes
8/20/2019	vesper sparrow	230	Vestas	No	No	Yes
8/21/2019	eastern red bat	637	No	Yes	No	No
8/21/2019	eastern red bat	641	Clipper	No	No	Yes
8/22/2019	eastern red bat	88	GE	No	No	Yes
8/23/2019	eastern red bat	S53	Siemens	No	No	Yes
8/23/2019	eastern red bat	S33	Siemens	No	No	Yes
8/23/2019	eastern red bat	S30	Siemens	No	No	Yes
8/23/2019	hoary bat	334	Vestas	Yes	No	No
8/26/2019	eastern red bat	339	Vestas	No	No	Yes
8/26/2019	eastern red bat	226	Vestas	No	No	Yes
8/26/2019	eastern red bat	624	Clipper	No	No	Yes
8/26/2019	eastern red bat	641	Clipper	No	No	Yes
8/26/2019	eastern red bat	631	Clipper	No	No	Yes
8/27/2019	eastern red bat	156	Vestas	No	No	Yes
8/27/2019	eastern red bat	87	GE	No	No	Yes
8/27/2019	eastern red bat	87	GE	No	No	Yes
8/28/2019	eastern red bat	S42	Siemens	No	No	Yes
8/28/2019	silver-haired bat	S1	Siemens	No	No	Yes
8/28/2019	rock pigeon	375	Vestas	Yes	No	No
8/28/2019	big brown bat	627	Clipper	No	No	Yes
8/28/2019	eastern red bat	631	Clipper	No	No	Yes
8/28/2019	eastern red bat	260	Vestas	No	No	Yes
8/28/2019	eastern red bat	23	GE	Yes	No	No
9/3/2019	eastern red bat	339	Vestas	No	No	Yes
9/3/2019	silver-haired bat	459	Vestas	No	No	Yes
9/3/2019	silver-haired bat	478	Vestas	No	No	Yes
9/4/2019	hoary bat	S54	Siemens	No	No	Yes
9/4/2019	eastern red bat	S54	Siemens	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 1 – October 15, 2019.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
9/4/2019	silver-haired bat	S18	Siemens	No	No	Yes
9/4/2019	eastern red bat	S21	Siemens	No	No	Yes
9/4/2019	silver-haired bat	611	Clipper	No	No	Yes
9/5/2019	killdeer	268	Vestas	No	No	Yes
9/5/2019	eastern red bat	459	Vestas	No	No	Yes
9/5/2019	eastern red bat	32	GE	Yes	No	No
9/6/2019	eastern red bat	230	Vestas	No	No	Yes
9/7/2019	eastern red bat	S60	Siemens	No	No	Yes
9/7/2019	hoary bat	S59	Siemens	No	No	Yes
9/9/2019	silver-haired bat	369	Vestas	No	No	Yes
9/9/2019	silver-haired bat	390	Vestas	No	No	Yes
9/9/2019	eastern red bat	611	Clipper	No	No	Yes
9/10/2019	silver-haired bat	61	GE	No	No	Yes
9/10/2019	killdeer	28	GE	No	No	Yes
9/11/2019	hoary bat	S30	Siemens	No	No	Yes
9/11/2019	eastern red bat	432	Vestas	No	No	Yes
9/13/2019	silver-haired bat	14	GE	No	No	Yes
9/13/2019	eastern red bat	S35	Siemens	Yes	No	No
9/13/2019	hoary bat	S27	Siemens	No	No	Yes
9/13/2019	hoary bat	S54	Siemens	No	No	Yes
9/13/2019	eastern red bat	S30	Siemens	No	No	Yes
9/16/2019	silver-haired bat	375	Vestas	No	No	Yes
9/16/2019	hoary bat	29	GE	Yes	No	No
9/17/2019	silver-haired bat	605	Clipper	No	No	Yes
9/17/2019	eastern red bat	311	Vestas	Yes	No	No
9/18/2019	hoary bat	339	Vestas	No	No	Yes
9/18/2019	killdeer	442	Vestas	No	No	Yes
9/18/2019	killdeer	442	Vestas	No	No	Yes
9/23/2019	silver-haired bat	329	Vestas	No	No	Yes
9/23/2019	eastern red bat	S20	Siemens	Yes	No	No
9/24/2019	silver-haired bat	46	GE	No	No	Yes
9/24/2019	hoary bat	121	GE	No	No	Yes
9/25/2019	hoary bat	S48	Siemens	No	No	Yes
9/25/2019	hoary bat	S54	Siemens	No	No	Yes
9/25/2019	mourning dove	423	Vestas	No	No	Yes
9/25/2019	eastern red bat	611	Clipper	No	No	Yes
9/26/2019	silver-haired bat	82	GE	No	No	Yes
9/27/2019	evening bat	S57	Siemens	No	No	Yes
9/30/2019	unidentified bat	442	Vestas	No	No	Yes
9/30/2019	silver-haired bat	478	Vestas	No	No	Yes
10/1/2019	eastern red bat	101	GE	No	No	Yes
10/2/2019	silver-haired bat	S43	Siemens	No	No	Yes
10/2/2019	eastern red bat	S60	Siemens	No	No	Yes
	unidentified					
10/3/2019	passerine	72	GE	No	No	Yes
10/4/2019	silver-haired bat	S38	Siemens	No	No	Yes
10/4/2019	silver-haired bat	S21	Siemens	No	No	Yes
10/7/2019	silver-haired bat	388	Vestas	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 1 – October 15, 2019.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
10/7/2019	silver-haired bat	611	Clipper	No	No	Yes
10/9/2019	silver-haired bat	S43	Siemens	No	No	Yes
10/9/2019	silver-haired bat	369	Vestas	Yes	No	No
10/11/2019	silver-haired bat	310	Vestas	Yes	No	No
10/15/2019	silver-haired bat	S46	Siemens	No	No	Yes
10/15/2019	golden-crowned kinglet	S48	Siemens	No	No	Yes