

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

**DRAFT Report
May 4 – October 15, 2020**



**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 during the fall migration period. 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. The estimated Indiana bat fatality rate was below adaptive management thresholds in both years, so less intensive implementation phase monitoring began in 2016 for Phases I, II, and III, 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 Phase IV. The estimated Indiana bat fatality rate was below adaptive management thresholds in both years for this phase, so implementation phase monitoring 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 when the original HCP was prepared and the ITP was issued. In 2018, the HCP was amended to account for spring take of Indiana bats due to evidence indicating a risk of Indiana bat take during the spring migration period. An ITP amendment was granted, and two years of evaluation phase monitoring were conducted during the spring of 2018 and 2019 at all phases of the FRWF. Estimated Indiana bat fatality rates were below adaptive management thresholds in both years, so implementation phase monitoring for all phases began in the spring of 2020 and will continue unless adaptive management thresholds are exceeded in the future.

Standardized carcass searches were completed weekly at 114 turbines during the spring (May 4 – May 15) and twice weekly during the fall (August 1 – October 15), corresponding with migration periods of Indiana bats. Stay-at-home orders for Indiana residents due to COVID-19 prevented monitoring from April 1 – May 3. Turbines were searched twice weekly during the fall of 2020 because the average length of persistence for bat carcasses in the fall of 2019 was 4.14 days. The search area was restricted to the gravel roads and pads within 80 meters (262 feet) of each turbine included in the study in both seasons. Searcher efficiency and carcass persistence trials were also conducted during both seasons to adjust for detection and removal bias.

No Indiana bat or other *Myotis* species were found. There were 124 bat carcasses of five known species and one identified to the genus *Lasiurus*, and 18 bird carcasses of 14 known species found during searches and incidentally. Similar to previous years of monitoring, the most

commonly found bat species were eastern red bats and silver-haired bats, followed by hoary bats. Four Seminole bats and four big brown bats were also found.

Estimated 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 fatality estimate was adjusted upward for the spring period when COVID-19 prevented surveys. The combined spring and fall bat fatality rate in 2020 was estimated to be 14.32 bat fatalities/turbine/study period (90% confidence interval: 11.09–18.41). The results of monitoring during 2020 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 2020 because bat fatality rates were below adaptive management thresholds.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY i

INTRODUCTION 1

STUDY AREA..... 2

METHODS 4

 Standardized Carcass Searches 4

 Turbine Operation Schedule 5

 Bias Trials 6

 Searcher Efficiency Trials 6

 Carcass Persistence Trials 6

 Quality Assurance and Quality Control 7

 Statistical Analysis 7

 Bat Fatality Rate Estimation 7

 Carcass Persistence Rates 8

RESULTS 9

 Bat and Bird Carcass Surveys 9

 Species Composition 9

 Estimated Time since Death 11

 Timing of Bat Carcasses 11

 Distribution of Bat Carcasses 13

 Bat Carcasses by Turbine Type 14

 Bias Trials 14

 Searcher Efficiency Trials 14

 Carcass Persistence Trials 16

 Estimated Fatality Rates 16

 End-of-year Adaptive Management Threshold 19

 Within-season Adaptive Management 19

 End-of-season Indiana Bat Take Estimate 24

REFERENCES 24

LIST OF TABLES

Table 1. Turbine characteristics at the Fowler Ridge Wind Farm, Benton County, Indiana.....2

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.....4

Table 3. Total number and percent composition of bat carcasses found at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020.**Error! Bookmark not defined.**

Table 4. Total number and percent composition of bird carcasses found at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020. 11

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 May 4 – May 15 and August 1 – October 15, 2020. 11

Table 6. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates..... 13

Table 7. Total number of carcasses found and unadjusted fatality rate by turbine type and season at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020. 14

Table 8. Searcher efficiency based on empirical pi methodology for post-construction fatality monitoring at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020. 15

Table 9. Carcass persistence rates reported at the Fowler Ridge Wind Farm from April 1 – May 15 (Spring) and August 1 – October 15 (Fall) from 2010 – 2020. 16

Table 10. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from April 1 – May 15, 2020. An adjustment of 0.29 was applied to account for the shorter study period. 17

Table 11. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from August 1 – October 15, 2020..... 17

Table 12. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from April 1 – May 15, 2020. ¹ 18

Table 13. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from August 1 – October 15, 2020. ¹ 19

Table 14a. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in spring 2020 (Phases I, II, III, and IV).22

Table 14b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2020 (Phases I, II, III, and IV).23

Table 15. 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.....24

LIST OF FIGURES

Figure 1. Land cover types and locations of Phase I–IV turbines searched from May 4 – May 15 and August 1 – October 15, 2020, at the Fowler Ridge Wind Farm, Benton County, Indiana.3

Figure 2. Timing of eastern red bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates..... 12

Figure 3. Timing of silver-haired bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates..... 12

Figure 4. Timing of hoary bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates. 13

Figure 5. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates..... 14

Figure 6. A comparison of estimated bat fatality rates and 90% confidence intervals (CIs) for the Fowler Ridge Wind Farm.20

Figure 7. Weekly per-turbine fatality rates (number of bat carcasses found per turbine) at the Fowler Ridge Wind Farm in 2020. This graph was used to determine if weekly fatality rates were approaching the 50% adaptive management threshold. Fatality rates for 2020 shown above were based on 2019 bias trial results.21

LIST OF APPENDICES

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

Appendix B. Bat and Bird Casualties Found at the Fowler Ridge Wind Farm, Benton County, Indiana, between May 4 – May 15 and August 1 – October 15, 2020

Appendix C. Representative Photos of Carcass Removal Events Recorded at Fowler Ridge Wind Farm, Benton County, Indiana, between September 14 – 23, 2020

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, II, 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 FRWF used 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 are at 5.0 meters per second (m/s; 16.4 feet per second [ft/s]) or lower, on a nightly basis from sunset to sunrise during the fall migration period from August 1 – October 15. 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 were completed at Phases I, II, and III during the fall migration season for Indiana bats in 2014 (Good et al. 2015) and 2015 (Good et al. 2016). Construction of Phase IV was completed in December 2015, and the required two years of evaluation phase monitoring were conducted during the fall migration season for Indiana bats in 2016 (Good et al. 2017) and 2017 (Good et al. 2018). Because the estimated Indiana bat fatality rate was estimated to be below adaptive management thresholds for all phases during their respective evaluation years, as outlined in the HCP, implementation phase monitoring began in the fall of 2016 at Phases I, II, and III, and in the fall of 2018 at Phase IV, and will continue unless adaptive management thresholds are exceeded in the future (Good et al. 2018, 2019, 2020).

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). To minimize Indiana bat take during the spring migration period, turbine blades are 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. As per the amended HCP and ITP, two years of spring evaluation phase monitoring were conducted in 2018 (Good et al. 2019) and 2019 (Good et al. 2020) at the FRWF. Because the estimated Indiana bat fatality rate was estimated to be below adaptive management thresholds during the spring of 2018 and 2019, implementation phase monitoring began in 2020 and will continue unless adaptive management thresholds are exceeded in the future.

Prior to the start of the spring 2020 fatality monitoring season, the Health, Safety, Security and Environment Advisor for BP informed WEST that monitoring would be delayed while a stay-at-home order was in place in Indiana (N. Allred, BP, pers. comm., March 25, 2020). The stay-at-home restrictions were eased by the governor of Indiana as of May 1, 2020, and an abbreviated spring monitoring season began on May 4, 2020. This report describes the results of the 2020 spring and fall fatality monitoring required under the HCP and ITP.

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 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 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*; Figure 1). Within 0.8 kilometers (0.5 mile) of turbine locations, cultivated crops compose 92.5% of the land use in the 67,894-acre (27,476-hectare) 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 compose 5.3% of the total, and pastures/hayfields, which compose 1.5% of the total area. Forested areas, grasslands (herbaceous), and wetlands are rare within the study area (National Land Cover Database 2016).

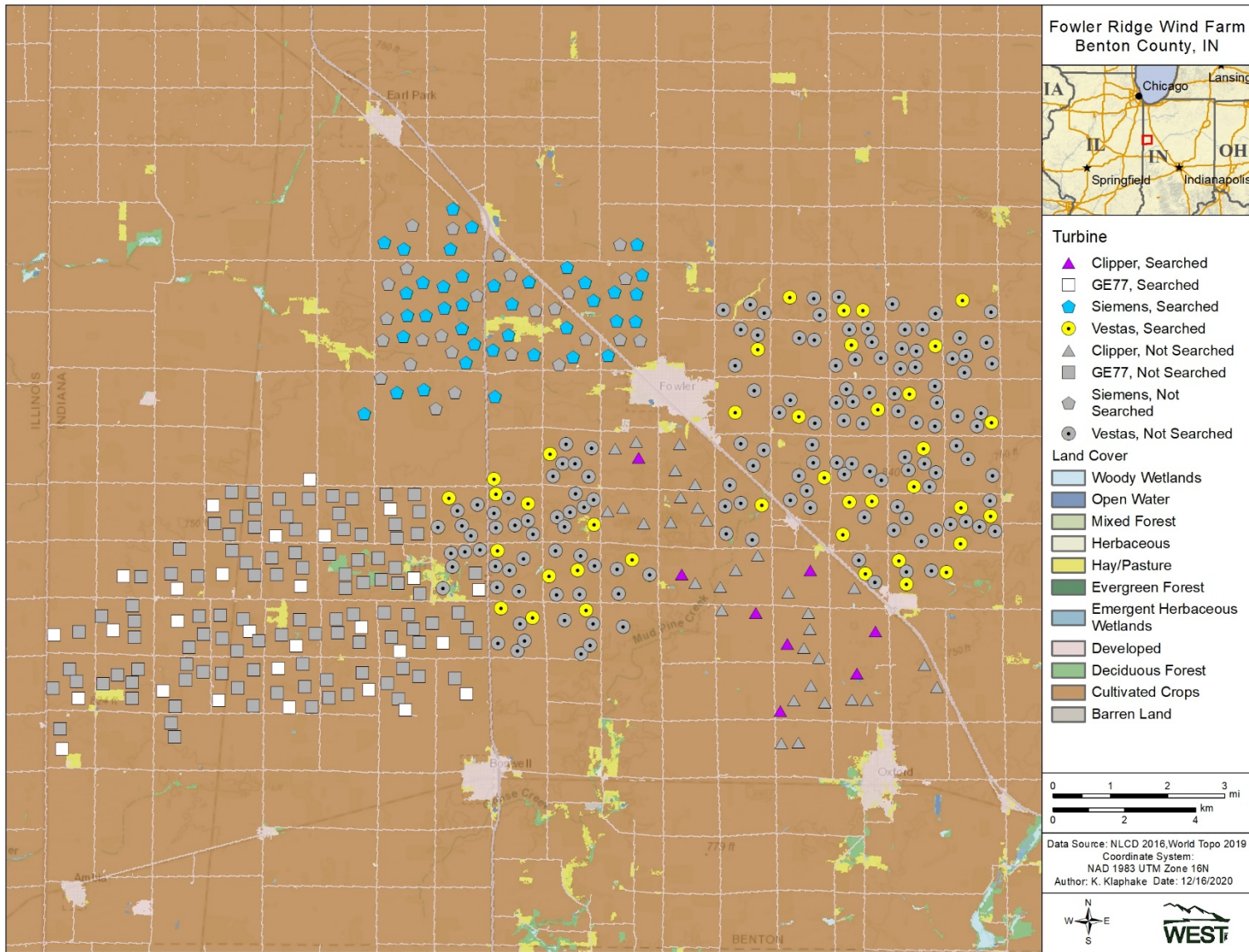


Figure 1. Land cover types and locations of Phase I-IV turbines searched from May 4 – May 15 and August 1 – October 15, 2020, at the Fowler Ridge Wind Farm, Benton County, Indiana.

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	67,894.0	100

Source: National Land Cover Database (2016).

METHODS

Standardized Carcass Searches

Most of the preceding monitoring efforts have 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 fatality estimates 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 (April 1 – May 15) for Indiana bats as well. All phases of the FRWF are in the implementation phase monitoring period of the HCP during both spring and fall monitoring periods, so a randomly chosen subset of turbines were searched from May 4 – May 15 and August 1 – October 15, 2020, for 75 turbines at Phases I, II, and III, and 39 turbines at Phase IV (Figure 1).

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 8.5 days recorded during spring monitoring at the FRWF in 2019 (Good et al. 2020). During the fall monitoring period, carcass searches were conducted twice weekly. This search interval was determined by the mean carcass persistence time of 4.1 days recorded during fall monitoring at the FRWF in 2019 (Good et al. 2020).

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 of the tower. Searchers walked at a rate of approximately 45–60 m (148-197 ft) per minute along each transect, looking for bat and bird carcasses. Transects were spaced at approximately 3-m (10-ft) intervals, and searchers scanned the area on both sides out to 1.5 m (5.0 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 is complete, shows little to no decomposition, and no sign of being fed upon by a predator or scavenger
- Scavenged – an entire carcass that shows signs of scavenging or is heavily infested by insects, or portion(s) of a carcass in one location (e.g., wings, skeletal remains)
- Dismembered – an entire carcass, but found in more than one piece, where the pieces are separated by more than 5.0 m (16.4 ft)
- Injured – a live bird or bat that is harmed, damaged, or impaired in some way
- Feather Spot (for bird carcasses only) – 10 or more feathers (or two or more primary feathers) at 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 latitude and longitude, distance and azimuth from turbine, condition (live, intact, scavenged, dismembered, feather spot), and any comments regarding possible cause of death or scavenging. 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, two to three 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 carcass with the potential to be a state- or federally listed endangered or threatened species was reported to the appropriate agency within 48 hours. A permitted bat biologist verified the species identification of all bat carcasses, which were 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 identification tag 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 selected 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, but left in place.

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 searchers found 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, e.g. during the spring season.

Multiple searcher efficiency trials were conducted in each season. Across both seasons, 13 bats were placed from zero to six days prior to searches in the spring, and 62 bats were placed from zero to four days prior to searches in the fall to estimate the overall probability that a bat carcass was available and detected (empirical pi). Searchers had multiple chances to find a trial carcass on subsequent search days. The first day a searcher discovered a carcass was recorded to estimate the overall probability that a carcass was available and detected. 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 and were collected when found.

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 searches occurred.

Persistence trials were conducted during both spring and fall to incorporate the effects of varying weather and scavenger densities. Thirty-five bat carcasses were monitored to estimate persistence rates. Carcasses were checked on days 1, 2, 4, 6, 8, 10, 12, 18, and 24 after

placement to calculate average carcass persistence rates. Day 1 was defined as the day after a carcass was placed. The schedule varied slightly depending on weather and coordination with other survey work. 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.

Trail cameras were used in conjunction with standard carcass persistence monitoring to determine if more precise removal times could be achieved, as well as collect data on scavengers that are most active at the FRWF (Rosa et al. 2019). Three infrared trail cameras, model *LTL Acorn 5210A*, were positioned at three different turbine types to collect photos of scavenging events (Clipper Turbine 639, GE Turbine 7, and Siemens Turbine S12). The trail cameras were programmed to take a burst of three pictures at every trigger event, separated by five minutes to reduce the risk of filling the memory card or depleting the batteries.

Quality Assurance and Quality Control

WEST implemented quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. All WEST field staff were trained in proper survey techniques and all data collected were recorded in a tablet, electronically. Data were reviewed before they were submitted for data entry. If errors or anomalies were found, follow-up measures were implemented including discussions and review of field data with searchers and/or Project managers.

WEST data entry staff were trained on proper data entry procedures. System controls were implemented to ensure correct data were entered; however, if any errors, omissions, or problems were identified in later stages of analysis, they were traced back to the raw data where appropriate changes and measures were implemented. Data were entered into a MS SQL database and were QA/QC'd throughout the course of the study. Statisticians provided an extra level of QA/QC to ensure proper protocols were followed and data collected were congruent with the objectives of the study.

Statistical Analysis

Bat Fatality Rate Estimation

Fatality estimates for bats were calculated based on:

- Observed number of bat carcasses found in search areas 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
- The search area adjustment factor for bat carcasses landing outside of searched roads and pads

Carcasses found in a search area 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 May 4 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 in search areas would have been found at the next search if they had not been found incidentally. Carcasses found outside of search areas 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.

An adjustment factor (r) of 6.56 was used to adjust for carcasses estimated to occur outside of searched roads and pads for Fowler Ridge I–III Wind Farms (Fowler I–III), to determine total estimated bat fatality during the fall migration period. This area adjustment factor was an average of the road and pad adjustment 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 adjustment factor in order to accurately estimate bat fatality rates. An adjustment factor (r) of 26.38 was used to adjust for carcasses that likely occurred outside of searched roads and pads for Fowler Ridge IV Wind Farm (Fowler IV) to determine the total estimated bat fatality rate 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:

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

Due to the differences in MW ratings for each turbine type, bat fatality rates were calculated for each type of turbine present, and a weighted average was used to calculate the facility wide bat fatality rate (bats/turbine/study period and bats/MW/study period). The proportion of each turbine type at the FRWF were used as weights for calculating the overall bat fatality rate for the FRWF.

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, in days, a carcass remained in the study area before it was removed:

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

Between Years Comparisons

Percent change in fatality rates between 2020 (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

There were 2,635 surveys conducted on roads and pads at 114 turbines from May 4 – May 15, and from August 1 – October 15, 2020. Due to turbine maintenance or severe weather, 101 surveys (3.6%) were missed. Overall, 124 bat carcasses and 18 bird carcasses were found during the survey (Table 3, Appendix B).

Species Composition

No Indiana bats or other *Myotis* species were found during the study. The most commonly found bat species were eastern red bat (*Lasiurus borealis*; 63 carcasses; 51.8%), silver-haired bat (*Lasionycteris noctivagans*; 39 carcasses; 31.4%), and hoary bat (*Lasiurus cinereus*; 12 carcasses; 9.7%). Four Seminole bat (*L. seminolus*) carcasses (3.2%) and four, big brown bat carcasses were also found (3.2%; Table 3). One bat carcass was heavily scavenged and could only be identified to the *Lasiurus* genus.

Eighteen bird carcasses found during the survey period represent 14 known bird species (Table 4). No eagles or any bird species listed as threatened or endangered by IDNR (2019), or the federal Endangered Species Act (1973) were found (USFWS 2019).

Table 3. Total number and percent composition of bat carcasses found at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020.

Species	Number Included in Fatality Estimate	Percent Composition Included in Fatality Estimate*	Number Found Outside Plot	Percent Composition Found Outside Plot*	Number with Estimated Time of Death Outside Study Period	Percent Composition with Estimated Time of Death Outside Study Period*	Number of All Carcasses Found	Percent Composition of All Carcasses Found*
eastern red bat	55	56.7	9	36.0	0	0	64	51.6
silver-haired bat	26	26.8	12	48.0	1	50.0	39	31.4
hoary bat	9	9.3	3	12.0	0	0	12	9.7
Seminole bat	4	4.1	0	0	0	0	4	3.2
big brown bat	3	3.1	1	4.0	0	0	4	3.2
unidentified <i>Lasiurus</i> bat	0	0	0	0	1	50.0	1	0.8
Totals	97	100	25	100	2	100	124	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 May 4 – May 15 and August 1 – October 15, 2020.

Species	Number	Percent Composition*
mourning dove	4	22.2
horned lark	2	11.1
American redstart	1	5.6
bay-breasted warbler	1	5.6
black-and-white warbler	1	5.6
blue jay	1	5.6
European starling	1	5.6
house sparrow	1	5.6
killdeer	1	5.6
red-breasted nuthatch	1	5.6
red-eyed vireo	1	5.6
rock pigeon	1	5.6
ruby-throated hummingbird	1	5.6
turkey vulture	1	5.6
Totals	18	100

* Totals may not add to 100% due to rounding.

Estimated Time since Death

The majority of bat carcasses found on search plots and included in the analyses had an estimated time of death of less than a week (94 carcasses; 96.9%; Table 5) A little more than half of the bat carcasses were estimated to have been killed the night before the search (57.7%), while only one bat carcass (1.0%) had an estimated time of death beyond seven days (Table 5). Two bats were found injured and were not collected, both 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 May 4 – May 15 and August 1 – October 15, 2020.

Estimated Time Since Death^a	Number of Carcasses	Percent Composition
Last night	56	57.7
2–3 days	33	34.0
4–7 days	5	5.2
8–14 days	1	1.0
Greater than 14 days	0	0
Greater than 30 days	0	0
Unknown	0	0
Injured	2	2.1

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

Timing of Bat Carcasses

Eastern red bats fatalities in search areas were found throughout the fall season with peaks occurring during the last week of August and the second week of September (Figure 2). Silver-haired bats were the only bat species found in search areas in the spring, and they occurred regularly throughout the fall, after the last week of August (Figure 3). Hoary bat fatalities were consistently at low levels from early August through the middle of September (Figure 4).

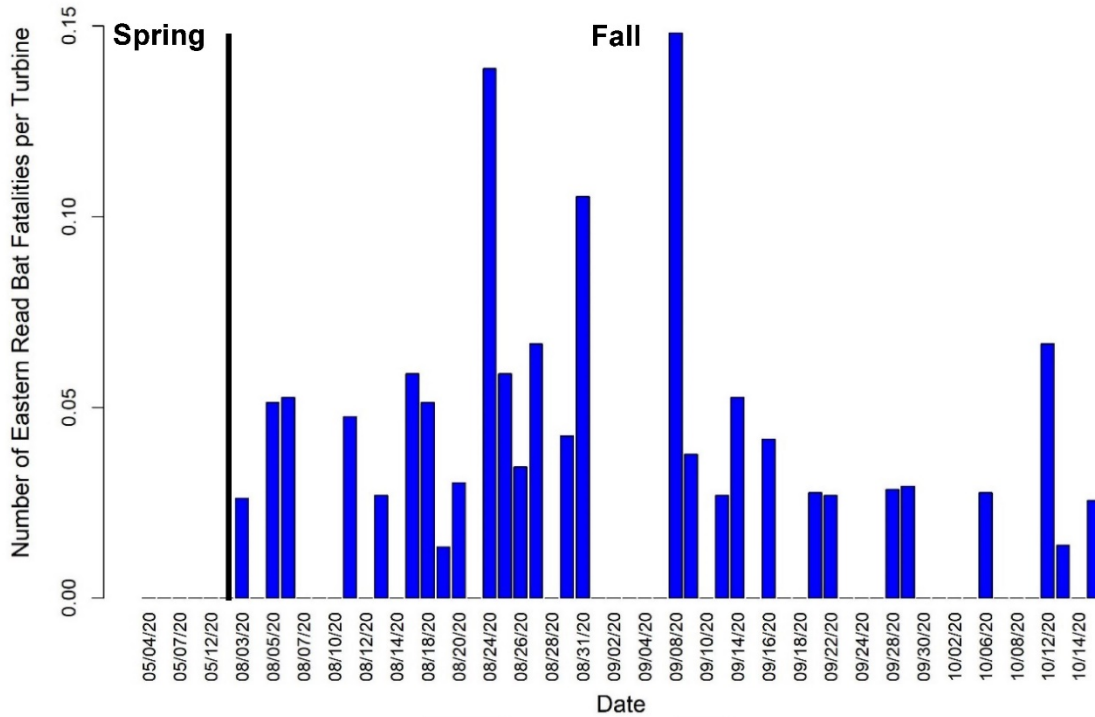


Figure 2. Timing of eastern red bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates.

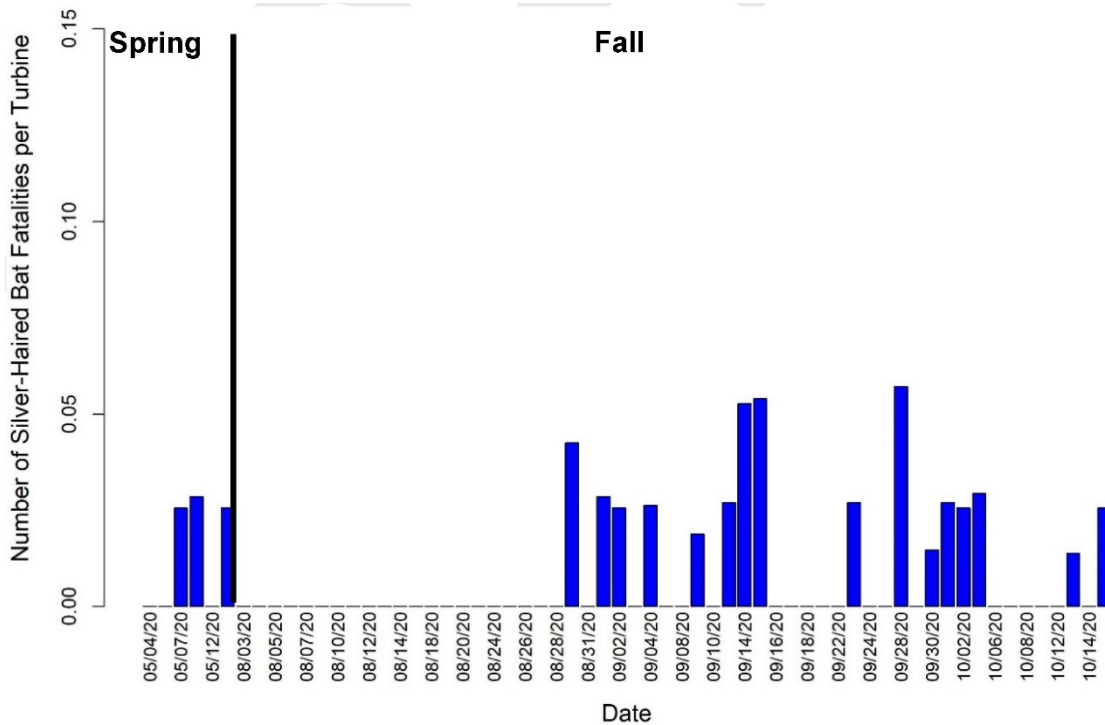


Figure 3. Timing of silver-haired bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates.

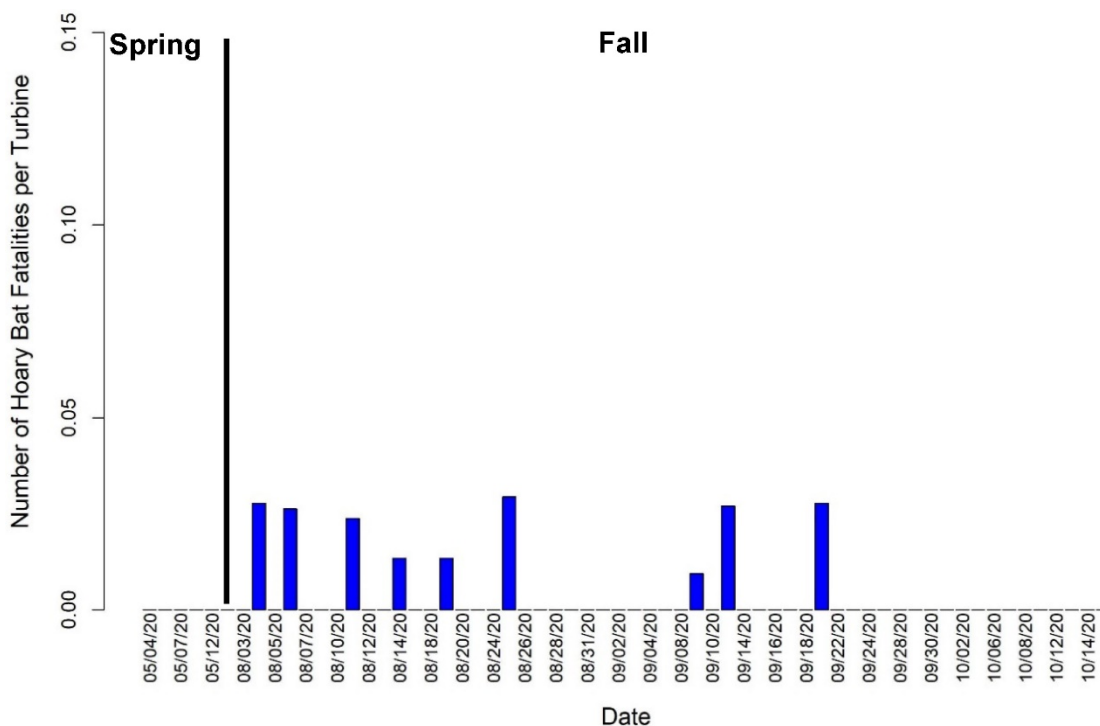


Figure 4. Timing of hoary bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates.

Distribution of Bat Carcasses

Almost 95% of bat carcasses were found within 50 m (164 ft) of turbines, with the highest percentage (36.1%) of carcasses found between zero to 10 m (zero to 33 ft), followed by 20.6% found between 10–20 m (33–66 ft; Table 6, Figure 5). 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 May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates.

Distance from Turbine (meters)	Number of Carcasses	Percent Composition
0 to 10	35	36.1
10 to 20	20	20.6
20 to 30	16	16.5
30 to 40	13	13.4
40 to 50	8	8.2
50 to 60	2	2.1
60 to 70	1	1.0
70 to 80	2	2.1

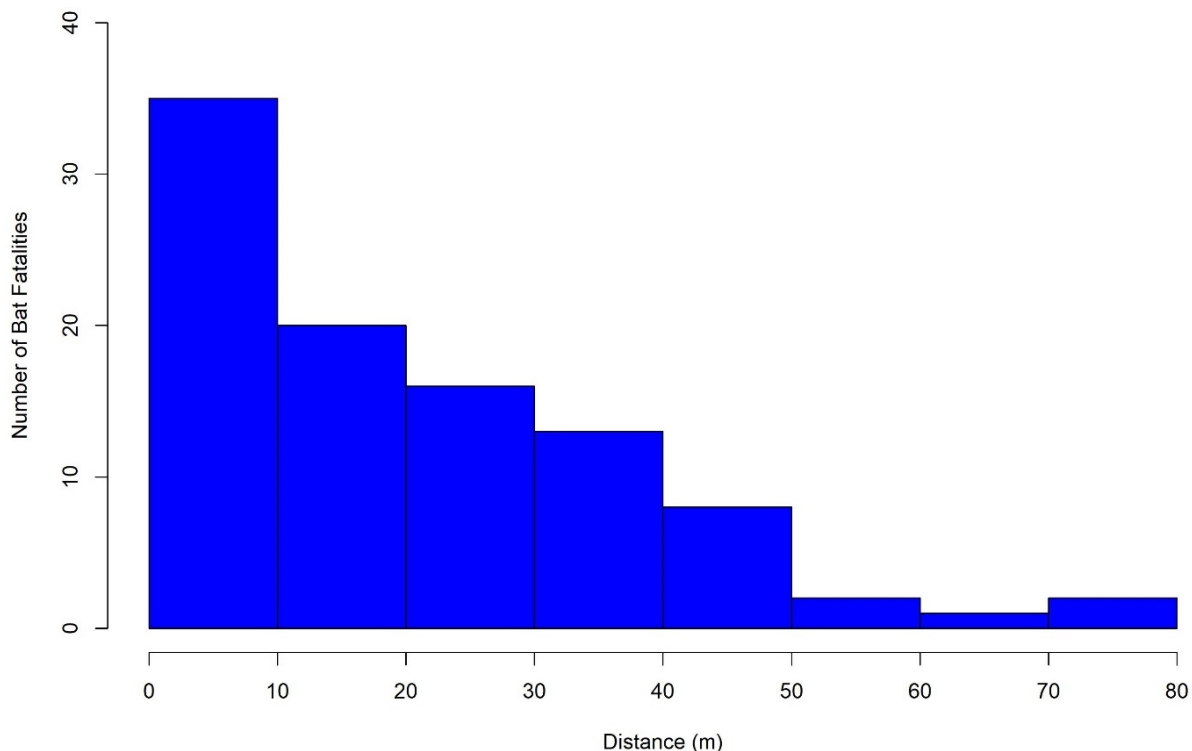


Figure 5. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020, that were included in fatality estimates.

Bat Carcasses by Turbine Type

More carcasses were found during the fall compared to the abbreviated spring season (Table 7). During the abbreviated spring monitoring season, the highest observed fatality rate occurred at Clipper turbines (0.13 observed bat carcass per turbine) followed by Siemens turbines (0.05). During the fall monitoring season, the highest observed fatality rate was also at Clipper turbines (2.0) followed by Vestas turbines (0.92).

Table 7. Total number of carcasses found and unadjusted fatality rate by season at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020.

Season	Carcasses Found On Plot During Search or Incidentally	Number of Turbines Searched	Observed Fatalities per Turbine
Spring	3	114	0.03
Fall	94	114	0.82

Bias Trials

Searcher Efficiency Trials

During the spring season, 10 of the 13 carcasses placed for bias trials were found at the first scheduled search, with one additional bat found after multiple searches, resulting in an overall probability of a carcass being available and detected of 81.3% (Table 8). The percent found for

the season was calculated as an average across the number of days prior to search values. During the fall season, 36 of 62 bias trial carcasses placed 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 59.2% (Table 8).

Table 8. Searcher efficiency based on empirical pi methodology for post-construction fatality monitoring at the Fowler Ridge Wind Farm from May 4 – May 15 and August 1 – October 15, 2020.

Number of Days Prior to Search*	Number Placed	Number Found on First Search	Total Found	Percent Found
Spring				
0	2	2	2	100
1	2	2	2	100
2	2	2	2	100
3	2	1	2	100
4	2	1	1	50.0
5	1	1	1	100
6	2	1	1	50.0
Total	13	10	11	81.3
Fall				
0	20	17	17	85.0
1	8	4	4	50.0
2	11	7	8	72.7
3	15	4	5	33.3
4	8	4	4	50.0
Total	62	36	38	59.2

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

Carcass Persistence Trials

Thirty-five bats were used to measure carcass persistence rates, split between the spring and fall seasons. The average length of persistence for bat carcasses in 2020 was 4.2 days in the spring and 11.7 days in the fall. Carcass persistence in the spring of 2020 was lower than the spring of 2018 (13.4 days) and spring of 2019 (8.5 days). Fall persistence rates in 2020 were within the range of rates recorded previously at FRWF. A summary of carcass persistence at FRWF over the past 10 years shows year-to-year variation (Table 9).

Table 9. Carcass persistence rates reported at the Fowler Ridge Wind Farm from April 1 – May 15 (Spring) and August 1 – October 15 (Fall) from 2010 – 2020.

Year	Spring (days)	Fall (days)
2010	–	10.3
2011	–	15.1
2012	–	–
2013	–	5.8
2014	–	19.4
2015	–	13.9
2016	–	20.8
2017	–	10.7
2018	13.4	6.8
2019	8.5	4.1
2020	4.2	11.5

Three trail cameras recorded the timing of the removal of several bias trial carcasses during the fall. Ten carcasses were placed and six scavenger removal events were recorded by the cameras. A technician checked six of the placed carcasses as part of the regular carcass persistence trials. The remaining four carcasses were placed after the removal of the original trial carcass at turbines with cameras to increase the sample size. Virginia opossums (*Didelphis virginiana*) removed three trial carcasses at Clipper Turbine 639, while the camera at GE Turbine 7 recorded trial carcass removals by one each of raccoon (*Procyon lotor*), American crow (*Corvus brachyrhynchos*), and red-tailed hawk (*Buteo jamaicensis*) (Appendix C). Two scavenging events were not detected by the camera due to the distance between the camera and the carcass. The searcher recorded these carcasses as missing when checked, but the removal was not detectable by the camera because the carcasses were placed greater than five m from the camera. One trial carcass at Siemens Turbine S12 was removed from camera view due to a bulldozer moving gravel, but the technician confirmed the carcass was still present on the next check day. One carcass was never removed, by any means, before the end of the trial period.

The results of the trial suggest that game cameras can be used to measure carcass persistence at FRWF, if cameras are placed no farther than five m from the carcass. Use of game cameras could provide a more cost effective and more precise method for measuring carcass persistence.

Estimated Fatality Rates

Three of seven bat carcasses found during the spring survey period were included in the analyses. Three carcasses were excluded from the analysis because they were found outside the search

area at a normally searched turbine, and one was excluded because it was estimated to have perished before May 4. For the fall surveys, 94 bat carcasses were included in the analyses and 23 bat carcasses were excluded because they were incidental finds at non-searched turbines (n=14), found outside the search area at a normally searched turbine (n=8), or were estimated to have perished before July 31 (n=1; Appendix B).

An observed fatality rate of 0.03 bat per turbine was calculated for the spring (Table 10) and 0.82 bat per turbine in the fall (Table 11). The observed fatality rate was then divided by the empirical probability of availability and detection (0.81 for spring and 0.59 for fall). This value was multiplied by the road and pad area adjustment 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. An additional adjustment was applied to the spring estimate to account for the shorter survey period. We adjusted the spring estimate by assuming the two rounds of surveys we completed during the last two weeks of spring (May 4 – May 15) were representative of the spring study period. Seven rounds of surveys would have been conducted in the spring, one for each week. The fatality estimate from May 4 – May 15 was adjusted upwards by 71% (we surveyed 29% of the spring period) to account for the missed surveys.

Table 10. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from April 1 – May 15, 2020. An adjustment of 0.29 was applied to account for the shorter study period.

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I–III	6.56	–	–	–
	Fowler IV	26.38	–	–	–
Observed fatalities per turbine*		0.03	–	–	–
Observed fatalities per turbine adjusted for missed spring surveys		0.11			
Empirical pi		0.81	0.08	0.69	0.94
Estimated number of fatalities per turbine*		1.24	–	–	–

* Standard deviation and confidence intervals not calculated due to the small number of carcasses found.

Table 11. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from August 1 – October 15, 2020.

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I–III	6.56	–	–	–
	Fowler IV	26.38	–	–	–
Observed fatalities per turbine		0.82	0.11	0.65	1.01
Empirical pi		0.59	0.05	0.52	0.67
Adjusted number of fatalities per turbine		13.09	2.05	9.99	16.87

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 1.24 bat fatalities/turbine/study period, or 0.53 bat fatality/MW/study period (Table 12). The adjusted

fatality estimate for the fall was 13.09 bat fatalities/turbine/study period or 6.87 bat fatalities/MW/study period (Table 13).

The facility wide fatality rate was calculated using a weighted average across turbine type due to differences in MW ratings for turbine types. Past studies at FRWF have suggested that bat fatality rates may vary by MW ratings, how they operate, rotor swept area, or a combination of factors (Good et al. 2012). The reasons for why fatality rates may vary between turbine types are unclear. Previous research at FRWF, and the current monitoring study, were not designed to conclusively determine if certain brands of turbines result in higher or lower mortality. Survey methodology may explain the differences observed. For example, two different methods were used to calculate area corrections at Phases I, II and III (which contain 3 turbine types), compared to the area correction method used to estimate Phase IV mortality rates. All turbines operate under the same basic principles, and it is inappropriate to conclude that certain turbine brands have higher or lower mortality rates based on the results of monitoring at FRWF.

Table 12. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from April 1 – May 15, 2020. ¹

Turbine Type	Mean	90% Confidence Interval²
Number of fatalities/turbine/year		
Siemens	5.83	–
Vestas	0	–
GE	0	–
Clipper	3.53	–
All Turbines	1.24	–
Number of fatalities/megawatt/year³		
Siemens	2.53	–
Vestas	0	–
GE	1.41	–
Clipper	1.41	–
All Turbines	0.53	–

¹ This study was not designed to determine if bat fatality rates differ between turbine models, and this table should not be used to inform management actions or assessments at other wind-energy facilities.

² Confidence intervals not calculated due to the small number of carcasses found.

³ Estimates are calculated by turbine type due to differences in MW ratings by turbine type

Table 13. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from August 1 – October 15, 2020. ¹

Turbine Type	Mean	90% Confidence Interval
Number of fatalities/turbine/year		
Siemens	28.55	18.34–39.15
Clipper	22.15	7.95–40.20
Vestas	10.22	6.86–14.44
GE	6.72	3.59–10.39
All Turbines	13.09	9.99–16.87
Number of fatalities/megawatt/year²		
Siemens	12.41	7.97–17.02
Clipper	8.86	3.18–16.08
Vestas	6.20	4.16–8.75
GE	4.48	2.39–6.93
All Turbines	6.87	5.25–8.82

¹ This study was not designed to determine if bat fatality rates differ between turbine models, and this table should not be used to inform management actions or assessments at other wind-energy facilities.

² Estimates are calculated by turbine type due to differences in MW ratings by turbine type

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 2020 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 14.32 bat fatalities/turbine/study period (90% CI 11.09–18.41), which was 27% lower than the end-of-year adaptive management threshold, and 64% 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 2020 (Figure 6).

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 fatality, bias correction factors from the previous year’s monitoring results were applied (Tables 14a and 14b). The within-season adaptive management threshold for 2020 was 130 bat carcasses, spring and fall combined. There were 97 bat carcasses found on search plots that were estimated to have been killed during the

study’s two monitoring periods. Figure 7 illustrates the within-season tracking tool that was used to determine if a fatality was approaching within-season adaptive management thresholds. The weekly 2020 estimated bat fatality rate shown in Figure 7 was a prediction calculated using the 2019 bias trial data. The final 2020 bat fatality estimate was based on 2020 bias trial results. Adaptive management thresholds were not exceeded at any time during the study, and no changes to minimization efforts were required during 2020.

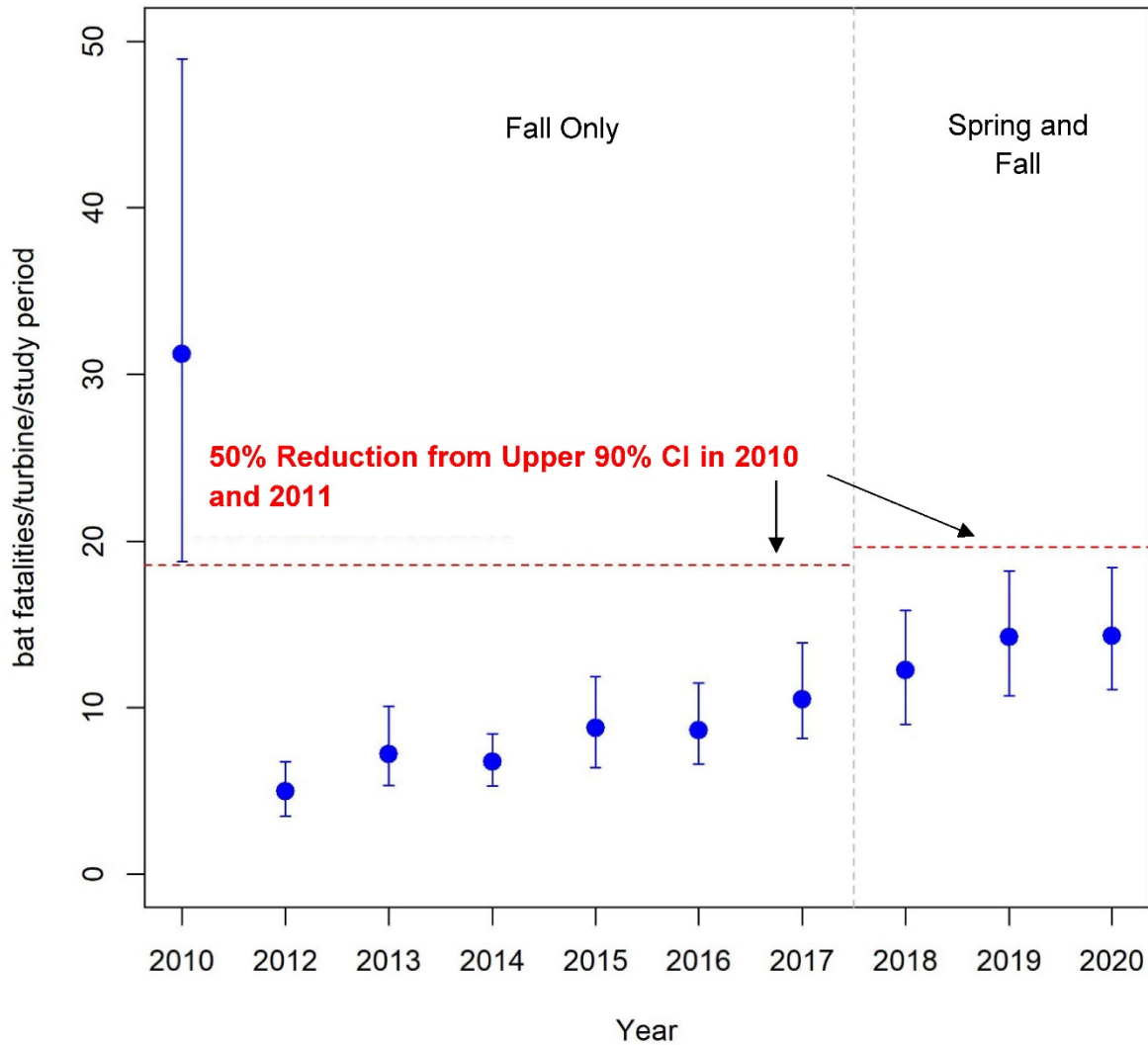


Figure 6. A comparison of estimated bat fatality rates and 90% confidence intervals (CIs) for the Fowler Ridge Wind Farm.

Note: 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 (m/s) in the fall only. The 2018 – 2020 estimates represent turbines feathered below 5.0 m/s in the fall and 3.5 m/s 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% CI of bat fatality rates compared to the 2010 and 2011 combined fatality estimates.

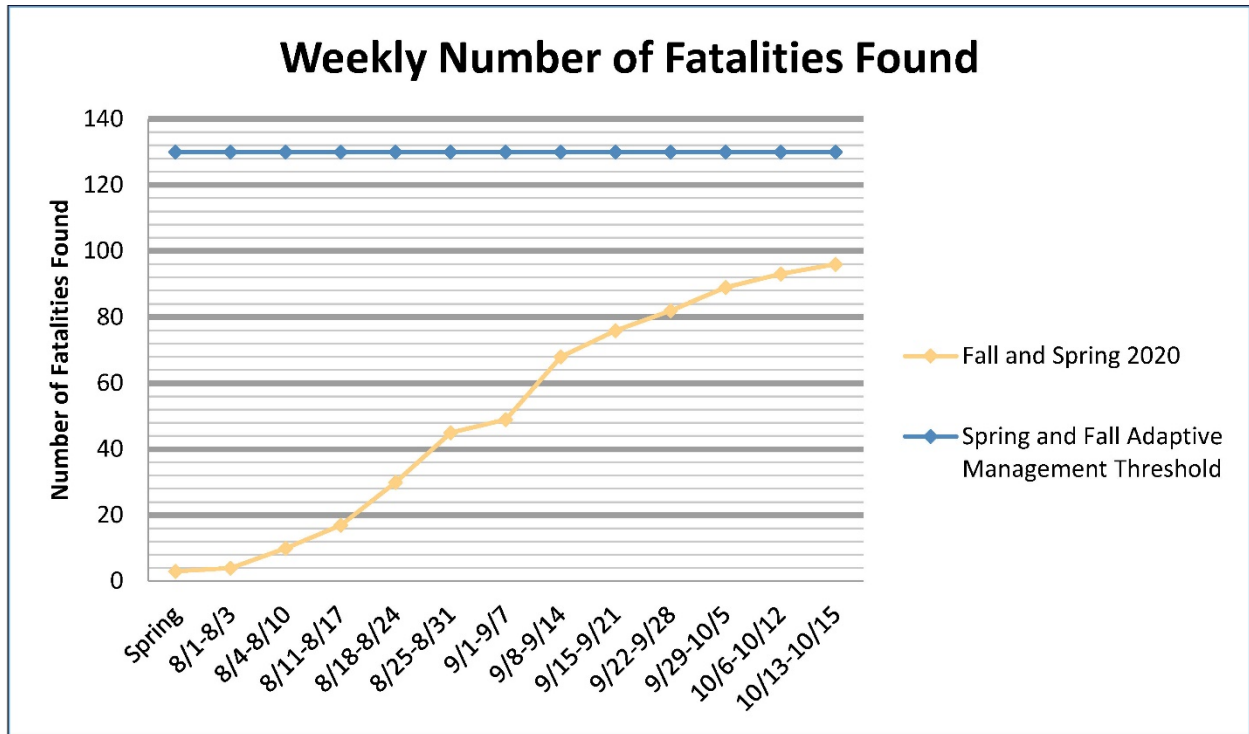


Figure 7. Weekly per-turbine fatality rates (number of bat carcasses found per turbine) at the Fowler Ridge Wind Farm in 2020. This graph was used to determine if weekly fatality rates were approaching the 50% adaptive management threshold. Fatality rates for 2020 shown above were based on 2019 bias trial results.

Table 14a. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in spring 2020 (Phases I, II, III, and IV).

Parameter	Fowler I–III	Fowler IV	Descriptions of Data Sources
Adaptive management threshold for Indiana bats	0.60		Upper quartile (i.e., 75 th percentile) of estimated spring bat mortality in 2010 and 2011 at control turbines with minimization measures in place.
Percent of all Indiana bat fatalities	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	0.62		Estimated probability of carcasses being available and detected based on Fowler 2019 empirical bias trials from weekly road and 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	0.02	0.01	Predicted based on estimated fatality rate per turbine (0.90), multiplied by empirical pi (0.62), divided by road and pad correction factor (6.56 or 26.38), and divided by the seasonal adjustment factor (0.29).
Total bats found in one spring season based on turbines searched	1.82	1.33	Predicted based on estimated number of bats found per turbine (0.02 or 0.01) multiplied by the number of turbines searched (75 or 39). Calculated value represents adaptive management threshold for 2020.
Total Bats Found Threshold	2.06		Sum of expected bat mortality from Phases I, II, III, and IV during the Spring

Table 14b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2020 (Phases I, II, III, and IV).

Parameter	Fowler I–III		Fowler IV	Descriptions of Data Sources
Adaptive management threshold for Indiana bats	11.22			Upper quartile (i.e., 75 th percentile) of estimated fall bat mortality in 2010 and 2011 at control turbines with minimization measures in place.
Percent of all Indiana bat fatalities	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	16.70			Estimated by dividing the bat mortality count (7,016) by the number of operational turbines (420).
Empirical pi estimate	0.59			Estimated probability of carcasses being available and detected based on Fowler 2019 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	1.51	0.38		Predicted based on estimated fatality rate per turbine (16.7), multiplied by empirical pi (0.59), divided by road and pad correction factor (6.56 or 26.38).
Total bats found in one fall season based on turbines searched	113.48	14.67		Predicted based on estimated number of bats found per turbine (1.51 or 0.38) multiplied by the number of turbines searched (75 or 39). Calculated value represents adaptive management threshold for 2020.
Total Bats Found Threshold	128.15			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 2020 was calculated based on the overall estimated bat fatality rate during 2020, and the relative percent of Indiana bat carcasses compared to all bat carcasses found during the fall of 2009, 2010, and 2011 (0.16%). In the spring of 2020, 0.8 Indiana bat fatalities were estimated to have occurred, and an estimated 8.8 (90% CI 6.7–11.3) Indiana bat fatalities in the fall (Table 15). The total estimated number of Indiana bat fatalities was lower than the number that was predicted to occur as fatalities within the HCP after minimization, 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 2021.

Table 15. 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		
			Mean	Lower 90% CI	Upper 90% CI
2014	355	4.1	8.6	7.0	10.6
2015	355	5.2	8.6	7.0	10.6
2016	420	5.8	10.9	8.8	13.4
2017	420	7.1	10.9	8.8	13.4
2018-Spring	420	0.7	0.7	–	–
2018-Fall	420	7.6	10.9	8.8	13.4
2019-Spring	420	0.8	0.7	–	–
2019-Fall	420	9.0	10.9	8.8	13.4
2020-Spring	420	0.8	0.7	–	–
2020-Fall	420	8.8	10.9	8.8	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 May 4 – May 15 and August 1 – October 15, 2020**

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between May 4 – May 15 and August 1- October 15, 2020.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
5/4/2020	silver-haired bat	631	Clipper	Yes	Yes	No
5/4/2020	European starling	411	Vestas	No	No	Yes
5/7/2020	eastern red bat	611	Clipper	Yes	No	No
5/7/2020	silver-haired bat	S1	Siemens	Yes	No	No
5/7/2020	silver-haired bat	S54	Siemens	No	No	Yes
5/7/2020	silver-haired bat	S54	Siemens	Yes	No	No
5/11/2020	silver-haired bat	641	Clipper	No	No	Yes
5/15/2020	horned lark	S41	Siemens	No	No	Yes
5/15/2020	silver-haired bat	S1	Siemens	No	No	Yes
8/3/2020	unidentified <i>Lasiurus</i> bat	322	Vestas	No	Yes	No
8/3/2020	eastern red bat	459	Vestas	No	No	Yes
8/4/2020	hoary bat	20	GE	No	No	Yes
8/5/2020	Seminole bat	S41	Siemens	No	No	Yes
8/5/2020	eastern red bat	S1	Siemens	No	No	Yes
8/5/2020	hoary bat	32	GE	Yes	No	No
8/5/2020	eastern red bat	S43	Siemens	No	No	Yes
8/6/2020	eastern red bat	639	Clipper	No	No	Yes
8/6/2020	hoary bat	388	Vestas	No	No	Yes
8/6/2020	eastern red bat	448	Vestas	No	No	Yes
8/11/2020	eastern red bat	3	GE	No	No	Yes
8/11/2020	eastern red bat	68	GE	No	No	Yes
8/11/2020	hoary bat	52	GE	No	No	Yes
8/13/2020	eastern red bat	285	Vestas	No	No	Yes
8/14/2020	hoary bat	83	GE	No	No	Yes
8/14/2020	big brown bat	S63	Siemens	Yes	No	No
8/17/2020	eastern red bat	378	Vestas	No	No	Yes
8/17/2020	eastern red bat	611	Clipper	No	No	Yes
8/18/2020	eastern red bat	9	GE	No	No	Yes
8/18/2020	eastern red bat	17	GE	No	No	Yes
8/19/2020	eastern red bat	S18	Siemens	No	No	Yes
8/19/2020	Seminole bat	S3	Siemens	No	No	Yes
8/19/2020	eastern red bat	417	Vestas	Yes	No	No
8/19/2020	hoary bat	442	Vestas	No	No	Yes
8/20/2020	eastern red bat	56	GE	No	No	Yes
8/24/2020	eastern red bat	229	Vestas	No	No	Yes
8/24/2020	eastern red bat	329	Vestas	No	No	Yes
8/24/2020	eastern red bat	611	Clipper	No	No	Yes
8/24/2020	big brown bat	459	Vestas	No	No	Yes
8/24/2020	eastern red bat	251	Vestas	No	No	Yes
8/24/2020	eastern red bat	459	Vestas	No	No	Yes
8/24/2020	big brown bat	459	Vestas	No	No	Yes
8/25/2020	hoary bat	224	Vestas	No	No	Yes
8/25/2020	mourning dove	19	GE	Yes	No	No
8/25/2020	eastern red bat	8	GE	Yes	No	No
8/25/2020	eastern red bat	88	GE	No	No	Yes
8/25/2020	hoary bat	19	GE	Yes	No	No
8/25/2020	eastern red bat	39	GE	No	No	Yes
8/26/2020	eastern red bat	S43	Siemens	No	No	Yes
8/26/2020	eastern red bat	243	Vestas	Yes	No	No
8/27/2020	eastern red bat	309	Vestas	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between May 4 – May 15 and August 1- October 15, 2020.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
8/19/2020	eastern red bat	620	Vestas	Yes	No	No
8/27/2020	eastern red bat	268	Vestas	No	No	Yes
8/27/2020	eastern red bat	251	Vestas	No	No	Yes
8/29/2020	silver-haired bat	S46	Siemens	No	No	Yes
8/29/2020	eastern red bat	17	GE	No	No	Yes
8/29/2020	eastern red bat	S12	Siemens	No	No	Yes
8/29/2020	silver-haired bat	417	Vestas	Yes	No	No
8/29/2020	silver-haired bat	S52	Siemens	No	No	Yes
8/31/2020	silver-haired bat	408	Vestas	Yes	No	No
8/31/2020	silver-haired bat	448	Vestas	Yes	No	No
8/31/2020	killdeer	398	Vestas	Yes	No	No
8/31/2020	eastern red bat	401	Vestas	No	No	Yes
8/31/2020	eastern red bat	631	Clipper	No	No	Yes
8/31/2020	eastern red bat	631	Clipper	No	No	Yes
8/31/2020	eastern red bat	442	Vestas	No	No	Yes
9/1/2020	silver-haired bat	42	GE	Yes	No	No
9/1/2020	eastern red bat	60	GE	Yes	No	No
9/1/2020	silver-haired bat	39	GE	No	No	Yes
8/13/2020	eastern red bat	37	GE	Yes	No	No
9/2/2020	silver-haired bat	425	Vestas	No	No	Yes
9/2/2020	silver-haired bat	624	Clipper	No	No	Yes
9/2/2020	eastern red bat	51	GE	Yes	No	No
9/4/2020	silver-haired bat	S23	Siemens	No	No	Yes
9/4/2020	horned lark	S52	Siemens	No	No	Yes
9/7/2020	mourning dove	388	Vestas	Yes	No	No
9/8/2020	eastern red bat	411	Vestas	No	No	Yes
9/8/2020	eastern red bat	458	Vestas	No	No	Yes
9/8/2020	eastern red bat	631	Clipper	No	No	Yes
9/8/2020	eastern red bat	641	Clipper	No	No	Yes
9/9/2020	silver-haired bat	S27	Siemens	No	No	Yes
9/9/2020	eastern red bat	S60	Siemens	No	No	Yes
9/9/2020	silver-haired bat	S23	Siemens	No	No	Yes
9/9/2020	eastern red bat	S33	Siemens	No	No	Yes
9/9/2020	hoary bat	S54	Siemens	No	No	Yes
9/9/2020	eastern red bat	624	Clipper	No	No	Yes
9/9/2020	eastern red bat	388	Vestas	No	No	Yes
9/10/2020	Seminole bat	7	GE	No	No	Yes
9/11/2020	eastern red bat	S31	Siemens	No	No	Yes
9/11/2020	silver-haired bat	S33	Siemens	No	No	Yes
9/11/2020	hoary bat	S30	Siemens	No	No	Yes
9/14/2020	red-breasted nuthatch	339	Vestas	No	No	Yes
9/14/2020	eastern red bat	229	Vestas	No	No	Yes
9/14/2020	silver-haired bat	339	Vestas	No	No	Yes
9/14/2020	silver-haired bat	375	Vestas	No	No	Yes
9/14/2020	eastern red bat	622	Clipper	No	No	Yes
9/14/2020	American redstart	S45	Siemens	No	No	Yes
9/14/2020	red-eyed vireo	S45	Siemens	No	No	Yes
9/15/2020	big brown bat	S13	Siemens	No	No	Yes
9/15/2020	silver-haired bat	39	GE	No	No	Yes
9/15/2020	silver-haired bat	42	GE	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between May 4 – May 15 and August 1- October 15, 2020.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
9/16/2020	bay-breasted warbler	S27	Siemens	No	No	Yes
9/16/2020	eastern red bat	375	Vestas	No	No	Yes
9/16/2020	eastern red bat	390	Vestas	No	No	Yes
9/16/2020	turkey vulture	611	Clipper	No	No	Yes
9/16/2020	hoary bat	401	Vestas	Yes	No	No
9/16/2020	ruby-throated hummingbird	611	Clipper	No	No	Yes
9/16/2020	eastern red bat	611	Clipper	No	No	Yes
9/17/2020	rock pigeon	226	Vestas	No	No	Yes
9/15/2020	eastern red bat	43	GE	Yes	No	No
9/17/2020	mourning dove	52	GE	No	No	Yes
9/17/2020	silver-haired bat	481	Vestas	Yes	No	No
9/21/2020	hoary bat	631	Clipper	No	No	Yes
9/21/2020	silver-haired bat	624	Clipper	Yes	No	No
9/21/2020	eastern red bat	624	Clipper	No	No	Yes
9/22/2020	eastern red bat	198	Vestas	No	No	Yes
9/23/2020	silver-haired bat	639	Clipper	No	No	Yes
9/23/2020	silver-haired bat	S4	Siemens	No	No	Yes
9/25/2020	black-and-white warbler	S31	Siemens	No	No	Yes
9/28/2020	eastern red bat	448	Vestas	No	No	Yes
9/28/2020	silver-haired bat	251	Vestas	No	No	Yes
9/28/2020	silver-haired bat	448	Vestas	Yes	No	No
9/28/2020	silver-haired bat	375	Vestas	No	No	Yes
9/30/2020	silver-haired bat	322	Vestas	No	No	Yes
9/29/2020	mourning dove	42	GE	No	No	Yes
9/29/2020	eastern red bat	75	GE	No	No	Yes
9/30/2020	Seminole bat	S23	Siemens	No	No	Yes
10/1/2020	silver-haired bat	17	GE	Yes	No	No
10/1/2020	silver-haired bat	S50	Siemens	No	No	Yes
10/2/2020	silver-haired bat	S55	Siemens	No	No	Yes
10/5/2020	silver-haired bat	128	GE	Yes	No	No
10/5/2020	silver-haired bat	611	Clipper	No	No	Yes
10/6/2020	eastern red bat	46	GE	No	No	Yes
10/12/2020	unidentified bat	457	Vestas	No	No	Yes
10/12/2020	blue jay	369	Vestas	No	No	Yes
10/12/2020	eastern red bat	339	Vestas	No	No	Yes
10/12/2020	eastern red bat	420	Vestas	No	No	Yes
10/13/2020	eastern red bat	260	Vestas	No	No	Yes
10/13/2020	silver-haired bat	605	Clipper	No	No	Yes
10/14/2020	silver-haired bat	S3	Siemens	Yes	No	No
10/14/2020	house sparrow	S49	Siemens	No	No	Yes
10/15/2020	silver-haired bat	S57	Siemens	No	No	Yes
10/15/2020	eastern red bat	S16	Siemens	No	No	Yes

Appendix C. Representative Photos of Carcass Removal Events Recorded at Fowler Ridge Wind Farm, Benton County, Indiana, between September 14 – 23, 2020



Ltl Acorn ● 050F 010C 09/23/2020 06:23:25

Appendix C1. Virginia opossum walking toward trial carcass at Clipper Turbine 639.



Ltl Acorn ● 050F 010C 09/23/2020 06:25:17

Appendix C2. Virginia opossum at trial carcass at Clipper Turbine 639.



Ltl Acorn ● 095F 035C 09/14/2020 15:25:44

Appendix C3. Red-tailed hawk looking at trial carcass at General Electric Turbine 7.



Ltl Acorn ● 095F 035C 09/14/2020 15:30:08

Appendix C4. Hawk and trial carcass gone five minutes after Photo 3 was taken.



Ltl Acorn ● 062F 017C 09/21/2020 20:38:02

Appendix C5. Trial carcass at Clipper Turbine 639 immediately prior to removal by raccoons.



Ltl Acorn ● 073F 023C 01/03/2016 17:14:06

Appendix C6. Trial carcass at General Electric Turbine 7 immediately prior to removal by American crow.