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

April 1 – October 15, 2018

Prepared for:

Fowler Ridge Wind Farm

Prepared by:

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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. (WEST) conducted post-construction fatality studies of bats within Phases I, II and III in the fall of 2009 and 2010 in which two Indiana bat carcasses were found. The FRWF worked with the US Fish and Wildlife Service and developed a Habitat Conservation Plan for the Indiana bat designed to minimize Indiana bat fatalities. FRWF received an Incidental Take Permit for Indiana bats in August of 2014.

Monitoring the effectiveness of minimization measures is required by both the Habitat Conservation Plan (HCP) and the Incidental Take Permit (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 FRWF Phase IV.

Indiana bat mortality was below adaptive management thresholds in both years so implementation phase monitoring for Phase IV began in the fall of 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 then, new evidence indicates risk of Indiana bat take during the spring migration period as well. 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, two years of spring evaluation phase monitoring began in 2018 at all phases of the FRWF.

Standardized carcass searches were completed weekly at 183 turbines during the spring (April 1 – May 15) and at 114 turbines during the fall (August 1 – October 15), corresponding with migration periods of Indiana bats. The search area was restricted to the gravel roads and pads within 80 meters (262 feet) of each searched turbine. 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* spp. were found. A total of 138 bat carcasses of six species and 19 bird carcasses of 11 known species were found during searches and incidentally. Similar to previous years of monitoring, the most commonly found bat species were eastern red bats, hoary bats and silver-haired bats. Seven big brown bats, two Seminole bats and one evening bat (state-listed as endangered) 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 2018 was estimated to be 12.26 bat fatalities/turbine/study period (90% confidence interval: 9.01 – 15.84), which was 61.3% lower than fatality estimates at turbines

operating normally in spring and fall of 2010 and fall of 2011. The results of monitoring during 2018 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 adjustments of minimization strategies were not required in 2018 because bat fatality rates were well below adaptive management thresholds.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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), during which an Indiana bat carcass (*Myotis sodalis*) 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) or lower during the fall migration period. FRWF received an Incidental Take Permit (ITP) for Indiana bats in August of 2014 (TE95012A-0) based on the HCP. The ITP and HCP included requirements for monitoring the effectiveness of minimization measures. The first two years of evaluation phase monitoring were completed in 2014 (Good et al. 2015) and 2015 (Good et al. 2016) at Phases I, II and III during the fall migration season for Indiana bats. Because Indiana bat mortality was estimated to be below adaptive management thresholds outlined within the HCP during 2014 and 2015, implementation phase monitoring was conducted in 2016 (Good et al. 2017) and 2017 (Good et al. 2018).

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 was begun in the fall of 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 FRWF. To minimize Indiana bat take during the spring, turbines were feathered below a cut-in speed of 3.5 meters per second (m/s; 11.5 feet per second [ft/s])) on a nightly basis from sunset to sunrise from April 1 – May 15, 2018. The following report describes that results of 2018 spring and fall mortality monitoring required under the HCP.

STUDY AREA

The FRWF currently 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	Mega Watt	Turbine Height (meters)	Rotor Diameter (meters)	Standard cut-in speed (meters/second)
GE 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 of 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, comprised primarily of corn (*Zea mays*) and soybeans (*Glycine max*) (Figures 1a and 1b). Within 0.80 kilometers (approximately one half-mile) of turbine locations, cultivated crops compose about 93% 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 and buildings), 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 (0.4%, 0.04% and <0.01%, respectively; US Geological Survey [USGS] National Land Cover Database [NLCD] 2011, Homer et al. 2015).

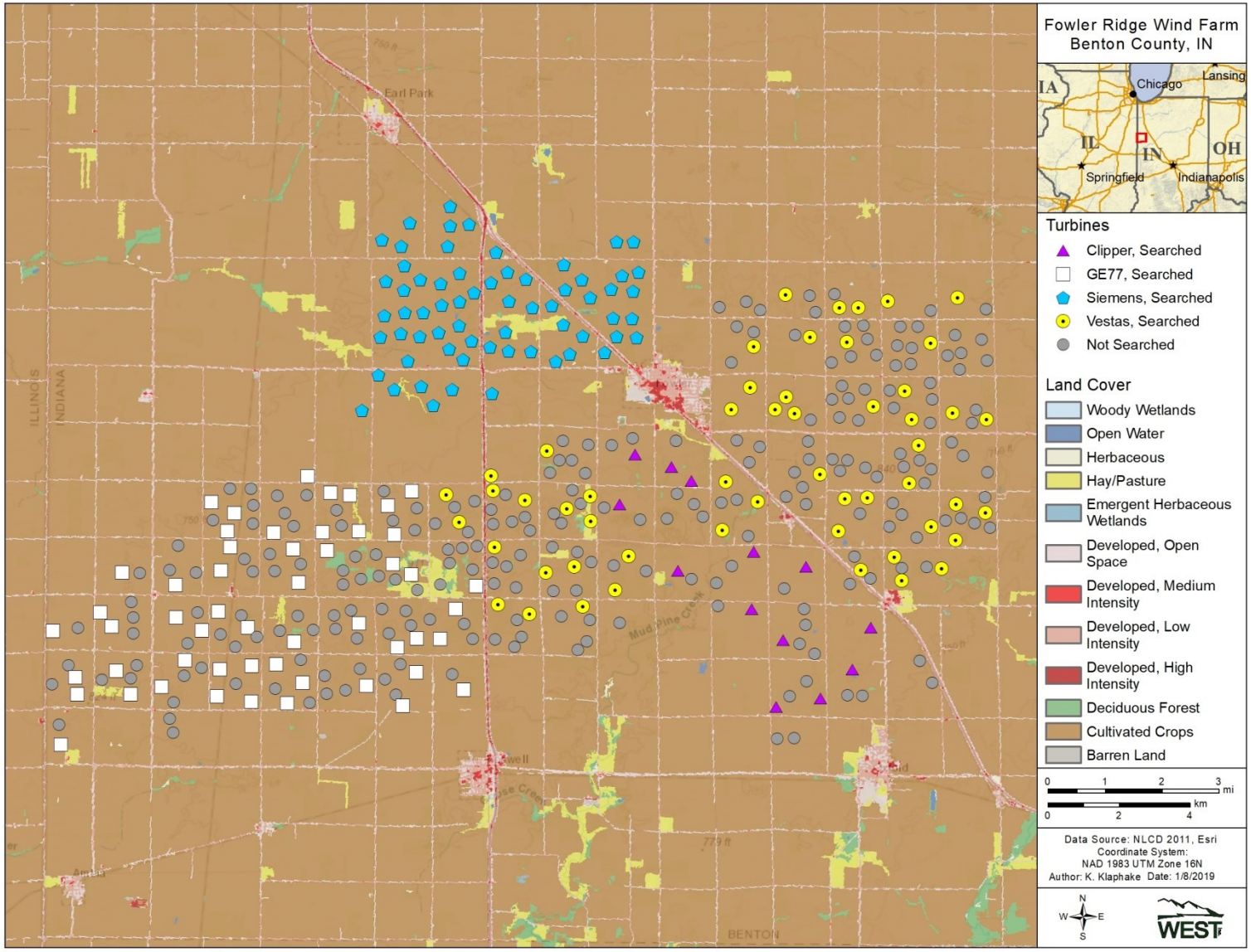

Figure 1a. Land cover types, and locations of Phase I-IV turbines searched from April 1 – May 15, 2018 at the Fowler Ridge Wind Farm, Benton County, Indiana.

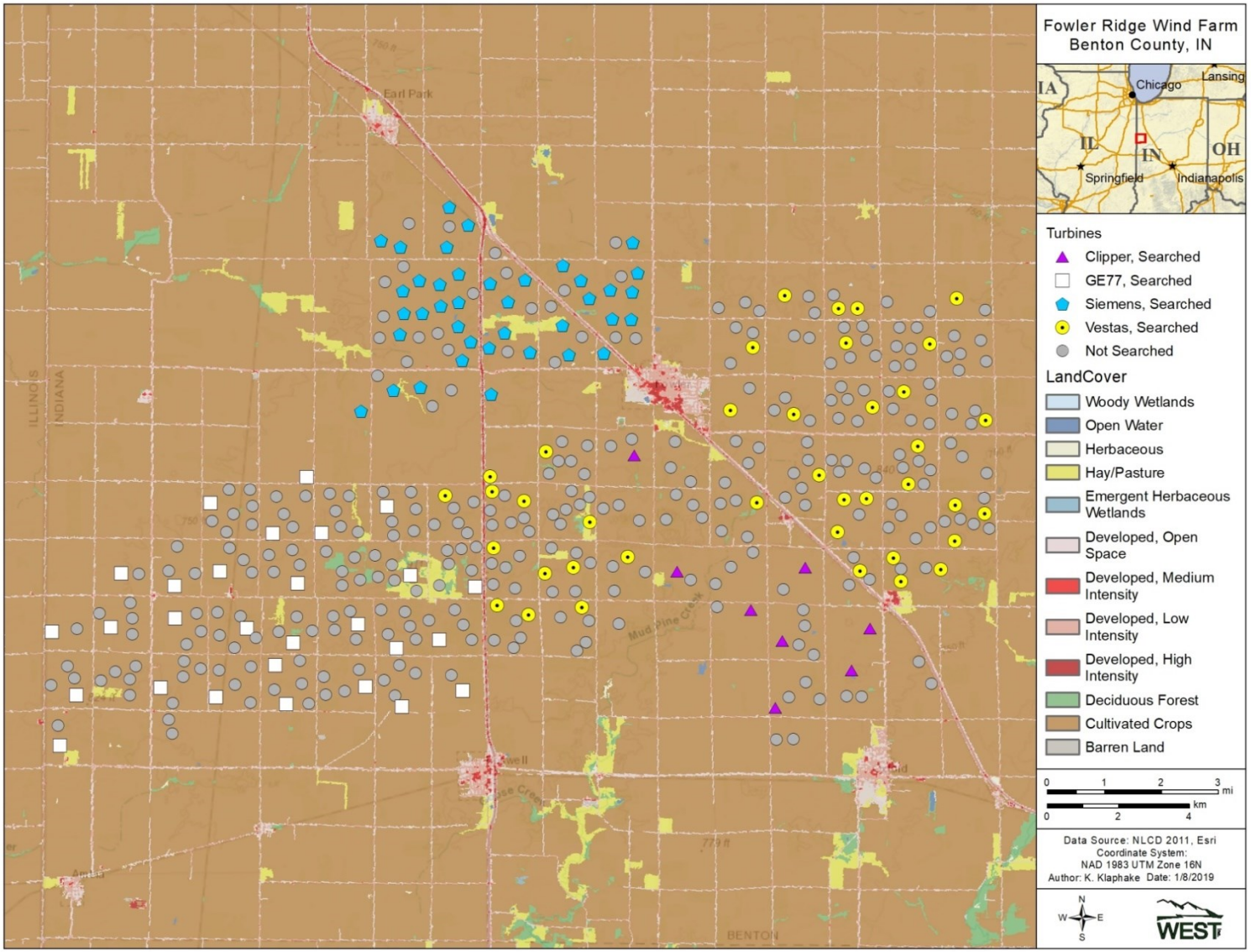

Figure 1b. Land cover types and locations of Phase I-IV turbines searched from August 1 – October 15, 2018 at the Fowler Ridge Wind Farm, Benton County, Indiana.

Table 2. Land cover types, coverage, and percent (%) composition within a half-mile of turbine locations within the Fowler Ridge Wind Farm, Benton County, Indiana.

Land Cover Types	Coverage (Acres)	% 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: US Geological Survey National Land Cover Database (2011), Homer et al. (2015)

METHODS

Standardized Carcass Searches

Most of the preceding monitoring efforts have been conducted from August 1 to October 15 as this encompassed the fall migration period for Indiana bats, as 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 spring fatality monitoring is considered an evaluation phase monitoring period and therefore 118 turbines were searched in Phases I, II and III, and all 65 turbines were searched in Phase IV between April 1 – May 15, 2018 (Figure 1a). All phases of FRWF are in the implementation phase monitoring period of the HCP during fall migration so a randomly chosen subset of turbines were searched between August 1 – October 15, 2018, for a total of 75 turbines at Phases I, II and III and 39 turbines at Phase IV (Figure 1b).

Carcass searches were conducted weekly along access roads and on turbine pads within 80 m (262 ft) of the selected turbines. The search interval was based on the mean carcass persistence time of 10.7 days recorded during monitoring at FRWF in 2017 (Good et al. 2018).

Technicians trained in proper search techniques conducted the carcass searches. Searches occurred along transects on roads and pads within 80 m (262 ft) of a sampled turbine. Searchers walked at a rate of approximately 45 to 60 m per minute (about 148 to 197 ft per minute) along each transect looking for bat and bird carcasses. Transects were spaced at approximately five m (16 ft) intervals, and searchers scanned the area on both sides out to approximately 2.5 m (about eight 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, was 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 is found in more than one piece and the pieces are separated by more than five meters
- 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 USFWS "Native Endangered & 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 in hand 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 rotation of the turbine blades below cut-in wind speed was feathered. Increasing of cut-in speed and feathering of 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 there were not enough fresh carcasses available.

Multiple searcher efficiency trials were conducted in each season. Across seasons, a total of 137 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). A subset of the total number of carcasses placed was randomly chosen to be used for the empirical pi estimate based on the lowest number of carcasses in each category (Table 3). 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 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.

Table 3. Carcasses placed and used for the empirical pi method by time since death for post-construction fatality monitoring at the Fowler Ridge Wind Farm from April 4 - October 11, 2018.

Number of Days Prior to Search	Number Placed		Used for Empirical Pi Estimate	
	Spring	Fall	Spring	Fall
0	18	19	7	6
1	9	13	7	6
2	8	8	7	6
3	8	8	7	6
4	8	9	7	6
5	8	6	7	6
6	7	8	7	6
Total	66	71	49	42

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 seasons 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 was removed at the end of the 24-day period.

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:

1) Observed number of bat carcasses found on search plots that were estimated to have been killed during the monitoring period;
2) 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
3) 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 then calculated and used as an empirical pi estimate of the probability of availability and detection. This method was used during previous study years at the FRWF.

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 FRWF (Good et al. 2011, 2012).

The road and pad area of each turbine at Phase IV is 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. The area correction was modeled using the carcass-density distribution and search area at each turbine. Data collected from 2012 through 2016 were used to estimate bat carcass-density as a function of distance from turbine. The carcass-density distribution was estimated by fitting truncated Weibull, truncated normal, truncated Gompertz, truncated Rayleigh, and truncated gamma density distributions to carcass distances (from turbines).

The best-supported model was selected using an information theoretic approach known as AICc, or corrected Akaike Information Criteria (Burnham and Anderson 2002). Fits were obtained using a weighted maximum likelihood approach (Khokan et al. 2013), where the weight for each observed carcass distance was the inverse of the fraction of area searched at the distance where the carcass was found, multiplied by the inverse of the probability of detection ($\hat{\pi}$) for that carcass. This approach results in weighted maximum likelihood estimates of carcass detection probabilities that vary systematically with distance from turbines. Areas near the turbine tend to have a higher density of bat carcasses than areas farther from the turbine (Huso and Dalthorp 2014) and therefore the search area was combined with the carcass-density distribution. The result was an estimate of the proportion of bat carcasses expected to land within searched and unsearched areas around turbines where only roads and pads were searched.

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

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

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 2018 (spring and fall combined) and the baseline year (2010) 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 2,397 surveys were conducted on roads and pads at 183 turbines from April 4 to May 15, and at 118 turbines from August 1 to October 11, 2018. Overall, 138 bat carcasses and 19 bird carcasses were found during the survey (Table 4; Appendix B). All turbines at the FRWF were shut down for portions of September 24 – October 1, 2018 for routine maintenance. Carcass surveys continued as scheduled during this time period.

Species Composition

No Indiana bats were found during the study. The most commonly found bat species were eastern red bat (*Lasiurus borealis*; 61 carcasses; 44.2%), hoary bat (*Lasiurus cinereus*; 38 carcasses; 27.5%) and silver-haired bat (*Lasionycteris noctivagans*; 29 carcasses; 21.0%). Seven big brown bat 5.1%), two Seminole bats (*Lasiurus seminolus*; 1.4%) and one evening bat 0.7%) carcasses were also found (Table 4). The evening bat is listed as state-endangered and was reported to the IDNR within 24 hours of its finding on May 15, 2018 (IDNR 2018).

The 19 bird carcasses found during the survey represent 11 individual known bird species (Table 4). No eagles or any bird species listed as threatened or endangered by the Indiana Department of Natural Resources (INHDC 2018), or the federal Endangered Species Act (ESA) 1973 were found (USFWS 2017).

Table 4. Total number of carcasses and the composition of carcasses discovered at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 11, 2018.

	Carcasses Found On Plot During Search or Incidentally		Carcasses Found Off Plot		Carcasses With Estimated Time of Death Prior to Study Period		Total Carcasses Found	
Species	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp
Bat								
eastern red bat	45	49.0	13	38.2	3	25.0	61	44.2
silver-haired bat	21	22.8	7	20.6	1	8.3	29	21.0
hoary bat	19	20.7	11	32.4	8	66.7	38	27.5
big brown bat	4	4.3	3	8.8	0	0	7	5.1
Seminole bat	2	2.2	0	0	0	0	2	1.4
evening bat	1	1.1	0	0	0	0	1	0.7
Overall Bats	**92**	**100**	**34**	**100**	**12**	**100**	**138**	**100**
Bird								
golden-crowned kinglet	3	18.8	0	0	0	0	3	15.8
mourning dove	2	12.5	0	0	0	0	2	10.5
American redstart	1	6.3	0	0	0	0	1	5.3
brown-headed cowbird	1	6.3	0	0	0	0	1	5.3
chestnut-sided warbler	1	6.3	0	0	0	0	1	5.3
chimney swift	1	6.3	0	0	1	50.0	2	10.5
dickcissel	1	6.3	0	0	0	0	1	5.3
red-winged blackbird	1	6.3	0	0	0	0	1	5.3
ruby-throated hummingbird	1	6.3	0	0	0	0	1	5.3
unidentified passerine	1	6.3	0	0	0	0	1	5.3
unidentified warbler	1	6.3	1	100	0	0	2	10.5
unidentified waterfowl	1	6.3	0	0	0	0	1	5.3
American crow	1	6.3	0	0	0	0	1	5.3
indigo bunting	0	0	0	0	1	50.0	1	5.3
Overall Birds	16	**100**	**1**	**100**	**2**	**100**	**19**	**100**

Estimated Time since Death

Most bat carcasses found on search plots were estimated to have been killed two to three days before the search (52.7%; Table 5). More than 92% of bat carcasses had an estimated time of death of less than a week while less than 3% of bat carcasses had an estimated time of death beyond seven days (Table 5). Four bats were found injured, three were released and one was euthanized; all four were included in 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 4 – May 15 and August 1 – October 11, 2018.

Estimated Time Since Death	Number of Carcasses	% Composition
last night	19	20.4
2-3 days	49	52.7
4-7 days	18	19.4
8-14 days	1	1.1
> 14 days	1	1.1
> 30 days	0	0
unknown	1	1.1
injured	4	4.3

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

Timing of Bat Carcasses

Most bat fatalities occurred from mid-August to early-September. There were three peaks during this time period; the first consisted mostly of eastern red bats while the other two peaks were a mix of bat species (Figure 2).

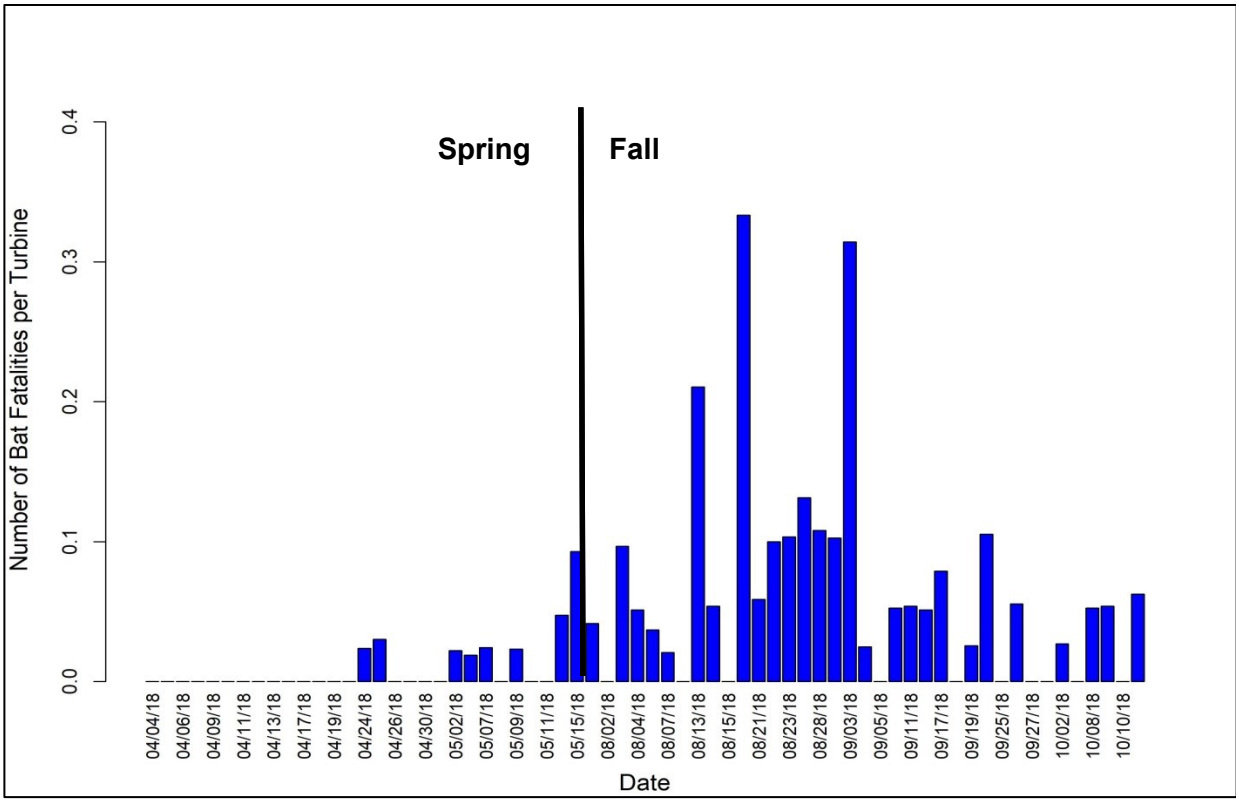

Figure 2. Timing of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 11, 2018 that were included in fatality estimates.

Distribution of Bat Carcasses

Over 95% of bat carcasses were found within 50 m (164.0 ft) of turbines, with the highest percentage (43.0%) of carcasses found between 0-10 m (0-32.8 ft), followed by 24.7% found between 20-30 m (65.6-98.4 ft; Table 6, Figure 3). This was a function of the amount of searchable area present because roads and pads comprise a higher percentage of the area in each distance band 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 4 – May 15 and August 1 – October 11, 2018 that were included in fatality estimates.

Distance to Turbine (m)	Number of Carcasses	% Composition
0 to 10	40	43.0
10 to 20	11	11.8
20 to 30	23	24.7
30 to 40	9	9.7
40 to 50	6	6.5
50 to 60	0	0
60 to 70	3	3.2
70 to 80	1	1.1

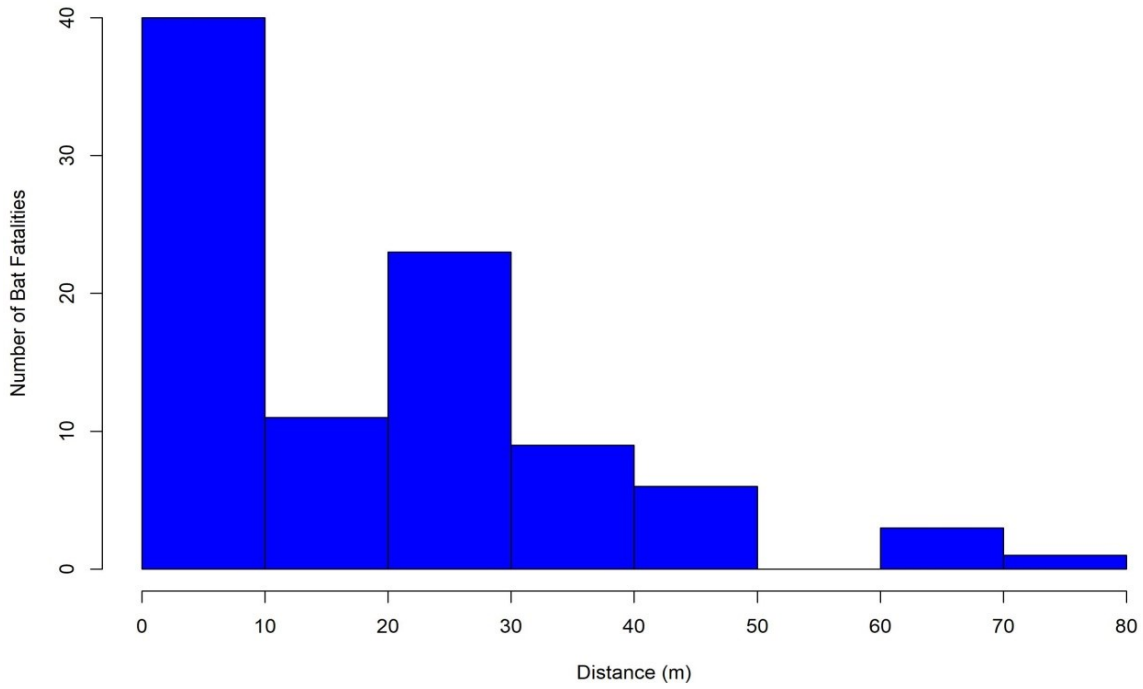

Figure 3. Distribution of distances from turbines of bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 11, 2018 that were included in fatality estimates.

Bat Carcasses by Turbine Type

During the spring monitoring season, the highest observed fatality rate occurred at Clipper turbines (0.15 observed bat carcasses per turbine) followed closely by Vestas turbines (0.12 observed bat carcasses per turbine; Table 7). During the fall monitoring season, the highest observed fatality rate was also at Clipper turbines (1.50 observed bat carcasses per turbine) followed by Vestas turbines (1.03 observed bat carcasses per turbine; Table 7).

Clipper and Vestas turbines are clustered in the eastern and southern portions of the FRWF (Figure 4). There are no obvious topographical or large-scale landscape features in those portions of the project area 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 11, 2018.

Turbine Type	Carcasses Found On Plot During Search or Incidentally	Number of Turbines Searched	Observed Fatalities per Turbine
Spring			
Vestas	6	52	0.12
Clipper	2	13	0.15
GE	2	53	0.04
Siemens	2	65	0.03
Total	**12**	**183**	
Fall			
Vestas	40	39	1.03
Clipper	12	8	1.50
GE	12	28	0.43
Siemens	16	39	0.41
Total	**80**	**114**	

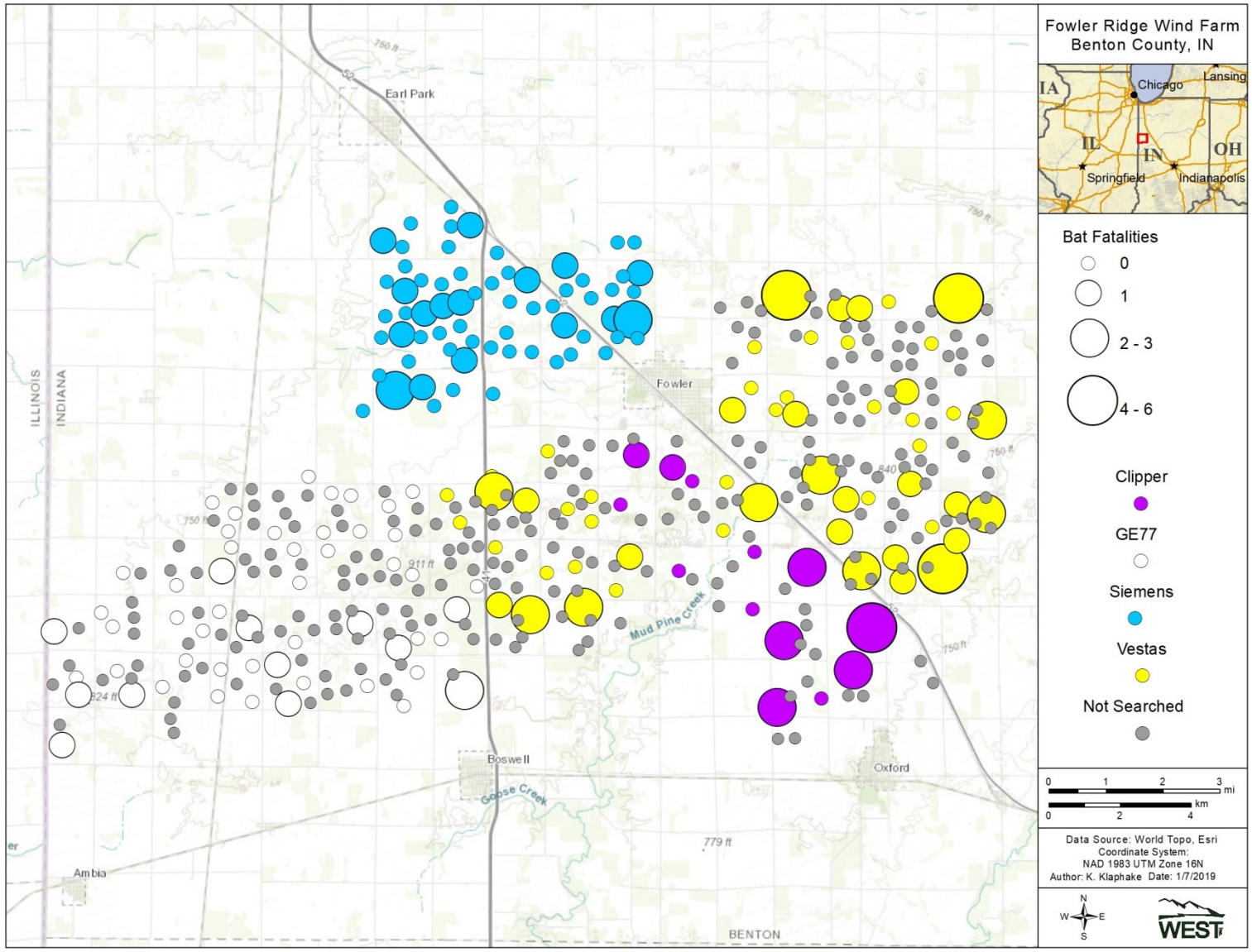

Figure 4. Number of bat carcasses found at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 11, 2018 that were included in analyses.

Bias Trials

Searcher Efficiency Trials

During the spring season, 25 of the 49 carcasses placed for bias trials were found at the first scheduled search, with five additional bats found after multiple searches, resulting in an overall probability of a carcass being available and detected of 61.2% (Table 8). During the fall season, 24 of 42 bias trial carcasses placed were found at the first scheduled search, with no additional bats found after multiple searches, resulting in an overall probability of a carcass being available and detected of 57.1% (Table 8). The probability that a carcass was available and detected in 2018 was similar to the fall-only surveys in 2017 (60.4%; Good et al. 2018).

Table 8. Searcher efficiency based on empirical pi methodology for post-construction fatality monitoring at the Fowler Ridge Wind Farm from April 4 – May 15 and August 1 – October 11, 2018.

Number of Days Prior to Search	Number Placed	Number Found on First Search	Total Found	Percent Found
Spring				
0	7	2	4	57.1
1	7	4	5	71.4
2	7	5	5	71.4
3	7	6	7	100.0
4	7	4	4	57.1
5	7	2	2	28.6
6	7	2	3	42.9
Total	49	25	30	61.2
Fall				
0	6	4	4	66.7
1	6	5	5	83.3
2	6	5	5	83.3
3	6	3	3	50.0
4	6	5	5	83.3
5	6	1	1	16.7
6	6	1	1	16.7
Total	42	24	24	57.1

Carcass Persistence Trials

A total of 40 bats were used to measure carcass persistence rates, split between the spring and fall seasons. The average length of persistence for bat carcasses in 2018 was 13.4 days in the spring and 6.8 days in the fall. The fall average carcass persistence estimate for 2017 was 10.7 days.

Adjusted Fatality Estimates

All twelve bat carcasses found during the spring survey period were used in the analyses. For the fall surveys, 80 bat carcasses were included in the analyses and 46 bat carcasses were excluded because they were found outside of search plots or were estimated to have perished before July

31 during the fall survey (Appendix B). An observed fatality rate of 0.07 bats per turbine was calculated for the spring (Table 9) and 0.70 bats per turbine in the fall (Table 10). The observed fatality rate was then divided by the empirical probability of availability and detection (0.61 for spring and 0.57 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.

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 1.03 bat fatalities/turbine/study period, or 0.56 bat fatalities/MW/study period (Table 11). The adjusted fatality estimate for the fall was 11.23 bat fatalities/turbine/study period or 6.06 bat fatalities/MW/study period (Table 12). The adjusted bat fatality rate per turbine was highest at Clipper turbines in the spring and at Siemens turbines in the fall (Tables 11 and 12).

Table 9. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from April 1 to May 15, 2018.

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I - III	6.56	-	-	-
	Fowler IV	26.38	-	-	-
Fatalities per turbine		0.07	0.02	0.03	0.10
Empirical pi		0.61	0.06	0.55	0.76
Adjusted number of fatalities per turbine		**1.03**	0.32	0.51	1.55

Table 10. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from August 1 to October 15, 2018.

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I - III	6.56	-	-	-
	Fowler IV	26.38	-	-	-
Fatalities per turbine		0.70	0.10	0.54	0.87
Empirical pi		0.57	0.07	0.48	0.69
Adjusted number of fatalities per turbine		**11.23**	2.11	8.06	14.94

Table 11. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from April 1 to May 15, 2018.

Turbine	Mean	CI
	# fatalities/turbine/year	
Clipper	1.65	0–3.53
GE	0.40	0-0.90
Siemens	1.33	0–2.84
Vestas	1.24	0.36–2.18
All Turbines	**1.03**	**0.51–1.55**
	# fatalities/MW/year	
Clipper	0.66	0–1.41
GE	0.27	0–0.60
Siemens	0.58	0–1.24
Vestas	0.75	0.22–1.32
All Turbines	**0.56**	**0.28-0.85**

Table 12. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from August 1 to October 15, 2018.

Turbine	Mean	CI
	# fatalities/turbine/year	
Clipper	17.22	5.50–31.32
GE	4.92	2.37-8.05
Siemens	18.94	10.78-28.41
Vestas	11.77	7.06-16.89
All Turbines	**11.23**	**8.06-14.94**
	# fatalities/MW/year	
Clipper	6.89	2.20-12.53
GE	3.28	1.58-5.37
Siemens	8.23	4.69-12.35
Vestas	7.14	4.28-10.24
All Turbines	**6.06**	**4.35-8.08**

Comparison to 2010 Fatality Estimates

A spring fatality estimate was developed from the 2010 monitoring effort at the FRWF because it was the only year that included spring searches at cleared plots. The spring and fall fatality estimates from 2010 were combined with the results from the Fall 2011 cleared plot searches to provide an annual all bat fatality rate of 31.71 bat fatalities/turbine/study period (90% confidence interval [CI] 25.59-39.28) with turbines in normal operation mode. Fatality estimates in 2018 from turbines feathered until wind speeds reached 3.5 m/s in the spring and 5.0 m/s in the fall were 61.3% lower than the fatality estimates at turbines operating normally in 2010 and 2011, with an estimated 12.26 bat fatalities/turbine/study period (90% CI 9.01-15.84). Uncertainty around bat fatality rate estimates was calculated using 90% CI.

Fatality rates from fall 2018 were compared to the anticipated 50% reduction in fatality rates from the baseline year (2010) to determine the effectiveness of the applied minimization measures. There is statistical evidence to support at least a 50% reduction in fatality rates from fall 2010 to fall 2018 (Figure 5).

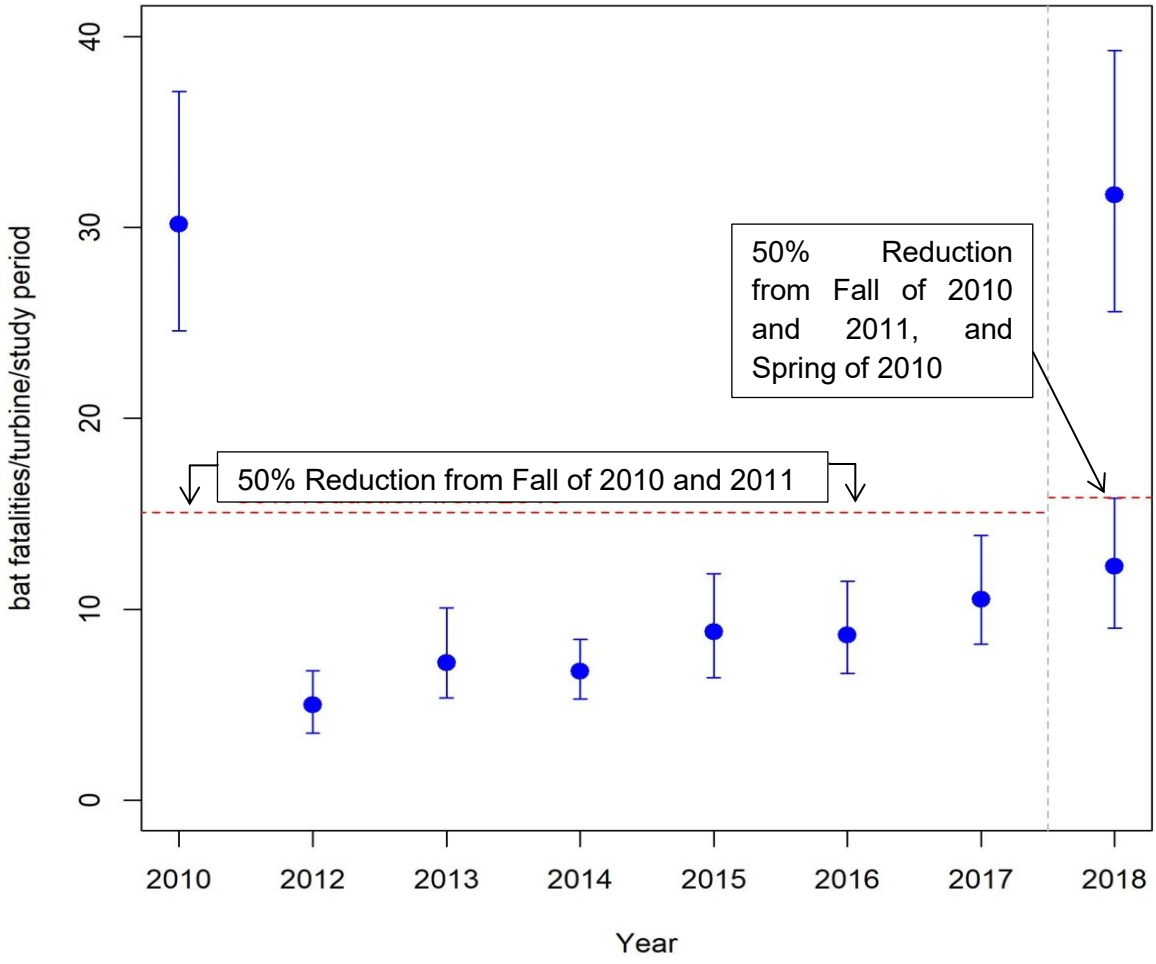

Figure 5. A comparison of estimated bat fatality rates and 90% confidence intervals for the Fowler Ridge Wind Farm. The 2010 and 2011 combined spring and fall estimate represents turbines operating at manufacturer cut-in speeds. The 2012-2017 estimates represent data collected at turbines that were feathered below 5.0 m/s in the fall. The 2018 estimate represents turbines that were 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 a 50% reduction in bat fatality rates compared to the 2010 and 2011 combined fall estimate, and represents a 50% reduction in bat fatality rates compared to the 2010 and 2011 fall and spring 2010 combined estimate in 2018 .

Within Season Adaptive Management

The Fowler 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: 11.8 Indiana bats per year for the entire facility.

The Fowler 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 13). The within season adaptive management threshold for 2018 was 141.4 bat carcasses, spring and fall combined. A total of 92 bat carcasses were found on search plots that were estimated to have been killed on or after the evening of July 31 during the study.

Figure 6 illustrates the within-season tracking tool that was used to determine if mortality was approaching within-season adaptive management thresholds. The weekly 2018 estimated bat fatality rate shown in Figure 6 was a prediction that was calculated using the 2017 bias trial data. The final 2018 bat fatality estimate was based on 2018 bias trial results. Adaptive Management thresholds were not exceeded at any time during the study, and no changes to minimization efforts were required during 2018.

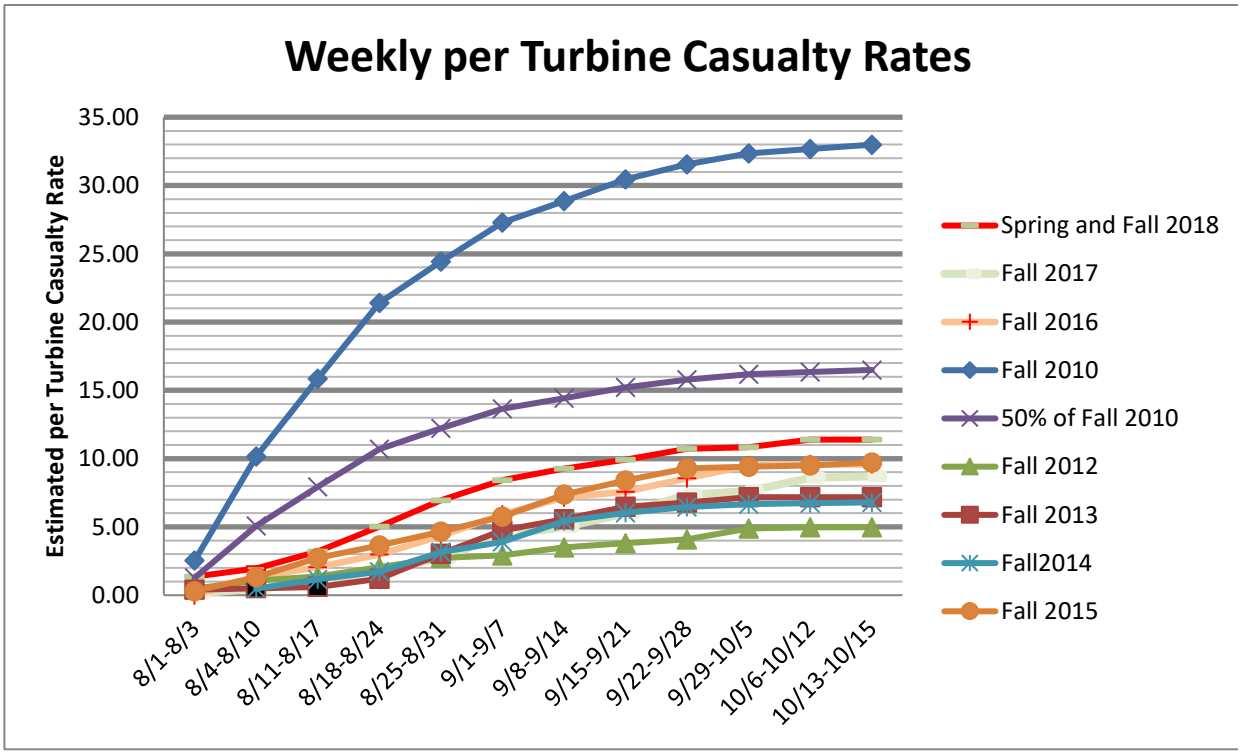

Figure 6. Weekly per turbine fatality rates (number of bat carcasses found per turbine) at the Fowler Ridge Wind Farm in 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 50% of fall 2010. This graph was used to determine if weekly fatality rates were approaching the 50% Adaptive Management Threshold. Fatality rates for 2018 shown above were based on 2017 bias trial results. The black squares during the weeks of August 4 and August 11 in 2013 represent the time when much of the Fowler Ridge Wind Farm was not operating due to a scheduled shut down for maintenance.

Table 13a. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in spring 2018 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Description of Where Data Came From
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 HCP
Estimated upper quartile of total fatalities during the period for which AM 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 rate per turbine during the period for which AM thresholds are based	0.90		Estimated by dividing the bat mortality count (378) by the number of operational turbines (420).
Empirical PI Estimate	0.60		Estimated probability of carcass being available and detected based on Fowler 2017 empirical bias trials from weekly road/pad searches; will be adjusted annually for subsequent years
Road & Pad Correction Factor	6.56	26.38	Phases I, II and III based on 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 AM thresholds are based	0.08	0.02	Predicted based on estimated fatality rate per turbine (0.90), multiplied by empirical PI (0.60), divided by road/pad correction factor (6.56 or 26.38)
Total Bats Found in One Spring Season Based on Turbines Searched	9.78	1.34	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 2018
Total Bats Found Threshold	**11.11**		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 2018 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Description of Where Data Came From
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 HCP
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 Rate 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	0.60		Estimated probability of carcass being available and detected based on Fowler 2017 empirical bias trials from weekly road/pad searches; will be adjusted annually for subsequent years
Road & 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 2017; the within season factor did not include 2017 data.

Table 13b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2018 (Phases I, II, III, IV).

Parameter	Fowler I-III	Fowler IV	Description of Where Data Came From
Predicted Upper Quartile of Number of Bats Found per Searched Turbine during the Period for which Adaptive Management Thresholds are Based	1.53	0.38	Predicted based on estimated fatality rate per turbine (16.7), multiplied by empirical Pi (0.60), divided by road/pad correction factor (6.56 or 26.38)
Total Bats Found in One Fall Season Based on Turbines Searched	115.3	14.9	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 2018
Total Bats Found Threshold	**130.30**		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 2018 was calculated based on the overall estimated bat fatality rate during 2018, and the relative percent that Indiana bat carcasses composed of all bat carcasses found during the fall of 2009, 2010 and 2011 (0.16%). A total of 0.70 (90% CI 0.34-1.04) Indiana bat fatalities were estimated to have occurred in the spring of 2018, and an estimated total of 7.6 (90% CI 5.41-10.04) Indiana bat fatalities in the fall, both of which are lower than the number of Indiana bats that were predicted to occur as fatalities within the HCP after minimization (Table 14). The estimated number of Indiana bat fatalities in 2018 during the fall season is below the 90% CI of Indiana bat fatalities predicted within the HCP. No confidence intervals 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 2019.

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

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
- No decomposition
- No infestations other than flies and eggs
- Body may be more flexible

2 – 3 Days

- Eyes will be sunken or missing
- May be infested with maggots, beetles, flies, and ants
- Flesh and internal organs will begin to be scavenged by insects

4 – 7 Days

- Eyes will be completely gone
- Most internal organs will be missing
- Bat may look like a hollow shell
- Fur may begin to fall off the skin and bat may look like it expanded in size
- Few maggots may be present but not prevalent

7 – 14 Days

- There is almost no meat left on body
- Skin has conformed to the skeletal system
- Body cavity should be devoid of insects

> 2 Weeks to < 1 Month

- Wing membrane is either gone or deteriorating
- Exposed bones are bleached in appearance

Appendix B. Bat and Bird Casualties Found at the Fowler Ridge Wind Farm, Benton County, Indiana between April 4 – October 11, 2018

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 4 – October 11, 2018.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have died outside of study period?	Included in fatality estimate?
4/5/2018	unidentified passerine	260	Vestas	No	Unknown	No
4/7/2018	golden-crowned kinglet	S17	Siemens	No	No	No
4/7/2018	golden-crowned kinglet	S37	Siemens	No	No	No
4/7/2018	golden-crowned kinglet	S58	Siemens	No	No	No
4/24/2018	eastern red bat	605	Clipper	No	Unknown	Yes
4/25/2018	eastern red bat	459	Vestas	No	No	Yes
4/26/2018	red-winged blackbird	S26	Siemens	No	No	No
4/30/2018	unidentified waterfowl	405	Vestas	No	No	No
5/1/2018	chimney swift	245	Vestas	No	No	No
5/2/2018	silver-haired bat	50	GE	No	No	Yes
5/3/2018	silver-haired bat	S38	Siemens	No	No	Yes
5/3/2018	brown-headed cowbird	S30	Siemens	No	No	No
5/7/2018	hoary bat	388	Vestas	No	No	Yes
5/9/2018	eastern red bat	S4	Siemens	No	No	Yes
5/14/2018	silver-haired bat	448	Vestas	No	No	Yes
5/14/2018	silver-haired bat	448	Vestas	No	No	Yes
5/15/2018	silver-haired bat	608	Clipper	No	No	Yes
5/15/2018	silver-haired bat	260	Vestas	No	No	Yes
5/15/2018	evening bat	226	Vestas	No	No	Yes
5/15/2018	silver-haired bat	11	GE	No	No	Yes
8/1/2018	hoary bat	348	Vestas	No	Yes	No
8/1/2018	eastern red bat	425	Vestas	No	Yes	No
8/1/2018	hoary bat	457	Vestas	No	Yes	No
8/1/2018	hoary bat	476	Vestas	No	No	Yes
8/1/2018	chimney swift	420	Vestas	No	Yes	No
8/1/2018	indigo bunting	420	Vestas	No	Yes	No
8/1/2018	eastern red bat	420	Vestas	No	Yes	No
8/1/2018	hoary bat	611	Clipper	No	Yes	No
8/2/2018	hoary bat	640	Clipper	No	Yes	Yes
8/3/2018	hoary bat	156	Vestas	No	Yes	No
8/3/2018	hoary bat	156	Vestas	No	Yes	No
8/3/2018	mourning dove	56	GE	No	No	No
8/3/2018	eastern red bat	28	GE	No	No	Yes

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 4 – October 11, 2018.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have died outside of study period?	Included in fatality estimate?
8/3/2018	hoary bat	3	GE	No	Yes	No
8/3/2018	eastern red bat	9	GE	No	No	Yes
8/4/2018	dickcissel	S34	Siemens	No	No	No
8/4/2018	eastern red bat	S25	Siemens	No	Yes	No
8/4/2018	hoary bat	S60	Siemens	No	No	Yes
8/4/2018	eastern red bat	S32	Siemens	No	No	Yes
8/4/2018	hoary bat	S18	Siemens	No	Yes	No
8/4/2018	silver-haired bat	S3	Siemens	No	Yes	No
8/6/2018	hoary bat	209	Vestas	Yes	No	No
8/6/2018	hoary bat	639	Clipper	No	No	Yes
8/7/2018	eastern red bat	195	Vestas	No	No	Yes
8/13/2018	eastern red bat	348	Vestas	No	No	Yes
8/13/2018	eastern red bat	339	Vestas	No	No	Yes
8/13/2018	eastern red bat	459	Vestas	No	No	Yes
8/13/2018	hoary bat	423	Vestas	No	No	Yes
8/13/2018	eastern red bat	359	Vestas	No	No	Yes
8/13/2018	eastern red bat	420	Vestas	No	No	Yes
8/13/2018	eastern red bat	390	Vestas	No	No	Yes
8/13/2018	eastern red bat	641	Clipper	No	No	Yes
8/14/2018	big brown bat	31	GE	No	No	Yes
8/14/2018	eastern red bat	56	GE	No	No	Yes
8/15/2018	big brown bat	379	Vestas	Yes	No	No
8/17/2018	eastern red bat	640	Clipper	Yes	No	No
8/20/2018	eastern red bat	339	Vestas	Yes	No	No
8/20/2018	hoary bat	339	Vestas	No	No	Yes
8/20/2018	eastern red bat	339	Vestas	No	No	Yes
8/20/2018	eastern red bat	459	Vestas	Yes	No	No
8/20/2018	hoary bat	459	Vestas	No	No	Yes
8/20/2018	hoary bat	459	Vestas	No	No	Yes
8/20/2018	hoary bat	359	Vestas	No	No	Yes
8/20/2018	Seminole bat	425	Vestas	No	No	Yes
8/20/2018	hoary bat	448	Vestas	No	No	Yes
8/20/2018	eastern red bat	603	Clipper	Yes	No	No
8/20/2018	hoary bat	603	Clipper	Yes	No	No
8/21/2018	eastern red bat	641	Clipper	No	No	Yes
8/21/2018	eastern red bat	329	Vestas	No	No	Yes
8/21/2018	eastern red bat	319	Vestas	Yes	No	No

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 4 – October 11, 2018.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have died outside of study period?	Included in fatality estimate?
8/22/2018	hoary bat	35	GE	No	No	Yes
8/22/2018	big brown bat	9	GE	No	No	Yes
8/22/2018	eastern red bat	68	GE	No	No	Yes
8/22/2018	eastern red bat	80	GE	Yes	No	No
8/23/2018	hoary bat	248	Vestas	Yes	No	No
8/23/2018	eastern red bat	S31	Siemens	No	No	Yes
8/23/2018	eastern red bat	S3	Siemens	No	No	Yes
8/23/2018	eastern red bat	S3	Siemens	No	No	Yes
8/24/2018	eastern red bat	S56	Siemens	Yes	No	No
8/26/2018	hoary bat	220	Vestas	Yes	No	No
8/27/2018	eastern red bat	371	Vestas	No	No	Yes
8/27/2018	eastern red bat	390	Vestas	No	No	Yes
8/27/2018	eastern red bat	641	Clipper	No	No	Yes
8/27/2018	hoary bat	624	Clipper	No	No	Yes
8/27/2018	eastern red bat	329	Vestas	No	No	Yes
8/28/2018	eastern red bat	224	Vestas	No	No	Yes
8/28/2018	eastern red bat	226	Vestas	No	No	Yes
8/28/2018	eastern red bat	3	GE	No	No	Yes
8/28/2018	hoary bat	9	GE	No	No	Yes
8/28/2018	eastern red bat	192	Vestas	Yes	No	No
8/29/2018	big brown bat	S45	Siemens	No	No	Yes
8/29/2018	eastern red bat	S23	Siemens	No	No	Yes
8/29/2018	eastern red bat	S53	Siemens	No	No	Yes
8/29/2018	eastern red bat	S46	Siemens	No	No	Yes
9/3/2018	hoary bat	309	Vestas	No	No	Yes
9/3/2018	seminole bat	339	Vestas	No	No	Yes
9/3/2018	big brown bat	459	Vestas	No	No	Yes
9/3/2018	silver-haired bat	478	Vestas	No	No	Yes
9/3/2018	eastern red bat	478	Vestas	No	No	Yes
9/3/2018	eastern red bat	375	Vestas	No	No	Yes
9/3/2018	silver-haired bat	458	Vestas	No	No	Yes
9/3/2018	silver-haired bat	448	Vestas	No	No	Yes
9/3/2018	hoary bat	411	Vestas	No	No	Yes
9/3/2018	eastern red bat	627	Clipper	No	No	Yes
9/3/2018	eastern red bat	329	Vestas	No	No	Yes
9/4/2018	hoary bat	203	Vestas	No	No	Yes
9/5/2018	eastern red bat	S23	Siemens	Yes	No	No

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 4 – October 11, 2018.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have died outside of study period?	Included in fatality estimate?
9/6/2018	big brown bat	325	Vestas	Yes	No	No
9/10/2018	silver-haired bat	369	Vestas	No	No	Yes
9/10/2018	silver-haired bat	285	Vestas	No	No	Yes
9/11/2018	hoary bat	119	GE	Yes	No	No
9/11/2018	eastern red bat	195	Vestas	No	No	Yes
9/11/2018	silver-haired bat	87	GE	No	No	Yes
9/11/2018	mourning dove	17	GE	No	No	No
9/12/2018	American redstart	S41	Siemens	No	No	No
9/12/2018	silver-haired bat	S54	Siemens	No	No	Yes
9/12/2018	silver-haired bat	S33	Siemens	No	No	Yes
9/12/2018	eastern red bat	640	Clipper	Yes	No	No
9/13/2018	silver-haired bat	615	Clipper	Yes	No	No
9/17/2018	eastern red bat	459	Vestas	No	No	Yes
9/17/2018	eastern red bat	624	Clipper	No	No	Yes
9/17/2018	silver-haired bat	631	Clipper	No	No	Yes
9/17/2018	American crow	622	Clipper	No	No	No
9/19/2018	eastern red bat	S25	Siemens	No	No	Yes
9/19/2018	ruby-throated hummingbird	S9	Siemens	No	No	No
9/19/2018	eastern red bat	126	GE	Yes	No	No
9/20/2018	hoary bat	260	Vestas	No	No	Yes
9/24/2018	eastern red bat	457	Vestas	No	No	Yes
9/24/2018	silver-haired bat	476	Vestas	No	No	Yes
9/24/2018	chestnut-sided warbler	390	Vestas	No	No	No
9/24/2018	hoary bat	641	Clipper	No	No	Yes
9/24/2018	eastern red bat	639	Clipper	No	No	Yes
9/24/2018	eastern red bat	601	Clipper	Yes	No	No
9/24/2018	silver-haired bat	603	Clipper	Yes	No	No
9/24/2018	silver-haired bat	603	Clipper	Yes	No	No
9/24/2018	silver-haired bat	603	Clipper	Yes	No	No
9/24/2018	hoary bat	606	Clipper	Yes	No	No
9/24/2018	silver-haired bat	607	Clipper	Yes	No	No
9/25/2018	hoary bat	615	Clipper	Yes	No	No
9/25/2018	eastern red bat	615	Clipper	Yes	No	No
9/25/2018	silver-haired bat	616	Clipper	Yes	No	No
9/26/2018	silver-haired bat	61	GE	No	No	Yes
9/26/2018	hoary bat	625	Clipper	Yes	No	No

Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 4 – October 11, 2018.

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have died outside of study period?	Included in fatality estimate?
9/26/2018	hoary bat	625	Clipper	Yes	No	No
9/26/2018	eastern red bat	S18	Siemens	No	No	Yes
9/26/2018	unidentified warbler	628	Clipper	Yes	No	No
9/26/2018	hoary bat	389	Vestas	Yes	No	No
9/27/2018	hoary bat	633	Clipper	Yes	No	No
9/27/2018	big brown bat	642	Clipper	Yes	No	No
10/2/2018	eastern red bat	72	GE	No	No	Yes
10/2/2018	silver-haired bat	3	GE	Yes	No	No
10/8/2018	silver-haired bat	627	Clipper	No	No	Yes
10/8/2018	silver-haired bat	631	Clipper	No	No	Yes
10/9/2018	unidentified warbler	226	Vestas	No	No	No
10/9/2018	hoary bat	S27	Siemens	No	No	Yes
10/9/2018	eastern red bat	S27	Siemens	No	No	Yes
10/11/2018	silver-haired bat	S9	Siemens	No	No	Yes