2022 Post-Construction Bat Mortality Monitoring Report Wildcat Wind Farm

Madison and Tipton Counties, Indiana

Project #193707045

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1.0 Introduction

1.1 PROJECT DESCRIPTION AND HISTORY

The Wildcat Wind Farm (Project or Wildcat), developed by Wildcat Wind Farm I, LLC (WWF), is located in Madison and Tipton counties, north of the town of Elwood, Indiana. The Project consists of 125 GE 1.6-megawatt (MW) wind turbine generators and associated access roads and collector line system for a total capacity of 200 MW (Figure 1). The Project includes towers of two different heights from foundation to top of tower ("hub height"): 76 towers of approximately 328 feet (ft; 100 meters [m]) and 49 towers of approximately 315 ft (96 m). The total turbine height (i.e., height at the highest blade tip position) is approximately 492 ft (150 m) for the 100 m towers and approximately 479 ft (146 m) for the 96 m towers. The Project is located on lands leased from private landowners who continue their pre-wind farm use of the land. Land use in the area is predominantly agricultural.

Wildcat is located within the range of both the federally endangered Indiana bat (*Myotis sodalis*) and federally threatened northern long-eared bat (*Myotis septentrionalis*)[1]. On 19 August 2016, WWF obtained an Incidental Take Permit (ITP) from the United States Fish and Wildlife Service (USFWS), allowing operations under the terms of the Project's Habitat Conservation Plan (HCP), which covers the Indiana bat and northern long-eared bat (covered species), requires curtailing of turbines to 5.0 meters/second (m/s) during the fall migration period (1 August–15 October) and feathering[2] of turbines below 3.5 m/s during the rest of the year, and outlines the requirements for post-construction monitoring to ensure permit compliance. The ITP authorizes the take of 162 Indiana bats and 81 northern long-eared bats over the 27 years of project operations, or an average of 6 Indiana bats and 3 northern long-eared bats per year. This is the tenth year of monitoring at the Project, and the seventh conducted under the HCP and ITP. The seven years of HCP monitoring included three years of baseline monitoring (2016-2018) and four years of implementation monitoring (2019-2022). Results of previous monitoring are outlined in Section 4.2.

1.2 PURPOSE AND OBJECTIVES OF THE STUDY

Post-construction mortality monitoring was conducted as part of the implementation monitoring process under the HCP post-construction monitoring plan to:

1. Provide a means of monitoring and ensuring the Project's compliance with the take limits authorized in the ITP
2. Assess the effectiveness of the HCP in meeting the biological objective of minimizing direct mortality of Indiana and northern long-eared bats

[1] As of January 2023, the northern long-eared bat will be up listed to endangered.

[2] Defined in the HCP as blades pitched parallel with the wind direction, causing them to spin at very low revolutions per minute (RPM), if at all

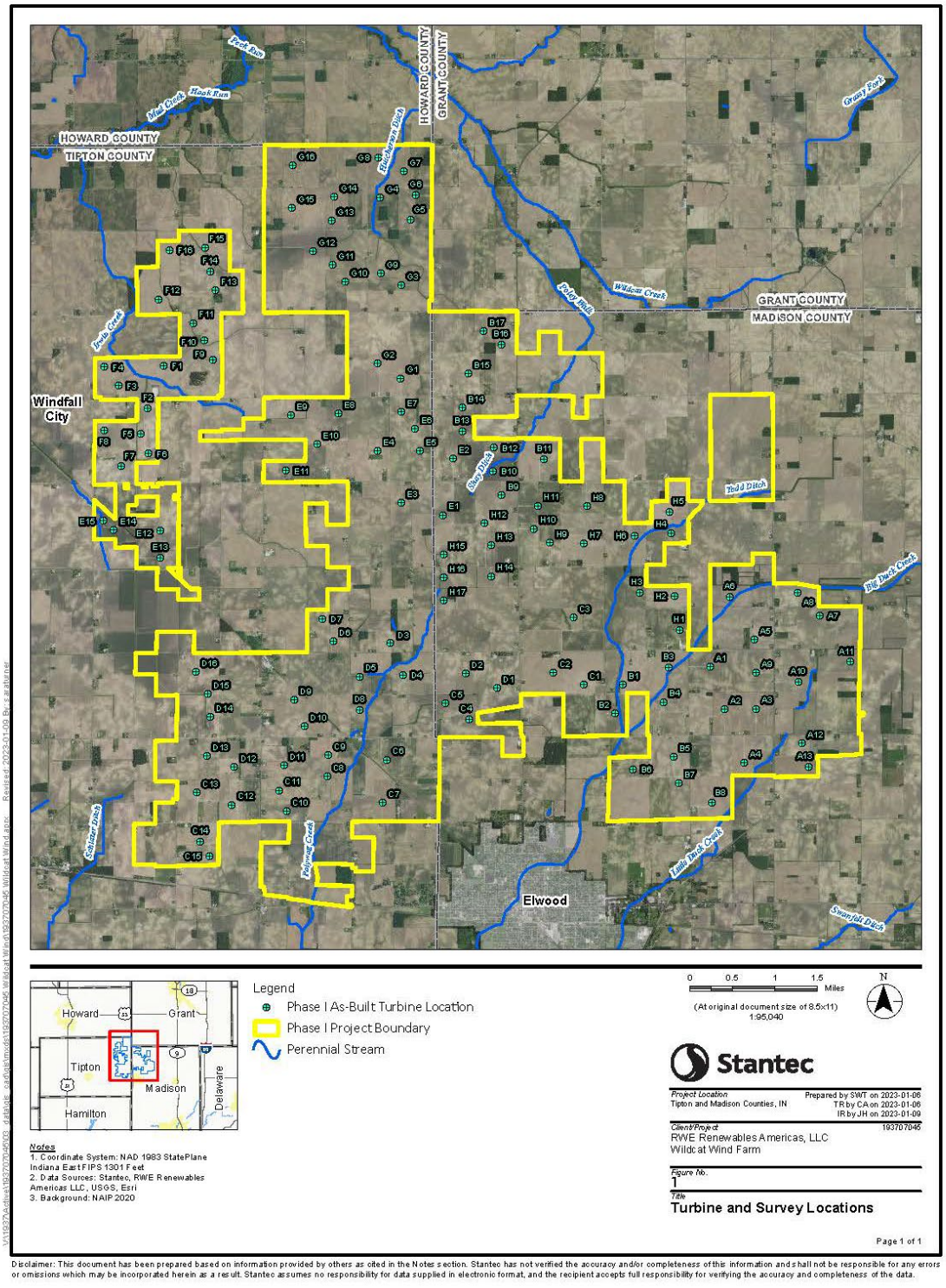

Figure 1. Turbine and Survey Locations

2.0 Methods

The post-construction monitoring included the following components:

1. Standardized carcass surveys to systematically search turbines for bat casualties attributable to the turbines

2. Searcher efficiency trial to estimate the percentage of bat casualties that were found by the searcher

3. Carcass removal trial to estimate the persistence time of carcasses on-site before scavengers removed them

2.1 MORTALITY STUDY

Carcass surveys were conducted from 1 August through 19 October during the 2022 year of project operation. The Project was operating at a 5.0 m/s cut-in speed, per the HCP.

2.1.1 Sample Size

Post-construction monitoring was conducted at 100% of the turbines. This study design provides full coverage of the facility and makes the survey comparable to subsequent and prior monitoring results.

2.1.2 Survey Plot Size

Surveys consisted of searching roads and pads out to 262 ft (80 m) at 100% of the turbines (n=125).

Previous post-construction studies have indicated that the majority of bat carcasses typically fall within 100 ft (30 m) of the turbine or within 50% of the maximum height of the turbine (Kerns and Kerlinger 2004, Arnett et al. 2005, Young et al. 2009, Jain et al. 2007, Piorkowski and O'Connell 2010, USFWS 2012). The plot size used for this study exceeds one-half the maximum turbine rotor height of the project turbines (246 ft [75 m]).

2.1.3 Survey Schedule

All turbines were searched weekly. An individual turbine was searched on the same day each week when conditions allowed.

2.1.4 Carcass Surveys

Carcass surveys were conducted by searchers experienced and/or trained in fatality search methods, including proper handling and reporting of carcasses. Searchers were familiar with and able to accurately identify bat species likely to be found in the Project area. Any unknown bats

discovered were positively identified by a permitted bat biologist either through photos or visual observation in person, and carcasses were kept on-site. During surveys, searchers walked at a rate of approximately 2 miles per hour (mph; 45 to 60 m per minute) while searching 10 ft (3 m) on either side.

For each carcass found, the following data were recorded digitally within Survey123 (ESRI, Redlands, CA):

- Date and time
- Initial species identification
- Sex, age, and reproductive condition (when possible)
- Global positioning system (GPS) location
- Distance and bearing to turbine
- Condition (intact, scavenged, decomposed)
- Any notes on presumed cause of death

A digital photograph of each carcass found was taken before the carcass was handled and removed. All carcasses were labeled with a unique number, bagged, and stored in a freezer at the Project Operations and Maintenance Building. Bat carcasses were collected and retained under Indiana Department of Natural Resources Special Purpose Salvage Permit No. 2228.

Bat carcasses found in non-search areas and any bird carcasses found were coded as incidental finds and documented in a similar fashion to those found in standardized surveys when possible. This included carcasses found during non-search times and decomposed carcasses found during the first week of searches that were deemed to have been killed prior to the post-construction monitoring period based on the level of decomposition. Maintenance personnel were informed of the standardized surveys and were trained in collision event reporting protocol in the case of an incidental find. Bird carcasses were photographed and documented, but they were not collected and were left as found. Incidental bat carcasses were collected and stored in the freezer with the carcasses found during standardized surveys. Incidental finds were not included in the mortality estimates.

2.1.5 Species Identification

Preliminary bird and bat species identifications were made in the field by qualified staff. When carcass condition allowed, sex, age, and reproductive condition of the carcass were recorded. For bat carcasses, forearm length was recorded to facilitate species identification. Any unknown bat was identified by a permitted bat biologist. In addition to the carcass, photographs and data collected for each carcass were used to verify the species identification.

2.2 SEARCHER EFFICIENCY TRIALS

A searcher efficiency trial was used to estimate the probability of bat carcass detection by the searcher. The searcher did not know when during the monitoring periods the trials were being conducted, at which turbines trial carcasses were placed, or the location or number of trial carcasses placed in any given search plot. Commercially-available brown mouse carcasses were used as trial carcasses to represent bats.

All searcher efficiency trial carcasses were randomly placed by the field lead within the search plots. These were placed in the morning prior to the planned carcass surveys for that day. The number of trial carcasses found by the searcher during the mortality surveys in each plot was recorded and compared to the total number of trial carcasses placed in the plot and available to be found (i.e., not scavenged prior to the mortality search).

2.3 CARCASS REMOVAL TRIALS

A carcass removal trial was conducted to estimate the average length of time carcasses remained in the search plots (i.e., were available to find) before being removed by scavengers. The carcass removal trial was conducted following the searcher efficiency trials during post-construction monitoring. Mouse carcasses used during the searcher efficiency trials were left in place, and their locations were discretely marked. Searchers monitored the trial carcasses over a period of up to 30 days. During the carcass removal trial, carcasses were checked every day for the first week, and then on days 10, 14, 20, and 30.

The condition of each carcass was recorded during each trial check. The conditions recorded were defined as follows:

- Intact – complete carcass with no body parts missing
- Scavenged – carcass with some evidence or signs of scavenging
- Fur spot – no carcass, but fur spot remaining
- Missing – no carcass or fur remaining

Any carcasses remaining at the end of the 30-day trial period were removed from the field.

2.4 STATISTICAL METHODS FOR MORTALITY ESTIMATES

Results include summaries of the raw data, including counts of species, the number of searches conducted, and the average search interval (calculated as the sum of the number of visits to a turbine divided by the number of days within a season).

In an effort to make results comparable with other post-construction monitoring at the Project, the Shoenfeld method was used to calculate the mortality estimates which largely follows the estimator proposed by Erickson et al. (2003), as modified by Young et al. (2009). The estimate of

the total number of turbine-related casualties was based on three components: (1) observed number of casualties, (2) searcher efficiency, and (3) carcass removal rates. The 90% confidence intervals were calculated using bootstrapping methods (Erickson et al. 2003 and Manly 1997 as presented in Young et al. 2009).

2.5 DATA ANALYSIS

2.5.1 Mean Observed Number of Casualties (c)

The estimated mean observed number of casualties (c) per turbine per monitoring period was calculated as:

$$c = \frac{\sum_{j=1}^{n} c_j}{n}$$

where n is the number of turbines searched, and c_j is the number of casualties found during mortality searches. Incidental carcass finds (those found outside of the surveyed areas or at times other than during mortality surveys) were not included in this calculation or in the estimated fatality rate.

2.5.2 Estimation of Searcher Efficiency (p)

Searcher efficiency (p) represents the average probability that a carcass was detected by the surveyor. The searcher efficiency rate was calculated by dividing the number of trial carcasses the observer found by the total number which remained available during the trial (non-scavenged).

2.5.3 Estimation of Carcass Removal (t)

Carcass removal rates were estimated to adjust the observed number of casualties to account for scavenger activity at the site. Mean carcass removal time (t) represents the average length of time a trial carcass remained at the site before it was removed by scavengers. Mean carcass removal time was calculated as:

$$t = \frac{\sum_{i=1}^{s} t_i}{s - s_c}$$

where s is the number of carcasses placed in the carcass removal trials and s_c is the number of carcasses remaining at day 30. This estimator is the maximum likelihood (conservative) estimator assuming the removal times follow an exponential distribution and that there is right-censoring of the data. Any trial carcasses remaining after 30 days were collected, yielding censored observations at 30 days.

2.5.4 Estimation of the Probability of Carcass Availability and Detection (π)

Searcher efficiency and carcass removal rates were combined to represent the overall probability (π) that a casualty incurred at a turbine was reflected in the mortality survey results. This probability was calculated as:

$$\pi = \frac{t \cdot p}{I} \cdot \left[\frac{\exp(I/t) - 1}{exp\,(I/t) - 1 + p} \right]$$

where I is the interval between searches.

2.5.5 Area Adjustment (A)

Since only roads and pads were searched during 2022, the average area adjustment from the three years of baseline post-construction monitoring was used to calculate mortality estimates for 2022 (Table 1).

Table 1. Summary and average of previous area adjustments during post-construction surveys, Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Year	Number of Carcasses Found on Full Plots	π_{FP}	Number of Carcasses Found on Road and Pad Plots	π_{RP}	Area Adjustment for Roads and Pads
2016	72	0.69	19	0.76	5.45
2017	40	0.46	21	0.66	3.57
2018	57	0.74	27	0.81	3.02
Average	n/a	n/a	n/a	n/a	4.01

Approximation of A, the adjustment for areas which were not surveyed, was calculated using data from 2016, 2017, and 2018 (when turbines were operating at 5.0 m/s) following methods and data collected during post-construction monitoring studies at Fowler Ridge Wind Farm in Indiana (Good et al. 2011). For this study, A_{RP} was calculated to represent the adjustment for the proportion of carcasses which likely fell outside of the area searched at roads and pads turbines. The value for A_{RP} was approximated using the following equation:

$$A_{RP} = \frac{\frac{C_{FP}}{\pi_{FP}}}{\frac{C_{RPFP}}{\pi_{RP}}} * A_{FP}$$

where π_{FP} is the π value calculated for full plot searches. C_{FP} is the number of observed casualties on full plots, π_{RP} is the π value calculated for roads and pads searches, and C_{RPFP} is the number of observed casualties on roads and pads of the full plot turbines. A_{RP} was calculated separately for each year, and then averaged for a value to use for 2022.

The value for A_{FP} used was equal to the correction factor calculated for the Fowler study (A_{FP}=1.305) as the Fowler study estimated that 23.4% of fatalities fall outside of the 262-foot x 262-foot (80-m x 80-m) square plots.

2.5.6 Estimation of Facility-Related Mortality (m)

Mortality estimates were calculated using the estimator proposed by Erickson et al. (2003), as modified by Young et al. (2009). The estimated mean number of bat casualties/turbine/monitoring period (m) was calculated by dividing the mean observed number of bat casualties/turbine/monitoring period (c) by π, an estimate of the probability a carcass was not removed by scavengers and was detected by the surveyor, and then multiplying by A, the adjustment for the area within which bats may have fallen but which was not surveyed.

$$m = \mathrm{A} * \frac{c}{\pi}$$

Where A is the area adjustment, C is the number of carcasses found per turbine, and π is the probability of carcass detection and availability.

2.6 TAKE ESTIMATION FOR COVERED SPECIES

The Evidence of Absence (EOA) software developed by Dalthorp et al. (2014, 2017) was used to estimate the probability of detection (g). This value represents the probability of detecting a carcass of either covered species that occurs at the site based on the post-construction monitoring effort performed that season.

The estimate of the overall probability of detection (g) is a function of several factors, including carcass persistence, searcher efficiency, area adjustment, search interval, and other factors (Dalthorp et al. 2014, 2017). These bias correction factors were calculated utilizing the methods described in Section 2.4 and input into the EOA model to calculate a probability of detection (g). The HCP set a goal of having a detection probability (g) between 0.08 and 0.12 during implementation monitoring.

Then, utilizing the EOA "Multi-Year Total" tool, the probability of detection (g) and the number of covered carcasses found (X) are input to determine, with a certain degree of confidence, that the number of fatalities of a covered species did not exceed the cumulative total authorized take and to estimate the annual take rate.

These estimates (cumulative total take and average annual take rate) are then used to determine whether either of the following two adaptive management triggers outlined in the Project's HCP have been triggered:

1. Short-term trigger – is actual average annual take rate larger than expected? This trigger would be an annual take rate of six Indiana bats or three northern long-eared bats or more, and it is calculated using a significance level of a=0.01.

2. Long-term trigger – does total cumulative take exceed the long-term authorized amount? This trigger would be an estimated cumulative mortality of 162 Indiana bats or 81 northern long-eared bats or more, and it is calculated using a significance level of a=0.50.

3.0 Results

3.1 SUMMARY OF SURVEYS

A total of 1,314 carcass searches were conducted over 12 weeks in the fall (1 Aug – 19 October) (Table 2). Due to schedules, weather conditions, and maintenance at turbines, the average time between surveys was 7.80 days during the post-construction monitoring period (Table 2).

Table 2. Summary of standardized surveys during the 2022 post-construction monitoring study at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Season	Date Range	Length (Weeks)	Road and Pad Turbines	Total Number of Searches Conducted	Search Interval	Bat Carcasses Found[1]
Fall	1 Aug–19 October	12	125	1,314	7.80	71

[1]This includes only carcasses found during standardized searches (within roads and pads on a scheduled search day).

A total of 71 individual bat carcasses were found during standardized carcass searches. An additional 10 individual bat carcasses were found incidentally (see Section 3.6.1).

3.1.1 Species Composition

A summary of all bat carcasses found incidentally (n=10) and during the standardized carcass surveys (n=71) during post-construction monitoring is shown in Table 3. Of the 81 bat carcasses found at the site, the most common species detected were the silver-haired bat (*Lasionycteris noctivagans*) (n=22; 27.2% of all bat carcasses found), eastern red bat (*Lasiurus borealis*;n=22; 27.2%), and big brown bat (*Eptesicus fuscus*; n=22; 27.2%). Thehoary bat (*Lasiurus cinereus*) was the next most common species (n=14; 17.3%), followed by the Seminole bat (*Lasiurus seminolus*; n=1; 1.2%). All bat carcasses were identified to the species level. No bat species federally listed as threatened or endangered under the Endangered Species Act of 1973 (ESA), as amended, were found. The silver-haired bat, eastern red bat, and hoary bat are all listed as special concern species in the state of Indiana, but none of these species receive any legal protection under the Indiana Nongame and Endangered Species Conservation Act.

Table 3. Summary of all bat carcasses found incidentally and during standardized carcass surveys during the 2022 post-construction monitoring study at the Wildcat Wind Farm, Tipton and Madison counties, Indiana. Percent of total shown in parenthesis.

Species	Number found during standardized searches	Number found incidentally	Total Number Found
Silver-haired Bat	21 (29.6%)	1 (10.0%)	22 (27.2%)
Eastern Red Bat	20 (28.2%)	2 (20.0%)	22 (27.2%)
Big Brown Bat	16 (22.5%)	6 (60.0%)	22 (27.2%)
Hoary Bat	13 (18.3%)	1 (10.0%)	14 (17.3%)
Seminole Bat	1 (1.4%)	0	1 (1.2%)
Total	**71**	**10**	**81**

3.1.2 Age and Sex

A summary of the age and sex of all bat carcasses found during the standardized post-construction monitoring is shown in Table 4. Of the 71 bat carcasses found during the standardized searches, 3 were adult females (4.2%), 4 were juvenile females (5.6%), 4 were females of unknown age (5.6%), 3 were adult males (4.2%), 6 were males of unknown age (8.5%), and 51 bats were of unknown age and unknown sex (71.8%; Table 4).

Table 4. Sex and age of bat carcasses found during standardized surveys for the 2022 post-construction monitoring study at the Wildcat Wind Farm, Tipton and Madison counties, Indiana. Ages include adults (A), juveniles (J), and unknown (U).

Species	Female			Male			Unknown		
	A	J	U	A	J	U	A	J	U
Silver-haired Bat	0	0	1	1	0	5	0	0	14
Eastern Red Bat	0	1	1	1	0	0	0	0	17
Big Brown Bat	2	0	1	1	0	1	0	0	11
Hoary Bat	1	3	1	0	0	0	0	0	8
Seminole Bat	0	0	0	0	0	0	0	0	1
Total	**3**	**4**	**4**	**3**	**0**	**6**	**0**	**0**	**51**

3.1.3 Temporal Patterns

During the post-construction monitoring period, bats were found during every week of searches, except Week 12 (week of 17 October; Figure 2.). The greatest number of bats found during a single week occurred the weeks of 15 August (week 3; n=11; 15.5%) and 12 September (week 7; n=11; 15.5%), followed by week 4 (22 August; n=10; 14.1%). The fewest number of bats found during a single week, other than week 12 which had no bat fatalities, occurred during weeks 10 and 11 (3 and 10 October, respectively) when one bat was found (n=1; 1.4%) (Figure 2.).

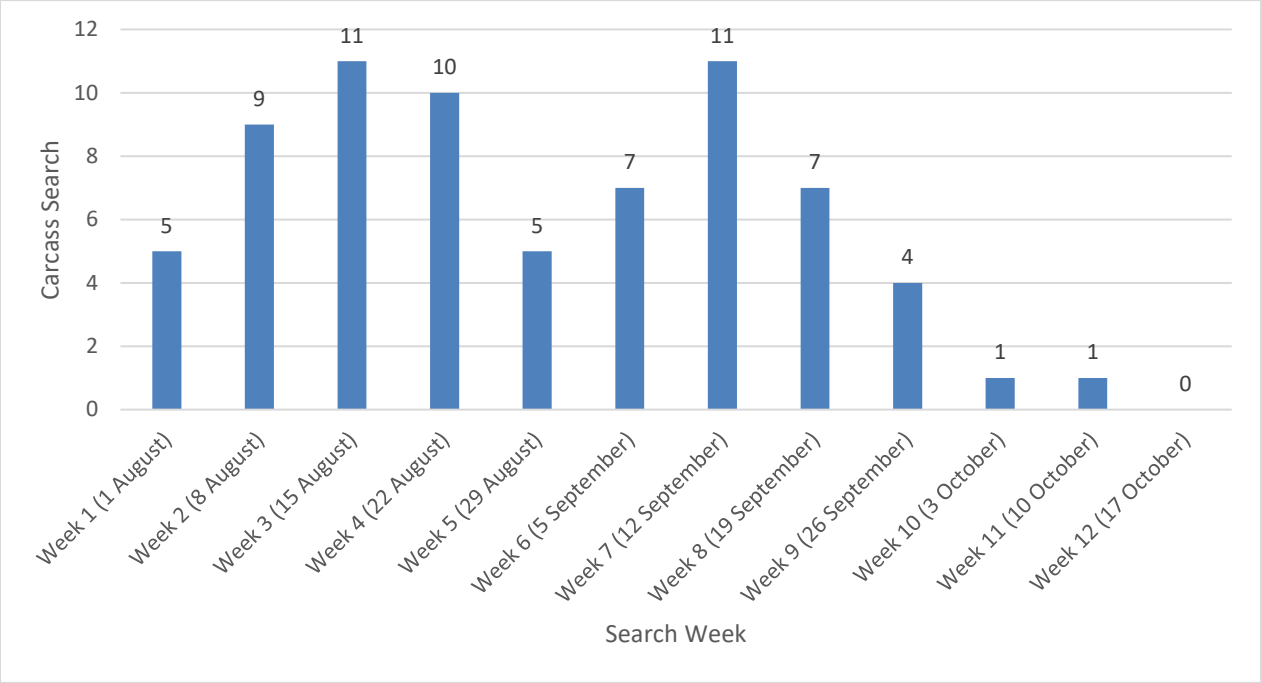

Figure 2. Bat carcasses found by week during the 2022 post-construction standardized surveys (1 Aug through 19 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

3.1.4 Spatial Patterns

During the standardized searches, bats were found at 53 of the 125 turbines (42.4%).

The number of carcasses found per turbine for the season varied from zero to three. The breakdown of carcasses per turbine is shown in Table 5.

Table 5. Summary of number of carcasses found per turbine during the 2022 standardized post-construction monitoring study at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Number of Carcasses Found	Number of Turbines	Turbine ID(s)
3 carcasses	2	B7, F2
2 carcasses	14	B15, C2, C6, C15, D5, D7, D13, D15, E4, E9, F3, H1, H5, H13
1 carcass	37	A4, A8, A9, A10, A11, A12, B3, B5, B6, B11, B12, B14, B16, B17, C1, C5, C11, C13, C14, D12, E3, E5, E8, E13, F9, F11, F12, F15, G3, G6, G9, G10, G11, G14, G15, H6, H8

The most carcasses found at a single turbine was at Turbines B7 and F2 (3 carcasses). Carcasses were found at turbines located throughout the Project area (Figure 1).

3.2 SEARCHER EFFICIENCY TRIALS

One searcher efficiency trial was conducted during post-construction monitoring for one searcher.

A total of 30 mouse carcasses were placed for the searcher efficiency trial during the post-construction monitoring period. Scavengers removed three of the trial carcasses prior to the searcher efficiency trial. The searcher found 26 of the 27 remaining carcasses, so searcher efficiency was 96.3% (Table 6).

Table 6. Searcher efficiency for the 2022 post-construction monitoring study at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Parameter	Value
Number of Carcasses Placed	30
Number of Carcasses Scavenged Prior	3
Number of Carcasses Available	27
Number of Carcasses Found	26

Parameter	Value
Searcher Efficiency Mean (p) (90% CI)	0.96 (0.89-1.0)

3.3 CARCASS REMOVAL TRIALS

Mouse carcasses used in the searcher efficiency trials were left for up to 30 days and checked each day for the first week and then on days 10, 14, 20, and 30 of the trial. Thirty mouse carcasses (the same as those used for searcher efficiency trials) were used during the post-construction monitoring period. Carcasses persisted for an average of 5.5 days (Table 7).

Table 7. Carcass removal during the 2022 post-construction monitoring study (1 August to 19 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Parameter	Value
Number of Carcasses Placed	30
Number of Carcasses Scavenged within 30 days	29
Mean Carcass Persistence time in days (90% CI)	**5.48 (3.87, 7.93)**

3.4 PROBABILITY OF CARCASS AVAILABILITY AND DETECTION

The probability of carcass availability and detection was estimated to be 52% (Table 8).

Table 8. Carcass availability and detection for the 2022 post-construction monitoring study (1 August to 19 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Parameter	Estimate (90% CI)
(p) Mean Searcher Efficiency	**0.96** (0.89, 1.0)
(t) Mean Carcass Persistence time in days	**5.48** (3.87, 7.93)
(π) Probability of carcass availability and detection	**0.52** (0.41, 0.63)

3.5 ADJUSTED MORTALITY ESTIMATES

Mortality rate estimates were calculated based upon the carcasses found during the mortality surveys and did not include any incidental finds. Observed bat mortality estimates were adjusted to account for searcher efficiency, carcass removal, and an area adjustment using the methods described in Section 2.5.6.

The estimated bat mortality was 4.40 bats/turbine, or 550 bats over the entire facility (Table 9).

Table 9. Bat mortality estimates for the 2022 post-construction monitoring study (1 August to 19 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana. The Project was operating at a cut-in speed of 5.0 m/s during this period.

Parameter	Estimate
(c) Observed bats/turbine	**0.57**
(A) Area Adjustment	**4.01**
(m) Estimated bats/turbine (90% CI)	**4.40** (3.32, 5.86)
Estimated bats/MW (90% CI)	**2.75** (2.08, 3.66)
Estimated bats/facility (90% CI)	**550** (415, 733)

3.6 INCIDENTAL FINDS

3.6.1 Bats

Ten incidental bats were discovered during the 2022 standardized post-construction monitoring period, nine during the first week of searches (week of 1 August, which were deemed to have occurred prior to the post-construction monitoring period based on the level of decomposition), and one in September. Species found include big brown bat (n=6), eastern red bat (n=2), hoary bat (n=1), and silver-haired bat (n=1). The incidental bats are included in the summary in Table 3, and the sex and age of incidental bat carcasses is summarized in Table 10.

Table 10. Sex and age of incidental bat carcasses found during 2022 post-construction monitoring study (1 August to 19 October) at Wildcat Wind Farm, Tipton and Madison counties, Indiana. Ages include adults (A), juveniles (J), and unknown (U).

Species	Female			Male			Unknown		
	A	J	U	A	J	U	A	J	U
Big Brown Bat	0	0	0	0	1	0	0	0	5
Eastern Red Bat	0	0	0	0	0	0	0	0	2
Hoary Bat	0	0	0	0	0	0	0	0	1
Silver-haired Bat	0	0	0	0	0	1	0	0	0
Total	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**8**

3.6.2 Birds

A total of six bird carcasses representing four species were found at six different turbines during the 2022 post-construction studies (Table 11). The bird finds included three horned larks (*Eremophila alpestris;* n=3, 50.0%), one common grackle (*Quiscalus quiscula*; n=1, 16.7%), one killdeer (*Charadrius vociferus;* n=1, 16.7%), and one mourning dove (*Zenaida macroura;* n=1, 16.7%) (Table 11).

Table 11. Summary of bird carcasses found during the 2022 post-construction monitoring study (1 August – 19 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

Date	Species	Turbine
2 August	Red-winged Blackbird (*Agelaius phoeniceus*)	E13
3 August	Horned Lark (*Eremophila alpestris*)	A12
15 August	Horned Lark (*Eremophila alpestris*)	C7
16 August	Horned Lark (*Eremophila alpestris*)	G15
7 September	Killdeer (*Charadrius vociferus*)	E11
7 September	Mourning Dove (*Zenaida macroura*)	B9

3.7 ESTIMATED TAKE OF INDIANA BATS AND NORTHERN LONG-EARED BATS

There were no Indiana bats or northern long-eared bats found during the 2022 post-construction monitoring surveys. The following inputs were used to calculate the probability of detection (g) for the 2022 post-construction monitoring using the EOA software:

- Temporal coverage: 1.0

- Searcher efficiency: 26 out of 27 carcasses found
- Coverage (a): 0.25 (1 divided by 4.01)
- Search interval: 7.75[3]
- Factor by which searcher efficiency changes with each search (k): 0.8 (EOA default)
- Persistence Distribution: exponential using the site-specific data (shape=0.185, scale=5.405)

This resulted in a probability of detection (g) of 0.126 (95% CI: 0.099, 0.156).

The "Multi-Year Module" tool was then used, with the corresponding inputs from the initial three years of baseline monitoring under the ITP, previous three years of implementation monitoring, and the inputs from 2022 (Table 12).

Table 12. Summary of EOA inputs based on fall monitoring (1 August – 15 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana from 2016 through 2022. The λ and M* for each species are identical since no carcasses of either species have been found.

Year	Number Of Indiana Bats Found	Number Of Northern Long-eared Bats Found	Detection Probability (g)	Average Annual Take Rate (λ) (α=0.01)	Average Annual Take Rate (λ) (α=0.01)	Cumulative Total Take (M*) (α=0.5)
2016	0	0	0.267 (B_a = 139.4113, B_b = 383.4858)	n/a (requires 3 years of data per HCP)		2
2017	0	0	0.206 (B_a = 21.865, B_b = 84.2986)			0
2018	0	0	0.293 (B_a = 151.0874, B_b = 363.702)	0.6564	0.6564	0
2019	0	0	0.179 (B_a = 133.47, B_b = 610.949)	0.531	0.7416	0
2020	0	0	0.132 (B_a = 52.3731, B_b = 343.227)	0.4655	0.829	0
2021	0	0	0.147 (B_a = 104.7369, B_b = 605.8749)	0.4092	1.094	1

[3] Closest value to 7.80 that would allow EofA to function properly.

Year	Number Of Indiana Bats Found	Number Of Northern Long-eared Bats Found	Detection Probability (g)	Average Annual Take Rate (λ) (α=0.01)	Average Annual Take Rate (λ) (α=0.01)	Cumulative Total Take (M*) (α=0.5)
2022	0	0	0.126 (Ba = 66.8777, Bb = 462.7968)	0.3709	1.239	1

This resulted in an estimated cumulative total take (α=0.5) of one or fewer Indiana bat and one or fewer northern long-eared bat, which means that the probability is ≥50% that the actual take is ≤ 1 bat of each species. The estimated annual fatality rate is 0.3709 for both species (95% CI: 0.000366, 1.86), and the 3-year average estimated annual fatality rate is 1.239 for both species, which does not trigger the short-term adaptive management trigger at α=0.01. Since neither the Indiana bat nor northern long-eared bat have been found at the Project, the estimates are the same for both species.

4.0 Summary and Conclusions

4.1 SUMMARY

- A total of 1,314 standardized carcass surveys were conducted over 12 weeks from 1 August to 19 October 2022.
- A total of 71 bat carcasses were found during standardized carcass searches, with an additional 10 incidental bat carcasses and 6 incidental bird carcasses.
- No bird or bat species listed as federally threatened or endangered under the ESA or listed as state-threatened or endangered under the Indiana Nongame and Endangered Species Conservation Act were found during this study.
- Three Indiana special concern bat species (silver-haired bat, eastern red bat, and hoary bat) were found during this study. No Indiana special concern bird species were found during this study.
- Bat species found during standardized surveys and incidentally included silver-haired bat (22), eastern red bat (22), big brown bat (22), hoary bat (14), and Seminole bat (1).
- The estimated bat mortality was 4.40 bats/turbine, 2.75 bats/MW, or 550 bats over the entire facility.
- The estimated cumulative total take (α=0.5) is one or fewer Indiana bat and one or fewer northern long-eared bat and the estimated annual fatality rate for 2016-2022 is 0.3709 for both species (95% CI: 0.000366, 1.86). No adaptive management triggers have been met.

4.2 COMPARISON TO PREVIOUS STUDIES

A Post-Construction Mortality Minimization and Monitoring Proposal (MMMP) was developed in June 2012, revised in June 2015 (Stantec 2015), and is consistent with methods and the recommendations of the USFWS Land-Based Wind Energy Guidelines (USFWS 2012). From 2013 through June 2015, the Project operated under the terms of a Technical Assistance Letter (TAL) dated 18 June 2012, that established an operational scenario under which no take of Indiana bats was expected to occur (i.e., 6.9 m/s cut-in speed during the fall migration period [1 August–15 October]).

From July 2015 to 18 August 2016, the Project operated under the terms of a second TAL secured on 2 July 2015 that established a revised operational scenario under which no take of Indiana bats or northern long-eared bats was expected to occur. This second TAL required curtailment to 6.9 m/s during the fall migration period (1 August–15 October) and 5.0 m/s during the spring migration period (15 March–15 May). On 19 August 2016, the Project obtained an ITP from the USFWS, allowing operations under the terms of the Project's HCP, including curtailment of turbine operations at wind speeds below 5.0/s during the fall migration period (1 August–15 October) when temperatures are above 50°F, and feathering of turbines below the manufacturer's cut-in speed of 3.5 m/s during the remainder of the year. Due to this, the 2016 data were analyzed separately for the time periods before and after 19 August due to the differing operational protocols that the turbines were operating under.

Post-construction monitoring has been conducted for ten years at the Project. While the surveys differed in level of effort (search interval, search area) and bias correction factors (searcher efficiency, carcass persistence, area adjustments), all surveys had overall fatality estimates corrected for these differences, allowing for comparison of results. In addition, the Project operated under different cut-in speed adjustments between years based on the TAL or ITP requirements.

As described above, for the first three years of project operations prior to ITP issuance, the turbines operated under the terms of TALs, with a cut-in speed of 6.9 m/s. The mean bat fatality estimate ranged from 88 to 188 bats during the fall period, compared to 328.8 bats during the 2016 fall season, 53.8 of which were attributed to the period prior to August 19 (when operating at 6.9 m/s), and 275 of which were attributed to the period after August 19 (when operating at 5.0 m/s; Table 13). From 2017 through 2022, the Project has operated at 5.0 m/s for the entire fall period, and the mean bat fatality estimate for the facility has ranged from 183 to 550 bats (Table 13).

Table 13. Bat mortality estimates by year for the fall migratory period (1 August–15 October) at the Wildcat Wind Farm, Tipton and Madison counties, Indiana.

	Year and Cut-in Speed										
	2013 (6.9 m/s)	**2014** (6.9 m/s)	**2015** (6.9 m/s)	**2016**		**2017** (5.0 m/s)	**2018** (5.0 m/s)	**2019** (5.0 m/s)	**2020** (5.0 m/s)	**2021** (5.0 m/s)	**2022** (5.0 m/s)
				(6.9 m/s until 19 August)	(5.0 m/s after 19 August)						
(m) Estimated bats/turbine	0.7	1.0	1.5	0.43	2.2	2.17	2.27	1.46	3.77	2.72	4.40
Estimated bats/MW	0.4	0.6	0.9	0.27	1.38	1.36	1.42	0.91	2.36	1.70	2.75
Estimated bats/facility	88	125	188	53.8	275	271	284	183	471	340	550

4.3 CONCLUSIONS

No Indiana bat or northern long-eared bat fatalities were detected during 2022, and neither the long-term trigger nor the short-term trigger were reached for either species when analyzed using EOA. Thus, no adaptive management actions will be implemented. The bias correction parameters from the 2022 post-construction monitoring period (e.g., searcher efficiency, carcass persistence, area adjustment, etc.) will be used in the design of protocols for additional implementation monitoring, in accordance with the ITP and HCP, to be conducted in 2023.

5.0 Literature Cited

Arnett, E.B., W.P. Erickson, J. Kerns, and J. Horn. 2005. Relationships Between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. Final Report prepared for the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas. June 2005.

Dalthorp, D., Huso, M., Dail, D, and Kenyon, J. 2014. Evidence of Absence Software User Guide. U.S. Department of the Interior, U.S. Geological Survey. Data Series 881.

Dalthorp, D., M. Huso, and D. Dail. 2017. Evidence of Absence (v2.0) Software User Guide: U.S. Geological Survey Data Series 1055, 109 p. https://doi.org/10.3133/ds1055.

Erickson, W.P., Gritski, B., and K. Kronner. 2003. Nine Canyon Wind Power Project Avian and Bat Monitoring Report, August 2003. Technical report submitted to energy Northwest and the Nine Canyon Technical Advisory Committee.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual Report for the Maple Ridge Wind Power Project: Post-Construction Bird and Bat Fatality Study – 2006. Final report. Prepared for PPM Energy and Horizon Energy and Technical Advisory Committee (TAC) for the Maple Ridge Project Study.

Good, R. E., Erickson, W., Merrill, A., Simon, S., Murray, K., Bay, K., & Fritchman, C. 2011. Bat monitoring studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana, April 13–October 15, 2010. Prepared for Fowler Ridge Wind Farm, by Western EcoSystems Technology, Inc. Cheyenne, WY, USA.

Kerns, J., and P. Kerlinger. 2004. A Study of Bird and Bat Collisions at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003. Prepared for FPL Energy and the Mountaineer Wind Energy Center Technical Review Committee. Technical report prepared by Curry and Kerlinger, LLC. February 14, 2004. 39 pp. http://www.wvhighlands.org/Birds/MountaineerFinalAvianRpt-%203-15-04PKJK.pdf.

Manly, B.F.J. 1997. Randomization, Bootstrap, and Monte Carlo Methods in Biology. Second edition. Chapman and Hall, New York. 399 pp.

Piorkowski, M.D., and T. J. O'Connell. 2010. Spatial Pattern of Summer Bat Mortality from Collisions with Wind Turbines in Mixed-grass Prairie. Am. Midl. Nat. 164:260-269.

US Fish and Wildlife Service (USFWS). 2012. Land-based Wind Energy Guidelines. March 2012. 71 pp.

Young, D. P., Erickson, W.P., Bay, K., Nomani, S., and W. Tidhar. 2009. Mount Storm Wind Energy Facility, Phase I Post-Construction Avian and Bat Monitoring, July-October 2008. Prepared for NedPower Mount Storm, LLC, by Western EcoSystems Technology, Inc. 40pp.