

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

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**April 1 – October 15, 2021**



**Prepared for:  
Fowler Ridge Wind Farm**

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**January 27, 2022**



## **EXECUTIVE SUMMARY**

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

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

Indiana bats were not believed to be at risk during the spring migration period when the original HCP was prepared and the ITP was issued. In 2018, the HCP was amended to account for spring take of Indiana bats due to evidence indicating a risk of Indiana bat take during the spring migration period. An ITP amendment was granted, and two years of evaluation phase monitoring were conducted during the spring of 2018 and 2019 at all phases of the FRWF. Estimated Indiana bat fatality rates were below adaptive management thresholds in both years, so implementation phase monitoring for all phases began in the spring of 2020 and will continue unless adaptive management thresholds are exceeded in the future.

Standardized carcass searches were completed weekly at 114 turbines during both the spring (April 1 – May 15) and fall (August 1 – October 15) of 2021, corresponding with migration periods of Indiana bats. During the spring, many Vestas turbines were undergoing blade inspections resulting in curtailment of operations for most of April and a replacement of normally searched Vestas turbines for other turbines of the same make. The search area was restricted to the gravel roads and pads within 80 meters (262 feet) of each turbine included in the study in both seasons. Searcher efficiency and carcass persistence trials were also conducted during both seasons to adjust for detection and removal bias.

No Indiana bat or other *Myotis* species were found. Sixty-eight bat carcasses of four known species and one unidentified bat species, were found during searches and incidentally. The one bat that remained unidentified was reported by the facility, observed on the top of a nacelle, was

not retrieved, and was unable to be identified from a photo. Twenty-eight bird carcasses of 17 known species or species groups were found during searches and incidentally. Similar to previous years of monitoring, the most commonly found bat species were eastern red bats and silver-haired bats, followed by hoary bats. One big brown bat was also found.

Estimated bat fatality rates were calculated based on the number of carcasses found, the results of bias trials, and adjustments for bats that did not fall on roads and pads. The combined spring and fall bat fatality rate in 2021 was estimated to be 11.16 bat fatalities/turbine/study period (90% confidence interval: 8.12–15.68). The results of monitoring during 2021 provide evidence that operational strategies exceeded the objective of reducing bat fatality rates by 50%, compared to fatality estimates from turbines operating normally in 2010 and 2011. Within-season and end-of-season adjustments of minimization strategies were not required in 2021 because bat fatality rates were below adaptive management thresholds.

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## **REPORT REFERENCE**

Good, R. E., K. Nasman, and A. Ciecka. 2022. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana. Draft Report: April 1 – October 15, 2021. Prepared for Fowler Ridge Wind Farm, Benton County, Indiana. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 27, 2022.

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## **INTRODUCTION**

The Fowler Ridge Wind Farm (FRWF) collectively includes Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC. The FRWF consists of 420 wind turbines in four phases in Benton County, Indiana. A post-construction fatality study of bats was conducted by Western EcoSystems Technology, Inc. (WEST) within Phases I, II, and III in 2009 (Johnson et al. 2010a, 2010b), when an Indiana bat (*Myotis sodalis*) carcass was found. Subsequent studies were conducted in 2010, 2011, 2012 and 2013 (Good et al. 2011, 2012, 2013, and 2014) under Scientific Research and Recovery Permits (TE15075A in 2010, TE15075A-2 in 2011, and TE73598A-0 in 2012 and 2013) within Phases I, II, and III. A second Indiana bat carcass was found in 2010 (Good et al. 2011). The results of this research were used by 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 are at 5.0 meters per second (m/s; 16.4 feet per second [ft/s]) or lower, on a nightly basis from sunset to sunrise during the fall migration period from August 1 – October 15. The FRWF received an Incidental Take Permit (ITP) for Indiana bats in August 2014 (TE95012A-0) based on the HCP. The HCP and ITP include requirements for monitoring the effectiveness of minimization measures.

The first two years of evaluation phase monitoring were completed at Phases I, II, and III during the fall migration season for Indiana bats in 2014 and 2015 (Good et al. 2015, 2016). Construction of Phase IV was completed in December 2015, and the required two years of evaluation phase monitoring were conducted during the fall migration season for Indiana bats in 2016 and 2017 (Good et al. 2017, 2018). Because the estimated Indiana bat fatality rate was estimated to be below adaptive management thresholds for all phases during their respective evaluation years, as outlined in the HCP, implementation phase monitoring began in the fall of 2016 at Phases I, II, and III, and in the fall of 2018 at Phase IV, and will continue unless adaptive management thresholds are exceeded in the future (Good et al. 2018, 2019, 2020).

Indiana bats were not believed to be at risk during the spring migration period (April 1 – May 15) when the original HCP was prepared and the ITP was issued. Since that time, new evidence indicates Indiana bats may be at risk of take during the spring migration period as well (Pruitt and Reed 2018). The HCP was amended to account for spring take of Indiana bats and an amendment to the ITP was granted on March 22, 2018 (TE95012A-1). To minimize Indiana bat take during the spring migration period, turbine blades are feathered below a cut-in speed of 3.5 m/s (11.5 ft/s) on a nightly basis from sunset to sunrise from April 1 – May 15. As per the amended HCP and ITP, two years of spring evaluation phase monitoring were conducted in 2018 (Good et al. 2019) and 2019 (Good et al. 2020) at the FRWF. Because the estimated Indiana bat fatality rate was estimated to be below adaptive management thresholds during the spring of 2018 and 2019,



implementation phase monitoring began in 2020 and will continue unless adaptive management thresholds are exceeded in the future.

This report describes the results of the 2021 spring and fall fatality monitoring required under the HCP and ITP.

## **STUDY AREA**

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

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

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

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

The FRWF is dominated by cultivated crops, consisting primarily of corn (*Zea mays*) and soybeans (*Glycine max*; Figure 1). Within 0.8 kilometers (0.5 mile) of turbine locations, cultivated crops compose 92.5% of the land use in the 67,894-acre (27,476-hectare) study area (Table 2). After cultivated crops, the next most common land uses within the FRWF are developed areas (e.g., houses, buildings, and open space), which compose 5.3% of the total, and pastures/hayfields, which compose 1.5% of the total area. Forested areas, grasslands (herbaceous), and wetlands are rare within the study area (National Land Cover Database 2016).

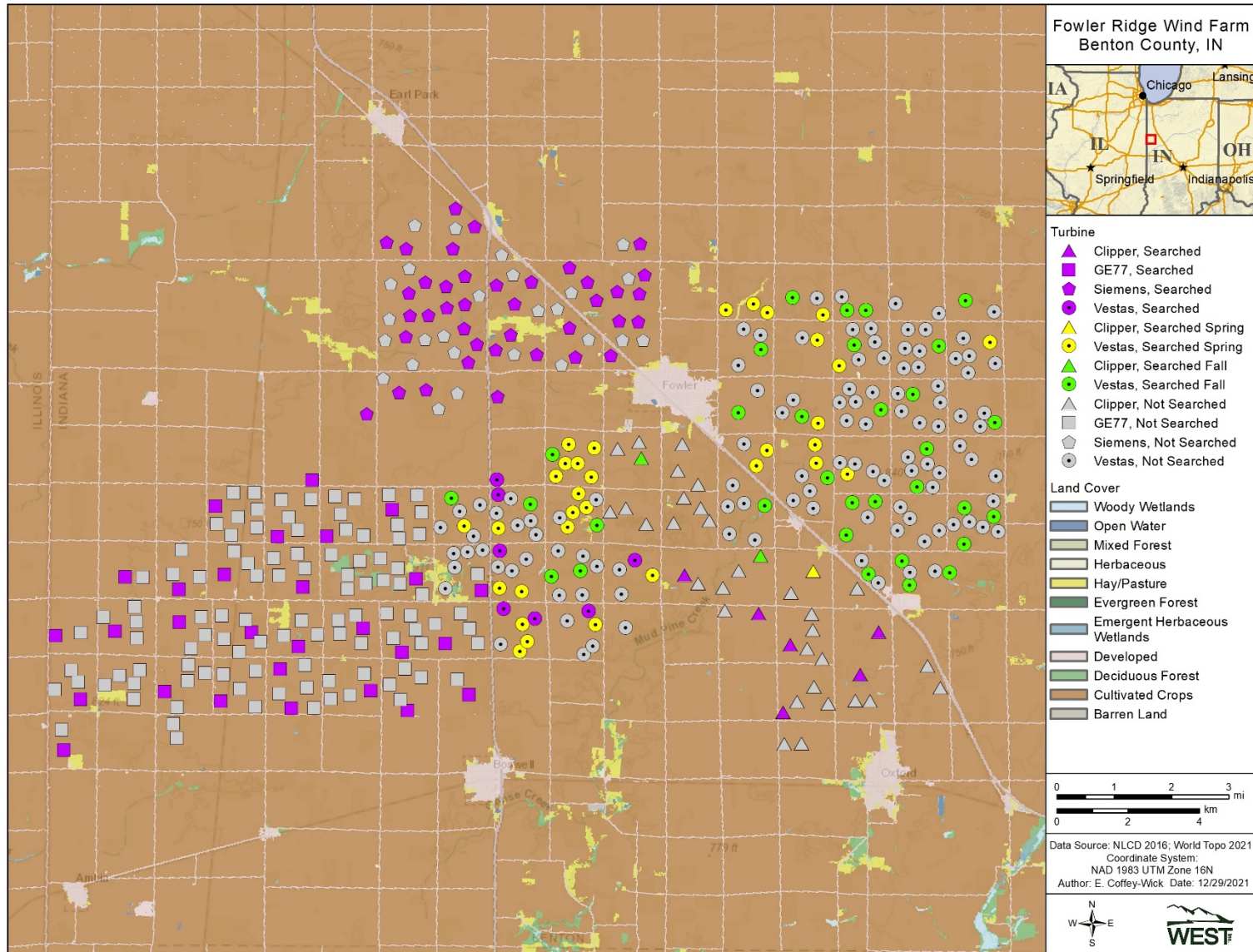


Figure 1. Land cover types and locations of Phase I–IV turbines searched from May 4 – May 15 and August 1 – October 15, 2021, at the Fowler Ridge Wind Farm, Benton County, Indiana.

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

<b>Land Cover Types</b>	<b>Coverage (acres)</b>	<b>Percent Composition</b>
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
<b>Total</b>	<b>67,894.0</b>	<b>100</b>

Source: National Land Cover Database 2016

## METHODS

### Standardized Carcass Searches

All phases of the FRWF are in the implementation phase of HCP monitoring for both spring and fall monitoring periods. Seventy-five turbines at Phases I, II, and III, and 39 turbines at Phase IV were searched from April 1 – May 15 and August 1 – October 15, 2021 (Figure 1). The same randomly chosen subset of 114 turbines that have been searched in prior years were intended to be searched in 2021 as well. However, prior to the start of the spring 2021 fatality monitoring season, BP informed WEST that inspections were being conducted at a portion of the Vestas turbines, which required a change in some turbines searched during the spring season from those searched in previous years. All Vestas turbines regularly searched in previous years were accessible during the fall search period. Clipper turbine 631 was non-operational during the fall monitoring period so turbine 623 was selected as a substitute.

Carcass searches were conducted along access roads and on turbine pads within 80 m (262 ft) of the selected turbines once per week. The monitoring period was shortened during the spring of 2020 due to COVID-19 travel restrictions, preventing a full measurement of spring persistence rates. Therefore, the spring search interval in 2021 was based on persistence measured during the fall of 2020. The mean carcass persistence time of 11.7 days was recorded during fall monitoring at the FRWF in 2020 (Good et al. 2021). The HCP recommends monitoring be conducted weekly if the prior year persistence rates are greater than seven days.

Technicians trained in proper search techniques conducted the carcass searches. Searches occurred along transects on the roads and pads of a sampled turbine within 80 m of the tower. Searchers walked at a rate of approximately 45–60 m (148–197 ft) per minute along each transect, looking for bat and bird carcasses. Transects were spaced at approximately 3-m (10-ft) intervals, and searchers scanned the area on both sides out to 1.5 m (5.0 ft) for carcasses as

they walked. All bat carcasses were recorded and collected. Bird carcasses were recorded, but left in the field. Searches began after 0700 hours each morning and were completed before sunset.

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

- Intact – a carcass that is complete, shows little to no decomposition, and no sign of being fed upon by a predator or scavenger
- Scavenged – an entire carcass that shows signs of scavenging or is heavily infested by insects, or portion(s) of a carcass in one location (e.g., wings, skeletal remains)
- Dismembered – an entire carcass, but found in more than one piece, where the pieces are separated by more than 5.0 m (16.4 ft)
- Injured – a live bird or bat that is harmed, damaged, or impaired in some way
- Feather Spot (for bird carcasses only) – 10 or more feathers (or two or more primary feathers) at one location indicating predation or scavenging

Data recorded for each carcass included date and time collected, turbine number, species, sex and age when identifiable, carcass location as latitude and longitude, distance and azimuth from turbine, condition (live, intact, scavenged, dismembered, feather spot), and any comments regarding possible cause of death or scavenging. Digital photographs were taken of the carcass, any visible injuries, and surrounding habitat. Time since death for all carcasses was also estimated and recorded (e.g., last night, two to three days). Criteria used to determine time since death are listed in Appendix A.

Bat carcasses were collected under the Special Purpose Salvage Permit 18-044 from the Indiana Department of Natural Resources (IDNR) and the WEST and USFWS Native Endangered and Threatened Species Recovery permit TE234121-9. Any carcass with the potential to be a state- or federally listed endangered or threatened species was reported to the appropriate agency within 48 hours. A permitted bat biologist verified the species identification of all bat carcasses, which were delivered to the USFWS Bloomington Field Office at the end of the study, along with any tissue and fur samples taken from carcasses that were not submitted in their entirety. A copy of the identification tag for each bat carcass was kept with the carcass and tissue samples at all times.

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

## **Turbine Operation Schedule**

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

## **Bias Trials**

### *Searcher Efficiency Trials*

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

Multiple searcher efficiency trials were conducted in each season. Across both seasons, 75 bats were placed from zero to seven days prior to searches in the spring, and 82 bats were placed from zero to seven days prior to searches in the fall to estimate the overall probability that a bat carcass was available and detected (empirical  $\pi$ ). Searchers had multiple chances to find a trial carcass on subsequent search days for any trial carcasses placed at least one day before searches. The first day a searcher discovered a carcass was recorded to estimate the overall probability that a carcass was available and detected. Bat carcasses were placed throughout each study season by a technician not involved in the carcass search effort, and were randomly placed within a turbine’s searchable area using distances derived from a random number generator. Searchers had no knowledge of the number, placement, or timing of carcasses placed at turbines. Data recorded for each trial carcass included date of placement, species, turbine number, the distance and azimuth from the turbine, and date the carcass was found. Carcasses were identified as bias trial carcasses through the placement of a small, indistinct black zip tie on the bat’s forearm and were collected when found.

### *Carcass Persistence Trials*

The objective of carcass persistence trials was to estimate the average length of time (in days) a carcass persisted in the field (i.e., before a carcass was no longer available for detection). Carcasses could be removed by scavenging or rendered undetectable by typical farming or wind farm maintenance activities. Carcass persistence trials were conducted when carcass searches occurred.

Persistence trials were conducted during both spring and fall to incorporate the effects of varying weather and scavenger densities. Forty bat carcasses were monitored to estimate persistence rates. Carcasses were checked on days 1, 2, 4, 6, 8, 10, 12, 18, and 24 after placement to calculate average carcass persistence rates. Day 1 was defined as the day after a carcass was placed. The schedule varied slightly depending on weather and coordination with other survey work. Trial carcasses were left at the placement location until they were removed by scavenging or other means, completely decomposed, or the end of the carcass persistence trial, whichever occurred first. Any evidence of carcasses that remained at the end of the 24-day period was removed.

Trail cameras were used in conjunction with standard carcass persistence monitoring to determine more precise removal times on a sample of carcasses placed for persistence trials, and to identify scavengers (Rosa et al. 2019). Three infrared trail cameras, model *LTL Acorn 5210A*, were positioned at a total of six different turbines in the spring, and five different turbines in the fall, to collect photos of scavenging events. The trail cameras were programmed to take a burst of three pictures at every trigger event, separated by five minutes to reduce the risk of filling the memory card or depleting the batteries.

### **Quality Assurance and Quality Control**

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

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

### **Statistical Analysis**

#### *Bat Fatality Rate Estimation*

Fatality estimates for bats were calculated based on:

- Observed number of bat carcasses found in search areas estimated to have been killed during the monitoring period
- Persistence rates combined with searcher efficiency, expressed as the estimated average probability a bat carcass is expected to be available for detection and was detected by the searchers during combined bias trials

- The search area adjustment factor for bat carcasses landing outside of searched roads and pads

Carcasses found in a search area were included in the fatality analysis if the bat was estimated to have perished during either monitoring period (i.e., on or after the evening of April 1 for spring surveys and July 31 for fall surveys), regardless of whether they were found during a scheduled search or incidentally at some other time. We assumed that all carcasses found incidentally in search areas would have been found at the next search if they had not been found incidentally. Carcasses found outside of search areas were not included in fatality estimates.

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

An adjustment factor ( $r$ ) of 6.56 was used to adjust for carcasses estimated to occur outside of searched roads and pads for Fowler Ridge I–III Wind Farms (Fowler I–III), to determine total estimated bat fatality during the fall migration period. This area adjustment factor was an average of the road and pad adjustment factors from 2011 and 2012 at Phases I, II, and III of the FRWF (Good et al. 2011, 2012).

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

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

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

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

### *Carcass Persistence Rates*

#### Definition of Variables

The following variables were used to calculate carcass persistence rates:

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

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

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

### Between Years Comparisons

Percent change in fatality rates between 2021 (spring and fall combined) and the baseline years (2010 and 2011) was calculated as the percent difference between estimates, and compared to the anticipated 50% reduction in fatality rates due to applied minimization measures.

## **RESULTS**

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

### **Bat and Bird Carcass Surveys**

There were 1,992 surveys conducted on roads and pads at 114 turbines from April 1 – May 15, and from August 1 – October 15, 2021. Due to turbine maintenance, accessibility, or severe weather, 60 surveys (2.9%) were missed. Overall, 68 bat carcasses and 28 bird carcasses were found during the survey (Table 3, Appendix B).

#### *Species Composition*

No Indiana bats or other *Myotis* species were found during the study. The most commonly found bat species were eastern red bat (*Lasiurus borealis*; 33 carcasses; 48.5%), silver-haired bat (*Lasionycteris noctivagans*; 22 carcasses; 32.4%), and hoary bat (*Lasiurus cinereus*; 11 carcasses; 16.2%). One big brown bat carcass (1.5%) and one unidentified bat (1.5%) were also found (Table 3). The unidentified bat was reported from the top of the nacelle, was not retrieved, and was not identifiable from a photo.

Twenty-eight bird carcasses found during the survey period represent 17 known bird species or bird groups (Table 4). No eagles or any bird species listed as threatened or endangered by IDNR (2020), or the federal Endangered Species Act of 1973 were found (USFWS 2019).



**Table 3. Total number and percent composition of bat carcasses found at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021.**

<b>Species</b>	<b>Number Included in Fatality Estimate</b>	<b>Percent Composition Included in Fatality Estimate*</b>	<b>Number Found Outside Plot</b>	<b>Percent Composition Found Outside Plot*</b>	<b>Number with Estimated Time of Death Outside Study Period</b>	<b>Percent Composition with Estimated Time of Death Outside Study Period*</b>	<b>Number of All Carcasses Found</b>	<b>Percent Composition of All Carcasses Found*</b>
Eastern red bat	31	50.0	2	33.3	0	0	33	48.5
silver-haired bat	21	33.9	1	16.7	0	0	22	32.4
hoary bat	8	12.9	3	50.0	0	0	11	16.2
big brown bat	1	1.6	0	0	0	0	1	1.5
unidentified bat**	1	1.6	0	0	0	0	1	1.5
<b>Totals</b>	<b>62</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>68</b>	<b>100</b>

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

\*\* Reported from top of nacelle; unidentifiable from photo

**Table 4. Total number and percent composition of bird carcasses found at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021.**

<b>Species</b>	<b>Number</b>	<b>Percent Composition*</b>
mourning dove	4	14.3
Killdeer	3	10.7
unidentified small bird	3	10.7
European starling	2	7.1
horned lark	2	7.1
red-tailed hawk	2	7.1
unidentified blackbird	2	7.1
American crow	1	3.6
black-throated green warbler	1	3.6
brown-headed cowbird	1	3.6
common grackle	1	3.6
Cooper's hawk	1	3.6
Dickcissel	1	3.6
red-breasted nuthatch	1	3.6
ring-necked pheasant	1	3.6
tree swallow	1	3.6
unidentified passerine	1	3.6
<b>Totals</b>	<b>28</b>	<b>100</b>

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

#### *Timing of Bat Carcasses*

Eastern red bat fatalities in search areas were found in the middle of April during the spring season, and throughout the fall season with a peak occurring during the last week of August (Figure 2). Silver-haired bats were found in search areas in early April, and also in the fall, after the last week of August (Figure 3). Hoary bat fatalities were absent in the spring, and declined through the fall after occurring at peak numbers starting in mid-August (Figure 4).

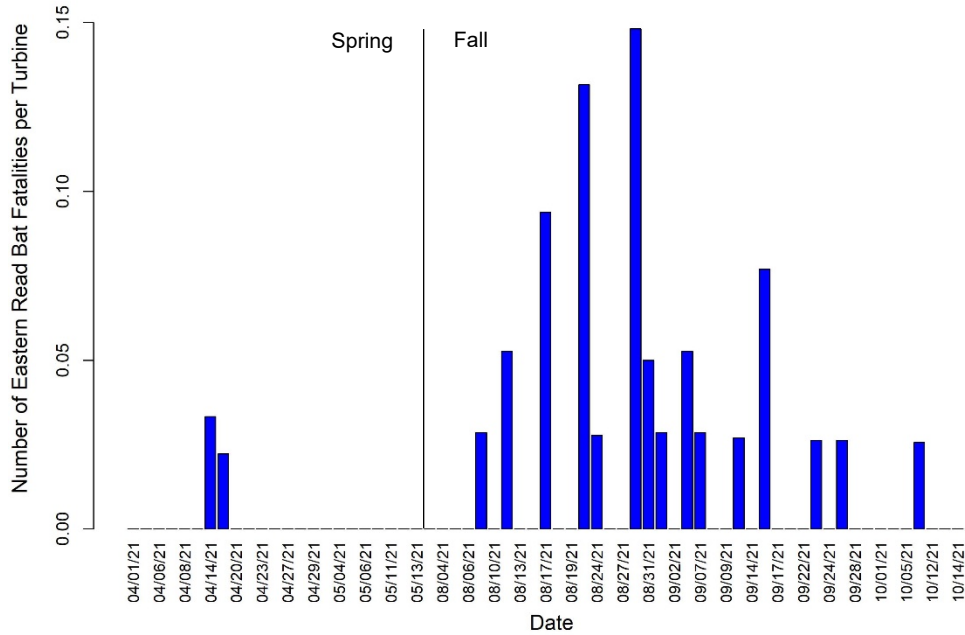


Figure 2. Timing of eastern red bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021, that were included in fatality estimates.

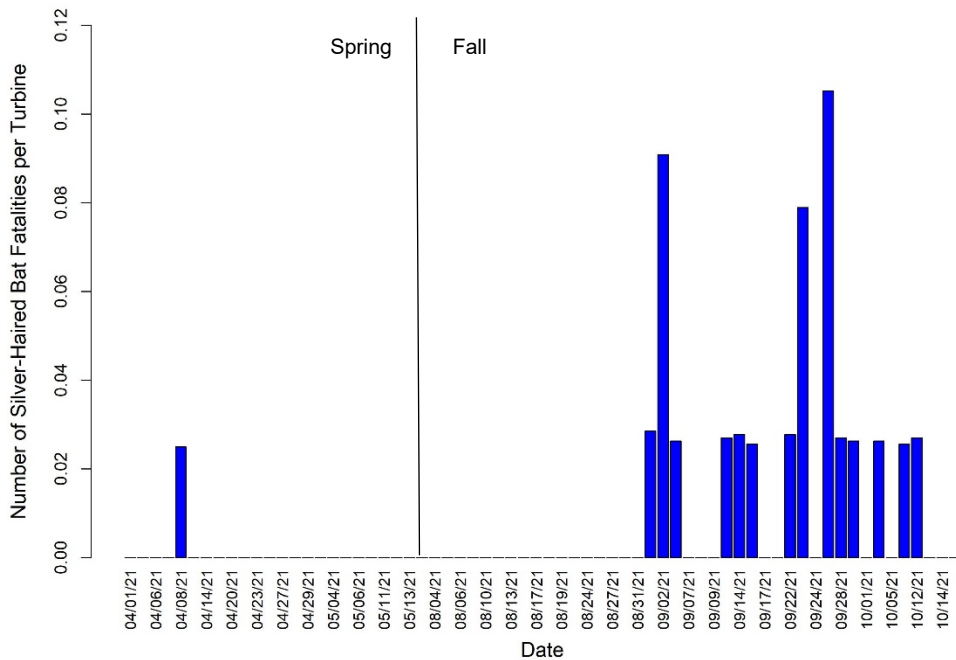
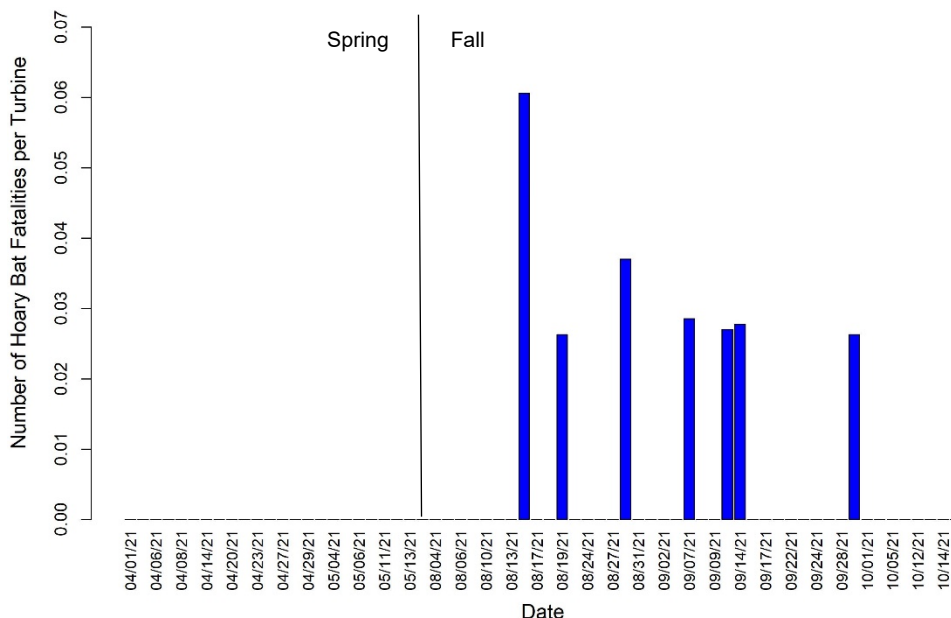


Figure 3. Timing of silver-haired bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021, that were included in fatality estimates.



**Figure 4. Timing of hoary bat carcasses found on search plots during scheduled searches at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021, that were included in fatality estimates.**

**Bias Trials**

*Searcher Efficiency Trials*

During the spring season, 41 of the 75 carcasses placed for bias trials were found at the first scheduled search, with two additional bat carcasses found after multiple searches, resulting in an overall probability of a carcass being available and detected of 49.3% (Table 5). The percent found for the season was calculated as an average across the number of days prior to search values. During the fall season, 39 of 82 bias trial carcasses placed were found at the first scheduled search, with three additional bats found after multiple searches, resulting in an overall probability of a carcass being available and detected of 46.8% (Table 5).

**Table 5. Searcher efficiency based on empirical pi methodology for post-construction fatality monitoring at the Fowler Ridge Wind Farm from April 1 – May 15 and August 1 – October 15, 2021.**

Number of Days Prior to Search	Number Placed	Number Found on First Search	Total Found	Percent Found
<b>Spring</b>				
0	20	19	19	95.0
1	8	7	7	87.5
2	8	4	4	50.0
3	10	2	3	30.0
4	6	2	2	33.3
5	6	0	1	16.7
6	9	4	4	44.4
7	8	3	3	37.5
<b>Total</b>	<b>75</b>	<b>41</b>	<b>43</b>	<b>49.3</b>
<b>Fall</b>				
0	23	17	18	78.3
1	9	6	6	66.7
2	9	5	5	55.6
3	5	2	2	40.0
4	6	3	3	50.0
5	14	3	3	21.4
6	8	1	2	25.0
7	8	2	3	37.5
<b>Total</b>	<b>82</b>	<b>39</b>	<b>42</b>	<b>46.8</b>

*Carcass Persistence Trials*

Forty bats were used to measure carcass persistence rates, split between the spring and fall seasons. The average length of persistence for bat carcasses in 2021 was 12.8 days in the spring and 10.6 days in the fall. Carcass persistence in the spring of 2021 was longer than the spring of 2020 (4.2 days) and more similar to the spring seasons in 2018 and 2019. The spring season in 2020 was approximately two weeks long, and occurred later in the spring (May 1 – 15). Fall persistence rates in 2021 were within the range of rates recorded previously at FRWF. A summary of carcass persistence at FRWF over the past 11 years shows year-to-year variation (Table 6).

Three trail cameras were placed at the same time as several bias trial carcasses in an attempt to record the timing of carcass removal events. Eleven carcasses were placed in view of cameras and five scavenger removal events were recorded. Striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), American crow (*Corvus brachyrhynchos*), and one unidentified mammal, possibly coyote (*Canis latrans*) were the species recorded on trail camera photos removing trial carcasses at Siemens turbines AZ-12, AZ-40 and AZ-52, as well as GE turbines 7 and 121 (Appendix C). One scavenging event was not recorded due to a camera malfunction. Two scavenging events were not detected by the camera due to the angle of the camera toward the carcass. Three trial carcasses that had cameras in place were never removed, by any means, before the end of the trial period.

**Table 6. Carcass persistence rates reported at the Fowler Ridge Wind Farm from April 1 – May 15 (Spring) and August 1 – October 15 (Fall) from 2010 – 2021.**

Year	Spring (days)	Fall (days)
2010	–	10.3
2011	–	15.1
2012	–	–
2013	–	5.8
2014	–	19.4
2015	–	13.9
2016	–	20.8
2017	–	10.7
2018	13.4	6.8
2019	8.5	4.1
2020	4.2	11.5
2021	12.8	10.6

### Estimated Fatality Rates

All four bat carcasses found during the spring survey period were included in the analyses. For the fall surveys, 58 bat carcasses were included in the analyses and six bat carcasses were excluded because they were incidental finds at non-searched turbines (n = 3), or found outside the search area at a normally searched turbine (n = 3; Appendix B).

An observed fatality rate of 0.04 bat per turbine was calculated for the spring (Table 7) and 0.52 bat per turbine in the fall (Table 8). The observed fatality rate was then divided by the empirical probability of availability and detection (0.49 for spring and 0.47 for fall). This value was multiplied by the road and pad area adjustment factor (6.56 for Fowler I–III, 26.38 for Fowler IV) to obtain the per turbine adjusted fatality estimate for each type of turbine.

**Table 7. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from April 1 – May 15, 2021.**

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I–III	6.56	–	–	–
	Fowler IV	26.38	–	–	–
Observed fatalities per turbine*		0.04	–	–	–
Empirical pi		0.49	0.05	0.40	0.58
<b>Estimated number of fatalities per turbine*</b>		<b>0.73</b>	–	–	–

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

**Table 8. Number of bat fatalities per turbine per study period for the Fowler Ridge Wind Farm from August 1 – October 15, 2021.**

Estimator		Point Estimate	Standard Deviation	90% Confidence Interval	
				Lower Limit	Upper Limit
Area Adjustment	Fowler I–III	6.56	–	–	–
	Fowler IV	26.38	–	–	–
Observed fatalities per turbine		0.52	0.09	0.38	0.68
Empirical pi		0.47	0.06	0.37	0.57
<b>Adjusted number of fatalities per turbine</b>		<b>10.65</b>	<b>2.33</b>	<b>7.31</b>	<b>14.47</b>

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 0.73 bat fatalities/turbine/study period, or 0.34 bat fatality/MW/study period (Table 9). The adjusted fatality estimate for the fall was 10.65 bat fatalities/turbine/study period or 5.37 bat fatalities/MW/study period (Table 10).

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

**Table 9. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from April 1 – May 15, 2021. <sup>1</sup>**

<b>Turbine Type</b>	<b>Mean</b>	<b>90% Confidence Interval<sup>2</sup></b>
<b>Number of fatalities/turbine/year</b>		
Siemens (2.3 MW)	2.74	–
Vestas (1.65 MW)	0.34	–
GE (1.50 MW)	0	–
Clipper (2.50 MW)	1.66	–
<b>All Turbines</b>	<b>0.73</b>	<b>–</b>
<b>Number of fatalities/megawatt/year<sup>3</sup></b>		
Siemens (2.3 MW)	1.19	–
Vestas (1.65 MW)	0.21	–
GE (1.50 MW)	0	–
Clipper (2.50 MW)	0.67	–
<b>All Turbines</b>	<b>0.34</b>	<b>–</b>

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

<sup>2</sup> Confidence intervals not calculated due to the small number of carcasses found.

<sup>3</sup> Estimates are calculated by turbine type due to differences in MW ratings by turbine type

**Table 10. Adjusted bat fatality estimates (empirical pi) for different turbine types within the Fowler Ridge Wind Farm from August 1 – October 15, 2021. <sup>1</sup>**

<b>Turbine Type</b>	<b>Mean</b>	<b>90% Confidence Interval</b>
<b>Number of fatalities/turbine/year</b>		
Siemens (2.30 MW)	26.02	16.03–39.45
Clipper (2.50 MW)	22.78	6.52–43.80
Vestas (1.65 MW)	6.47	3.51–10.13
GE (1.50 MW)	4.51	1.21–8.57
<b>All Turbines</b>	<b>10.43</b>	<b>7.31–14.47</b>
<b>Number of fatalities/megawatt/year<sup>2</sup></b>		
Siemens (2.30 MW)	11.31	6.97–17.15
Clipper (2.50 MW)	9.11	2.61–17.52
Vestas (1.65 MW)	3.92	2.13–6.14
GE (1.50 MW)	3.00	0.81–5.71
<b>All Turbines</b>	<b>5.27</b>	<b>3.70–7.34</b>

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

<sup>2</sup> Estimates are calculated by turbine type due to differences in MW ratings by turbine type

### *End-of-year Adaptive Management Threshold*

The end-of-year adaptive management threshold, as described within the HCP, is 19.64 bat fatalities/turbine/year, which is based on the upper 90% confidence interval (CI) of the average of 2010 and 2011 spring and fall bat mortality estimates, reduced by 50% (39.28 bat fatalities/turbine/year ÷ 2). The 2021 fatality estimate with turbines feathered until wind speeds reached 3.5 m/s in the spring and 5.0 m/s in the fall was 11.16 bat fatalities/turbine/study period (90% CI 8.12, 15.68), which was 43% lower than the end-of-year adaptive management threshold, and 71% lower than the mean spring and fall fatality estimate from 2010 and 2011 with

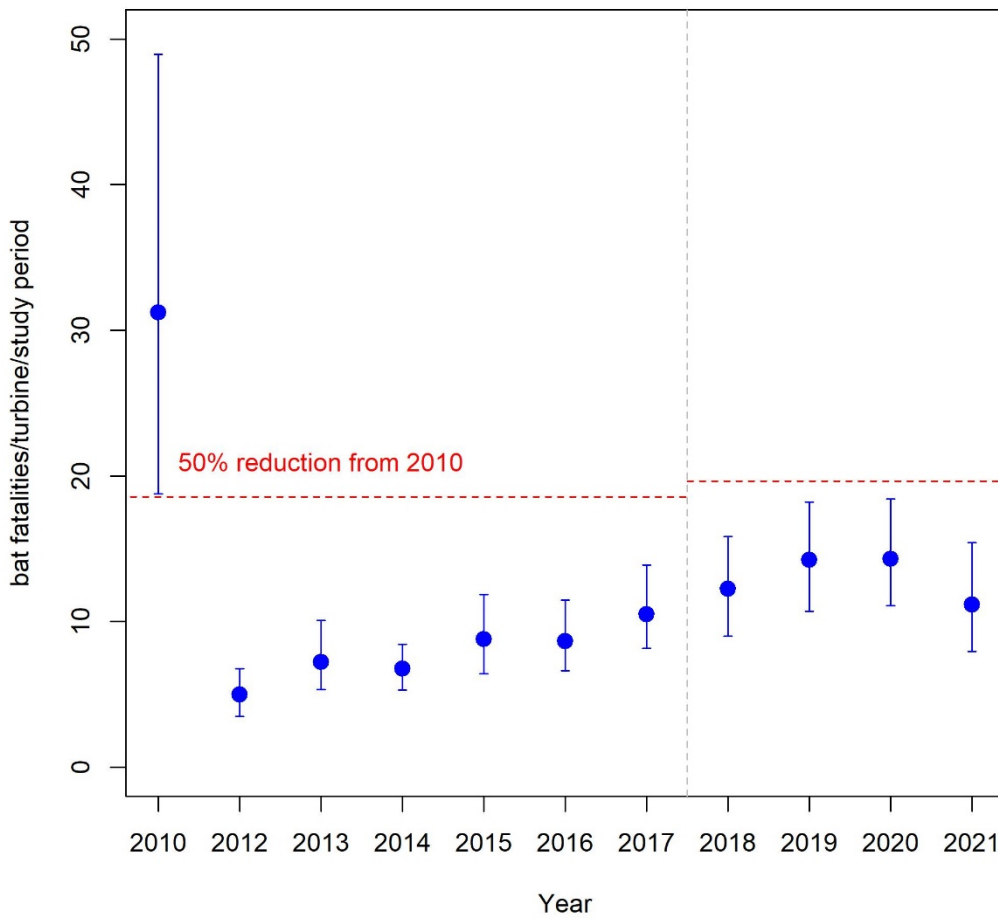


turbines that operated at manufacturer cut-in speed. The end-of-year threshold for triggering adaptive management was not met in 2021 (Figure 5).

#### *Within-season Adaptive Management*

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

The HCP prescribes a sampling approach utilizing roads and pads to calculate fatality estimates. Per the HCP, to determine the number of bat carcasses of all species found that would equate to the adaptive management threshold for within-season Indiana bat fatality, bias correction factors from the previous year's monitoring results were applied (Tables 11a and 11b). The within-season adaptive management threshold for 2021 was 132 bat carcasses, spring and fall combined. There were 63 bat carcasses found on search plots that were estimated to have been killed during the study's two monitoring periods. Figure 6 illustrates the within-season tracking tool that was used to determine if a fatality was approaching within-season adaptive management thresholds. The weekly 2021 estimated bat fatality rate shown in Figure 6 was a prediction calculated using the 2020 bias trial data. The final 2021 bat fatality estimate was based on 2021 bias trial results. Adaptive management thresholds were not exceeded at any time during the study, and no changes to minimization efforts were required during 2021.



**Figure 5. A comparison of estimated bat fatality rates and 90% confidence intervals (CIs) for the Fowler Ridge Wind Farm.**

Note: The 2010 and 2011 combined spring and fall estimate represents turbines operating at manufacturer cut-in speeds. The 2012 – 2017 estimates represent data collected at turbines feathered below 5.0 meters/second (m/s) in the fall only. The 2018 – 2021 estimates represent turbines feathered below 5.0 m/s in the fall and 3.5 m/s in the spring. The red dotted line from 2010 – 2017 represents the end-of-year adaptive management thresholds, which is a 50% reduction of the upper 90% CI of bat fatality rates compared to the 2010 and 2011 combined fatality estimates.

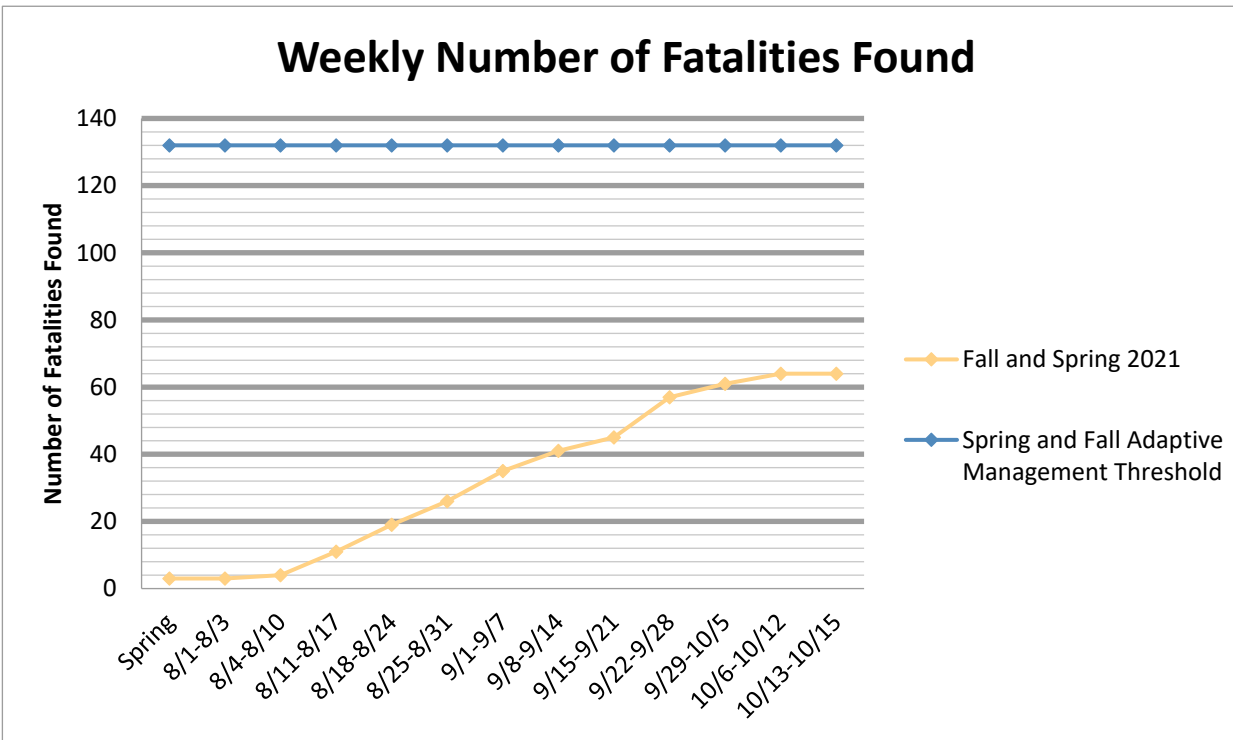


Figure 6. Weekly per-turbine fatality rates (number of bat carcasses found per turbine) at the Fowler Ridge Wind Farm in 2021. This graph was used to determine if weekly fatality rates were approaching the 50% adaptive management threshold. Fatality rates for 2021 shown above were based on 2020 bias trial results.

**Table 11a. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in spring 2021 (Phases I, II, III, and IV).**

<b>Parameter</b>	<b>Fowler I–III</b>	<b>Fowler IV</b>	<b>Descriptions of Data Sources</b>
Adaptive management threshold for Indiana bats	0.60		Upper quartile (i.e., 75 <sup>th</sup> percentile) of estimated spring bat mortality in 2010 and 2011 at control turbines with minimization measures in place.
Percent of all Indiana bat fatalities	0.16		Percentage based on total number of Indiana bats found during searches over total bats found, as described within the Habitat Conservation Plan.
Estimated upper quartile of total fatalities during the period for which adaptive management thresholds are based	378		Calculated—0.60/0.0016
Number of turbines	355	65	Fowler Phases I, II, III, and IV.
Estimated upper quartile of all bat fatality rates per turbine during the period for which adaptive management thresholds are based	0.90		Estimated by dividing the bat mortality count (378) by the number of operational turbines (420).
Empirical pi estimate	0.81		Estimated probability of carcasses being available and detected based on Fowler 2020 empirical bias trials from weekly road and pad searches; will be adjusted annually for subsequent years.
Road and pad correction factor	6.56	26.38	Phases I, II, and III estimated based on number of bats found on road and pads of cleared plots in relation to the total number of bats found at cleared plots in 2010 and 2011. Phase IV based on road and pad area searched measured at Phase IV and modeled carcass density distribution based on carcass distance data collected at Fowler from 2012 – 2016 on roads and pads.
Predicted upper quartile of number of bats found per searched turbine during the period for which adaptive management thresholds are based	0.11	0.03	Predicted based on estimated fatality rate per turbine (0.90), multiplied by empirical pi (0.81), and divided by road and pad correction factor (6.56 or 26.38).
Total bats found in one spring season based on turbines searched	8.33	1.08	Predicted based on estimated number of bats found per turbine (0.11 or 0.03) multiplied by the number of turbines searched (75 or 39). Calculated value represents adaptive management threshold for 2021.
<b>Total Bats Found Threshold</b>	<b>9.41</b>		<b>Sum of expected bat mortality from Phases I, II, III, and IV during the Spring</b>

**Table 11b. Variables used to calculate the within-season adaptive management threshold for 420 operational turbines in fall 2021 (Phases I, II, III, and IV).**

<b>Parameter</b>	<b>Fowler I–III</b>		<b>Fowler IV</b>	<b>Descriptions of Data Sources</b>
Adaptive management threshold for Indiana bats	11.22			Upper quartile (i.e., 75 <sup>th</sup> percentile) of estimated fall bat mortality in 2010 and 2011 at control turbines with minimization measures in place.
Percent of all Indiana bat fatalities	0.16			Percentage based on total number of Indiana bats found during searches over total bats found, as described within the Habitat Conservation Plan.
Estimated upper quartile of total fatalities during the period for which adaptive management thresholds are based	7,016			Calculated—11.22/0.0016
Number of turbines	355	65		Fowler Phases I, II, III, and IV.
Estimated upper quartile of all bat fatality rates per turbine during the period for which adaptive management thresholds are based	16.70			Estimated by dividing the bat mortality count (7,016) by the number of operational turbines (420).
Empirical pi estimate	0.57			Estimated probability of carcasses being available and detected based on Fowler 2018 empirical bias trials from road and pad searches every 7 days; will be adjusted annually for subsequent years
Road and pad correction factor	6.56	26.38		Phases I, II, and III based on number of bats found on road and pads of cleared plots in relation to the total number of bats found at cleared plots in 2010 and 2011. Phase IV based on road and pad area searched measured at Phase IV and modeled carcass density distribution based on carcass distance data collected at Fowler from 2012 – 2016 on roads and pads. The road and pad correction factor used to estimate within-season thresholds is different than the factor used to calculate end-of-season fatality estimates. The end-of-season correction factor includes carcass distribution information collected during 2018; the within-season factor did not include 2018 data.
Predicted upper quartile of number of bats found per searched turbine during the period for which adaptive management thresholds are based	1.45	0.36		Predicted based on estimated fatality rate per turbine (16.7), multiplied by empirical pi (0.57), and divided by road and pad correction factor (6.56 or 26.38).
Total bats found in one fall season based on turbines searched	108.85	14.08		Predicted based on estimated number of bats found per turbine (1.45 or 0.36) multiplied by the number of turbines searched (75 or 39). Calculated value represents adaptive management threshold for 2021.
<b>Total Bats Found Threshold</b>	<b>122.93</b>			<b>Sum of expected bat mortality from Phases I, II, III, and IV.</b>

*End-of-season Indiana Bat Take Estimate*

The estimated number of Indiana bat fatalities that occurred during 2021 was calculated based on the overall estimated bat fatality rate during 2021, and the relative percent of Indiana bat carcasses compared to all bat carcasses found during the fall of 2009, 2010, and 2011 (0.16%). In the spring of 2021 0.49 Indiana bat fatalities were estimated to have occurred, and an estimated 7.01 Indiana bat fatalities in the fall for a combined total of 7.50 (90% CI: 5.34, 10.37; Table 12). The total estimated number of Indiana bat fatalities was lower than the number that was predicted to occur as fatalities within the HCP after minimization, and is within the 90% CI of Indiana bat fatalities predicted within the HCP. No CIs were provided in the HCP for the spring predicted number of Indiana bat fatalities. The end-of-year adaptive management threshold is equal to the upper bound of the 90% CI of Indiana bat mortality predicted within the HCP. Per the terms of the HCP, no changes to minimization efforts are required for 2022.

**Table 12. The estimated number of Indiana bat fatalities compared to the number of predicted Indiana bat fatalities at the Fowler Ridge Wind Farm.**

Year	Number of Operating Turbines	Estimated Number of Indiana Bat Fatalities	Predicted Number of Indiana Bat Fatalities to Occur within the HCP after Minimization		
			Mean	Lower 90% CI	Upper 90% CI
2014	355	4.1	8.6	7.0	10.6
2015	355	5.2	8.6	7.0	10.6
2016	420	5.8	10.9	8.8	13.4
2017	420	7.1	10.9	8.8	13.4
2018-Spring	420	0.7	0.7	–	–
2018-Fall	420	7.6	10.9	8.8	13.4
2019-Spring	420	0.8	0.7	–	–
2019-Fall	420	9.0	10.9	8.8	13.4
2020-Spring	420	0.8	0.7	–	–
2020-Fall	420	8.8	10.9	8.8	13.4
2021-Spring	420	0.49	0.7	–	–
2021-Fall	420	7.5	10.9	8.8	13.4

HCP=Habitat Conservation Plan; CI=confidence interval.

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

## Estimated Time of Death Information Sheet

### Last Night

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

### 2–3 Days

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

### 4–7 Days

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

### 7–14 Days

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

### Greater than 2 Weeks

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

**Appendix B. Bat and Bird Casualties Found at the Fowler Ridge Wind Farm, Benton  
County, Indiana, between April 1 – May 15 and August 1 – October 15, 2021**

**Appendix B. Bat and bird casualties found at Fowler Ridge Wind Farm between April 1 – May 15 and August 1- October 15, 2021.**

Date	Common Name	Location	Turbine Type	Outside of Search Plot?	Estimated to have Died Outside of Study Period?	Included in Fatality Estimate?
4/14/2021	eastern red bat	631	Clipper	No	No	Yes
4/15/2021	European starling	S30	Siemens	Yes	No	No
4/15/2021	common grackle	S63	Siemens	Yes	No	No
4/15/2021	eastern red bat	S57	Siemens	No	No	Yes
4/27/2021	brown-headed cowbird	323	Vestas	No	No	No
4/8/2021	silver-haired bat	S38	Siemens	No	No	Yes
5/3/2021	red-tailed hawk	S25	Siemens	Yes	No	No
5/4/2021	unidentified blackbird	323	Vestas	No	No	No
5/4/2021	unidentified blackbird	239	Vestas	No	No	No
4/9/2021	unidentified bat	220	Vestas	No	No	Yes
5/11/2021	ring-necked pheasant	241	Vestas	No	No	No
5/11/2021	horned lark	256	Vestas	No	No	No
5/12/2021	mourning dove	68	GE	No	No	No
5/12/2021	horned lark	605	Clipper	No	No	No
8/5/2021	killdeer	14	GE	No	No	No
8/3/2021	mourning dove	375	Vestas	No	No	No
8/6/2021	red-tailed hawk	S9	Siemens	No	No	No
8/3/2021	Cooper's hawk	401	Vestas	No	No	No
8/9/2021	killdeer	432	Vestas	Yes	No	No
8/9/2021	eastern red bat	411	Vestas	No	No	Yes
8/11/2021	eastern red bat	S1	Siemens	No	No	Yes
8/11/2021	eastern red bat	S38	Siemens	No	No	Yes
8/16/2021	hoary bat	7	GE	No	No	Yes
8/16/2021	hoary bat	388	Vestas	No	No	Yes
8/17/2021	eastern red bat	61	GE	No	No	Yes
8/17/2021	eastern red bat	61	GE	No	No	Yes
8/17/2021	unidentified passerine	35	GE	Yes	No	No
8/17/2021	eastern red bat	61	GE	No	No	Yes
8/18/2021	eastern red bat	118	GE	Yes	No	No
8/19/2021	hoary bat	S57	Siemens	No	No	Yes
8/19/2021	hoary bat	S1	Siemens	No	No	Yes
8/23/2021	eastern red bat	623	Clipper	No	No	Yes
8/23/2021	eastern red bat	442	Vestas	No	No	Yes
8/23/2021	unidentified small bird	229	Vestas	No	No	No
8/23/2021	eastern red bat	369	Vestas	No	No	Yes
8/23/2021	eastern red bat	611	Clipper	No	No	Yes
8/23/2021	eastern red bat	285	Vestas	No	No	Yes
8/24/2021	American crow	28	GE	No	No	No
8/24/2021	mourning dove	82	GE	Yes	No	No
8/24/2021	eastern red bat	7	GE	No	No	Yes
8/25/2021	unidentified small bird	S42	Siemens	No	No	No
8/30/2021	hoary bat	641	Clipper	No	No	Yes
8/30/2021	eastern red bat	641	Clipper	No	No	Yes
8/30/2021	killdeer	411	Vestas	No	No	No
8/30/2021	eastern red bat	411	Vestas	No	No	Yes
8/30/2021	eastern red bat	639	Clipper	No	No	Yes
8/30/2021	eastern red bat	432	Vestas	No	No	Yes
8/31/2021	eastern red bat	448	Vestas	No	No	Yes
8/31/2021	black-throated green warbler	285	Vestas	No	No	No

8/31/2021	eastern red bat	260	Vestas	No	No	Yes
9/1/2021	eastern red bat	S40	Siemens	No	No	Yes
9/1/2021	silver-haired bat	S27	Siemens	No	No	Yes
9/2/2021	silver-haired bat	S33	Siemens	No	No	Yes
9/2/2021	dickcissel	423	Vestas	No	No	No
9/2/2021	eastern red bat	S51	Siemens	Yes	No	No
9/2/2021	silver-haired bat	S3	Siemens	Yes	No	No
9/6/2021	eastern red bat	339	Vestas	No	No	Yes
9/6/2021	silver-haired bat	624	Clipper	No	No	Yes
9/6/2021	eastern red bat	442	Vestas	No	No	Yes
9/6/2021	big brown bat	641	Clipper	No	No	Yes
9/7/2021	eastern red bat	203	Vestas	No	No	Yes
9/7/2021	hoary bat	68	GE	No	No	Yes
9/8/2021	silver-haired bat	S25	Siemens	No	No	Yes
9/13/2021	eastern red bat	411	Vestas	No	No	Yes
9/13/2021	silver-haired bat	622	Clipper	No	No	Yes
9/13/2021	hoary bat	398	Vestas	No	No	Yes
9/13/2021	red-breasted nuthatch	322	Vestas	No	No	No
9/14/2021	hoary bat	88	GE	No	No	Yes
9/14/2021	silver-haired bat	68	GE	No	No	Yes
9/14/2021	unidentified small bird	35	GE	No	No	No
9/15/2021	eastern red bat	S22	Siemens	No	No	Yes
9/15/2021	eastern red bat	S48	Siemens	No	No	Yes
9/15/2021	silver-haired bat	S25	Siemens	No	No	Yes
9/15/2021	eastern red bat	S45	Siemens	No	No	Yes
9/22/2021	silver-haired bat	605	Clipper	No	No	Yes
9/23/2021	silver-haired bat	S16	Siemens	No	No	Yes
9/23/2021	silver-haired bat	S46	Siemens	No	No	Yes
9/23/2021	silver-haired bat	S15	Siemens	No	No	Yes
9/23/2021	eastern red bat	S13	Siemens	No	No	Yes
9/23/2021	hoary bat	55	Vestas	Yes	No	No
9/27/2021	eastern red bat	622	Clipper	No	No	Yes
9/27/2021	silver-haired bat	641	Clipper	No	No	Yes
9/27/2021	silver-haired bat	260	Vestas	No	No	Yes
9/27/2021	silver-haired bat	390	Vestas	No	No	Yes
9/27/2021	silver-haired bat	622	Clipper	No	No	Yes
9/27/2021	mourning dove	369	Vestas	No	No	No
9/28/2021	European starling	87	GE	No	No	No
9/29/2021	hoary bat	S43	Siemens	No	No	Yes
9/29/2021	silver-haired bat	S10	Siemens	No	No	Yes
9/28/2021	silver-haired bat	193	Vestas	No	No	Yes
9/30/2021	hoary bat	S29	Siemens	Yes	No	No
10/4/2021	silver-haired bat	641	Clipper	No	No	Yes
10/6/2021	silver-haired bat	52	GE	No	No	Yes
10/6/2021	eastern red bat	S57	Siemens	No	No	Yes
10/6/2021	tree swallow	S12	Siemens	No	No	No
10/12/2021	silver-haired bat	322	Vestas	No	No	Yes

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**Appendix C. Representative Photos of Carcass Removal Events Recorded at Fowler Ridge Wind Farm, Benton County, Indiana, between August 1 – October 15, 2021**



Ltl Acorn      🕒 084°F 029°C    08/17/2021 19:37:33

**Appendix C1. American crow next to trial bat carcass at General Electric turbine 121.**



Ltl Acorn      🕒 082°F 028°C    08/17/2021 19:44:59

**Appendix C2. Three American crows at General Electric turbine 121, seven minutes after Appendix C1 photo; bat trial carcass is absent.**



Ltl Acorn ○ 118F 048C 08/25/2021 17:37:26

Appendix C3. American crow next to trial bat carcass at General Electric turbine 7.



Ltl Acorn ● 073F 023C 09/14/2021 00:59:24

Appendix C4. Virginia opossum consuming bat trial carcass at Siemens turbine AZ-52.





Ltl Acorn      ○      098F 037C      09/19/2021 15:27:14

**Appendix C5. Bat trial carcass at Siemens turbine AZ-40 prior to removal by skunk.**



Ltl Acorn      ●      066F 019C      09/27/2021 02:24:18

**Appendix C6. Skunk at Siemens turbine AZ-40 in the early morning prior to the bat trial carcass confirmed absent later that day.**