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

August 3 – October 14, 2015

Prepared for:

Fowler Ridge Wind Farm

Prepared by:

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REPORT REFERENCE

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EXECUTIVE SUMMARY

The Fowler Ridge Wind Farm (FRWF) collectively includes Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge Wind Farm IV LLC. Phases I, II and III consists of 355 wind turbines that have been operating in Benton County, Indiana since 2009. Phase IV was constructed during 2015 and began commercial operation in January of 2016. A post-construction casualty study of bats was conducted by Western EcoSystems Technology, Inc. (WEST) within Phases I and III in 2009. During that study period, an Indiana bat carcass was found. The FRWF worked with the U.S. Fish and Wildlife Service and developed a Habitat Conservation Plan for the Indiana bat designed to minimize Indiana bat casualties. FRWF received an Incidental Take Permit for Indiana bats in August of 2014 (TE95012A-0). FRWF contracted with WEST to complete evaluation phase monitoring of bat carcasses in 2014 and 2015 per the terms of the Habitat Conservation Plan, with the goal of determining if the level of Indiana bat mortality was within authorized limits.

The primary objective of the 2015 monitoring was to determine if the FRWF's approved minimization measures resulted in a 50% or greater reduction in mortality compared to turbines that operated normally in 2010. The 2015 casualty study occurred during the fall (August 1 – October 15) migration period for Indiana bats. Casualty searches were completed once per week on roads and gravel pads of 118 turbines from August 3 – October 14, 2015. Personnel trained in proper search techniques conducted the carcass searches. Searchers walked at a rate of approximately 45 to 60 meters (m) per minute (about 148 to 197 feet [ft] per minute) along each transect looking for bat carcasses. Transects were spaced at approximately 5 m (16 ft) intervals on road and pads, and searchers scanned the area on both sides out to approximately 2.5 m (about eight ft) for casualties as they walked each transect. Bias trials of searcher efficiency and carcass removal trials were conducted.

A total of 164 bat carcasses were found in 2015 during carcasses searches and incidentally. Similar to previous years of monitoring, the most commonly found bat species were eastern red bats, silver-haired bats, and hoary bats. Four big brown bats, one Seminole bat and one little brown bat were also found. No Indiana bat carcasses were found.

Bat fatality rates were calculated based on number of carcasses found, the results of bias trials, and adjustments for bats that did not fall on roads and pads. Bat fatality rates in 2015 were estimated to be 4.86 bat fatalities/MW/study period (90% confidence interval 3.66 – 6.65), which was 71.8% lower than casualty estimates at turbines operating normally in 2010. The results of monitoring during 2015 provide evidence that operational strategies exceeded the objective of reducing bat casualty rates by 50% compared to casualty estimates from turbines in normal operation modes in 2010. Within-season adjustments (for minimization strategies) were not required in 2015 because bat fatality rates were well below adaptive management thresholds.

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INTRODUCTION

The Fowler Ridge Wind Farm (FRWF) collectively includes Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge Wind Farm IV LLC. Phases I, II and III consists of 355 wind turbines that have been operating in Benton County, Indiana since 2009. Phase IV was constructed during 2015 and began commercial operation in January of 2016. A post-construction casualty study of bats was conducted by Western EcoSystems Technology, Inc. (WEST) within Phases I and III in 2009 (Johnson et al. 2010a, 2010b). During that study period, an Indiana bat 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. The results of research at the FRWF in 2010 and 2011 were used by the FRWF to design an operational monitoring strategy for reducing Indiana bat casualty 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 casualties by feathering blades when winds were at 5.0 m/s or lower. FRWF received an Incidental Take Permit for Indiana bats in August of 2014 (TE95012A-0) based on the HCP. FRWF contracted with WEST to complete evaluation phase monitoring of bat carcasses in 2014 and 2015 per the terms of the HCP and TE95012A-0. The primary objective of the 2015 monitoring was to determine if the FRWF's approved minimization measures resulted in a 50% or greater reduction in bat mortality compared to turbines that operated normally in 2010.

STUDY AREA

At the time of the study, the FRWF had a total energy capacity of 600 megawatts (MW). Phase I consists of 122 Vestas V82 1.65-MW turbines and 40 Clipper C96 2.5-MW turbines for a total of 301 MW of energy capacity. Phase II consists of 133 1.5-MW General Electric (GE) SLE turbines with a total capacity of 199.5 MW. Phase III consists of 60 Vestas V82 1.65-MW turbines (99 total MW of capacity). The three turbine types varied in size (Table 1).

Table 1. Turbine characteristics at the Fowler Ridge Wind Farm.

Turbine Model	MW	Turbine Height (meters)	Rotor Diameter (meters)	Standard cut-in speed (meters/second)
GE SLE	1.5	80	77	3.5
Vestas V82	1.65	80	82	3.5
Clipper C96	2.5	80	96	3.5

Phases I and III were constructed in 2008 and became operational during January of 2009. Phase II was constructed in 2009 and became operational by December 31, 2009. Phase IV was constructed in 2015 and began commercial operation in January of 2016. The 2015 monitoring study included phases I, II and III of the FRWF.

The FRWF is located in western Indiana in Benton County (Figure 1). The wind energy facility lies within the Tipton Tall Plain physiographic region that includes much of central Indiana and lies within the Grand Prairie Natural Region that includes a small section of north central Indiana (Whitaker and Mumford 2009). The topography of the FRWF is mostly flat to slightly rolling and there are no hills, ridges, or other areas of starkly elevated topography (Figure 2). Elevations in the project area range from approximately 700-800 feet (ft; 213-244 meters [m]). Soils in the FRWF are various combinations of silt loam, clay loam, loam, silty clay loam, sandy loams and sandy clays (USDA-NRCS 2006). Much of the area is classified as prime farmland based on soil type.

The FRWF is dominated by tilled agriculture with corn (*Zea mays*) and soybeans (*Glycine max*) being the dominant crops. Of the roughly 59,000 acres (about 92 square miles [mi^2]) within one half-mile (0.80 kilometers) of turbine locations, row crops comprise about 93% of the land use for the study area (Homer et al. 2004; Table 2). After tilled agriculture, the next most common land uses within the FRWF are developed areas (e.g., houses and buildings), which compose 5.3% of the total, and pastures/hayfields, which compose 1.7% of the total area. There are 23.9 acres (0.04 mi^2) of grasslands, which compose less than 0.1% of the FRWF. Grasslands in the study area are limited primarily to strips along drainages, railroad rights-of-way (ROWs), and ROWs along county and state roads. There are also a few grass-lined waterways within cultivated fields in the study area. Trees in the study area occur at homesteads, along some of the drainages and fencerows, and within some small, isolated woodlots. Forested areas are rare within the study area based on 2001 data (Homer et al. 2004), and the 291.11 acres (0.45 mi^2) of forest compose 0.5% of the total area. Small amounts of barren ground, open water, and woody wetlands are also present.

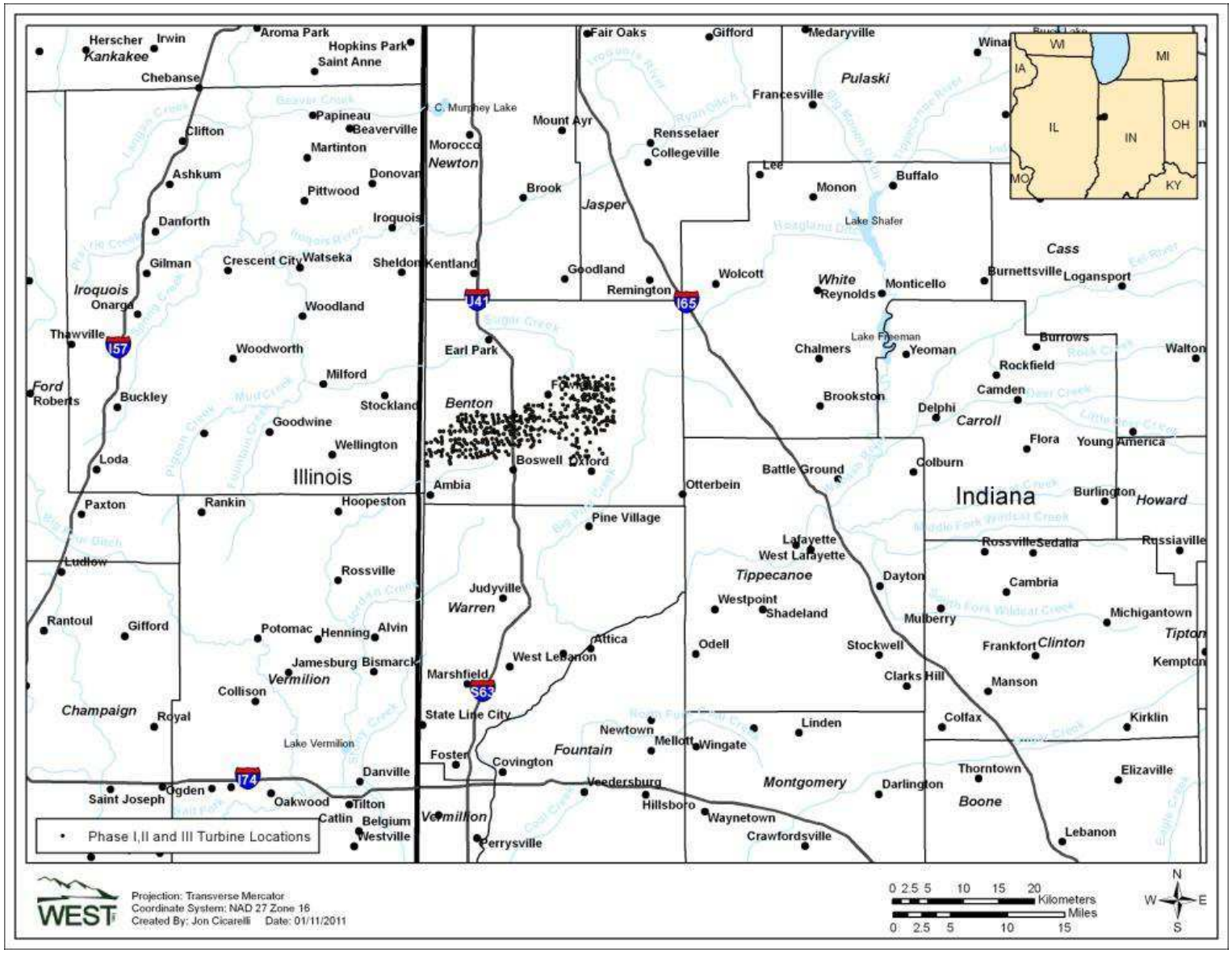

Figure 1. Location of the Fowler Ridge Wind Farm: Phases I, II and III.

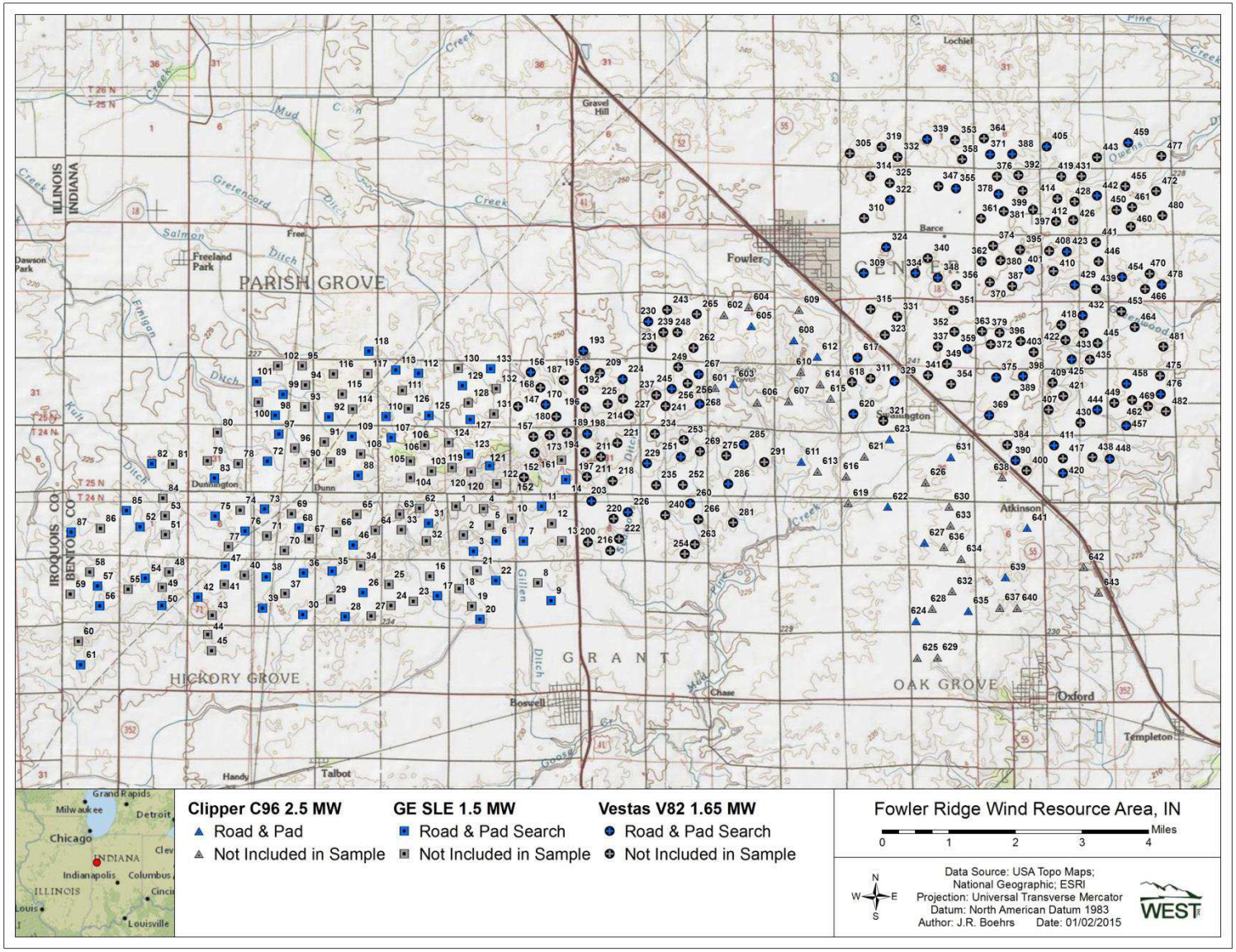

Figure 2. Elevation and topography of the Fowler Ridge Wind Farm.

Table 2. Land cover data within a half-mile of turbine locations within the Fowler Ridge Wind Farm (Homer et al. 2004).

Habitat Type	Acres	Percent Composition
Crops	54,611.24	92.5
Developed, Low Intensity	1,682.37	2.9
Developed, Open Space	1,347.93	2.3
Pasture/Hay	978.15	1.7
Deciduous Forest	291.90	0.5
Developed; Medium Intensity	53.65	0.1
Grassland	23.90	<0.1
Open Water	18.25	<0.1
Developed, High Intensity	16.40	<0.1
Barren	10.02	<0.1
Woody Wetlands	1.23	<0.1
Total	**59,035.05**	**100**

METHODS

Season

The 2015 casualty study occurred during fall from August 3 – October 14. This time period encompassed the fall migration period for Indiana bats, as outlined in the Draft Indiana Bat Recovery Plan (USFWS 2007), the period of highest bat mortality at the FRWF (Good et al. 2011, 2012), and the period in which previous Indiana bat carcasses occurred at the FRWF.

Search Plot and Sample Size

Phases I, II and III are comprised of 355 turbines. One-hundred-eighteen turbines (about 33%) were sampled during the study (Figure 2). The same turbines sampled in 2014 were searched in 2015. Carcass searches were conducted along access roads and turbine pads within 80 m (262 ft) of the turbine.

Search Frequency

Turbines were searched weekly. The search interval was based on the mean carcass removal time of 19.36 days recorded during monitoring at FRWF in 2014 (Good et al. 2015).

Turbine Operation Schedule

Turbine cut-in speeds were raised to 5.0 m/s at the FRWF from August 1 – October 15. Turbine operational parameters were set so that the rotation of the turbine rotors below cut-in wind speed was feathered. Increasing cut-in speed and feathering of turbine blades below cut-in wind speed were implemented on a nightly basis from sunset to sunrise, 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.

Turbine 603 was not operational for one month of the survey, due to maintenance activities. All other turbines operated as described above.

Field Methods

Casualty Searches

Observers trained in proper search techniques conducted the carcass searches. Searches occurred along transects on roads and pads within each search plot within 80 m of turbines. Searchers walked at a rate of approximately 45 to 60 m per minute (about 148 to 197 ft per minute) along each transect looking for bat carcasses. Transects were spaced at approximately 5 m (16 ft) intervals, and searchers scanned the area on both side sides out to approximately 2.5 m (about eight ft) for casualties as they walked each transect. All bat carcasses were recorded and collected. Bird carcasses were recorded, but left in the field. Searches began after 0700 hours each morning and they were completed before sunset.

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

- Live/Injured – a live or injured bat or bird.
- Intact - a carcass that was completely intact, was not badly decomposed, and showed no sign of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass, which showed signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that was heavily infested by insects.
- Feather Spot (for bird carcasses only) – 10 or more body feathers and/or at least two primary feathers, which indicated predation or scavenging.

Tissue and hair samples were collected from all dead bats and delivered to the USFWS Bloomington Field Office. All collected bat carcasses were delivered to the USFWS Bloomington Field Office. A copy of the data sheet for each carcass was maintained, bagged, and kept with the carcass at all times. For all casualties found, data recorded included: species, sex and age when possible, turbine identification number, date and time collected, global positioning system location, condition (live, intact, scavenged, feather spot), and distance from turbine, as well as any comments that may indicate cause of death. All bird and bat carcasses located were photographed as found. Estimated time since death for bats was also recorded. Criteria used to determine time since death can be found in Appendix A.

Casualties found outside the formal search area by observers or by FRWF personnel were treated following the above protocol as closely as possible. Casualties found in non-search areas (e.g., near a turbine not included in the sample of search area) were coded as incidental discoveries, collected, and documented in a similar fashion as those found during standard

searches. Incidental carcasses found in non-search areas were not included in the analysis. In addition to carcasses, all injured bats and birds observed in search plots were recorded and treated as a casualty for the purpose of the analyses.

Field Bias Trials

Searcher efficiency and removal of carcasses by scavengers was quantified to adjust the estimate of total bat fatalities for detection bias. Bias trials were conducted throughout the entire study period. Seventy one bats were placed prior to a scheduled search ranging from zero to six days prior to searches for bias trials (Table 3). Forty-nine bats were used for the calculation of empirical pi because the empirical pi method requires an equal sample number for days prior to search. Eleven freshly killed bats were placed for searcher efficiency trials and the rest of the carcasses were obtained from Indiana State University were also used to increase sample sizes during the early part of the survey. Trial bats were placed throughout the study session by a biologists not involved in the carcass search effort at a particular set of turbines, and were placed within any given turbine's searchable area. Searchers had no knowledge of the number, placement, or timing of carcasses at turbines. Data recorded for each trial carcass prior to placement included date of placement, species, turbine number, and the distance and bearing from the turbine. Carcasses were identified as bias trial carcasses through the placement of small, indistinct black zip ties on the bats' wings. Bat carcasses were placed at varying intervals before scheduled searches on plots (i.e., a carcass may have been placed at a plot not scheduled to be searched for four days). Carcasses were left in the field for up to 24 days, resulting in searchers having three chances of finding a carcass that lasted the full 24 days. The first day the carcass was discovered by the searcher was recorded to estimate the overall probability that a carcass was available and detected.

Sixty-one bat carcasses were left in the field and monitored to estimate removal rates. Carcasses were checked on days one, two, four, six, eight, 10, 12, 18, and 24 to calculate average carcass removal rates. Day one was defined as the next day after a carcass was placed.

Table 3. Searcher efficiency carcasses placed and used for the empirical pi method by time since death for post-construction casualty monitoring at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Number of Days Prior to Search	Number Placed	Used for Analysis
0	8	7
1	11	7
2	12	7
3	9	7
4	7	7
5	13	7
6	11	7
Total	71	49

Statistical Analysis

Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for reviewing data for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the original data entry, and appropriate changes in all steps were made. A Microsoft SQL Server database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference.

Bat Mortality Estimation

Estimates of facility-related bat mortality were calculated based on:

1) Observed number of bat carcasses found during standardized searches during the monitoring period;
2) Non-removal rates combined with searcher efficiency, expressed as the estimated average probability a bat carcass is expected to remain in search areas and be available for detection and was detected by the observers during combined bias trials; and
3) The area adjustment factor for bat carcasses landing outside of searched roads and pads.

Carcasses found on a search plot were included in the casualty analysis if the bat was estimated to have perished on or after the evening of July 31, regardless of whether they were found during a scheduled search or incidentally at some other time. We assumed that all carcasses found incidentally on scheduled search plots would have been found at the next search if they had not been found incidentally. Those carcasses found during searches but not within the search area were not included in casualty estimates.

The probability of carcass availability and detection ($\hat{\pi}$) was calculated based on the results of combined bias trials. Carcasses were placed in the field throughout the search interval and left until they were either found by searchers or removed by some means such as scavenging. The ratio of the number found to the number placed was then calculated and used as an empirical estimate of the probability of availability and detection. This method was used during previous study years at the FRWF.

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

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

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

Carcass Removal Rates

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

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

Definition of Variables

The following variables were used to calculate carcass removal rates:

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

Between Years Comparisons

Percent change in casualty rates between 2015 and the baseline year (2010) was calculated as the percent difference between point estimates and compared to the anticipated 50% reduction in casualty rates due to applied minimization measures.

RESULTS

The following sections contain the results of studies conducted under permit TE96012A-0. Per the requirements of this permit, information regarding the date, locations, and species of bats encountered can be found in Appendix B.

Bat and Bird Carcasses

A total of 1,288 weekly surveys were conducted on roads and pads across 118 turbines from August 3 – October 14, 2015. Overall, 164 bat carcasses and 22 bird carcasses were found during the survey (Table 4; Appendix B).

Species Composition

The most commonly found bat species during the 2015 study were eastern red bat (*Lasiurus borealis*; 53 carcasses, 58.2% of carcasses), followed by silver-haired bat (*Lasionycteris noctivagans;* 18 carcasses, 19.8%), and hoary bat (*Lasiurus cinereus*; 14 carcasses, 15.4%).

Three other species were found, including big brown bat (*Eptesicus fuscus;* 4 carcass, 4.4%), Seminole bat (*Lasiurus seminolus*; 1 carcass, 1.1%) and little brown bat (*Myotis lucifugus*, 1 carcass, 1.1%). No Indiana bat carcasses were found during the 2015 study (Table 4).

Table 4. Total number of bird and bat carcasses and the percent composition of carcasses found during post-construction monitoring at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Species	Carcasses found on plots during Scheduled Searches		Incidental carcasses at Search Plots		Incidental carcasses found off of search plots		Total	
	Total	% Comp.	Total	% Comp.	Total	% Comp.	Total	% Comp.
Bats								
eastern red bat	71	60.2	4	57.1	22	56.4	97	59.1
hoary bat	21	17.8	0	0.0	11	28.2	32	19.5
silver-haired bat	18	15.3	1	14.3	4	10.3	23	14.0
big brown bat	6	5.1	2	28.6	2	5.1	10	6.1
little brown bat	1	0.8	0	0.0	0	0.0	1	0.6
Seminole bat	1	0.8	0	0.0	0	0.0	1	0.6
Total Bats	**118**	**100**	**7**	**100**	**39**	**100**	**164**	**100**
Birds								
killdeer	4	20	0	0	0	0	4	18.2
Tennessee warbler	2	10	0	0	1	50	3	13.6
cliff swallow	2	10	0	0	0	0	2	9.1
American robin	1	5	0	0	0	0	1	4.5
barn swallow	1	5	0	0	0	0	1	4.5
common yellowthroat	1	5	0	0	0	0	1	4.5
European starling	1	5	0	0	0	0	1	4.5
least sandpiper	1	5	0	0	0	0	1	4.5
mourning dove	1	5	0	0	0	0	1	4.5
ring-necked pheasant	1	5	0	0	0	0	1	4.5
unidentified passerine	1	5	0	0	0	0	1	4.5
unidentified warbler	1	5	0	0	0	0	1	4.5
Wilson's warbler	1	5	0	0	0	0	1	4.5
yellow-billed cuckoo	1	5	0	0	0	0	1	4.5
indigo bunting	1	5	0	0	0	0	1	4.5
ruby-crowned kinglet	0	0	0	0	1	50	1	4.5
Total Birds	**20**	**100**	**0**	**0**	**2**	**100**	**22**	**100**

The sixteen bird carcasses found during the survey represent 14 individual known bird species (Table 3). No bird species listed as threatened or endangered by the State of Indiana, INHDC 2013) or federal endangered species acts (ESA 1973, USFWS 2013) were found.

Estimated Time since Death

Most bat carcasses were estimated to have been killed two to three days (31.1%) or four to seven days before the scheduled search (23.2%; Table 5a). Most bird carcasses were

estimated to have been killed last night or two to three days before the scheduled search ((31.8% for both; Table 5b).

Table 5a. Estimated time since death of bat carcasses at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Estimated Time Since Death	Number of Carcasses	Percent Composition
Bats		
last night	31	18.9%
2-3 days	51	31.1%
4-7 days	38	23.2%
7-14 days	18	11.0%
>2 weeks	8	4.9%
>month	12	7.3%
unknown	6	3.7%

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

Table 5b. Estimated time since death of bird carcasses at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Estimated Time Since Death	Number of Carcasses	Percent Composition
Birds		
last night	7	31.8%
2-3 days	7	31.8%
4-7 days	6	27.3%
7-14 days	0	0.0%
>2 weeks	0	0.0%
>month	2	9.1%
unknown	0	0.0%

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

Timing of Bat Carcasses

Bat casualties occurred throughout the study period (Figure 3). The highest number of bat causalities were found in mid-August (08/17/15) and the middle of September (09/15/15; Figure 3). A low number of carcasses were found in October.

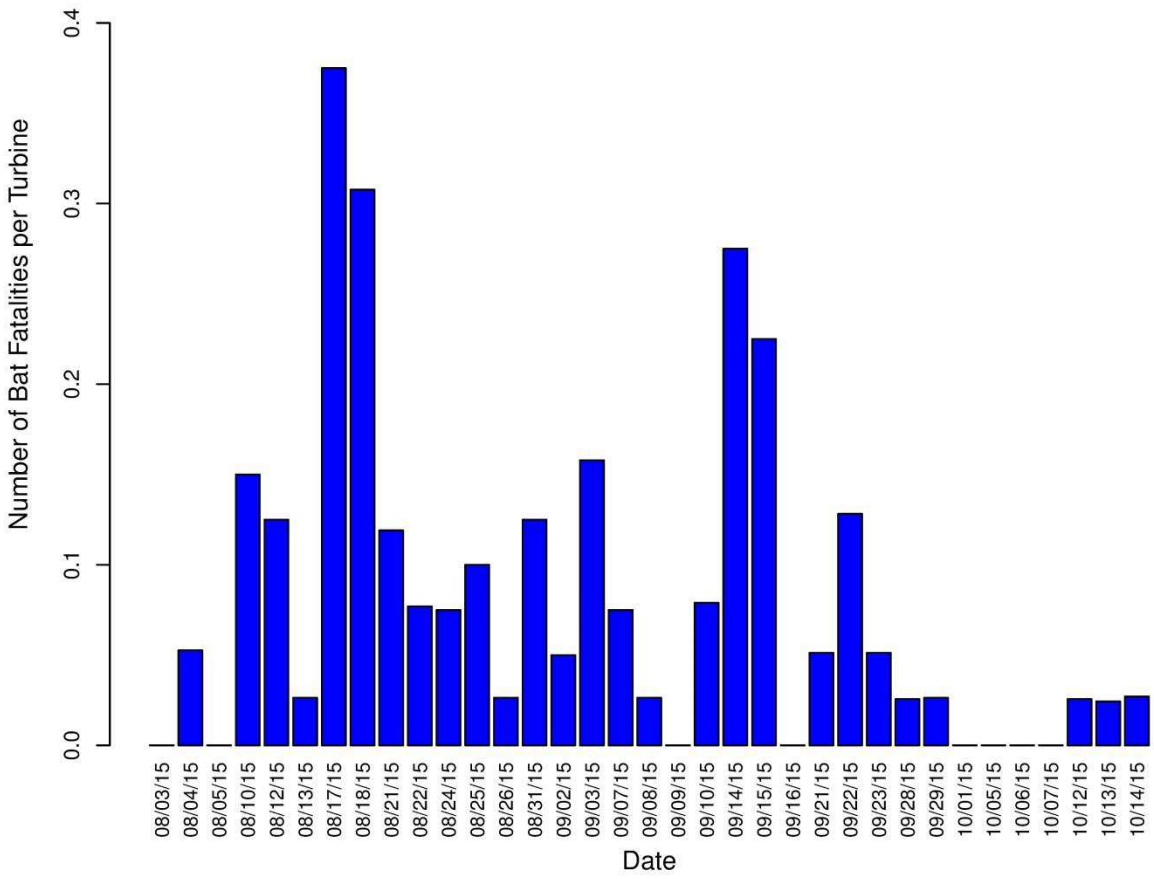

Figure 3. Timing of bat carcasses found on turbine search plots, and estimated to have perished between July 31 – October 15 at the Fowler Ridge Wind Farm.

Distribution of Bat Casualties

A total of 96.9% of bat carcasses were found within 50 m (164 ft) of turbines, with the highest percentage (43.3%) of carcasses found between 0 – 10 m (0 – 33 ft), followed by 22.7% of bat carcasses each found between 10 – 20 m (33 – 68 ft) and 18.6 % found between 20 – 30 m (68 – 98 ft) from turbines (Table 6, Figure 4). This was a function of the amount of searchable area present within varying distances of turbines as road and pad comprise a higher percentage of area in each distance band closer to turbines.

Table 6. Distribution of distances from turbines of bat casualties found during scheduled searches or incidentally on turbine search plots at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Distance to Turbine (m)	% Bat Casualties
0 to 10	43.3
10 to 20	22.7
20 to 30	18.6
30 to 40	9.3
40 to 50	3.1
50 to 60	1.0
60 to 70	2.1
70 to 80	0.0
80 to 90	0.0
>90	0.0

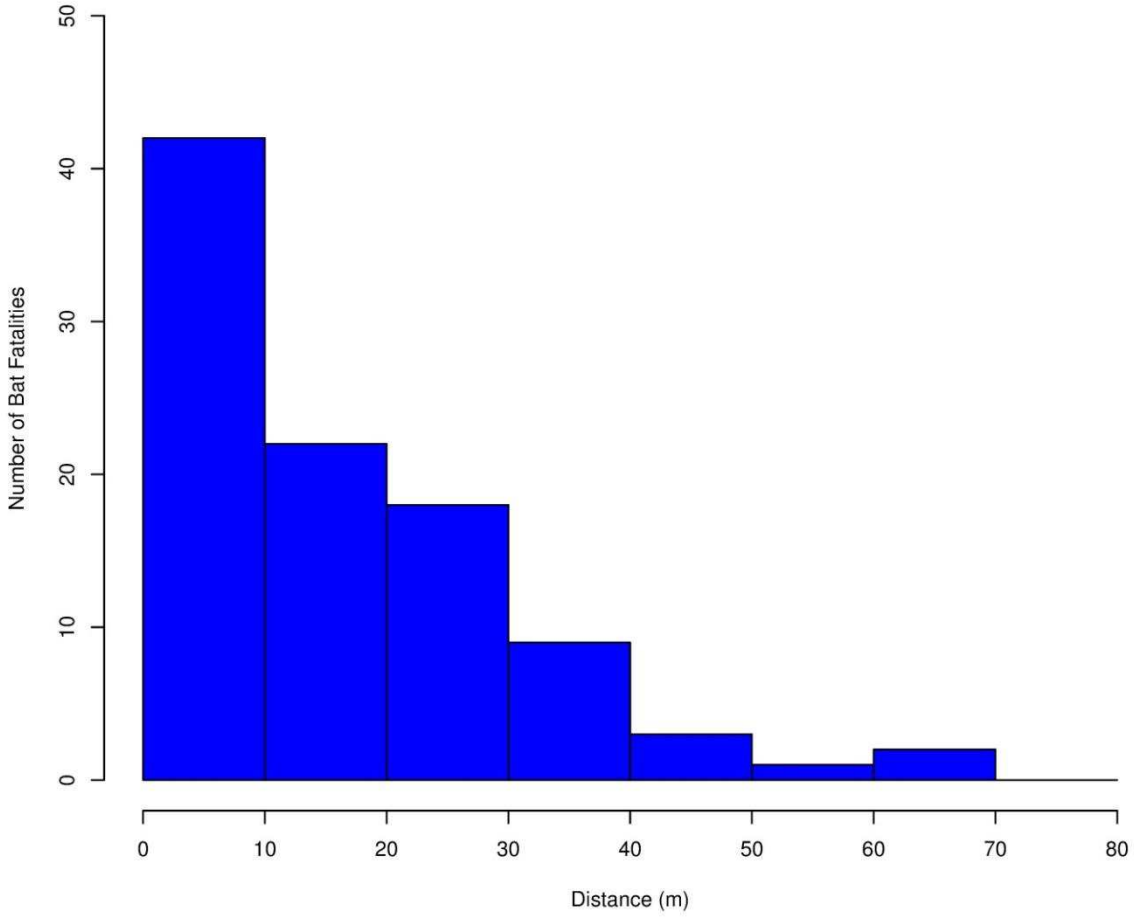

Figure 4. Distance of bat carcasses found during scheduled searches or incidentally on turbine search plots at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Bat Carcasses by Turbine Location

Turbines 622 and 624 had the highest density of bat casualties (six casualties) (Clipper; see Figure 5). Turbine 226 had the second highest density of bat casualties (five casualties, Vestas), followed by turbines 627, 639 (four casualties each, Clipper; Figure 5).

Bat carcasses occurred more frequently in the central and eastern portions of the FRWF, with the majority of casualties being found at Vestas and Clipper turbine locations (Figure 6). The highest observed fatality rates occurred at the Clipper turbines with 33 carcasses on 13 searched turbines, for a rate of 2.54 observed bat carcasses per turbine. Thirty-nine carcasses were found at 52 Vestas turbines (0.75 observed bat carcasses per turbine). Twenty five bat carcasses were found at 53 GE turbines (0.47 bat carcasses per turbine).

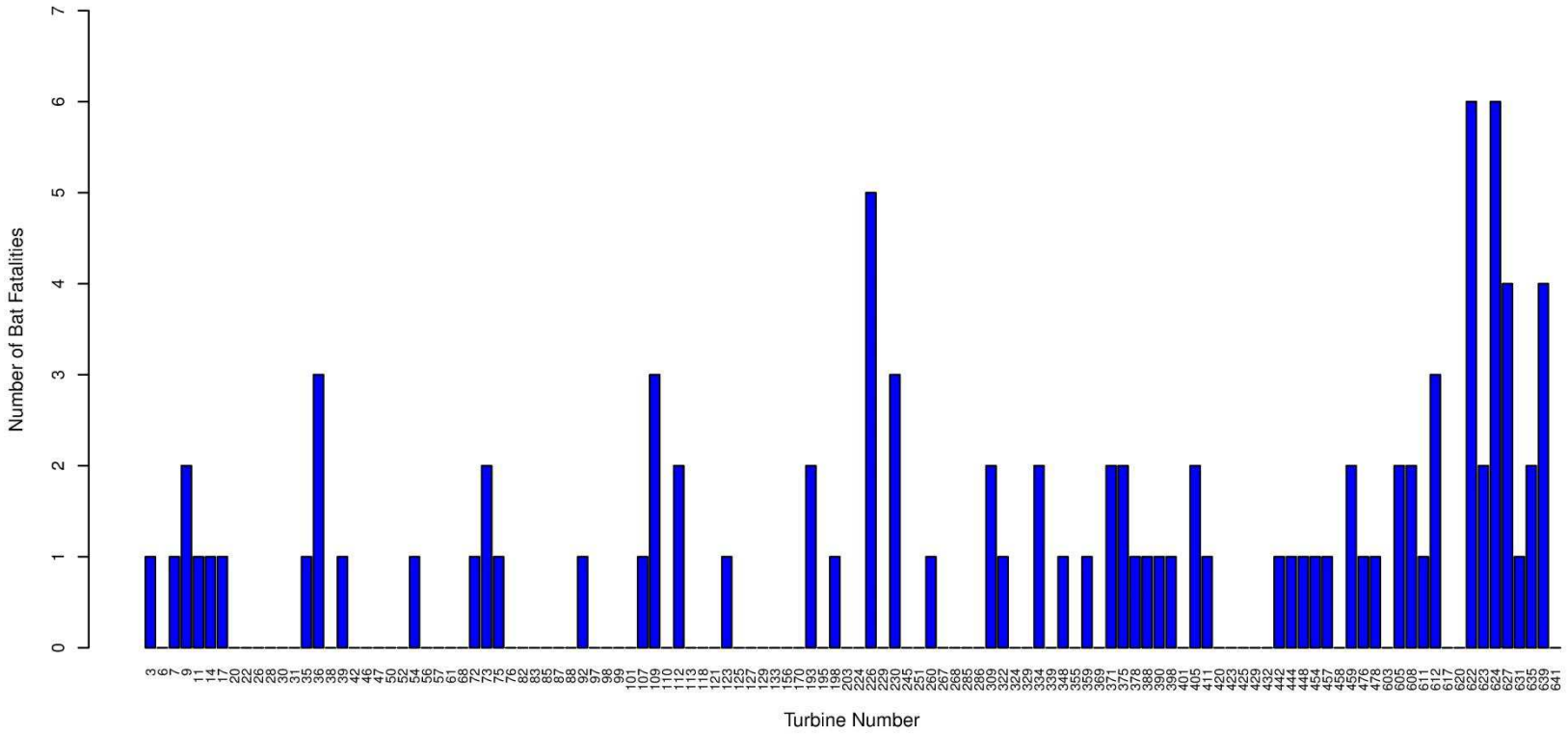

Figure 5. Number of bat carcasses estimated to have perished between July 31 – October 15, and found on turbine search plots at the Fowler Ridge Wind Farm.

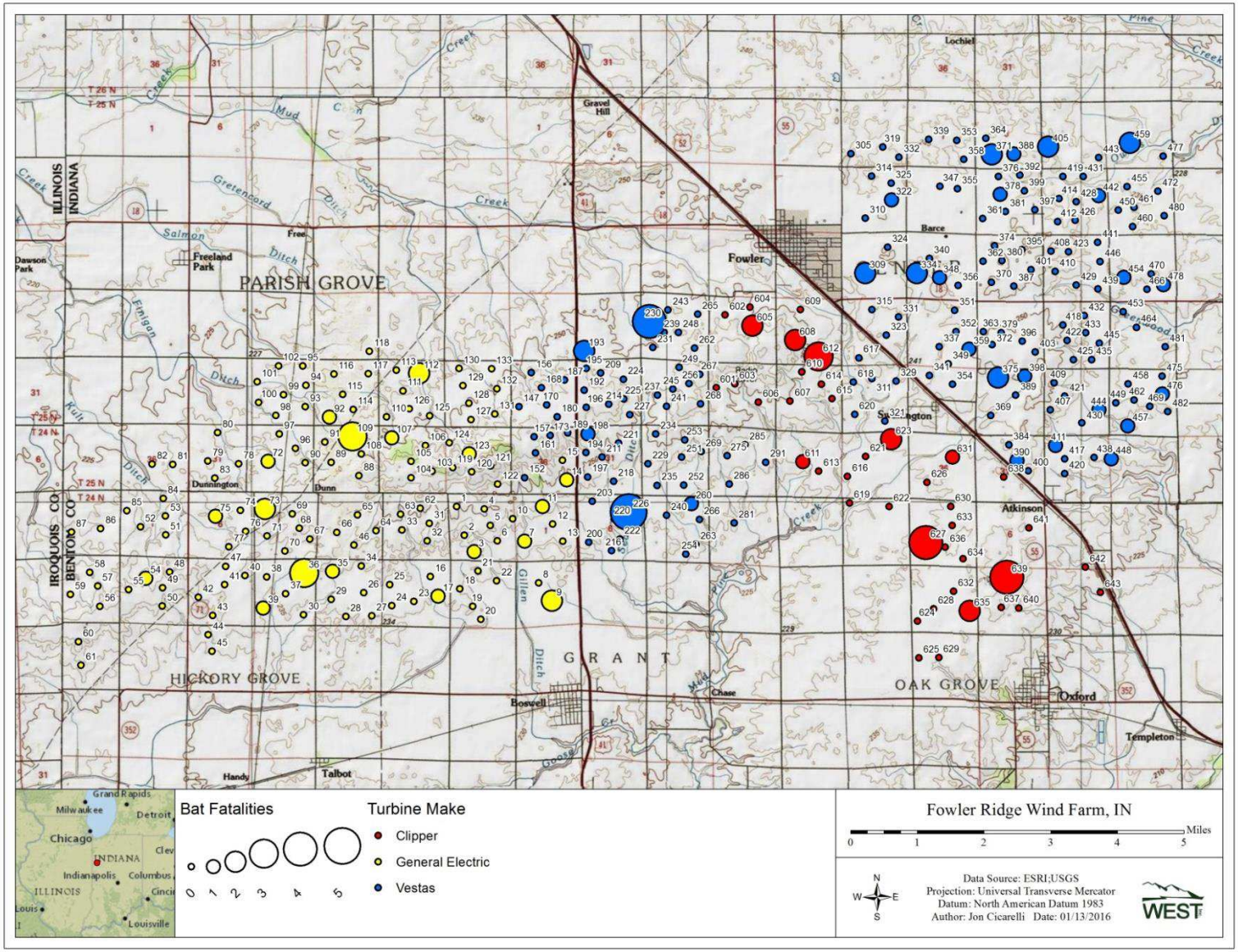

Figure 6. Location of all bat casualties estimated to have perished between July 31 – October 15 at the Fowler Ridge Wind Farm.

Bias Trials

Bias trials were conducted throughout the study period at seven placement intervals. Seventy one bats were placed prior to a scheduled search ranging from zero to six days prior to searches. Forty nine bats (7 per category of days prior to search) bat carcasses were randomly chosen and used to estimate the overall probability that a bat carcass was available and detected. Of the 49 trial carcasses, 30 were found at the next scheduled search (Table 7), with no additional bats found after multiple searches, resulting in an overall probability of available and detected of 61% for a 7 day interval between searches (Table 8). The probability that a carcass was available and detected in 2015 was slightly higher than previous years where weekly searches were completed (i.e., 2013 [0.55], 2012 [0.57] and 2010 [0.51]).

Table 7. Searcher efficiency based on empirical pi by time since death methodology for post-construction casualty monitoring at the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Number of Days Prior to Search	Number Placed	Number Found on Next Search	Total Found	Percent Found
0	7	7	7	100
1	7	5	5	71.4
2	7	4	4	57.1
3	7	4	4	57.1
4	7	5	5	71.4
5	7	4	4	57.1
6	7	1	1	14.3
Total	49	30	30	**0.61**

A total of 39 bats were used to measure carcasses removal rates. The average length of stay for bat carcasses in 2015 was 13.89 days. The carcass removal estimates for 2015 were similar to 2014 (19.36 days, Good et al. 2015) and 2011 (15.1 days; Good et al. 2012), and longer than the estimate of 2013 (5.8 days; Good et al. 2014).

Adjusted Casualty Estimates

Sixty seven casualties found were not included in analyses because carcasses were found outside of search plots or the fatalities were estimated to have occurred before July 31 (Appendix B). Of the remaining casualties, 97 were included in the casualty estimate, resulting in an observed casualty rate of 0.82 bats per turbine. The observed casualty rate was then divided by the empirical probability of availability and detection (0.61). The value was multiplied by the road and pad correction factor (6.56) to obtain the per turbine adjusted fatality estimate for each type of turbine. The adjusted casualty estimate for the 2015 study was 8.81 bat casualties/turbine/study period (Table 8), or 4.86 bat casualties/MW/study period (Table 9). Similar to previous years of study, more bat casualties were found on Clipper turbines compared to Vestas and GE (Table 9).

Table 8. Number of bat casualties per turbine for the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

Estimator	Point Estimate	Standard Deviation	90% Confidence Interval	
			Lower Limit	Upper Limit
Area Adjustment	6.56	-	-	-
Casualties per turbine	0.82	0.13	0.61	1.05
Empirical pi	0.61	0.06	0.51	0.71
Adjusted number of fatalities per turbine	8.81	1.69	6.42	11.87

Table 9. Adjusted bat casualty estimates (Empirical Pi) for different turbine types within the Fowler Ridge Wind Farm from August 3 to October 14, 2015.

	Adjusted Overall Fatality Estimate and 90% Confidence Intervals	
	Mean	Confidence Interval
	# casualties/turbine/year	
GE	5.05	(3.03, 7.48)
Clipper	27.20	(12.72, 45.15)
Vestas	8.04	(5.38, 11.51)
All Turbines	8.81	(6.42, 11.87)
	# casualties/MW/year	
GE	3.37	(2.02, 4.99)
Clipper	10.88	(5.09, 18.06)
Vestas	4.87	(3.26, 6.97)
All Turbines	4.86	(3.66, 6.65)

Comparison to 2010 Casualty Estimates

Road and pad searches completed in 2010 at turbines in normal operation mode provide the most direct comparison of casualty estimates to the 2012, 2013, 2014 and 2015 estimates. During 2010, 31.23 bat casualties/turbine/study period (90% confidence interval [CI] 18.77 – 48.94) were estimated from road and pad searches of 100 turbines in normal operation mode, after adjusting for bats falling outside of 40 m (Good et al. 2012). Point estimates of 2015 casualty estimates from turbines feathered until wind speeds reached 5.0 m/s were 71.8% lower than road and pad casualty estimates at turbines operating normally in 2010, with an estimated 8.81 bat casualties/turbine/study period (90% CI 6.42 – 11.87).

Uncertainty surrounding bat casualty rates was estimated using 90% confidence intervals. Casualty rates from 2015 were compared to the anticipated 50% reduction in casualty rates from the baseline year (2010) to determine the effectiveness of the applied minimization measures. There is statistical evidence to support a greater than 50% reduction in casualty rate from 2010 to 2012, 2013, 2014 and 2015 (Figure 7).

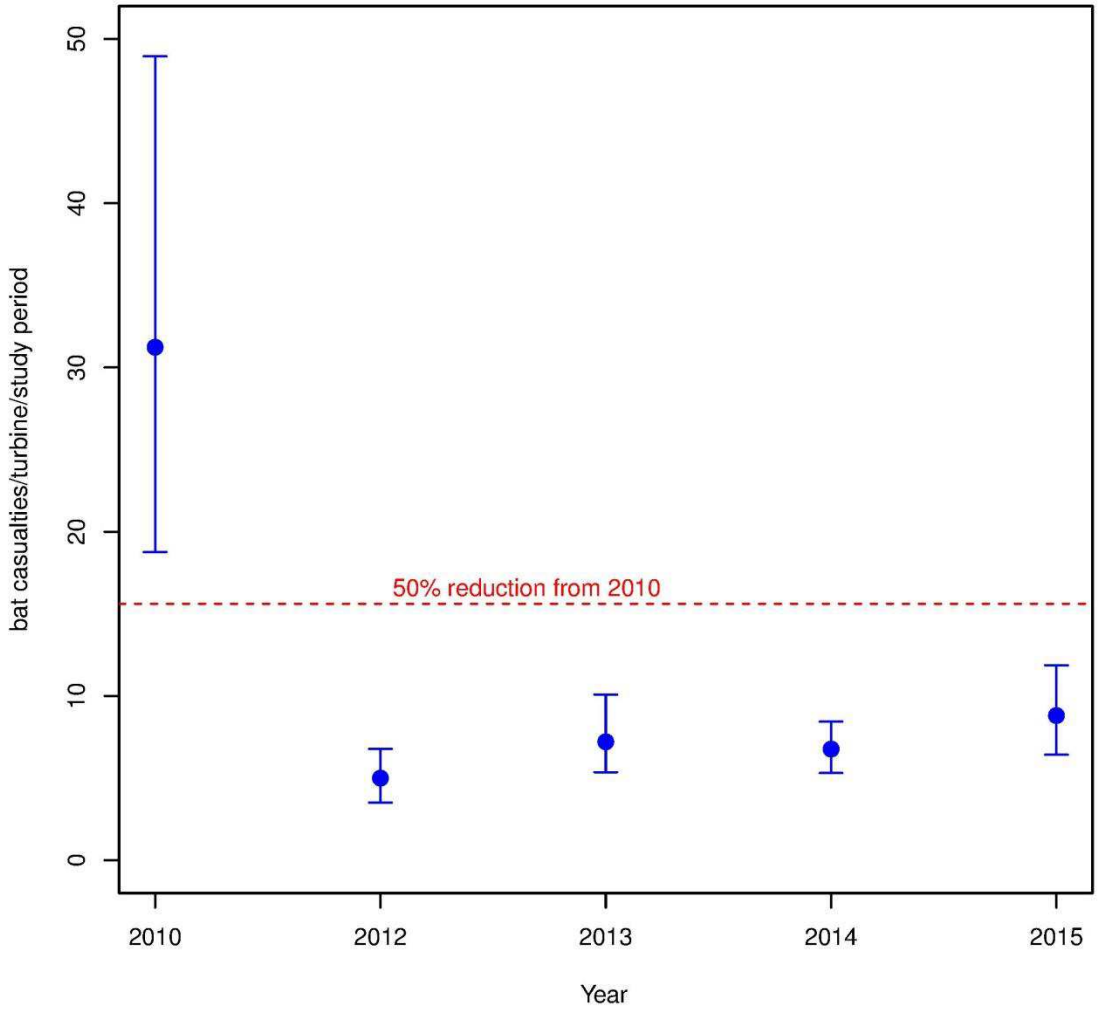

Figure 7. A comparison of estimate bat casualty rates and 90% confidence intervals for Fowler Ridge Wind Farm. The 2010 estimate represents turbine operating at manufacturer cut-in speeds. The 2012, 2013, 2014, and 2015 estimates represent data collected at turbines that were feathered below 5.0 m/s. The red dotted line represents a 50% reduction in bat casualty rates compared to the 2010 point estimate.

Within Season Adaptive Management

The Fowler HCP includes an active adaptive management approach that facilitates responsiveness in management actions based on results from annual take compliance monitoring to ensure permit compliance. Within-season adaptive management thresholds were calculated to serve as an early indicator if adjustments to minimization efforts may be necessary before the conclusion of the monitoring year. Per the HCP, within-season adaptive management thresholds were based on the predicted number of bat carcasses that would be found that would equal the upper quartile (i.e., 75th percentile) of estimated fall bat mortality in 2010 and 2011 at control turbines with minimization measures in place: 9.5 Indiana bats per year for the

entire facility. Based on the species composition described within the HCP, a fatality rate of 16.7 bats per turbine per season would be needed to result in 9.5 Indiana bat fatalities.

The Fowler HCP prescribes a sampling approach utilizing roads and pads to calculate fatality estimates. Per the HCP, to determine the number of bat carcasses of all species found that would equate to the adaptive management threshold for within season Indiana bat mortality, bias correction factors (i.e., unsearched areas, scavenger removal, and carcass removal) from the previous year's monitoring results should be applied. The HCP also requires the use of empirical pi to calculate the probability a carcass was available and detected.

Carcass searches at Fowler occurred weekly in 2015. This is a decrease in search frequency compared to the 2014 monitoring (twice per week). Search frequency was decreased in 2015 according the terms of the HCP, which state that search intervals will be weekly if carcass removal rates average 7 days or greater during the previous year of monitoring. The average removal rate for bats in 2014 was 19.36 days.

The calculation of empirical pi requires carcasses to be placed at varying intervals prior to a scheduled carcass search. Searches were completed twice per week in 2014, thus carcasses were placed between 0 and 4 days prior to a search occurring. The results of the 2014 bias were not used to calculate the empirical pi for a weekly search because carcasses could only be placed between 0 and 4 days prior to a search in 2014. Using 2014 bias trial results would have resulted in an unrealistically low estimated bat mortality rate. Thus we used the empirical pi (0.55) calculated from searches in 2013, which was the last year in which a weekly search occurred at Fowler Ridge. We then used the maximum adjusted fatality rate given in the HCP (16.7 fatalities/turbine) and the road and pad area correction factor (6.56), and back calculated the within season adaptive management threshold for 2015: 1.4 bat carcasses found/turbine or a total of 165 bat carcasses. A total of 97 bat carcasses were found on search plots that were estimated to have been killed on or after the evening of July 31 during the study. Adaptive Management thresholds were not exceeded at any time during the study, and no changes to minimization efforts were required during 2015.

End of Season Indiana Bat Take Estimate

The estimated number of Indiana bat casualties that occurred during 2015 was calculated based on the overall estimated bat fatality rate during 2015 and the relative percent that Indiana bat carcasses comprised of all bat carcasses found during Fall in 2009, 2010, and 2011 (0.16%). The total number of bats estimated to have occurred as casualties in 2015 was calculated for each turbine type, and then summed to calculate the total estimate. A total of 5.16 (90% CL 3.65 – 6.74) Indiana bat casualties were estimated to have occurred in 2015, which is 40% lower than the 8.6 Indiana bats that were predicted to occur as casualties within the HCP after minimization. Per the terms of the HCP, no changes to minimization efforts are required for 2016.

DISCUSSION

The results of monitoring during 2015 provided evidence that operation strategies exceeded the objective of reducing bat casualty rates by 50% compared to casualty estimates of turbines in normal operation modes in 2010. The 71% - 84% reduction in point estimates of overall bat casualty rates observed in 2012, 2013, 2014 and 2015 compared to 2010 were greater than expected based on earlier curtailment studies at the FRWF (Good et al. 2011, 2012). The most likely explanation relates to differences between raising cut-in speeds versus blade feathering; turbine cut-in speeds were raised but blades were not feathered during the 2010 study (Good et al 2011). Feathering blades results in less rotation of blades at lower wind speeds and greater reductions in bat fatalities.

REFERENCES

Endangered Species Act (ESA). 1973. 16 United States Code (USC) §§ 1531-1544, Public Law (PL) 93-205, December 28, 1973, as amended, PL 100-478 [16 USC 1531 *et seq.*]; 50 Code of Federal Regulations (CFR) 402.

Good, R. E., K. Adachi, C. Lebeau, S. Simon, and B. Hale. 2014. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana. Final Report: August 1 – October 15, 2013. Prepared for Fowler Ridge Wind Farm, Fowler, Indiana. Prepared by Western EcoSystems Technology, Inc. Bloomington, Indiana.

Good, R. E., W. P. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 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. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 28, 2011.

Good, R.E., G. Iskali, and K. Adachi. 2015. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: August 4 – October 14, 2014. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 30, 2015.

Good, R. E., A. Merrill, S. Simon, K. Murray, and K. Bay. 2012. Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: April 1 - October 31, 2011. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 31, 2012.

Good, R. E., M. Sonnenburg, and S. Simon. 2013. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: August 1 - October 15, 2012. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 31, 2013.

Homer, C., C. Huang, L. Yang, B. Wylie, and M. Coan. 2004. Development of a 2001 National Land Cover Database for the United States. Photogrammetric Engineering and Remote Sensing 70(7): 829-840.

Indiana Natural Heritage Data Center (INHDC). 2013. List of Endangered, Threatened, and Rare Species by County. INHDC Division of Nature Preserves, Indiana Department of Natural Resources (IDNR). April 16, 2013. Available online at: http://www.in.gov/dnr/naturepreserve/4666.htm; Benton County at: http://www.in.gov/dnr/naturepreserve/files/np_benton.pdf

Johnson, G. D., M. Ritzert, S. Nomani, and K. Bay. 2010a. Bird and Bat Fatality Studies, Fowler Ridge I Wind-Energy Facility Benton County, Indiana. Unpublished report prepared for British Petroleum Wind Energy North America Inc. (BPWENA) by Western EcoSystems Technology, Inc. (WEST).

Johnson, G. D., M. Ritzert, S. Nomani, and K. Bay. 2010b. Bird and Bat Fatality Studies, Fowler Ridge III Wind-Energy Facility, Benton County, Indiana. April 2 - June 10, 2009. Prepared for BP Wind Energy North America. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). 2006. Soil Survey Geographic (Ssurgo) Database for Benton County, Indiana. USDA-NRCS. Fort Worth, Texas.

US Fish and Wildlife Service (USFWS). 2007. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. US Department of Interior, Fish and Wildlife Service, Region 3. USFWS. Fort Snelling, Minnesota. 260 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/070416.pdf

US Fish and Wildlife Service (USFWS). 2013. Endangered Species. Last updated March 22, 2013. USFWS Endangered Species Program homepage: http://www.fws.gov/endangered/; Environmental Conservation Online System (ECOS): http://ecos.fws.gov/ecos/indexPublic.do; Threatened and Endangered Species System (TESS) listings by state: http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrence.jsp; Individual species profiles and status information available from the ECOS webpage.

Whitaker, J. O. and R. E. Mumford, eds. 2009. Mammals of Indiana. Indiana University Press. 660 pp.

Appendix A. Estimated Time of Death Information Sheet

Estimated Time of Death Information Sheet

Last Night

- Eyes will be round and fluid filled or slightly dehydrated
- No decomposition
- No infestations other than flies and eggs
- Body may be more flexible

2 – 3 Days

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

4 – 7 Days

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

7 – 14 Days

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

> 2 Weeks to > **1 Month**

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

Appendix B. Complete Casualty Listing for the 2015 Casualty Monitoring at the Fowler Ridge Wind Farm

Appendix B. Complete casualty listing for the 2015 casualty monitoring at the Fowler Ridge Wind Farm.

Date	Common Name	Location	Turbine Type	Found Outside of Search Plot?	Estimated to have perished prior to the evening of July 31?
8/3/2015	eastern red bat	322	Vestas	no	yes
8/3/2015	killdeer	355	Vestas	yes	no
8/3/2015	eastern red bat	454	Vestas	no	yes
8/3/2015	eastern red bat	429	Vestas	no	yes
8/3/2015	hoary bat	423	Vestas	no	no
8/3/2015	eastern red bat	359	Vestas	no	yes
8/3/2015	eastern red bat	425	Vestas	no	yes
8/3/2015	hoary bat	476	Vestas	no	yes
8/3/2015	hoary bat	476	Vestas	no	yes
8/3/2015	eastern red bat	448	Vestas	no	yes
8/3/2015	eastern red bat	411	Vestas	no	yes
8/3/2015	eastern red bat	635	Clipper	no	yes
8/3/2015	eastern red bat	635	Clipper	no	yes
8/3/2015	eastern red bat	624	Clipper	no	yes
8/3/2015	eastern red bat	627	Clipper	no	no
8/3/2015	hoary bat	631	Clipper	no	yes
8/3/2015	indigo bunting	631	Clipper	no	yes
8/3/2015	hoary bat	631	Clipper	no	yes
8/4/2015	eastern red bat	623	Clipper	yes	no
8/4/2015	eastern red bat	611	Clipper	no	yes
8/4/2015	eastern red bat	611	Clipper	yes	no
8/4/2015	ring-necked pheasant	224	Vestas	yes	no
8/4/2015	eastern red bat	224	Vestas	no	yes
8/4/2015	hoary bat	241	Vestas	no	yes
8/4/2015	eastern red bat	203	Vestas	no	yes
8/4/2015	hoary bat	198	Vestas	no	yes
8/4/2015	eastern red bat	170	Vestas	no	yes
8/4/2015	big brown bat	156	Vestas	no	yes
8/4/2015	hoary bat	156	Vestas	no	yes
8/4/2015	eastern red bat	31	GE	no	yes
8/4/2015	eastern red bat	22	GE	no	yes
8/5/2015	eastern red bat	622	Clipper	no	yes
8/5/2015	big brown bat	260	Vestas	no	yes
8/5/2015	killdeer	75	GE	yes	no
8/5/2015	hoary bat	101	GE	no	yes
8/5/2015	eastern red bat	82	GE	no	yes
8/5/2015	eastern red bat	82	GE	no	yes
8/6/2015	eastern red bat	243	Vestas	no	yes
8/6/2015	hoary bat	196	Vestas	no	yes
8/10/2015	hoary bat	334	Vestas	yes	no
8/10/2015	big brown bat	405	Vestas	yes	no
8/10/2015	killdeer	459	Vestas	yes	no
8/10/2015	hoary bat	476	Vestas	yes	no

Appendix B. Complete casualty listing for the 2015 casualty monitoring at the Fowler Ridge Wind Farm.

Date	Common Name	Location	Turbine Type	Found Outside of Search Plot?	Estimated to have perished prior to the evening of July 31?
8/10/2015	eastern red bat	639	Clipper	yes	no
8/10/2015	eastern red bat	624	Clipper	yes	no
8/10/2015	eastern red bat	624	Clipper	yes	no
8/12/2015	eastern red bat	623	Clipper	yes	no
8/12/2015	big brown bat	612	Clipper	yes	no
8/12/2015	hoary bat	608	Clipper	yes	no
8/12/2015	hoary bat	605	Clipper	yes	no
8/12/2015	eastern red bat	605	Clipper	yes	no
8/12/2015	least sandpiper	230	Vesta	yes	no
8/13/2015	eastern red bat	76	GE	no	no
8/13/2015	eastern red bat	75	GE	yes	no
8/13/2015	eastern red bat	225	Vestas	no	no
8/17/2015	hoary bat	309	Vestas	yes	no
8/17/2015	eastern red bat	309	Vestas	yes	no
8/17/2015	eastern red bat	610	Clipper	no	no
8/17/2015	big brown bat	610	Clipper	no	no
8/17/2015	eastern red bat	348	Vestas	yes	no
8/17/2015	eastern red bat	334	Vestas	yes	no
8/17/2015	eastern red bat	322	Vestas	yes	no
8/17/2015	eastern red bat	378	Vestas	yes	yes
8/17/2015	eastern red bat	459	Vestas	yes	no
8/17/2015	eastern red bat	375	Vestas	yes	no
8/17/2015	eastern red bat	375	Vestas	yes	no
8/18/2015	eastern red bat	395	Vestas	no	no
8/18/2015	eastern red bat	411	Vestas	yes	no
8/18/2015	big brown bat	639	Clipper	yes	no
8/18/2015	eastern red bat	639	Clipper	yes	no
8/18/2015	unidentified passerine	639	Clipper	yes	no
8/18/2015	eastern red bat	627	Clipper	yes	no
8/21/2015	European starling	622	Clipper	yes	no
8/22/2015	cliff swallow	36	GE	yes	no
8/20/2015	eastern red bat	629	Clipper	no	no
8/20/2015	hoary bat	629	Clipper	no	no
8/21/2015	eastern red bat	622	Clipper	yes	no
8/21/2015	eastern red bat	622	Clipper	yes	no
8/21/2015	eastern red bat	622	Clipper	yes	no
8/21/2015	big brown bat	608	Clipper	yes	no
8/21/2015	eastern red bat	226	Vestas	yes	no
8/22/2015	eastern red bat	35	GE	yes	no
8/22/2015	silver-haired bat	36	GE	yes	no
8/22/2015	eastern red bat	54	GE	yes	no
8/24/2015	eastern red bat	478	Vestas	yes	no
8/24/2015	eastern red bat	457	Vestas	yes	no

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Date	Common Name	Location	Turbine Type	Found Outside of Search Plot?	Estimated to have perished prior to the evening of July 31?
8/24/2015	eastern red bat	627	Clipper	yes	no
8/25/2015	eastern red bat	612	Clipper	yes	no
8/25/2015	hoary bat	226	Vestas	yes	no
8/25/2015	hoary bat	4	GE	no	no
8/25/2015	eastern red bat	17	GE	yes	no
8/25/2015	eastern red bat	14	GE	yes	no
8/26/2015	eastern red bat	109	GE	yes	no
8/26/2015	eastern red bat	625	Clipper	no	no
8/26/2015	hoary bat	625	Clipper	no	no
8/26/2015	eastern red bat	625	Clipper	no	no
8/26/2015	eastern red bat	625	Clipper	no	no
8/26/2015	eastern red bat	625	Clipper	no	no
8/26/2015	eastern red bat	640	Clipper	no	no
8/26/2015	big brown bat	640	Clipper	no	no
8/26/2015	eastern red bat	640	Clipper	no	no
8/28/2015	hoary bat	633	Clipper	no	no
8/31/2015	eastern red bat	405	Vestas	yes	no
8/31/2015	eastern red bat	417	Vestas	no	no
8/31/2015	cliff swallow	641	Clipper	yes	no
8/31/2015	little brown bat	624	Clipper	yes	no
8/31/2015	eastern red bat	624	Clipper	yes	no
8/31/2015	eastern red bat	624	Clipper	yes	no
8/31/2015	eastern red bat	627	Clipper	yes	no
9/2/2015	hoary bat	226	Vestas	yes	no
9/2/2015	hoary bat	3	GE	yes	no
9/2/2015	barn swallow	7	GE	yes	no
9/3/2015	eastern red bat	112	GE	yes	no
9/3/2015	eastern red bat	112	GE	yes	no
9/3/2015	eastern red bat	107	GE	no	no
9/3/2015	eastern red bat	109	GE	yes	no
9/3/2015	eastern red bat	109	GE	yes	no
9/3/2015	eastern red bat	36	GE	yes	no
9/3/2015	eastern red bat	73	GE	yes	no
9/11/2015	silver-haired bat	193	Vestas	yes	no
9/11/2015	silver-haired bat	403	Vestas	no	no
9/14/2015	silver-haired bat	371	Vestas	yes	no
9/14/2015	silver-haired bat	371	Vestas	yes	no
9/14/2015	silver-haired bat	388	Vestas	yes	no
9/14/2015	hoary bat	459	Vestas	yes	no
9/14/2015	hoary bat	442	Vestas	yes	no
9/14/2015	Tennessee warbler	423	Vestas	yes	no
9/14/2015	eastern red bat	359	Vestas	yes	no
9/14/2015	killdeer	457	Vestas	yes	no

Appendix B. Complete casualty listing for the 2015 casualty monitoring at the Fowler Ridge Wind Farm.

Date	Common Name	Location	Turbine Type	Found Outside of Search Plot?	Estimated to have perished prior to the evening of July 31?
9/14/2015	eastern red bat	457	Vestas	no	no
9/14/2015	silver-haired bat	389	Vestas	no	no
9/14/2015	hoary bat	390	Vestas	yes	no
9/14/2015	silver-haired bat	639	Clipper	yes	no
9/14/2015	silver-haired bat	627	Clipper	yes	no
9/14/2015	silver-haired bat	622	Clipper	yes	no
9/14/2015	silver-haired bat	631	Clipper	yes	no
9/15/2015	Tennessee warbler	603	Clipper	yes	no
9/15/2015	silver-haired bat	608	Clipper	no	no
9/15/2015	silver-haired bat	230	Vestas	yes	no
9/15/2015	eastern red bat	230	Vestas	yes	no
9/15/2015	silver-haired bat	230	Vestas	yes	no
9/15/2015	hoary bat	198	Vestas	yes	no
9/15/2015	silver-haired bat	193	Vestas	yes	no
9/15/2015	silver-haired bat	123	GE	yes	no
9/15/2015	silver-haired bat	9	GE	yes	no
9/15/2015	silver-haired bat	7	GE	yes	no
9/15/2015	eastern red bat	640	Clipper	no	no
9/4/2015	big brown bat	635	Clipper	yes	no
9/4/2015	hoary bat	116	GE	no	no
9/7/2015	hoary bat	444	Vestas	yes	no
9/7/2015	eastern red bat	622	Clipper	yes	no
9/8/2015	big brown bat	39	GE	yes	no
9/8/2015	Seminole bat	9	GE	yes	no
9/8/2015	hoary bat	117	GE	no	no
9/8/2015	hoary bat	636	Clipper	no	no
9/8/2015	eastern red bat	636	Clipper	no	no
9/8/2015	eastern red bat	636	Clipper	no	no
9/9/2015	eastern red bat	636	Clipper	no	no
9/9/2015	hoary bat	636	Clipper	no	no
9/10/2015	eastern red bat	636	Clipper	no	no
9/10/2015	eastern red bat	92	GE	yes	no
9/10/2015	unidentified warbler	109	GE	yes	no
9/10/2015	hoary bat	72	GE	yes	no
9/10/2015	American robin	72	GE	yes	no
9/21/2015	common yellowthroat	458	Vestas	yes	no
9/21/2015	eastern red bat	448	Vestas	yes	no
9/21/2015	eastern red bat	635	Clipper	yes	no
9/22/2015	eastern red bat	612	Clipper	yes	no
9/22/2015	eastern red bat	226	Vestas	yes	no
9/22/2015	eastern red bat	226	Vestas	yes	no
9/22/2015	eastern red bat	11	GE	yes	no
9/22/2015	eastern red bat	622	Clipper	yes	no

Appendix B. Complete casualty listing for the 2015 casualty monitoring at the Fowler Ridge Wind Farm.

Date	Common Name	Location	Turbine Type	Found Outside of Search Plot?	Estimated to have perished prior to the evening of July 31?
9/23/2015	silver-haired bat	107	GE	yes	no
9/23/2015	eastern red bat	36	GE	yes	no
9/23/2015	Wilson's warbler	83	GE	yes	no
10/6/2015	ruby-crowned kinglet	245	Vestas	no	no
9/28/2015	eastern red bat	398	Vestas	yes	no
9/28/2015	silver-haired bat	616	Clipper	no	no
9/29/2015	eastern red bat	624	Clipper	yes	no
9/29/2015	Tennessee warbler	11	GE	no	no
10/1/2015	yellow-billed cuckoo	97	GE	yes	no
10/1/2015	mourning dove	57	GE	yes	no
10/12/2015	silver-haired bat	454	Vesta	yes	no
10/13/2015	silver-haired bat	260	Vesta	yes	no
10/14/2015	silver-haired bat	73	GE	yes	no
10/14/2015	eastern red bat	417	Vestas	no	no