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

April 1 – October 31, 2011

Prepared for:

Fowler Ridge Wind Farm

Prepared by:

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January 31, 2012

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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REPORT REFERENCE

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

ACKNOWLEDGEMENTS

A number of individuals from different organizations were instrumental in the completion of the 2011 monitoring at the Fowler Ridge Wind Farm. The US Fish and Wildlife Service, Bloomington, Indiana Field Office provided review of the study protocol. Fowler Ridge Wind Farm personnel including Facility Manager Scott Tompkins and Office Manager Kathy Sowers for providing information and coordination to WEST staff and guiding communication with other Fowler Ridge Wind Farm personnel; and Deputy Facility Managers Manny Dominguez, Ryan Linzner, and Curt Wehkamp were extremely helpful in providing safety training, daily project coordination with WEST staff, and deploying study equipment on nacelles of selected turbines and providing routine maintenance of this equipment. Indiana State University provided bat carcasses for spring bias trials. The WEST field crew who's efforts were invaluable to this study including Crew Leader Anna Ciecka and our Field Technicians, Nick Vitale, Kasey Clark, Goniela Iskali, Parker Maners, Bobby Wheatcraft, Amelia Pratz Saint-Geours, Todd Reed, Teddy Lasky, Ruthann Weist, Ryan Webb, Erin Smith, and Phil Baigas. Mike Sondegrath cleared and maintained the search plots throughout the duration of the study. Blayne Gunderman and Bob Meyer of the Fowler Ridge Wind Farm provided invaluable logistical and technical support. Gregg Crenshaw, Marylin Teague, and Kimberly Lanterman of the Fowler Ridge Wind Farm provided input on study design and the report. All the participating landowners in the Fowler Ridge Wind Farm deserve recognition for their support and cooperation in allowing safe, secure, and trouble-free property access. The Fowler Ridge Wind Farm provided funding for this research.

EXECUTIVE SUMMARY

The Fowler Ridge Wind Farm (FRWF) is located in Benton County, Indiana, and currently consists of 355 wind turbines in three operating phases. A post-construction casualty study of birds and bats was conducted by Western EcoSystems Technology, Inc. (WEST) in Phases I and III during 2009. During such study, an Indiana bat carcass was discovered by staff at the FRWF. A Scientific Research and Recovery Permit (SRRP) for the Indiana bat (TE15075A-2) was issued for further research of Phases I, II, and III in 2010 and 2011. One additional Indiana bat carcass was found, in the fall of 2010. As a result of this discovery, the US Fish and Wildlife Service (USFWS) Field Office in Bloomington, Indiana, recommended that the FRWF develop a Habitat Conservation Plan (HCP). Consequently, the owners of the FRWF requested that WEST conduct further research of Indiana bat use and methods for reducing bat fatality rates. The results of the research at the FRWF will be used for developing an HCP and applying for an Incidental Take Permit (ITP) from Region 3 of the USFWS. The results presented in this report were collected under the SRPP referenced above.

Studies at the FRWF in 2011 were comprised of two components: a bat casualty study and an acoustical bat survey. The primary objectives included:

1. Measuring the effectiveness of feathering turbine blades prior to reaching cut-in speeds for reducing bat fatality rates;

2. Determining if overall fall bat fatality rates were similar to or different from rates recorded in fall of 2010;

3. Determining if bat activity rates were similar between fall of 2010 and 2011;

4. Determining if bat activity rates by species or species group are related to bat fatality rates; and

5. Determining if relatively large amounts of Indiana bat activity occurs during fall migration.

6. Further examine the efficacy of use of roads and pads as primary sampling units for measuring bat casualty rates

The 2011 casualty study took place during spring (April 1 – May 15) and fall (July 15 – October 29) migration periods for Indiana bats. Casualty searches were completed on two types of plots: 1) 80-meter (262-[ft]) radius circular plots cleared of vegetation; and 2) roads and pads within 80 meters of turbines. Carcass searches were conducted at 6-day intervals during the spring on 177 roads and pads. During the fall, 168 turbines were sampled on roads and pads daily, and

nine cleared plots were searched every other day. Tests of searcher efficiency and carcass removal rates were also conducted.

Bat casualty rates were measured at three different speed adjustments or “treatments” and two sets of “control” turbines with no cut-in speed adjustment. Nine turbines were randomly selected from the sample of 36 cleared plots searched in 2010, and were considered a “control” sample, and had no treatments for the duration of the study. The nine control turbines were comprised of three each of the GE SLE 1.5-MW turbines, the Clipper C96 2.5-MW turbines, and the Vestas V82 1.65-MW turbines at cleared plots. Treatments for blade feathering and a second set of “control” turbines were rotated on a nightly basis between the remaining 168 turbines where only roads and pads were searched, with 42 turbines assigned to each group. The treatment included turbines with blades feathered below 5.5 m per second (m/s; 18.0 ft/s), below 4.5 m/s (14.8 ft/s), and below 3.5 m/s (11.5 ft/s), and a control group with no feathering. Turbines were assigned to control and treatment groups among the 168 turbines on a nightly basis using a balanced block design to ensure that equal numbers of each turbine type were assigned to each treatment.

A total of 573 bat carcasses were found, of which 425 bats were found during regularly scheduled searches, with an additional seven bats being found incidentally at turbine search plots. The remaining 141 bat carcasses were found outside of the study period during clearing searches or not on scheduled search turbines; they were identified, but were not included in the casualty estimates. Most fatalities occurred during the fall migration period. Similar to 2010, the most commonly found bat species was eastern red bat (305 casualties, 53.23% of fatalities), followed by hoary bat (159 casualties, 27.75%), silver haired bat (81 casualties, 14.14%), and big brown bat (16 casualties, 2.79%). Two new species were found in 2011, including four evening bats and three Seminole bats. No Indiana bat carcasses were found in 2011, and similar to 2010, *Myotis* casualties were comparatively rare in 2011. Two *Myotis* carcasses were found in 2011 (0.4% of all bat casualties), both little brown bats.

Casualty estimates from 2010 were based on searches within 80 X 80 m (262 X 262 ft) cleared plots. The corners of each plot were 57 m (187 ft) away from the turbine. The search area covered 6,400 m^2(68,889 ft^2) on each plot and was equivalent to searching a circle with a radius of 45 m (484 ft). Based on the distribution of bat fatalities within the larger 80-m radius cleared plots that were searched in 2011, 23.3% of fatalities in 2010 fell outside of 40-m square plots. Estimates of bat fatality rates at control plots were similar in 2010 (29.79 fatalities/turbine/year with empirical estimator) and 2011 (34.10 fatalities/turbine/year with empirical estimator) after 2010 estimates were adjusted for bats falling outside of plots.

Bat casualty rates were decreased by about 36%, 57%, and 73% in 2011 compared to control turbines when blades were feathered at 3.5 m/s, 4.5 m/s, and 5.5 m/s, respectively. Chi-square tests of proportions showed that decreases in observed bat fatality rates between control turbines with no feathering compared to feathered turbines was statistically significant ($p < 0.05$). Chi-square tests of proportions between successive treatment levels also showed significant decreases in fatality counts ($p < 0.05$).

Bat activity was monitored with Anabat ultrasonic bat detectors at four turbines on a total of 46 nights during the spring period of March 31 through May 15, and again at 4 turbines and two reference locations on a total of 95 nights during the fall period of July 14 through October 31, 2011. Anabat units were placed on nacelles as well as at the base of turbines. Anabat units were operable for 67.2% and 96.2% of the spring sampling period for raised and ground units, respectively; and 79.0% and 98.9% of the fall sampling period for raised and ground units, respectively. Anabat units recorded 535 bat passes on 323 detector-nights during the spring and 11,730 bat passes on 860 detector-nights during the fall. The average spring bat activity (mean ± standard error) was 2.57 ± 0.06 and 0.56 ± 0.02 bat passes per detector-night for ground and raised stations, respectively. The average fall activity was 16.72 ± 1.52 and 5.19 ± 0.59 at ground and raised stations, respectively. The big brown/silver-haired group composed the majority of calls identified to species groups (44.1%), followed by eastern red bat (25.5%) and hoary bat (17.8%). Hoary bats were the most commonly identified call at raised stations, while big brown/silver-haired were the most commonly identified call at ground stations. *Myotis* species composed 0.2% of calls identified to species group, and no calls were identified as Indiana bat by WEST biologists.

Relationships between bat casualty rates, bat activity, turbine model, and weather were evaluated utilizing generalized linear modeling during the fall migration period of 2011. The 2011 study involved feathering blades at 126 of the 168 turbines searched on a daily basis. The blade feathering experiment altered the relationship between bat fatalities and wind speed, with fewer bat fatalities occurring when winds were below cut-in speeds of turbines. A total of about 77% of all bat fatalities and 73% of all bat activity recorded by detectors on nacelles occurred below 5.5 m/s. This suggests that wind speeds above certain thresholds greatly reduce bats' ability to fly near nacelle height.

In 2011, bat fatality rates and barometric pressure were inversely related. Barometric pressure typically decreases in advance of weather fronts, followed by precipitation events. It is unclear if the relationship between barometric pressure and bat fatalities was the result of bats migrating in front of oncoming weather fronts, or decreases in bat activity and bat fatality rates associated with precipitation and increasing barometric pressure after storm fronts arrived. Bat fatality rates were positively associated with increasing barometric pressure in 2010. The differences in this relationship between 2010 and 2011 present seemingly contradictory results. However, 2010 was one of the driest summer and fall periods on record in Indiana, and many passages of fronts in 2010 were not followed by precipitation events. The summer and fall of 2011 was closer to the historical average for precipitation.

Other researchers have also noted relationships between lower wind speeds and passage of weather fronts on bat activity and casualty rates in Tennessee, West Virginia, Iowa, and Wisconsin. The consistency of results across wind-energy facilities and regions suggests it is possible to predict when the largest numbers of bat casualties occur, which can serve as a basis for designing strategies to reduce bat casualty rates.

Turbine model was a significant predictor of bat fatalities in 2011, with more bat fatalities observed at control Vestas and Clipper turbines, and fewer observed at control GE turbines. Although Clipper turbines have a greater rotor swept area, control Vestas turbines showed a higher per turbine fatality rate in 2011 compared to control Clipper and GE turbines. Further examination in 2011 suggests that turbine behavior prior to reaching cut-in speeds may also affect bat fatality rates. Prior to reaching cut-in speeds in 2011, control Vestas turbines were spinning more often and at higher speeds than GE and Clipper turbines. Differences in turbine behavior between turbine type prior to reaching cut-in speeds, as well as the results of the blade feathering experiment, suggest that the rotor swept area was not the only factor determining differences in bat fatality rates between turbine types. Bats are more active during lower wind speeds, and decreasing the amount of time turbines are spinning during lower wind speeds significantly decreased bat fatality rates.

The results of research conducted at FRWF during 2010 and 2011 show that comparable estimates of overall bat casualty rates can be obtained utilizing roads and pads as the primary sampling unit, under a double sampling strategy, compared to reliance on cleared plots. The results also show that daily searches are not needed to calculate comparable casualty estimates at FRWF assuming the carcass removal rates remain similar in the future. Use of roads and pads as sampling units provide a more cost-effective method for estimating overall bat casualty rates at FRWF compared to reliance on cleared plot searches or searches of standing corn and soybean fields.

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INTRODUCTION AND BACKGROUND

The Fowler Ridge Wind Farm (FRWF) is located in Benton County, Indiana, and currently consists of 355 wind turbines in three operating phases (Figure 1). A post-construction casualty study of birds and bats was conducted by Western EcoSystems Technology, Inc. (WEST) in Phases I and III during 2009 (Johnson et al. 2010a, 2010b, Good et al. 2011). During such study, an Indiana bat carcass was discovered by staff at the FRWF. A Scientific Research and Recovery Permit (SRRP) for the Indiana bat (TE15075A-2) was issued for further research for Phases I, II, and III in 2010 and 2011. One additional Indiana bat carcass was found, in the fall of 2010 (Good et al. 2011). As a result of this discovery, the US Fish and Wildlife Service (USFWS) Field Office in Bloomington, Indiana, recommended that the FRWF develop a Habitat Conservation Plan (HCP). Consequently, the owners of the FRWF requested that WEST conduct further research of Indiana bat use and methods for reducing bat fatality rates. The results of the research at the FRWF will be used for developing an HCP and applying for an Incidental Take Permit (ITP) from Region 3 of the USFWS. The results presented in this report were collected under the SRPP referenced above.

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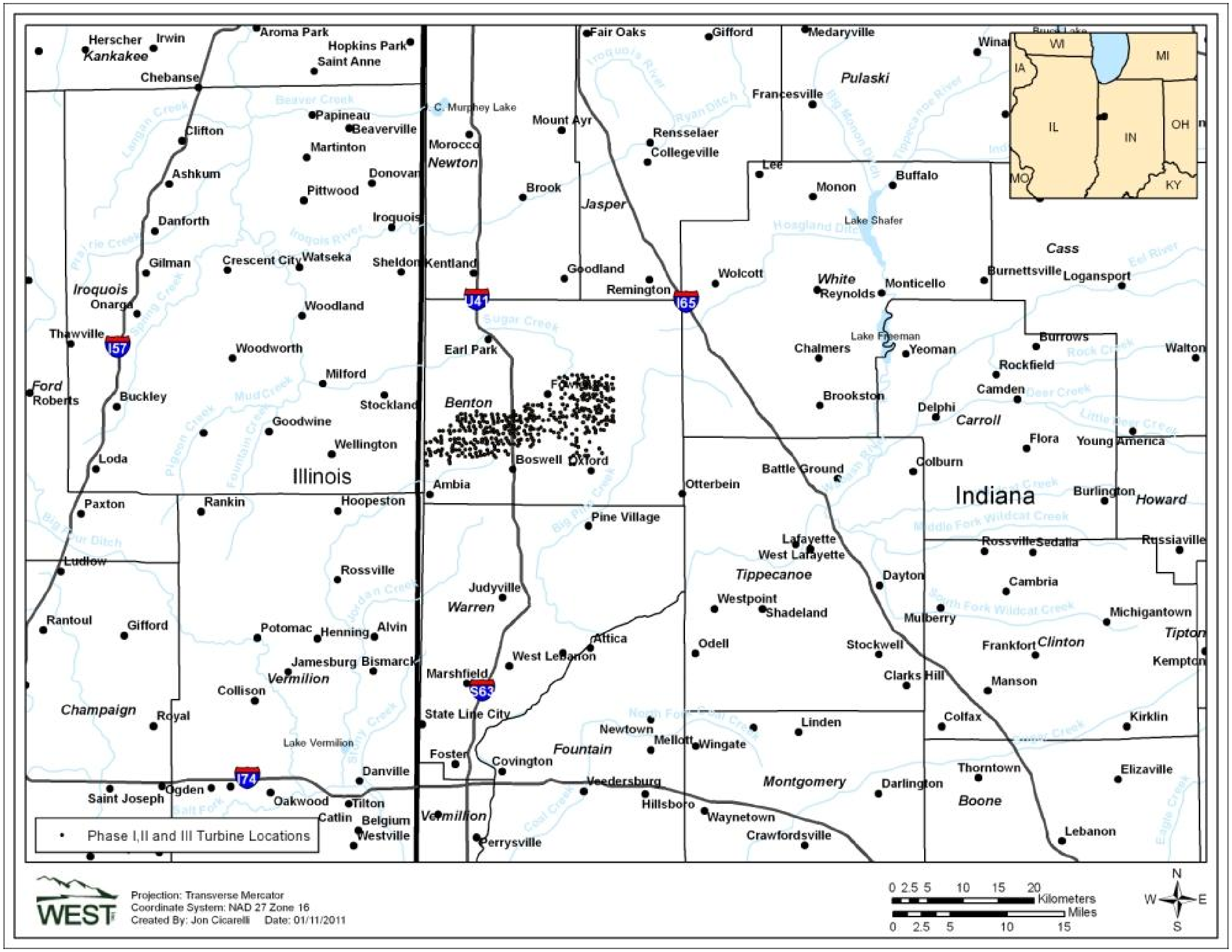

Figure 1. Location of the Fowler Ridge Wind Farm, Phases I, II and III.

STUDY AREA

The FRWF currently has a total energy capacity of 600 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.

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]). The area averages 40 inches (102 centimeters [cm]) of precipitation per year and average temperatures range from 19 to 45 °F (-7.2 to 7.3 °C) in January to 65 to 86 °F (18 to 30 °C) in July. 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 (Figure 3), 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 km) of turbine locations, row crops comprise about 93% of the land use for the study area (Homer et al. 2004; Table 2, Figure 3). 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.

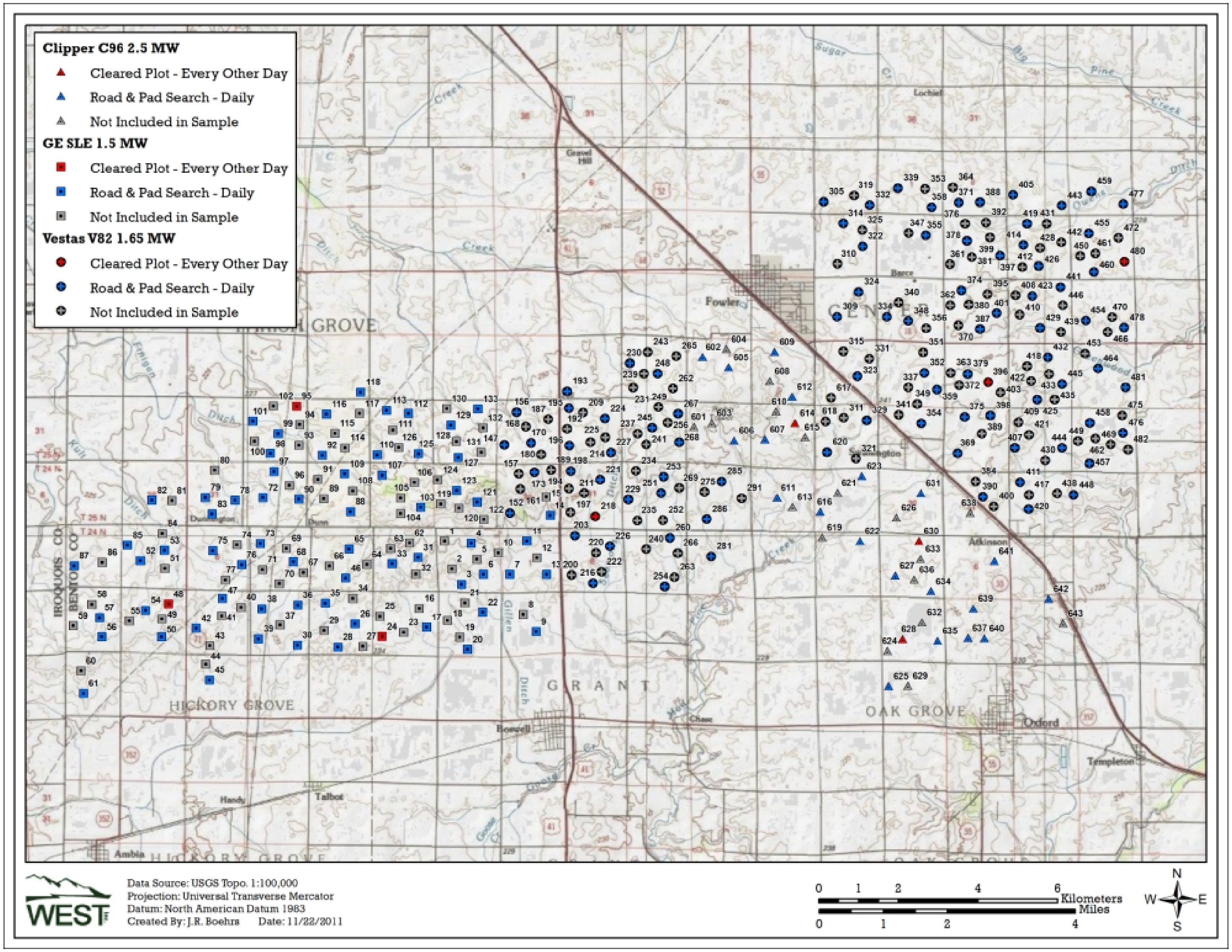

Figure 2. Elevation and topography of the Fowler Ridge Wind Farm.

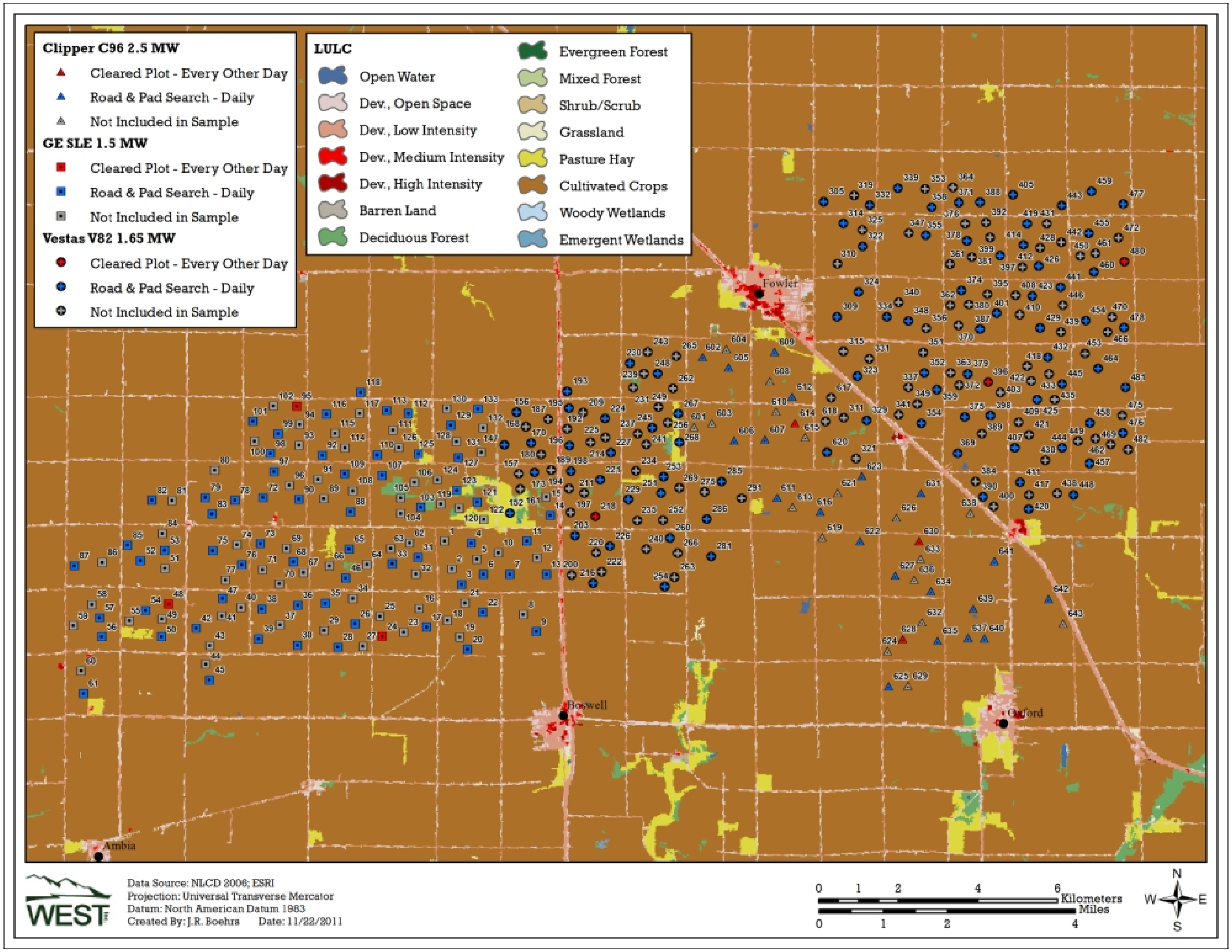

Figure 3. Turbine locations and land cover data at the Fowler Ridge Wind Farm (USGS NLCD 2001).

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	<0.01
Total	**59,035.05**	**100**

METHODS

Seasons

The 2011 casualty study occurred during spring (April 1 – May 15) and fall (July 15 – October 29) migration periods for Indiana bats (USFWS 2007). The FRWF is located within an area dominated by corn and soybean fields, and forest cover is rare. Based on the overall lack of forest cover, as well as an assessment of the project by the USFWS, Indiana bats were assumed to be absent during summer. The first Indiana bat carcass was found on September 11, 2009 (see USFWS 2010) and the second Indiana bat carcass was found on September 18, 2010 (Good et al. 2011). Based on timing and land cover surrounding the carcasses and turbines, the bats were assumed to have been fall migrants. The vast majority of bat fatalities of other species at Fowler I, II and III, and at other wind energy facilities, have also been found during the fall migration period, with a smaller peak of fatalities occurring during the spring migration period (Arnett et al. 2008; Johnson et al. 2010a, 2010b).

Search Plot and Sample Size

The FRWF is currently comprised of 355 turbines. One-hundred-seventy-seven turbines (50%) were sampled during the study (Figures 2 and 3). These 177 turbines included 136 turbines sampled in the fall of 2010. An additional 41 turbines were selected using a systematic sample with a random start to ensure sampling locations were representative of the entire FRWF.

During spring, carcass searches were conducted along access roads and turbine pads within 80 m (262 ft) of 177 turbines. The results of the 2010 study supported the use of road and pad searches for generating comparable and unbiased overall bat fatality estimates (Good et al. 2011).

During the fall, 168 turbine pads and roads were searched daily from July 15 – October 15, 2011. Circular 80-m radius plots (160 m [525 ft] in diameter; Figure 4) at nine turbines were maintained relatively free of vegetation during the fall in order to increase searcher efficiency rates. Weed and crop growth was minimized throughout the fall through the use of herbicides and mowing. Per USFWS request, three of each type of turbine (Clipper, Vestas, and GE turbines) were included in the nine cleared plots. The nine turbines were selected from the 36 cleared plots searched in 2010.

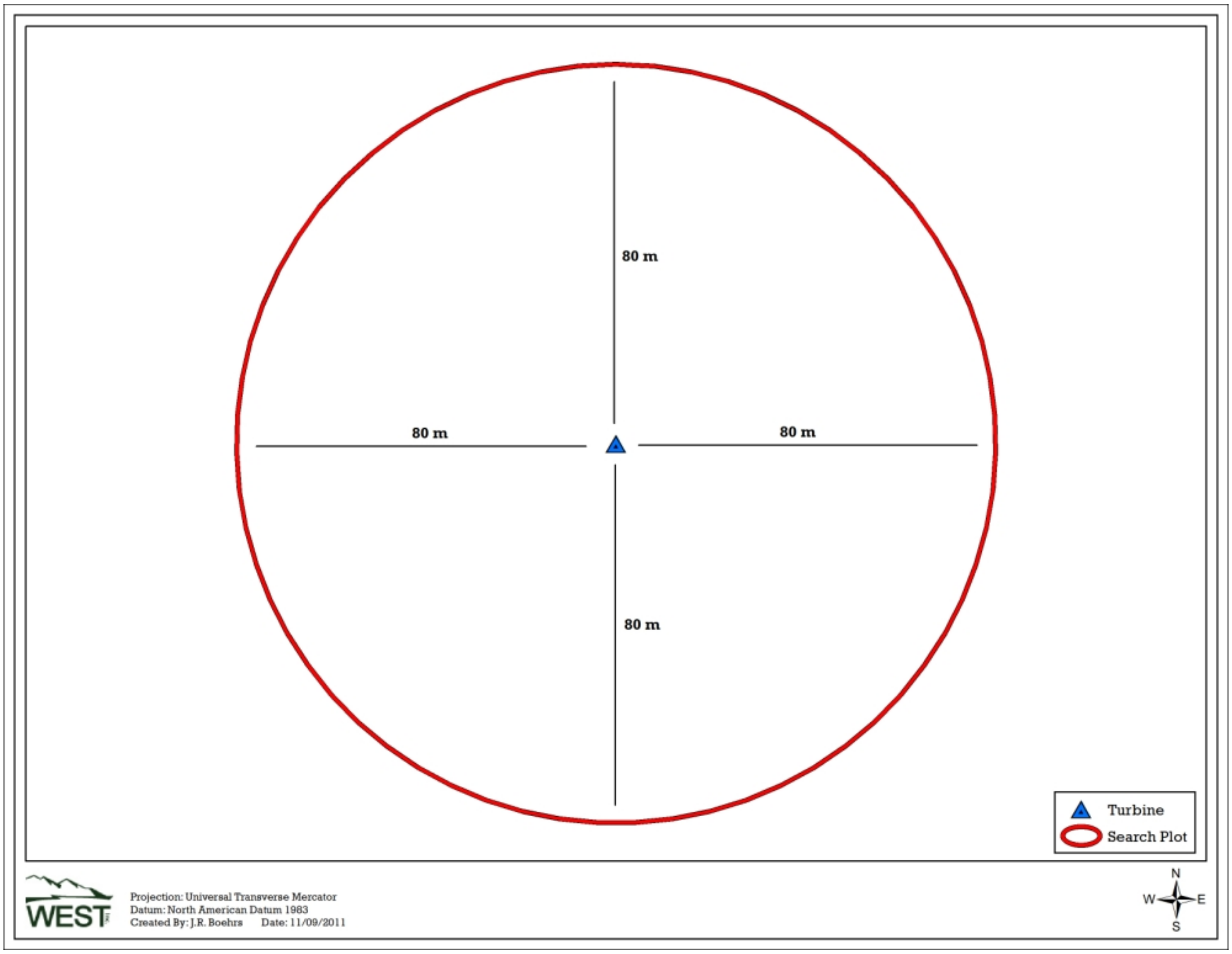

Figure 4. Example diagram of a cleared plot at the Fowler Ridge Wind Farm.

Search Frequency

Turbines were searched at 6-day intervals during the spring. The search intervals utilized in 2011 were based on the results of the 2010 casualty study. The mean carcass removal times in 2010 at roads and pads and cleared plots were 11.83 and 10.34 days, respectively (Good et al. 2011).

Turbines were searched at three intervals during the fall. One-hundred-sixty-eight turbine pads and roads were searched daily from July 15 – October 15, 2011 as part of the blade feathering experiment. The nine circular plots were used as “control turbines” and were searched every other day from July 15 – October 15, 2011. Per USFWS request, two additional searches (one per week) were conducted at the 177 sample turbines between October 15 – October 29, 2011.

Data from the weekly searches were used to determine if late migration fatality events occurred at the FRWF.

Facilities Management Study

The effectiveness of feathering turbine blades below multiple cut-in speeds for reducing bat casualty rates was evaluated during the fall of 2011. Facility management studies were limited to the fall because relatively few bat fatalities were expected to occur during the spring of 2011 (see Johnson et al. 2010a), potentially reducing WEST's ability to detect significant differences in casualty rates between treatments.

Bat casualty rates were measured at three different speed adjustments, or "treatments", and two sets of "control" turbines with no cut-in speed adjustment. Nine turbines were randomly selected from the sample of 36 cleared plots searched in 2010, and were considered a "control" sample, operating normally for the duration of the study. The nine control turbines were comprised of three GE SLE 1.5-MW turbines, three Clipper C96 2.5-MW turbines, and three Vestas V82 1.65-MW turbines. Treatments for blade feathering and a second set of "control" turbines were rotated on a nightly basis between the remaining 168 turbines, with 42 turbines assigned to each group. The treatments included turbines with blades feathered below 5.5 meters per second (m/s) (12.3 mph), below 4.5 m/s (10.1 mph), below 3.5 m/s (7.8 mph), and a control group with no feathering (Table 3). Turbines were assigned to control and treatment groups among the 168 turbines on a nightly basis using a balanced block design to ensure that equal numbers of each turbine type were assigned to each treatment.

Table 3. The 2011 fall study design treatments at the Fowler Ridge Wind Farm.

Treatment	Number of Turbines	Search Type
5.5 cut-in and feathering	42	Road and Pad
4.5 cut-in and feathering	42	Road and Pad
3.5 cut-in and feathering	42	Road and Pad
Control (3.5) and no feathering	42	Road and Pad
Control (3.5) and no feathering	9	Cleared Plot
Total	**177**	

Field Methods

Casualty Searches

Personnel trained in proper search techniques conducted the carcass searches. Searches occurred along transects within each search plot. 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 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 (H) each morning, and were completed by sunset, with most searches completed by early afternoon.

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

- 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.

Fresh bat carcasses found were collected, identified, and utilized during searcher efficiency and carcass removal trials (except for *Myotis* species; see below for more details). Older or scavenged bat carcasses were identified to the extent possible, labeled with a unique number, and then bagged and frozen for future reference and possible necropsy. 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 (GPS) location, condition (intact, scavenged, feather spot), location within plot (road and turbine pad versus other areas), vegetation cover, and any comments that may indicate cause of death. All bird and bat carcasses located were photographed as found and plotted on a detailed map of the study area, showing the location of the wind turbines and associated facilities. Estimated time since death for bats was also recorded. Criteria used to determine time since death was based on daily observations of bat carcasses placed in plots during bias trials (Appendix A).

Casualties found outside the formal search area by searchers, or carcasses reported to searchers by FRWF maintenance 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 search area) were coded 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 observed in search plots were recorded and treated as a casualty for the purposes of the analyses.

All *Myotis* carcasses were identified to species by biologists trained in the identification of *Myotis* species, including Indiana bat, and were delivered to the USFWS office in Bloomington, Indiana. Skin samples were sent to Dr.Jan Zink at Portland State University for identification via deoxyribonucleic acid (DNA) analysis, in order to verify field identifications of *Myotis* species that could not be conclusively identified.

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. A list of random turbine numbers and random azimuths and distances (m) from turbines was generated for placement of each bat used in bias trials.

During the fall, only freshly killed bats conclusively identified as non-*Myotis* species were used for searcher efficiency and carcass removal trials. At the end of each day's search, the field crew leader gathered all bat carcasses located during that day's surveys and then separated intact and fresh carcasses from scavenged carcasses. Intact carcasses were redistributed regularly to predetermined random points within any given turbine's searchable area. Searchers had no knowledge of the number and placement of carcasses at turbines. Data recorded for each trial carcass prior to placement included date of placement, species, turbine number, and the distance and direction from the turbine. Carcasses were identified as bias trial carcasses through the placement of small, indistinct black zip ties on the bats' wings. During spring, a mix of freshly killed non-*Myotis* bats and previously frozen bats obtained from Indiana State University were used in field bias trials in order to increase bias trial sample sizes. Twenty-five additional brown mouse carcasses, ranging in weight from seven to nine ounces (oz.; 198 to 255 grams), were used during spring migration carcass removal trials only.

Each trial bat was left in place and checked daily by the field crew leader or an observer not involved with the casualty searches; thus, trial bats were available and could be found by observers on consecutive searches unless the carcasses were previously removed by a scavenger. The date that each bat was found by an observer was recorded to determine the amount of time the carcass remained in the scavenger removal trial. If, however, a carcass was removed by a scavenger before detection by an observer, it was removed from the searcher efficiency trial and used only in the removal data set. When a bat carcass was found, the observer inspected the wing to determine if a bias trial carcass had been found. If so, the observer contacted the field crew leader and the bat was left in place for the carcass removal trial. Carcasses were left in place until removed by a scavenger, until they became decomposed to a point beyond recognition, or for a maximum of 24 days, at which time the number of days after placement was recorded.

Statistical Analysis

Casualty Estimates

Two methods were utilized to calculate overall bat casualty estimates: 1) Shoenfeld estimate of carcass availability (see Shoenfeld 2004), and 2) empirical measure of carcass availability. The Shoenfeld estimate is typically used when search intervals are fairly wide, and the probability of a carcass being found by a searcher needs to be estimated. The Shoenfeld estimate was calculated to provide a comparable overall bat casualty estimate to the 2009 study results (Johnson et al. 2010b) and was based on carcass persistence and searcher efficiency results. For 2011 surveys, a second bat casualty rate was calculated utilizing an estimate of the probability of detection that does not separate out the influence of scavenging versus searcher detection. This empirical estimate was based on the overall ratio of the number of trial carcasses found by searchers to the number placed. Only bats found at cleared plots in 2011 were used to estimate total bat casualty estimates using both methods.

Estimates of the number of facility-related fatalities were based on:

1) Observed number of carcasses found during standardized searches during the monitoring period;

2) Non-removal rates expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the observers during removal trials;

3) Searcher efficiency expressed as the proportion of trial carcasses found by observers during searcher efficiency trials;

4) Adjustment factor for bats landing outside of the search area.

Definition of Variables

The following variables were used in the equations below:

c_i	the number of carcasses detected at plot *i* for the entire study period
n	the number of search plots
k	the number of turbines searched
$\bar{c}$	the average number of carcasses observed per turbine per monitoring period
s	the number of carcasses used in removal trials
s_c	the number of carcasses in removal trials that remained in the study area after 24 days
se	standard error (square of the sample variance of the mean)
t_i	the time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
$\bar{t}$	the average time (in days) a carcass remained in the study area before it was removed, as determined by the removal trials
d	the total number of carcasses placed in searcher efficiency trials
p	the estimated proportion of detectable carcasses found by observers, as determined by the searcher efficiency trials
I	the average interval between standardized carcass searches, in days
A	proportion of the search area of a turbine actually searched
$\hat{\pi}_S$	the Shoenfeld estimate for the probability that a carcass was both available to be found during a search and was found, as determined by the removal trials and the searcher efficiency trials

$\hat{\pi}_E$ the empirical estimate for the probability that a carcass was both available to be found during a search and was found, as determined by the ratio of trial carcasses found over a 24-day period to the number of carcasses placed

m the estimated average number of fatalities per turbine per monitoring period, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

The estimated average number of carcasses ($\bar{c}$) observed per turbine per monitoring period was:

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{k \cdot A} \quad (1)$$

Estimation of Carcass Non-Removal Rates

Estimates of carcass non-removal rates were used to adjust carcass counts for removal bias. Mean carcass removal time ($\bar{t}$) was the average length of time a carcass remained in the study area before it was removed:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c} \quad (2)$$

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were expressed as *p,* the proportion of trial carcasses that were detected by observers in the searcher efficiency trials.

Estimation of Facility-Related Casualty Rates

The estimated per turbine casualty rate (*m*) was calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \quad (3)$$

where $\hat{\pi}_S$ includes adjustments for both carcass removal (from scavenging and other means) and searcher efficiency bias. Data for carcass removal and searcher efficiency bias were pooled across the study to estimate $\hat{\pi}_S$.

$\hat{\pi}_S$ is calculated as follows:

$$\hat{\pi} = \frac{\bar{t} \cdot p}{I} \cdot \left[\frac{\exp\left({}^{I}\!/\!_{\bar{t}} \right) - 1}{\exp\left({}^{I}\!/\!_{\bar{t}} \right) - 1 + p} \right]$$

This formula has been independently verified by Shoenfeld (2004). Empirical estimates for the probability of availability and detected $\hat{\pi}_E$ were caculated by the following equation.

$$\widehat{\pi_E} = \frac{number\ of\ trial\ carcasses\ detected}{number\ of\ trial\ carcasses\ placed}$$

The final reported estimates of *m* and associated standard errors and 90% confidence intervals (CI) were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics.

For each bootstrap sample, $\bar{c}$, $\bar{t}$, *p*, $\hat{\pi}$, and *m* were calculated and a total of 5,000 bootstrap samples were used. The reported estimates are the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates was the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates were estimates of the lower limit and upper limit of 90% confidence intervals.

Effects of Blade Feathering

Fatality rates at turbines with normal operation parameters versus fatality rates at turbines feathered below 3.5 m/s, 4.5 m/s, and 5.5 m/s were compared using a chi-square test of proportions. Chi-squared test of proportions were used to determine if significantly fewer fatalities were found under feathered turbine operation than under normal turbine operation. In addition to a chi-square test of proportions, differences in observed fatality rates by feathering condition were examined by building a negative binomial model to determine the relative difference in casualty rates. The magnitude of model coefficients represented the relative ratio of casualty rates between feathered operation at a given cut-in speed and those with no feathering. Tests for variable selection were used to assess the statistical significance of the *f* covariates corresponding to the levels of feathered operation. Since feathering condition was rotated nightly among turbines, only carcasses of bats that were estimated to have died the night prior to searches were included in the analysis.

Correlation Analyses

Weather and operational data from casualty search turbines and a meteorological (met) tower were analyzed in relation to fall 2011 mortality rates at the FRWF. Average nightly wind speed, rotor speed, ambient temperature, and barometric pressure, along with average nightly bat activity from Anabat™ acoustic surveys were included in a generalized linear regression model for daily fresh bat fatality rates (Table 4). Daily fatality rates were calculated using bat fatalities that were estimated to have died during the night preceding fall road and pad searches for each feathering level.

Table 4. Description of variables used in bat mortality and weather modeling

Response Variable	
Daily Fresh Bat Fatality Rates	The number of fresh fatalities (estimated to have died the preceding night) found during road and pad searches under each feathering treatment, divided by the number of searches conducted of the same
Explanatory Variables	
Turbine Brand	GE, Vestas, Clipper
Curtailment Level	3.5 m/s Normal Operation, 3.5 m/s Feathered, 4.5 m/s Feathered, 5.5 m/s Feathered
Wind Speed	Average nightly wind speed (m/s)
Rotor Speed	Rotations per minute to the turbine rotor (rpm)
Temperature	Average nightly ambient temperature (degrees Celsius)
Barometric Pressure	Average nightly barometric pressure (atmospheres)
Acoustic Activity	Nightly number of bat passes per operable Anabat detector

Associations between turbine, weather characteristics, acoustic activity and fresh bat casualties were investigated using graphical methods generalized linear multiple regression (Neter et al. 1996). Daily fresh bat fatality counts (F) were modeled using a negative binomial distribution with an offset term for the corresponding number of turbines searched that day that had operated under each curtailment level the preceding night (n_j). The fitted negative binomial models all had log link and were of the form:

$$\log\left(\frac{F}{n_j}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon \ ,$$

which related the behavior of the natural logarithm of the fresh bat fatality rate, to a linear function of the set of predictor variables $x_1, \ldots, x_p$. The β_j's are the parameters that specify the nature of the relationship and ε was a random error term. The statistical software R was used to perform step-wise variable selection based on Bayesian information criterion (BIC) to determine the best fitting negative binomial models. Stepwise variable selection performed a forward and backward stepwise approach in which variables entered or left the model based on the BIC value. The first step began with the full model containing all parameters. In the next step, covariates were added or subtracted from the model one at a time. If the model BIC decreased, the change in covariates was retained. If BIC increased, that change was discarded and the next covariate was tested. This procedure was repeated until none of the covariate changes produced a lower BIC. The final model was based on the results of stepwise variable selection and biological inference.

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 inspecting data forms 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 raw data forms, and appropriate changes in all steps were made. A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were entered into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Bat Acoustic Surveys

Bat surveys were conducted utilizing passive sampling techniques at turbines and at reference locations that were previously sampled in 2007. Sampling occurred at the base of four turbines and on nacelles during the spring and fall migration periods (Figure 5) to explore relationships between bat pass rates, bat casualty rates, and weather variables (Figure 6). Bat use was also monitored from July 28 – October 31 at two reference locations that were sampled in 2007 in order to determine if bat pass rates were similar before and after construction of the FRWF (Figure 6).

Bats were surveyed using Anabat™ II bat detectors (Titley Scientific™, Australia) coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Scientific), as well as Anabat™ SD1 detectors. Anabat detectors record bat echolocation calls with a broadband microphone. The echolocation sounds are translated into frequencies audible to humans by dividing the frequencies by a predetermined ratio. A division ratio of 16 was used for the study. Bat echolocation detectors also detect other ultrasonic sounds, such as those sounds made by insects, raindrops hitting vegetation, and other sources. A sensitivity level of six was used to reduce interference from these other sources of ultrasonic noise (see Brooks and Ford 2005). Calls were recorded to a compact flash memory card with large storage capacity. The detection range of Anabat detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the bat, atmospheric conditions; Limpens and McCracken 2004), but is generally less than 30 m (98 ft) due to atmospheric absorption (attenuation) of echolocation pulses (Fenton 1991). To ensure similar detection ranges among detectors, microphone sensitivities were calibrated using a BatChirp (Tony Messina, Las Vegas, Nevada) ultrasonic emitter as described in Larson and Hayes (2000). All units were programmed to turn on each night approximately 30 minutes (min) before sunset and to turn off approximately 30 min after sunrise.

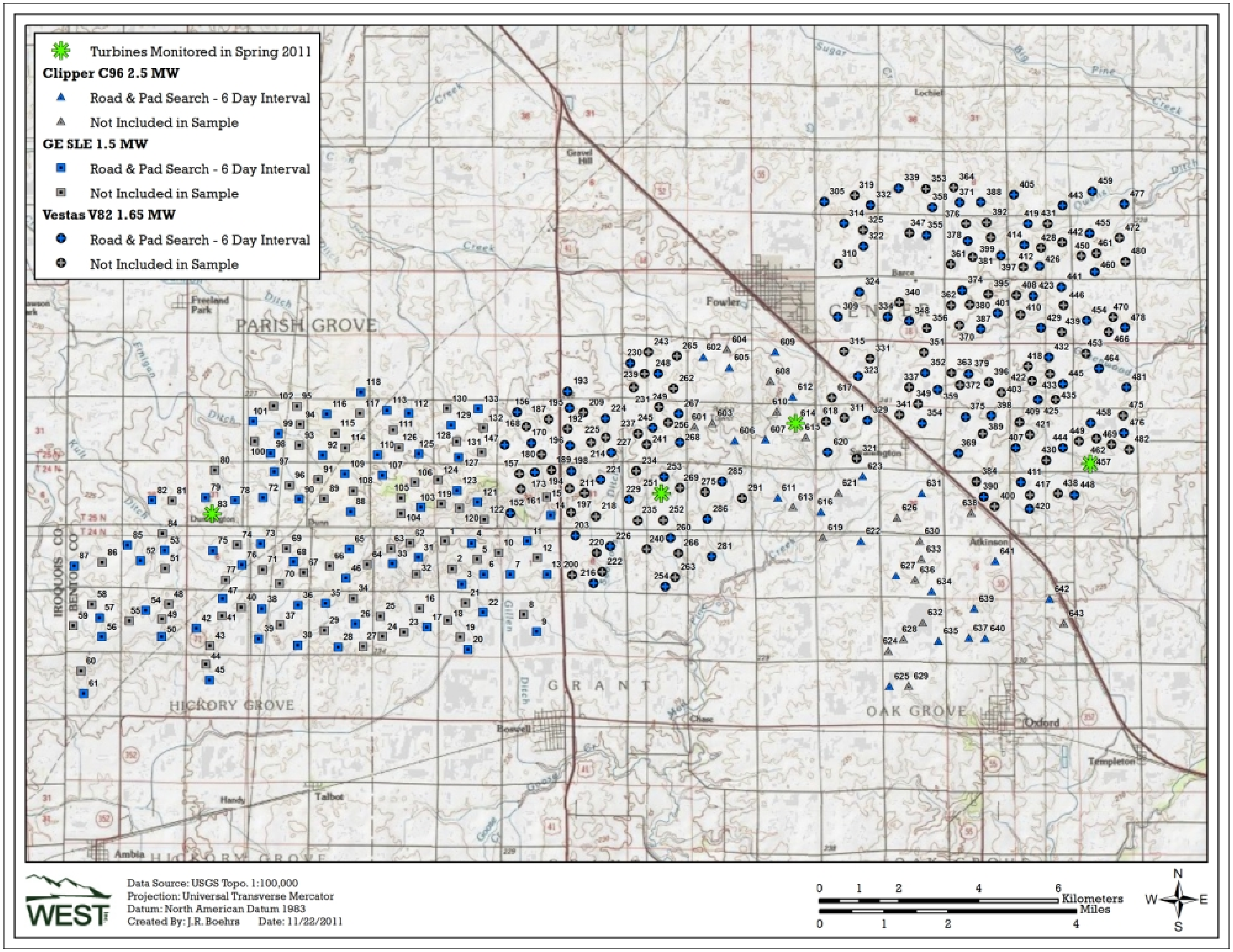

Figure 5. Study area map and spring fixed Anabat sampling stations at the Fowler Ridge Wind Farm.

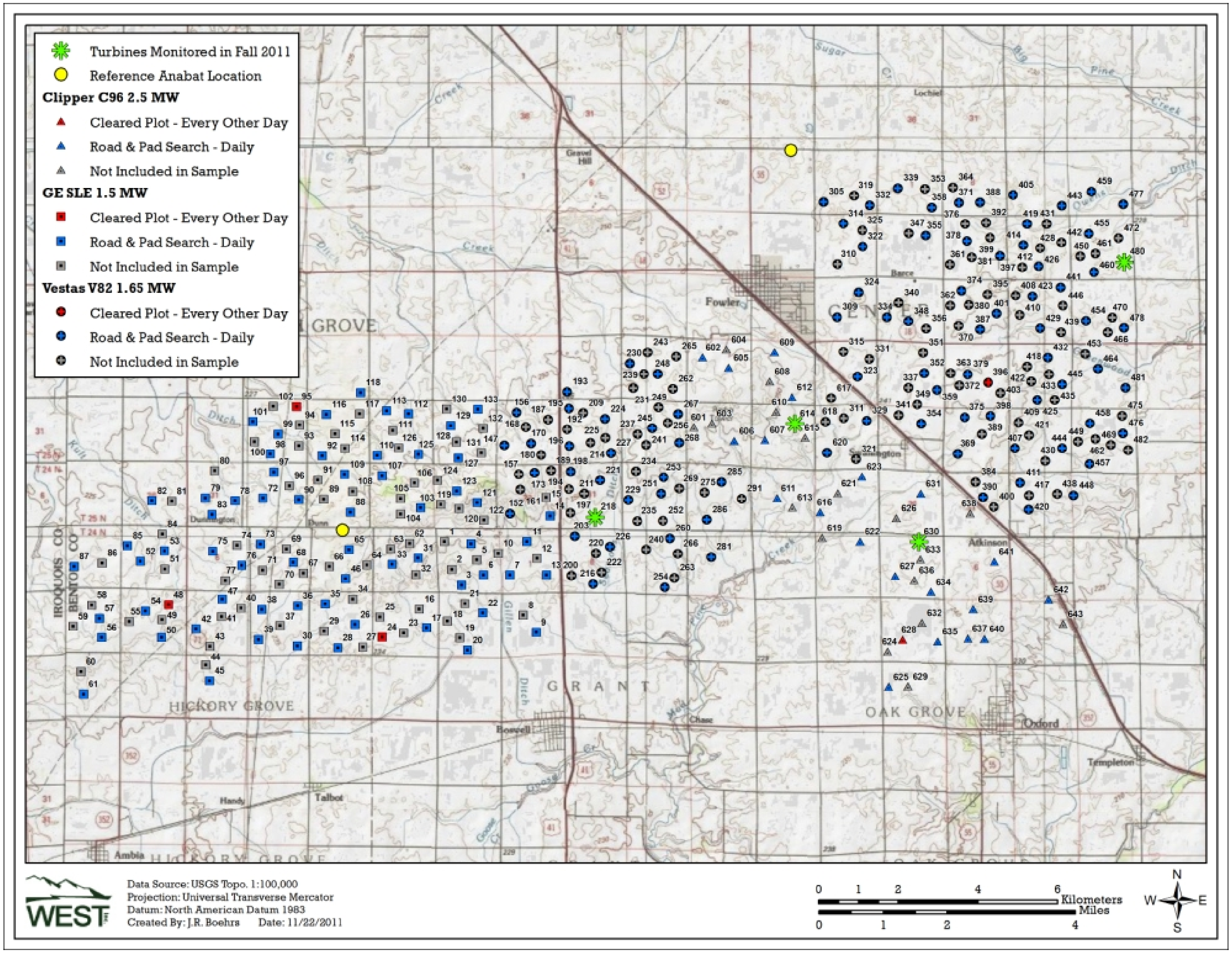

Figure 6. Study area map and fall fixed Anabat sampling stations at the Fowler Ridge Wind Farm.

To minimize the potential for water damage due to rain, Anabat detectors were placed inside plastic weather-tight containers that had a hole cut in the side through which the microphone extended. The microphones were encased in poly-vinyl chloride (PVC) tubing that curved skyward at 45 degrees outside the container, and holes were drilled in the PVC tubing. Detectors protected in this manner have been found to detect similar numbers and quality of bat calls as detectors exposed to the environment, and to record twice as many species as detectors protected with Bat-Hat (EME Systems, California) weatherproof housing (Britzke et al. 2010). Containers placed at the base of turbines were raised approximately 0.5 m (1.7 ft) off the ground to minimize echo interference and lift the unit above vegetation (Figure 7). Containers were also placed on nacelles, approximately 80 m above the ground (Figure 8). Anabat units on nacelles were connected to a GETMYLOG.com global data repository system (GML) and data were downloaded remotely.

Figure 7. Anabat unit placed at the base of a turbine at the Fowler Ridge Wind Farm.

Figure 8. Anabat unit mounted on the nacelle of a wind turbine at the Fowler Ridge Wind Farm.

Statistical Analysis

Bat Acoustic Surveys

Bat activity was measured by counting the number of bat passes (Hayes 1997), which was defined as a continuous series of two or more call notes (pulses) produced by an individual bat with no pauses between call notes of more than one second (White and Gehrt 2001, Gannon et al. 2003). The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected for effort by dividing by the number of detector-nights. One detector collecting data for one night was a detector-night.

For each station, bat calls were sorted into three groups, based on their minimum frequency, that correspond roughly to species groups of interest. For example, most species of *Myotis* bats and the tri-colored bat (*Perimyotis subflavus*) echolocate at frequencies above 40 kilohertz (kHz), whereas species such as the eastern red bat (*Lasiurus borealis*) typically have echolocation calls that fall between 30 kHz and 40 kHz. Species such as big brown (*Eptesicus fuscus*), silver-haired (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*) have echolocation frequencies that fall at or below 25 kHz. Therefore, calls were classified as being given by high-frequency (HF; more than 40 kHz), mid-frequency (MF; 30 kHz - 40 kHz), or low-frequency (LF; less than 30 kHz) species. Although eastern red bat calls typically occur in the MF category, eastern red bat calls are variable, and may also occur within the HF category. To establish which species may have produced passes in each category, a list of species expected to occur in the study area was compiled from range maps (Table 5; Whitaker 2009). Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a pass were removed from the analysis.

Table 5. Bat species with ranges that overlap with the Fowler Ridge Wind Farm, sorted by call frequency (Whitaker et al. 2007, Whitaker 2010).

Common Name	Scientific Name
High-Frequency (> 40 kHz)	
little brown bat[3]	*Myotis lucifugus*
northern long-eared bat[3]	*Myotis septentrionalis*
Indiana bat*[, 3]	*Myotis sodalis*
tri-colored bat (formerly eastern pipistrelle) [2,3]	*Perimyotis subflavus* (*Pipistrellus subflavus*)
Mid-Frequency (30-40 kHz)	
eastern red bat[1,3]	*Lasiurus borealis*
evening bat[2,3]	*Nycticeius humeralis*
Low-Frequency (< 30 kHz)	
big brown bat[3]	*Eptesicus fuscus*
silver-haired bat[1,3]	*Lasionycteris noctivagans*
hoary bat[1,3]	*Lasiurus cinereus*

1 = long-distance migrant
2 = species distribution on edge or just outside project area
3 = known casualty from wind turbines, species reported as fatalities by Kunz et al. 2007, USFWS 2010, and this study
*= Federally listed endangered species (USFWS 2011)

All calls of sufficient quality were identified to species by a biologist with acoustic identification experience (K. Murray) based on comparison of qualitative call characteristics to a known call library (O’Farrell et al. 1999, Murray et al. 2001, Yates and Muzika 2006). All high-frequency (above 40 kHz) bat calls were also examined to determine if they were potentially made by Indiana bats. In order to identify calls potentially made by Indiana bat, call characteristics were entered into a Discriminant Function (DF) model designed to statistically classify unknown echolocation calls based on comparison to a set of known echolocation calls. DF models have been used by other researchers to classify bat calls to species, including the Indiana bat (Britzke et al. 2002, Robbins et al. 2008, Wolff et al. 2009).

The DF model has been developed based on a library of 599 known bat call files from 11 species that occur in the Midwest, including 89 known Indiana bat call files (Murray et al. 2001). The correct classification rate for Indiana bats based on this initial model is approximately 90%. A detailed description of the model assumptions, parameters, and classification rates can be found in Appendix B.

While the DF model is a useful tool, the potential exists for “false positive” and “false negative” results to occur. In order to increase confidence in call identifications, any calls potentially identified as made by Indiana bat by the DF model were: 1) analyzed utilizing the “Britzke” filter; and 2) identified to species or species group (e.g. Myotis) based on comparison of qualitative call characteristics to a known call library (O’Farrell et al. 1999, Murray et al. 2001, Yates and Muzika 2006). Call characteristics such as minimum frequency, slope, and structure were used to identify calls. Calls were considered to be made by Indiana bats if they were positively identified by all of the three methods.

RESULTS

The following sections contain the results of studies conducted under SRRP TE15075A-2. Per the requirements of this permit, information regarding the date, time, and locations of bats encountered (Appendices C and D), locations where no bats were encountered (Appendix E), and detailed information in nightly operating parameters of each turbine searched and which specimens were salvaged at each turbine (Appendix E). Other information required under permit TE15075A-2 can be found below.

Bat Fatalities

Overall, 17,900 surveys were conducted across 177 turbines from April 1, to May 15, 2011 and from July 15, to October 29, 2011. Roads and pads of 177 turbines were searched at 6-day intervals during the spring for a total of 1,416 surveys. During the fall study period, 168 turbines were searched on roads and pads daily for a total of 16,040 surveys. Additional searches at nine turbines with 80 m radius circular plots cleared of crops were conducted every other day for a total of 444 surveys.

A total of 573 bat carcasses were found, of which 425 bats were found during regularly scheduled searches, with an additional seven bats found incidentally at turbine search plots. Of the remaining 141 bat carcasses, 18 that were found during a clearing search or had an estimated time of death placing them as should have been found during the clearing search, one bat was estimated to have been killed after October 15, 86 were found by FRWF wind technicians at turbines that were not searched by WEST, and 36 were found on cropland during scheduled road and pad searches (Table 6).

Table 6. Total number of bat casualties and the composition of casualties discovered at the Fowler Ridge Wind Farm from April 1 to May 15 and July 15 to October 15, 2011.

Species	Scientific Name	Scheduled Search Fatalities	Incidental Fatalities During the Study[1]	Other Incidental Fatalities[2]	Total Fatalities	% Comp
eastern red bat	*Lasiurus borealis*	221	5	79	305	53.2
hoary bat	*Lasiurus cinereus*	114	1	44	159	27.8
silver-haired bat	*Lasionycteris noctivagans*	67	0	14	81	14.1
big brown bat	*Eptesicus fuscus*	13	1	2	16	2.8
evening bat	*Nicticeius humeralis*	3	0	1	4	0.7
tri-colored bat	*Perimyotis subflavus*	3	0	0	3	0.5
Seminole bat	*Lasiurus seminolus*	3	0	0	3	0.5
little brown bat	*Myotis lucifugus*	1	0	1	2	0.4
Overall	**8 species**	**425**	**7**	**141**	**573**	**100**

1 Bat carcasses found that were estimated to have been killed during the course of the study, and were found within search plot boundaries, but were not found during scheduled carcass searches

2 Bat carcasses found that were estimated to have been killed prior to the start of the study, or carcasses that were found outside of plot boundaries.

Species Composition

Similar to 2010, the most commonly found bat species was eastern red bat (305 fatalities, 53.2% of fatalities), followed by hoary bat (159 fatalities, 27.8%), silver haired bat (81 fatalities, 14.1%), and big brown bat (16 fatalities, 28%). Two new species were found in 2011, including four evening bats (*Nicticeius humeralis*) and three Seminole bats (*Lasiurus seminolus*). No Indiana bat carcasses were found in 2011, and similar to 2010, *Myotis* casualties were rare in 2011. Two *Myotis* carcasses were found, both little brown bats (*Myotis lucifugus*). The number of males and females found were similar for most species, with the exception of silver-haired bat (Table 7).

Table 7. Gender composition by bat species found during carcass searches at the Fowler Ridge Wind Farm from April 1 to May 15 and July 15 to October 15, 2011.

Species	Scientific Name	Gender	Number of Individuals	% Total	% Comp.
big brown bat	*Eptesicus fuscus*	Female	5	0.9	31.3
		Male	7	1.2	43.8
		Unknown	4	0.7	25.0
Total			**16**	**2.8**	**100**
eastern red bat	*Lasiurus borealis*	Female	117	20.4	38.4
		Male	107	18.7	35.1
		Unknown	81	14.1	26.6
Total			**305**	**53.2**	**100**
evening bat	*Nicticeius humeralis*	Female	1	0.2	25.0
		Male	0	0.0	0.0
		Unknown	3	0.5	75.0
Total			**4**	**0.7**	**100**
hoary bat	*Lasiurus cinereus*	Female	58	10.1	36.5
		Male	47	8.2	29.6
		Unknown	54	9.4	34.0
Total			**159**	**27.7**	**100**

Table 7. Gender composition by bat species found during carcass searches at the Fowler Ridge Wind Farm from April 1 to May 15 and July 15 to October 15, 2011.

Species	Scientific Name	Gender	Number of Individuals	% Total	% Comp.
little brown bat	*Myotis lucifugus*	Female	1	0.2	50.0
		Male	0	0.0	0.0
		Unknown	1	0.2	50.0
Total			**2**	**0.3**	**100**
Seminole bat	*Lasiurus seminolus*	Female	3	0.5	100.0
		Male	0	0.0	0.0
		Unknown	0	0.0	0.0
Total			**3**	**0.5**	**100**
silver-haired bat	*Lasionycteris noctivagans*	Female	18	3.1	22.2
		Male	36	6.3	44.4
		Unknown	27	4.7	33.3
Total			**81**	**14.1**	**100**
tri-colored bat	*Perimyotis subflavus*	Female	0	0.0	0.0
		Male	1	0.2	33.3
		Unknown	2	0.3	66.7
Total			**3**	**0.5**	**100**
Overall			**573**	**100**	

Eastern red bats comprised a slightly lower percentage of the bat fatalities in 2011 compared to data from 2010 (53.2% versus 63.7% of the total, respectively), and a higher percentage compared to 2009 (35.9%, Johnson et al. 2010a). Hoary bats and silver-haired bats composed a higher percentage of the bat fatalities in 2011 (27.8% and 14.1%, respectively), compared to 2010 (18.1% and 13.7%, respectively). Hoary and silver-haired bats composed a lower percentage of the overall fatalities in 2011 compared to 2009 (30.8% and 26.9%, respectively; Johnson et al. 2010a).

Relatively few bat carcasses were found in the spring compared to the fall. The USFWS requested that surveys be extended later in October in 2011 compared to the 2010 study, to determine if any late fall fatality events occurred. Each study turbine was searched twice during the late fall. Three carcasses were found during this period, although only a single eastern red bat carcass was estimated to have been killed between October 16 – October 29, 2011 (Table 8). The other two carcasses were older and were estimated to have been killed prior to October 16.

Table 8. Total number of bat casualties and the composition of casualties discovered at the Fowler Ridge Wind Farm from April 1 to May 15 and July 15 to October 29, 2011, by estimated time of death.

Species	Spring	Clearing Search	July 15 - October 15, 2011	October 16 - October 29, 2011[a]	Overall
eastern red bat	6	11	287	1	305
hoary bat	4	4	151	0	159
silver-haired bat	5	1	75	0	81
big brown bat	0	0	16	0	16
evening bat	1	1	2	0	4
tri-colored bat	0	0	3	0	3
Seminole bat	0	0	3	0	3
little brown bat	0	1	1	0	2
Total	**16**	**18**	**465**	**1**	**573**

a: Each study turbine was surveyed twice during this period.

A total of 77 birds were also discovered during carcass searches in 2011 (Table 9). No bird species listed as threatened or endangered under the State of Indiana (INHDC 2010) or the federal Endangered Species Act (ESA 1973, USFWS 2011) were found. Carcasses were not collected, preventing identification of some severely scavenged or decomposed carcasses. Four carcasses were identified as unidentified large bird. These carcasses were too decomposed to identify to species group; however; the carcasses were not eagles based on bone and feather measurements.

Table 9. Total number of bird carcasses found at the Fowler Ridge Wind Farm April 1 to May 15 and July 15 to October 15, 2011.

Species	Scientific Name	Total Bird Carcasses	% Composition
killdeer	*Charadrius vociferus*	21	27.3
European starling	*Sturnus vulgaris*	7	9.1
mourning dove	*Zenaida macroura*	6	7.8
unidentified large bird		4	5.2
unidentified waterfowl		3	3.9
Tennessee warbler	*Vermivora peregrine*	3	3.9
red-tailed hawk	*Buteo jamaicensis*	3	3.9
chimney swift	*Chaetura pelagic*	2	2.6
golden-crowned kinglet	*Regulus satrapa*	2	2.6
horned lark	*Eremophila alpestris*	2	2.6
cliff swallow	*Petrochelidon pyrrhonota*	2	2.6
Nashville warbler	*Vermivora ruficapilla*	2	2.6
unidentified bird (small)		2	2.6
unidentified warbler		2	2.6
rock pigeon	*Columba livia*	2	2.6
common grackle	*Quiscalus quiscula*	1	1.3
eastern kingbird	*Tyrannus tyrannus*	1	1.3
Canada warbler	*Wilsonia Canadensis*	1	1.3
black-throated green warbler	*Dendroica virens*	1	1.3
indigo bunting	*Passerina cyanea*	1	1.3
American robin	*Turdus migratorius*	1	1.3
red-eyed vireo	*Vireo olivaceus*	1	1.3
yellow-throated vireo	*Vireo flavifrons*	1	1.3
ring-necked pheasant	*Phasianus colchicus*	1	1.3
rough-legged hawk	*Buteo lagopus*	1	1.3

Table 9. Total number of bird carcasses found at the Fowler Ridge Wind Farm April 1 to May 15 and July 15 to October 15, 2011.

ruby-crowned kinglet	*Regulus calendula*	1	1.3
ruby-throated hummingbird	*Archilochus colubris*	1	1.3
unidentified sparrow		1	1.3
pine warbler	*Dendroica pinus*	1	1.3
Overall		**77**	**100**

Estimated Time since Death

Most bat casualties were estimated to have been killed the previous night (Table 10).

Table 10. Estimated time since death for bat casualties found during scheduled carcass searches at the Fowler Ridge Wind Farm from April 1 to May 15 and July 15 to October 15, 2011.

Estimated Time Since Death[a]	Cleared Plots	Spring Road and Pad Only	Fall Road and Pad Only
Previous night	52.0	64.3	82.6
2-3 days	26.0	14.3	13.5
4-7 days	14.7	7.1	2.3
7-14 days	5.3	0.0	1.0
>2 weeks	0.7	7.1	0.7
> month	0.7	0.0	0.0
unknown	0.7	7.1	0.0

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

Timing of Bat Fatalities

Bat casualties occurred throughout the study period (Figure 9). While the majority of bat casualties occurred during the month of August, more bats were found in September in 2011 compared to 2010 (Good et al. 2011). Most bat casualties found at the FRWF during 2009 were recorded between August 1 – September 15 (Johnson et al. 2010b).

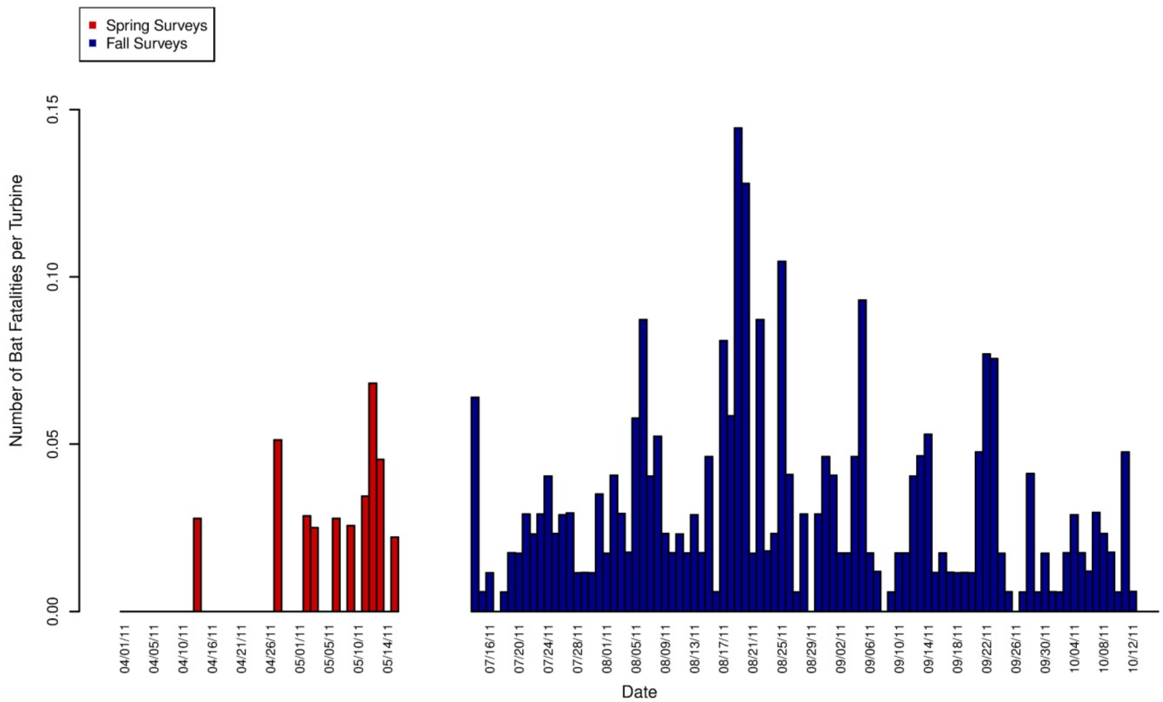

Figure 9. Timing of bat mortality at the Fowler Ridge Wind Farm from April 1 to May 15 and July 14 to October 15, 2011.

Distribution of Bat Casualties

Cleared plots were enlarged from 80 m x 80 m square plots in 2010 to 80m radius circles in 2011, in order to more fully measure the distribution of bat carcasses within a plot. A total of 94.1% of bat carcasses were found within 60 m (197 ft) of turbines at cleared plots, with the highest percentage of carcasses found between 20 - 40 m (66 -131 ft) from turbines (Table 11, Figure 10). Bats were found closer to turbines on road and pad searches (Table 11, Figure 10) compared to cleared plots. This was a function of the amount of area searched within varying distances of turbines on roads and pads compared to cleared plots; road and pads comprise a higher percentage of total area in each distance band closer to turbines, and a lower percentage of area farther from turbines. Data from cleared plots more accurately reflected distances at which bats fell from turbines.

While more bat carcasses were found in the 20 - 40 m distance bands from turbines, the highest densities of bat carcasses were found closer to turbines (Figure 11). The greater number of total bat carcasses within the 20 – 40 m distance band was a function of area searched. Greater amounts of area were searched within the 20 - 40 m distance bands, compared to 0 - 20 m from turbines.

Table 11. Distribution of distances of bat casualties from turbines at the Fowler Ridge Wind Farm from April 1 to May 15 and July 14 to October 29, 2011.

Distance from Turbine (m)	Road & Pad Only % Bat Fatalities	Cleared Plot % Bat Fatalities	Incidental % Bat Fatalities
0 to 10	47.3	13.7	54.7
10 to 20	22.5	14.4	27.9
20 to 30	10.5	22.9	10.5
30 to 40	12.9	20.3	2.3
40 to 50	3.3	12.4	3.5
50 to 60	3.0	10.5	1.2
60 to 70	0.0	3.3	0
70 to 80	0.6	2.6	0
> 80	0	0	0

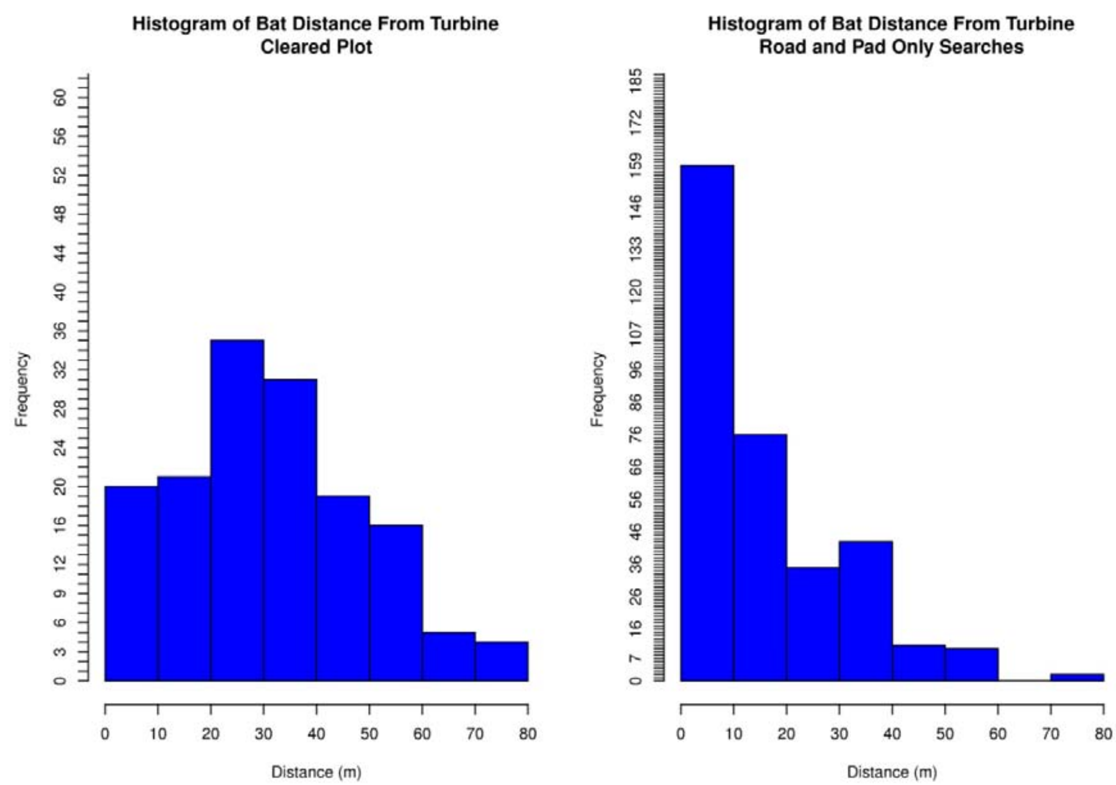

Figure 10. Distance from turbine for all bat casualties found at cleared plots and road and pads at the Fowler Ridge Wind Farm.

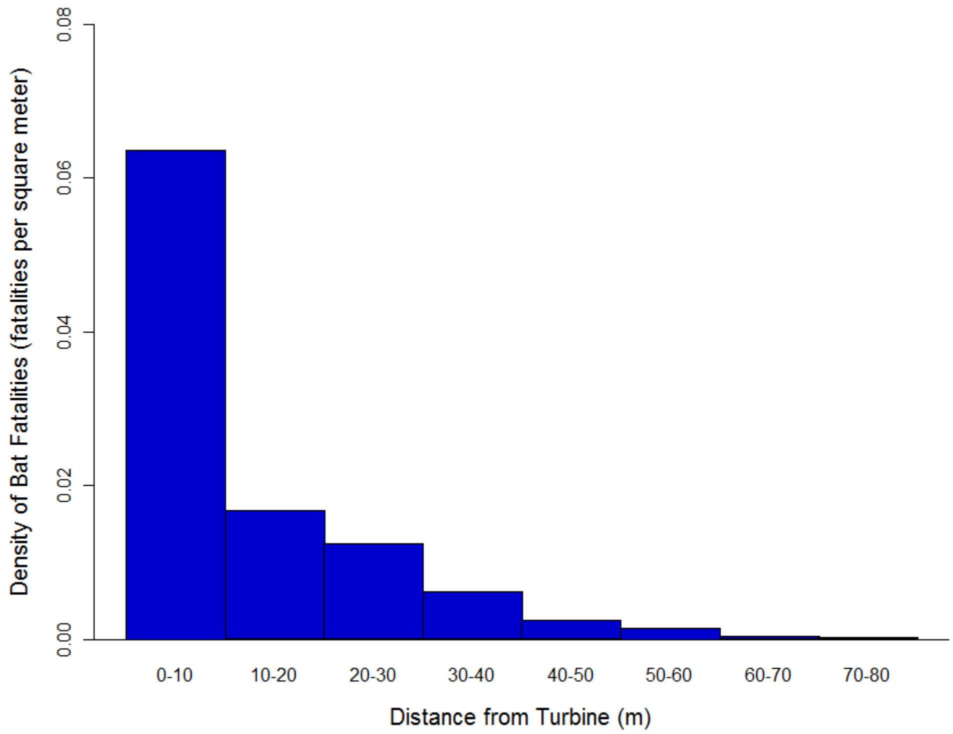

Figure 11. Density (fatalities per square meter searched) of bat fatalities at cleared plots by distance from turbine at the Fowler Ridge Wind Farm.

Bat Fatalities by Turbine Type

Bat fatality rates varied by turbine type. More bat fatalities were found at Vestas turbines (47.5%), compared to Clipper (34.5%) and GE (18.0%) turbines in normal operating modes that were searched daily on roads and pads (Tables 12 and 13). At cleared plots, more bats were found at GE turbines (39.1%), compared to Vestas (32.7%) and Clipper (28.2%) turbines (Table 12). Searches at roads and pads more accurately reflected differences between turbine types due to the larger number of turbines searched.

Table 12. Bat fatality rates per search by turbine type at the Fowler Ridge Wind Farm

Turbine	Fatalities	Searches	Fatality Rate (Fatalities per Search)	Percent Composition of Fatality Rate
Bat fatalities found on nine cleared 80 m circular plots				
GE	59	149	0.396	39.1
Vestas	49	148	0.331	32.7
Clipper	42	147	0.286	28.2
Fresh bat fatalities found on one-hundred sixty eight road and pads out to 80m from turbines estimated to have occurred under normal operating conditions				
Vestas	73	2043	0.036	47.5
Clipper	12	463	0.026	34.5
GE	20	1479	0.014	18.0

Table 13. *Myotis/Perimyotis* carcasses and the 2009 Indiana bat carcass found at the Fowler Ridge Wind Farm in 2009, 2010, and 2011.

Date	Species	Age	Sex	Turbine	Model	Phase	Treatment	Estimated Time of Death
9/11/2009	Indiana bat	A	F	230	Vestas	I	NA	2 to 3 days
8/7/2010	little brown bat	U	U	622	Clipper	I	NA	4 to 7 days
7/31/2010	tri-colored bat	U	U	339	Vestas	I	NA	2 to 3 days
8/20/2010	tri-colored bat	U	U	254	Vestas	I	NA	2 to 3 days
8/22/2010	little brown bat	A	U	14	GE	II	NA	4 to 7 days
8/26/2010	tri-colored bat	J	F	603	Clipper	I	5 m/s Cut-in	Last Night
9/18/2010	Indiana bat	A	F	640	Clipper	I	5 m/s Cut-in	Last Night
7/25/2011	little brown bat	U	U	611	Clipper	I	NA	Unknown
8/6/2011	little brown bat	J	F	397	Vestas	I	3.5 Feathered	Last Night
8/12/2011	tri-colored bat	J	U	152	Vestas	I	3.5 Feathered	Last Night
8/18/2011	tri-colored bat	U	M	156	Vestas	I	3.5 Normal Operation	Last Night
8/19/2011	tri-colored bat	J	U	369	Vestas	I	4.5 Feathered	Last Night

Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the study period at both cleared plots and roads and pads. A total of 45 bat carcasses were placed at roads and pads during the spring, of which 31 (73.8%) were both available and found during the next search day (Table 14). A total of 110 bat carcasses were placed at road and pads during the fall, of which 84 (80.8%) were both available and found on the next search day. A total of 56 bats were placed on cleared plots, of which 14 (29.2%) were both available and found during the next search day (Table 14). Single-day searcher efficiency rates were similar in 2010, when 31.8% of bats on plots were found on the next day, while 84.6% of bats on roads and pads were found on the next search day (Good et al. 2011).

Table 14. Searcher efficiency trials based on single day search results with 90% bootstrap confidence intervals at the Fowler Ridge Wind Farm.

	Spring Roads and Pads			Fall Roads and Pads			Fall Cleared Plots		
Placed	45			110			56		
Found	31			84			14		
Available	42			104			48		
Rate	**mean**	**ll**	**ul**	**mean**	**ll**	**ul**	**mean**	**ll**	**ul**
	73.8	**52.4**	**95.2**	**80.8**	**66.3**	**95.2**	**29.2**	**16.7**	**43.8**

Carcass Removal Trials

A total of 195 fresh bat carcasses and 39 mice were placed during carcass removal trials throughout the study period. Seven bat carcasses were placed within 6 days of the study completion and were not included in bias trials due to insufficient time for the carcass to be removed based on carcass remove rates observed during 2010 bias trials (10.34 days in the fall of 2010; Good et al. 2011). Of the remaining 188 bat carcasses 135 were removed by scavengers before the end of removal trials. Twenty-five of the 39 mice placed were removed by scavengers before the end of removal trials. The mean length of stay before removal or decomposition was 12.22 days for mice in the spring on roads and pads, 15.10 days for bats in the spring and fall on roads and pads, and 13.02 days for bats on cleared plots in the fall (Table 15, Figure 12). The mean length of removal during the fall of 2010 was similar to 2011

Table 15. Carcass removal estimates without surveys conducted 6 days previous to season end with 90% bootstrap confidence intervals.

	Spring Mouse Road and Pad	Spring and Fall Bats Road and Pad			Fall Bats Cleared Plots		
Total Days	305.5	1,419			534		
# Scavenged	25	94			41		
		mean	**ll**	**ul**	**mean**	**ll**	**ul**
Rate	**12.22**	**15.10**	**12.23**	**18.51**	**13.02**	**9.20**	**18.00**

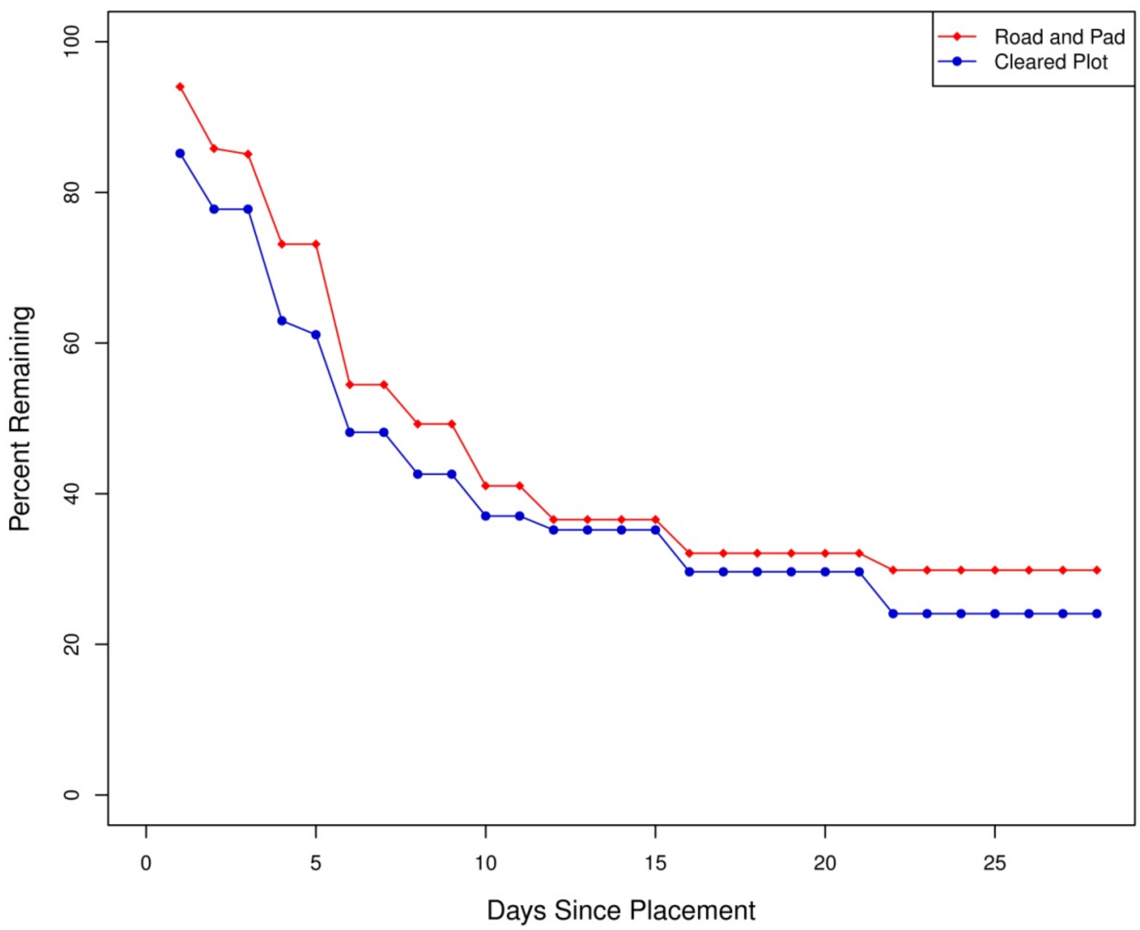

Figure 12. Removal rates for bats during carcass removal trials.

Empirical Estimate of the Probability of Carcass Availability and Detection

Given that the mean removal time of bats ranged from 13 - 15 days during the fall, carcass searchers had multiple opportunities to find bat carcasses. Single-day searcher efficiency estimates underestimated the true probability of searcher bats being available and detected by searchers. An empirical estimate of the probability of availability and detected was calculated. The empirical estimate was calculated from carcasses allowed to remain where placed for up to 24 days and the date when searchers found the carcasses was noted. Carcasses placed six days prior to survey completion were not included in these estimates due to insufficient time for scavenging to occur.

Of the 110 carcasses placed on turbines where only the road and pad were searched, 100 were found, resulting in a probability of 0.91 that carcasses were available and detected (Table 16). Probability of available and detected carcasses was lower on roads and pads in the spring (0.69) due to a longer search interval (Table 16). The empirical estimate for the probability of available and detected carcasses on cleared plots was similar between 2010 (0.58) and 2011 (0.52; Good et al. 2011).

Table 16. Empirical estimate of the bias correction factor with 90% bootstrap confidence intervals.

	Spring Bats Road and Pad			**Fall Bats Road and Pad**			**Fall Bats Cleared Plot**		
Ever Found	20			100			29		
Placed	29			110			56		
Rate	**mean**	**ll**	**ul**	**mean**	**ll**	**ul**	**mean**	**ll**	**ul**
	0.69	0.55	0.83	0.91	0.86	0.95	0.52	0.39	0.64

Adjusted Casualty Estimates

While searches at cleared plots encompassed an area where almost all bat carcasses were expected to fall, searches at roads and pads occurred within only a portion of the area where a bat carcass could fall. Thus an adjustment factor was needed in order to calculate valid casualty estimates for searches on roads and pads. A double sampling approach (Thompson 2002) was used to calculate this adjustment. The locations of casualties found within cleared plots were marked as being on or off roads and pads. The double sampling approach utilized the ratio of estimated total bat fatalities at cleared plot turbines to the estimated number of bats found on roads and pads of cleared plots as an adjustment factor for casualty estimates at road and pad only plots. Total fatalities at cleared plots and roads and pads of the same plot were estimated based on empirical bias trial conducted at cleared plots. Only bats found during the fall were used for this calculation. The 2011 road and pad correction factor (7.54) was similar to the 2010 road and pad correction factor (6.17), with overlapping confidence intervals (Table 17).

Table 17. Road and pad correction factor with 90% bootstrap confidence intervals during 2010 and 2011 carcass monitoring.

Monitoring Study Plot Size	2010 40 x 40m square			2011 80m radius circle		
	Count	Empirical Adj. Factor	Adjusted Fatalities	Count	Empirical Adj. Factor	Adj. Fatalities
Number of bats within cleared plots	342	0.58	590.4	150	0.52	289.7
Number of bats on road & pad of cleared plots	67	0.7	95.7	32	0.83	38.4
		90% Bootstrap CI			90% Bootstrap CI	
	Ratio	ll	ul	Ratio	ll	Ul
Road & Pad Correction Factor	6.17	3.82	8.79	7.54	5.30	11.14

Based on searcher efficiency and the carcass removal rates at the site, the Shoenfeld estimated average probability that a bat casualty would remain in the plot until a scheduled search and would be found was about 74% for road and pad searches in the spring, and about 69% for fall searches on cleared plots (Appendix A). The estimated number of bat fatalities per turbine (based on Shoenfeld's pi estimates) was 0.61 bats/turbine for spring road and pad searches, 22.99 bats/turbine for cleared plots in the fall (August 1 – October 15), and 2.18 bats/turbine for cleared plots from July 15 - July 31. The overall bat fatality estimate for both seasons combined was 25.78 bats/turbine (Table 18).

Table 18. Bootstrap point estimates (mean) and lower (ll) and upper (ul) of 90% confidence intervals for bat casualty rates using the Shoenfeld estimator and an empirical estimate for the probability a carcass was available and detected at the Fowler Ridge Wind Farm.

		Adjusted Mortality based on Shoenfeld Estimate of Detection Probability			Adjusted Mortality based on Empirical Bias Correction Factor		
Search Period/Method	**Brand**	**mean**	**ll**	**ul**	**mean**	**ll**	**Ul**
Spring Road and Pad Searches within 80 m of turbines, searched at 6-day intervals	Clipper	2.30	0.67	4.93	2.49	0.55	5.47
	Vestas	0.68	0.24	1.37	0.74	0.26	1.49
	GE	0.00	--	--	0.00	--	--
	Overall	**0.61**	**0.32**	**1.06**	**0.66**	**0.32**	**1.17**
July 15-July 31, 2011 Control Plots (80 m Circular Plot searched every other day)	Clipper	1.94	1.33	3.00	2.57	1.70	3.73
	Vestas	2.42	0.89	4.32	3.22	1.03	5.74
	GE	1.94	1.31	3.01	2.57	1.70	3.73
	Overall	**2.18**	**1.32**	**3.26**	**2.90**	**1.57**	**4.22**
Aug 1 - Oct 15, 2011 Control Plots (80 m Circular Plot searched every other day)	Clipper	18.39	14.66	25.18	24.46	19.17	32.24
	Vestas	21.29	15.02	30.20	28.32	20.14	40.00
	GE	26.69	22.17	35.93	35.40	28.00	44.80
	Overall	**22.99**	**19.21**	**29.35**	**30.54**	**25.40**	**37.45**
Total		**25.78**	**22.51**	**32.37**	**34.10**	**28.64**	**41.37**

Empirical estimates for the probability of carcass availability and detected were lower than Shoenfeld estimates, resulting in higher adjusted casualty rates. Seasonal adjusted casualty estimates based on the empirical probability of available and detected were 0.66 bats/turbine in the spring, 2.90 bats/turbine from July 15 – July 31, and 30.54 bats/turbine from August 1 – October 31, for an overall combined estimate of 34.10 bats/turbine (Table 19).

Table 19. Adjusted estimates of bat fatality rates at control plots from August 1 – October 15 during 2010 and 2011 carcass monitoring at the Fowler Ridge Wind Farm.

		Adjusted Fatality Estimates at Cleared Plots	
Fall Period (August 1 - October 15)	**Number of Cleared Plots**	**Shoenfeld**	**Empirical**
Fall 2010 80 x 80m square cleared plot *	18	21.81	29.80
Fall 2011 80 m radius circular cleared plot	9	22.99	30.54
Overall (Simple Average)	**45**	**22.40**	**30.17**
Overall (Weighted Average)	**45**	**22.04**	**29.94**

* Adjusted for fatalities that may have fell outside of 80 x 80 m square plots (2011 data estimated 23.3% of fatalities fell outside of 40 m square plots)

Casualty estimates from 2010 were based on searches within 80 X 80 m cleared plots. The corners of each plot were 57 m (187 ft) away from the turbine. The search area covered 6,400 m^2(68,889 ft^2) on each plot and was equivalent to searching a circle with a radius of 45 m (484 ft). Based on the distribution of bat fatalities within the larger 80-m radius cleared plots in 2011, 23.3% of fatalities in 2010 fell outside of the 40 m square plots. Estimates of fall bat fatality rates at control plots were similar in 2010 and 2011 after 2010 estimates were adjusted for bats falling outside of plots (Table 19).

Bat fatality estimates from road and pad searches and cleared plot searches in 2010 were compared to determine if road and pad sampling provided comparable estimates of fatalities to searches of cleared plots. Bat fatality estimates from road and pad searches in 2010 were re-calculated based a road and pad correction factor that accounts for unequal probability of detection between croplands and roads and pads, and accounting for the percentage of bats that fell farther than 40 m from turbines. Revised bat fatality estimates at 100 control turbines searched weekly on only road and pads in 2010 were 31.23 bats / turbine, with a 90% confidence interval of 18.77 – 48.94 utilizing the empirical estimator of available and detected. Revised bat fatality estimates from cleared plots searched daily at 18 control turbines in 2010 were 29.80 bats/turbine, with a 90% confidence interval of 23.84 – 36.80 utilizing the empirical estimator of available and detected. This provides further evidence that weekly searches of roads and pads as sampling units under a double sampling scenario provided comparable estimates to daily searches of cleared plots in 2010.

Effects of Feathering Blades on Bat Casualty Rates

The wind speed at which blades were feathered was changed on a nightly basis at each turbine in the feathering study. We estimated the time of death of each carcass to ensure bat carcasses were associated with the appropriate feathering speed. One-hundred-five bat carcasses were determined to have occurred at turbines while operating under normal operational cut-in speeds of 3.5 m/s (control) throughout the fall casualty searches. This compares to 66, 42, and 25 dead bats found at turbines where blades were feathered below 3.5 m/s, 4.5 m/s, and 5.5 m/s, respectively. Only one *Myotis* carcass, a little brown bat, was found during the feathering experiment conducted in the fall (Table 20).

Table 20. Species fatality count by turbine operation at the Fowler Ridge Wind Farm.

Species	3.5 Normal Operation	3.5 Feathered	4.5 Feathered	5.5 Feathered
big brown bat	7	2	2	1
eastern red bat	69	35	21	11
hoary bat	20	20	8	8
little brown bat	0	1	0	0
Seminole bat	1	0	0	0
silver-haired bat	7	7	10	5
tri-colored bat	1	1	1	0
Total	**105**	**66**	**42**	**25**

Chi-square tests of proportions show that decreases in observed bat fatality rates between control turbines with no feathering compared to feathered turbines was statistically significant (Table 21). Chi-square tests of proportions between successive treatment levels also showed significant decreases in fatality counts: (3.5 m/s feathered versus 4.5 m/s feathered; chi-square=5.1, df=1, p-value=0.02; 4.5m/s feathered versus 5.5 m.s feathered; chi-square=4.2, df=2, p-value=0.04)

Table 21. Chi-square test of proportions results of curtailment studies at the Fowler Ridge Wind Farm.

	Fatalities Found (w/ estimated time of death of Last Night)										
	GE		Vestas		Clipper		Overall		Percent Decrease in Fatalities from	Chi-Squared	P-
Treatment Condition	Found	Searches	Found	Searches	Found	Searches	Found	Searches	Normal Operation	Test Statistic	Value
3.5 m/s normal operation	20	1478	73	2039	12	461	105	3978	--	--	--
3.5 m/s feathered	12	1475	47	1947	7	461	66	3883	35.6	7.98	0.005
4.5 m/s feathered	11	1476	24	1901	7	460	42	3837	58.5	24.78	>0.001
5.5 m/s feathered	7	1477	14	1877	4	462	25	3816	75.2	45.92	>0.001

Negative Binomial Modeling

Negative binomial modeling of observed casualty rates resulted in significant blade feathering covariates. The parameter estimate for feathering below a 3.5 m/s cut-in speed corresponded to a 36.3% reduction in casualty rates, with a corresponding 90% confidence interval of 12.4% to 53.8% (Table 22). Feathering below a 4.5 m/s cut-in speed resulted in a parameter estimate of 56.7% reduction in the casualty rate, with a 90% confidence interval of 38.5% to 69.8%. A parameter estimate corresponding to a 73.3% (60.0% to 82.5%) reduction in fatality rates was estimated when the turbines were feathered below a 5.5 m/s cut-in speed.

Table 22. Mean percent decrease of bat fatalities with corresponding 90% confidence intervals based on coefficients of negative binomial regression modeling.

Treatment Condition	Mean Percent Decrease	90% Confidence Interval lower limit	upper limit
3.5 m/s feathered	36.3	12.4	53.8
4.5 m/s feathered	56.7	38.5	69.8
5.5 m/s feathered	73.3	60.0	82.5

Feathering blades below cut-in speeds appeared to reduce the amount of time wind turbines were operating below cut-in speeds compared to normal operational modes for most turbine types (Figure 13).

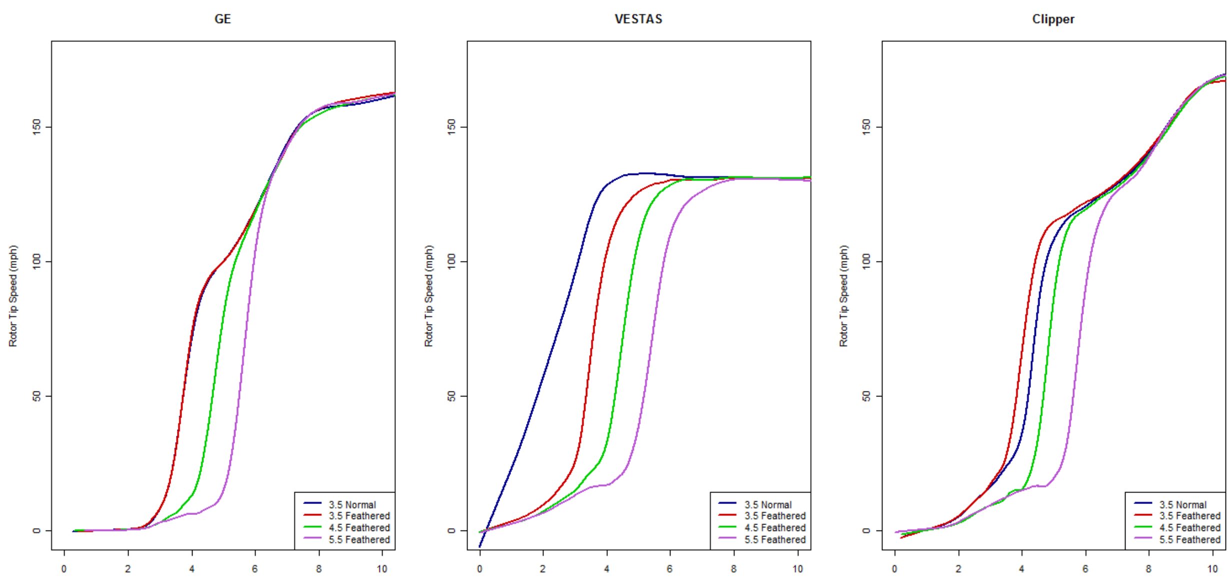

Figure 13. Estimated tip speed by wind speed for cut-in speed adjustments at GE, Clipper, and Vestas wind turbines during the 2011 carcass monitoring at the Fowler Ridge Wind Farm. Estimates were made based on Friedman's SuperSmoother (Friedman 1984).

Bat Acoustic Surveys

Bat activity was monitored at four turbines on a total of 46 nights during the spring period of March 31 through May 15, and again at 4 turbines and two reference locations on a total of 95 nights during the fall period of July 14 through October 31, 2011. During the fall season, sampling began on July 28 for the two reference locations, while monitoring at the base of turbines began July 14. Anabat units were operable for 67.2% and 96.2% of the spring sampling period for raised and ground units, respectively; and 79.0% and 98.9% of the fall sampling period for raised and ground units, respectively. Anabat units recorded 535 bat passes on 323 detector-nights during the spring (Table 23), and 11,730 bat passes on 860 detector-nights during the fall (Table 24). The average bat activity for ground stations (mean ± standard error) was 2.57 ± 0.06 and 0.56 ± 0.02 bat passes per detector-night for ground and raised stations in spring (Table 23), and 16.72 ± 1.52 at ground stations and 5.19 ± 0.59 at raised stations during fall (Table 24).

Table 23. Results of spring acoustic bat surveys conducted at the Fowler Ridge Wind Farm, March 31 – May 15, 2011, separated by call frequency (HF = high frequency, MF = mid frequency, LF = low frequency).

Anabat Station	Location	# of HF Bat Passes	# of MF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night
FR083g	ground	17	45	40	102	36	2.22±0.55
FR083r	raised	9	6	15	30	46	0.65±0.21
FR251g	ground	28	53	31	112	39	2.87±0.82
FR251r	raised	5	6	11	22	36	0.61±0.20
FR457g	ground	28	49	43	120	46	2.61±0.68
FR457r	raised	2	2	10	14	36	0.39±0.13
FR614g	ground	24	46	49	119	46	2.59±0.68
FR614r	raised	3	6	7	16	28	0.57±0.27
Total Ground		**97**	**193**	**163**	**453**	**177**	**2.57±0.06**
Total Raised		**19**	**20**	**43**	**82**	**146**	**0.56±0.02**
Total		**116**	**213**	**206**	**535**	**323**	**1.56±0.32**

Table 24. Results of fall acoustic bat surveys conducted at the Fowler Ridge Wind Farm, July 14 – October 31, 2010, separated by call frequency (HF = high frequency, MF = mid frequency, LF = low frequency). Stations FR5ref and FR6ref were previously monitored in 2007 and 2010, and were located away from turbines. The other stations shown here were located at turbines.

Anabat Station	Location	# of HF Bat Passes	# of MF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night
T218g	ground	425	371	1,125	1,921	102	18.83±2.06
T218r	raised	42	115	405	562	105	5.35±1.04
T480g	ground	723	831	955	2,509	109	23.02±2.59
T480r	raised	25	64	156	245	53	4.62±0.93
T614g	ground	651	824	954	2,429	109	22.28±2.45
T614r	raised	15	94	200	309	59	5.24±0.68
T630g	ground	579	719	798	2,096	102	20.55±2.08
T630r	raised	18	60	94	172	31	5.55±0.96
FR5ref	ground	228	245	480	953	95	10.03±1.53
FR6ref	ground	174	186	174	534	95	5.62±0.58
Total Ground		**2,780**	**3,176**	**4,486**	**10,442**	**612**	**16.72±1.52**
Total Raised		**100**	**333**	**855**	**1,288**	**248**	**5.19±0.59**
Grand Total		**2,880**	**3,509**	**5,341**	**11,730**	**860**	**12.11±1.02**

Species Composition

During the spring study season, the overall percent of passes by MF bats and LF bats were comparable (39.8% and 38.5% of all bat passes, respectively) and outnumbered bat passes by HF bats (21.7%; Table 23). Spatial patterns of use were similar among all three species groups for both ground and raised units during the spring study period (Figure 14).

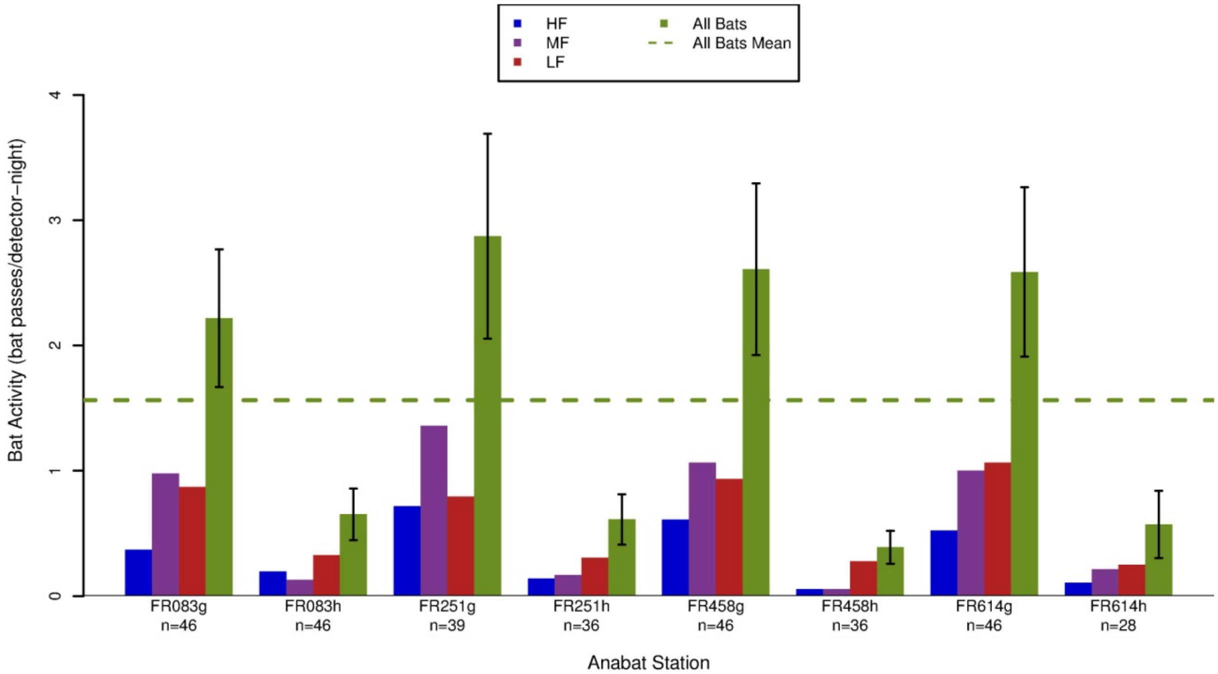

Figure 14. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the spring study period March 31 – May 15, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

During the fall study season, the overall percent of passes by LF bats (45.5% of all passes) outnumbered passes by MF bats (29.9%), and HF bats (24.6%; Table 24). Among raised stations, LF bats composed 66.4% of passes (Table 24). During the fall, LF and MF bats comprised a higher proportion, and HF species comprised a lower proportion, of calls recorded at raised versus ground locations at turbines (Figure 15). Spatial patterns of use were similar among all three species groups for both raised and ground units during the fall study period (Figure 16).

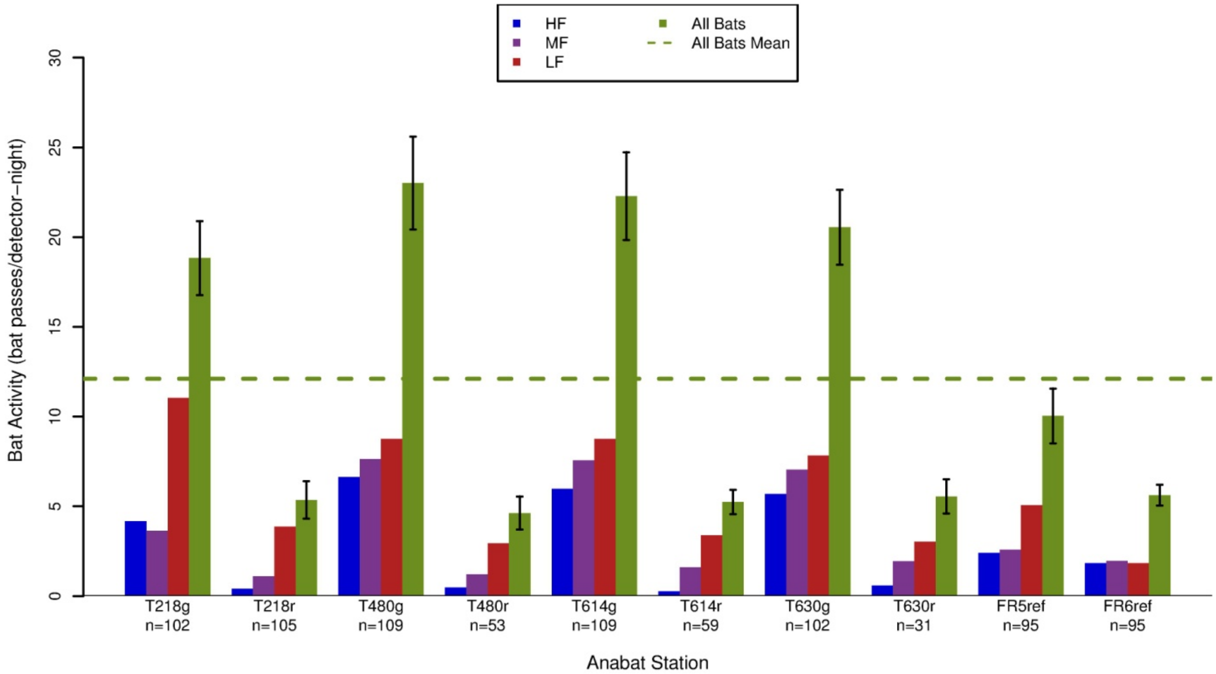

Figure 15. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the fall study period July 14 – October 31, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns. Stations FR5ref and FR6ref were previously monitored in 2007 and 2010, and were located in grasslands away from turbines.

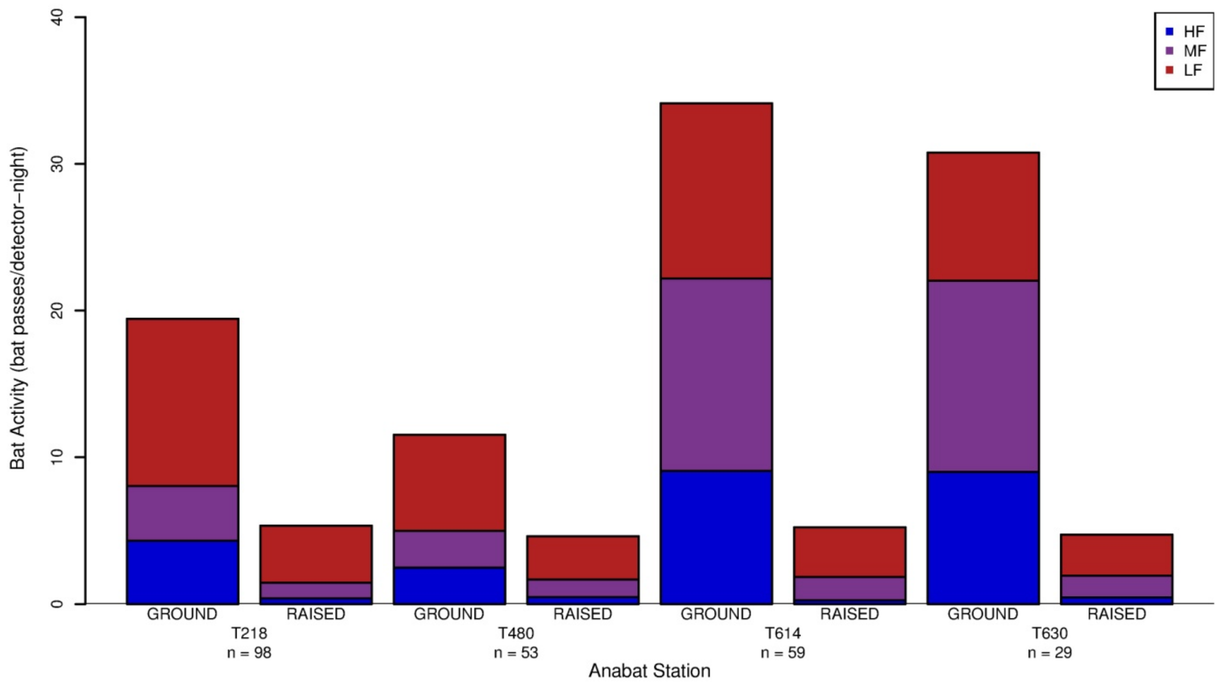

Figure 16. Bat activity at paired stations during the fall study period at the Fowler Ridge Wind Farm, July 22 – October 31, 2011 on nights when both ground and nacelle units were operational.

Species composition of calls was consistent between the spring and fall monitoring seasons, with big brown bat and silver-haired bat passes accounting for the highest percent of activity (40.2% and 44.3%, respectively; Table 25). The week with the highest LF bat passes (big brown bat and silver-haired) occurred from May 7 to May 13 in the spring and September 10 to September 16 in the fall (Figures 17 and 18). The week with the greatest MF bat passes (evening bat and eastern red bat) occurred from May 7 to May 13 in the spring (Figure 19). The week with the highest HF bat passes (tri-colored bat) occurred from August 20 to August 26 in the fall (Figure 20).

Table 25. Percent composition of high quality bat passes at raised and ground stations at the Fowler Ridge Wind Farm.

	Spring				Fall				Total			
Species	**Ground**	**Raised**	**Total**	**% Comp.**	**Ground**	**Raised**	**Total**	**% Comp.**	**Ground**	**Raised**	**Total**	**% Comp.**
big brown bat / silver haired bat	45	4	49	40.2	1,656	93	1,749	44.3	1,701	97	1,798	44.1
eastern red bat	32	2	34	27.9	954	69	1,023	25.9	986	71	1,057	25.9
hoary bat	7	2	9	7.4	513	202	715	18.1	520	204	724	17.8
unknown	7	1	8	6.6	233	15	248	6.3	240	16	256	6.3
evening bat / eastern red bat	12	1	13	10.7	95	3	98	2.5	107	4	111	2.7
tri-colored bat	6	0	6	4.9	71	1	72	1.8	77	1	78	1.9
little brown bat	2	0	2	1.6	39	0	39	1.0	41	0	41	1.0
Myotis	0	1	1	0.8	8	0	8	0.2	8	1	9	0.2
Overall	**111**	**11**	**122**	**100**	**3,569**	**383**	**3,952**	**100**	**3,680**	**394**	**4,074**	**100**

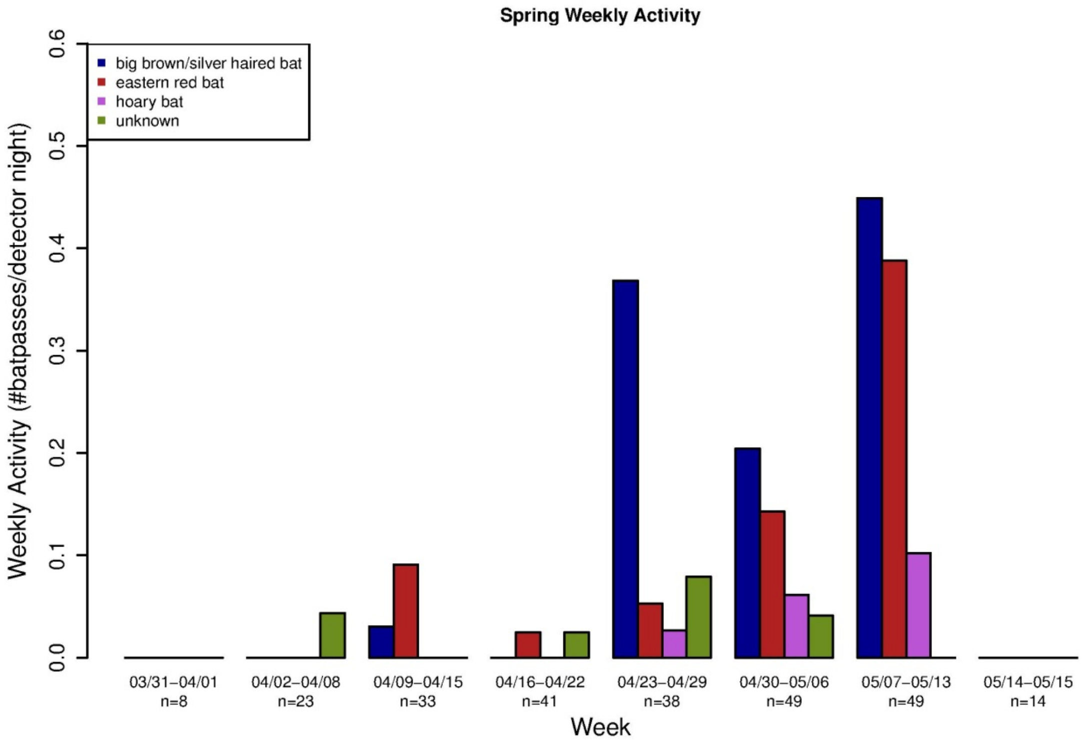

Figure 17. Composition of weekly activity for LF and MF bat species groups during spring monitoring at the Fowler Ridge Wind Farm.

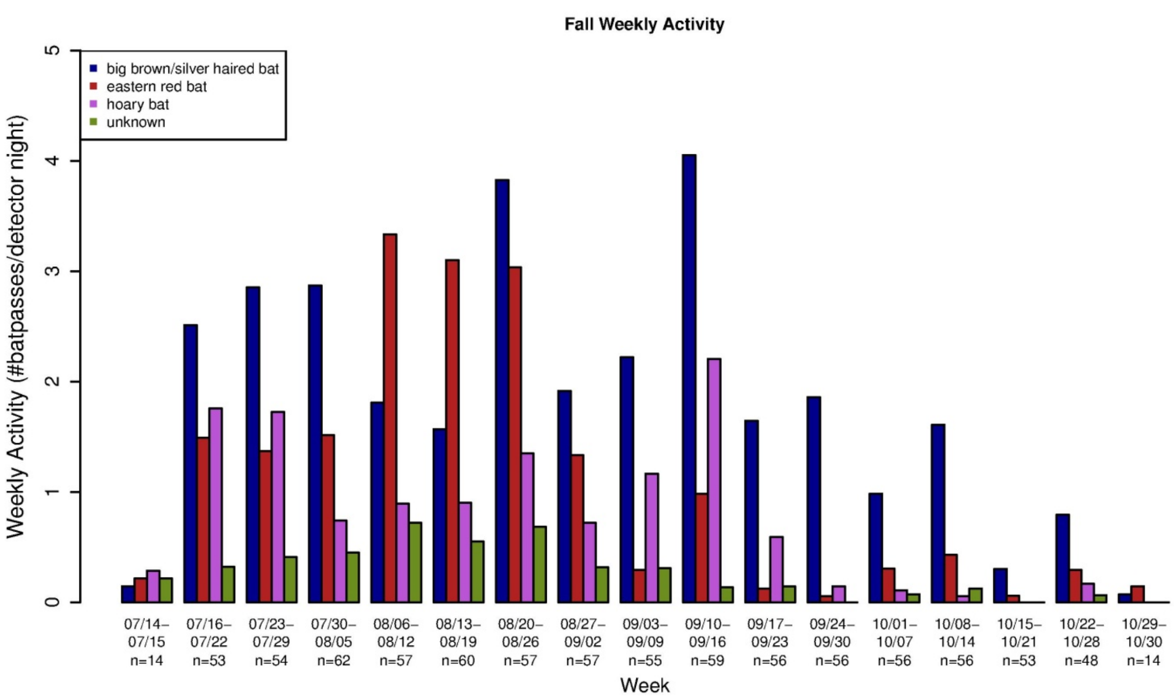

Figure 18. Composition of weekly activity for LF and MF bat species groups during fall monitoring at the Fowler Ridge Wind Farm.

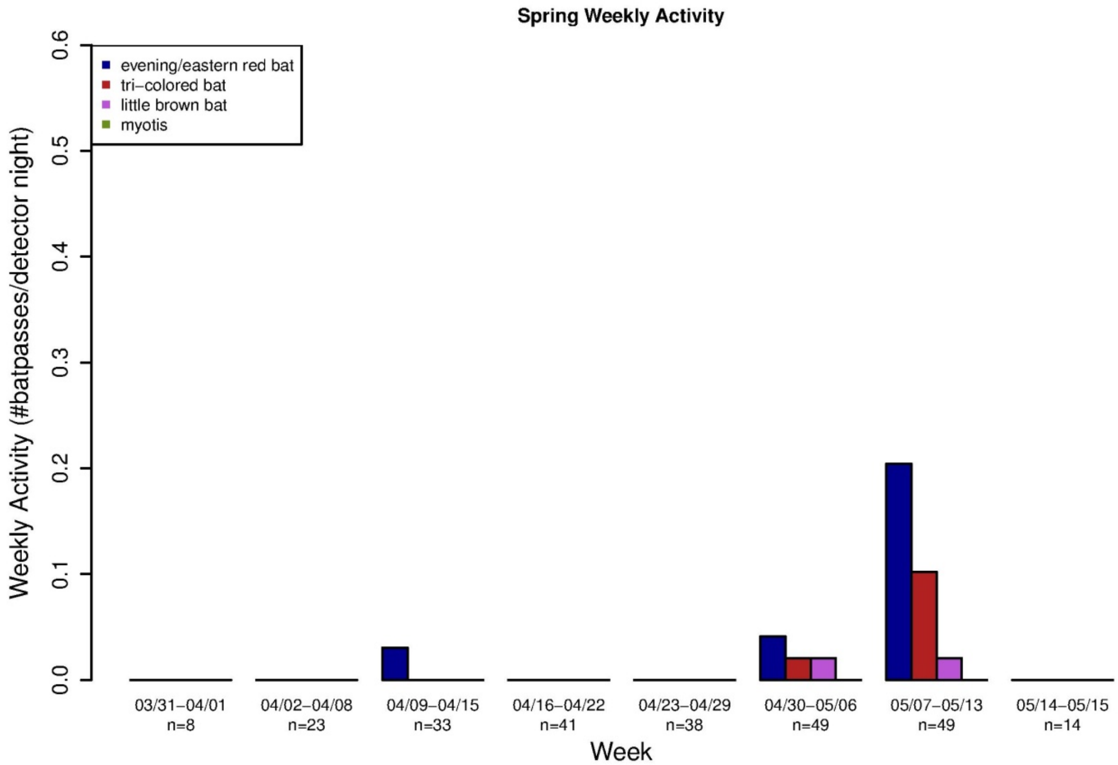

Figure 19. Composition of weekly activity for MF and HF bat species groups during spring monitoring at the Fowler Ridge Wind Farm.

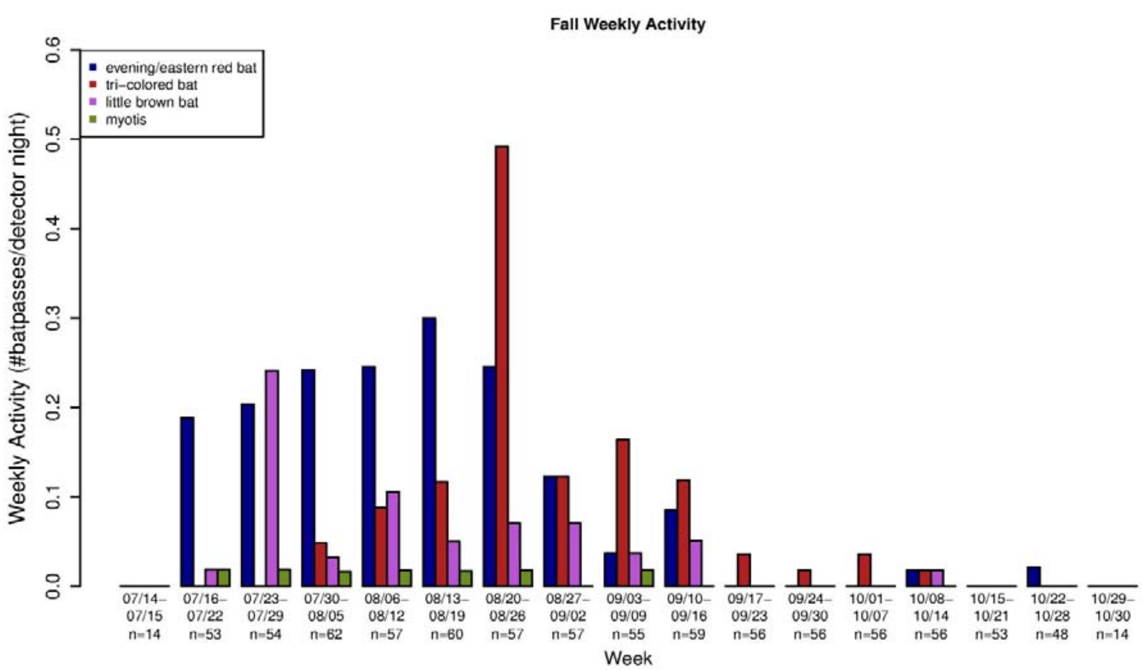

Figure 20. Composition of weekly activity for MF and HF bats during fall monitoring at the Fowler Ridge Wind Farm.

High-frequency calls were further analyzed, to determine if call characteristics resembled Indiana bat calls from a call library. Three methods were utilized to identify potential Indiana bat calls, including a DF Analysis (DFA), the “Britzke” filter, and a qualitative analysis by WEST biologists. No calls were identified by all three methods as resembling Indiana bat calls. The DFA identified five calls as potential Indiana bat calls (Table 26). Of the five calls, one was also identified as a potential Indiana bat call by the Britzke filter (I7300351.19#). Although the call structure and minimum frequency were characteristic of *M. sodalis* (Murray et al. 2001), WEST biologists observed that two or more red bat calls were associated with this call sequence and minimum frequency of the call was 35 kHz. This call was identified as unknown and not confirmed as a *M. sodalis* call.

Table 26. Bat calls identified by the Discriminant Function Analysis (DFA) in 2011 as potentially made by Indiana bats. MYSO = Indiana bat (*Myotis sodalis*), MYLU = Little brown bat (*Myotis lucifugus*), and LABO = Eastern red bat (*Lasiurus borealis*).

Station	Month	Date	Filename	DFA Results	Verified by Britzke Filter?	WEST Biologists
T480g	Aug	19	I8192137.02#	MYLU	NA	*Myotis* spp
T480g	Aug	6	I8070047.51#	MYSE	NA	LABO
T480g	Apr	26	I4270018.04#	MYSO	No	Unknown
T480g	Aug	14	I8150037.43#	MYSO	No	LABO
T614g	Aug	22	I8222307.52#	MYLU	NA	MYLU
T218g	Aug	31	I8312154.41#	MYLU	NA	Unknown
T218g	Sep	4	I9042217.12#	MYLU	NA	MYLU
T218g	Aug	18	I8182238.28#	MYSE	NA	LABO
T218g	Aug	21	I8220039.16#	MYSE	NA	LABO
T218g	Aug	15	I8160327.49#	MYSO	No	LABO
T218g	Aug	25	I8252218.06#	MYSO	No	*Myotis* spp
T630g	Aug	1	I8012337.49#	MYSE	NA	Unknown
T630g	Aug	5	I8060600.44#	MYSE	NA	Unknown
T630g	Jul	29	I7300351.19#	MYSO	Yes	Unknown
T218g	Aug	3	I8040056.01#	MYLU	NA	MYLU
T630g	Jul	25	I7260132.38#	MYLU	NA	Unknown

Spatial Variation

During the spring studies at the FRWF, bat activity was similar among the four fixed stations (Figure 14), ranging between 2.22 and 2.87 bat passes per detector-night among ground stations (Table 23). Overall, use was lowest at station FR083g (2.22 bat passes/detector night), and higher at stations FR614g (2.59), FR457g (2.61), and FR251g (2.87; Table 23)

During the fall study season, bat activity varied among the 10 ground stations in the FRWF (Figure 15), ranging between 5.62 and 23.02 bat passes per detector-night. Bat activity was similar among the 10 raised stations (ranging between 4.62 and 5.55 bat passes per detector-night; Table 24). Reference ground stations previously monitored in 2007 and 2010 (located away from turbines in grasslands) recorded lower bat activity rates (5.62 and 10.03 bat passes per detector-night) in 2011 compared to detectors located at the base of wind turbines (18.83, 20.55, 22.28, 23.02 bat passes per detector-night; Figure 15, Table 24). Raised detectors recorded lower activity rates than ground base detectors (Figure 16).

Temporal Variation

During the spring study season, bat activity increased from early-April through mid-May (Figure 21). The highest number of bat passes per detector-night (of all frequencies) within a single week were recorded May 6 through May 12 (5.02 bat passes per detector-night); the highest number of bat passes per detector-night of HF bats (0.78), MF bats (2.61), and LF bats (1.63) were also recorded May 6 through May 12 (Table 27).

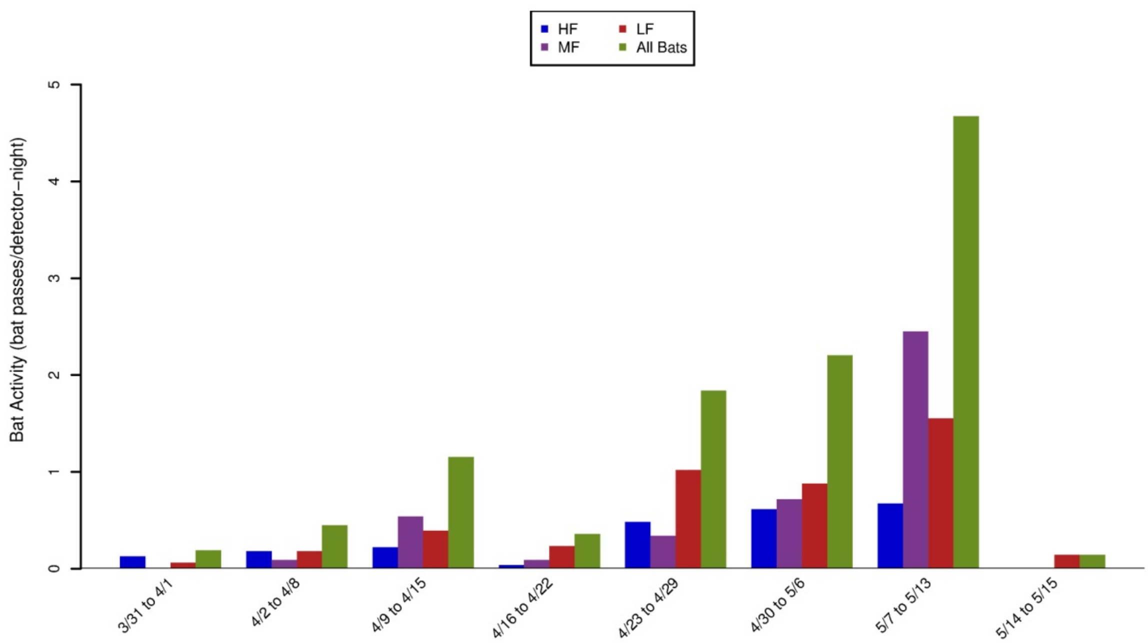

Figure 21. Bat activity, by week, during the spring migration period at the Fowler Ridge Wind Farm.

Table 27. Highest weekly activity rates (bat passes per detector-night), sorted by call frequency (HF=high frequency, MF=mid frequency, LF=low frequency), for the spring study period.

Frequency Group	Week(s) of Highest Passage Rate	Bat activity Rate
All Bats	05/06/11 to 05/12/11	5.02
HF Bats	05/06/11 to 05/12/11	0.78
MF Bats	05/06/11 to 05/12/11	2.61
LF Bats	05/06/11 to 05/12/11	1.63

During the fall study season, bat activity was highest from mid-July through late-August, and then decreased through late-October, with the exception of mid-September, where activity rose slightly (Figure 22). The highest number of bat passes per detector-night (all frequencies) was recorded August 17 through August 23 (34.21 bat passes per detector night), while the highest number of HF and MF bat passes per detector-night were recorded during the week of August 17 through August 23 (9.25 and 12.93 bat passes per detector-night, respectively), and the highest number of LF bat passes per detector-night were recorded during the week of August 18 through August 24 (13.04 bat passes per detector-night; Table 28).

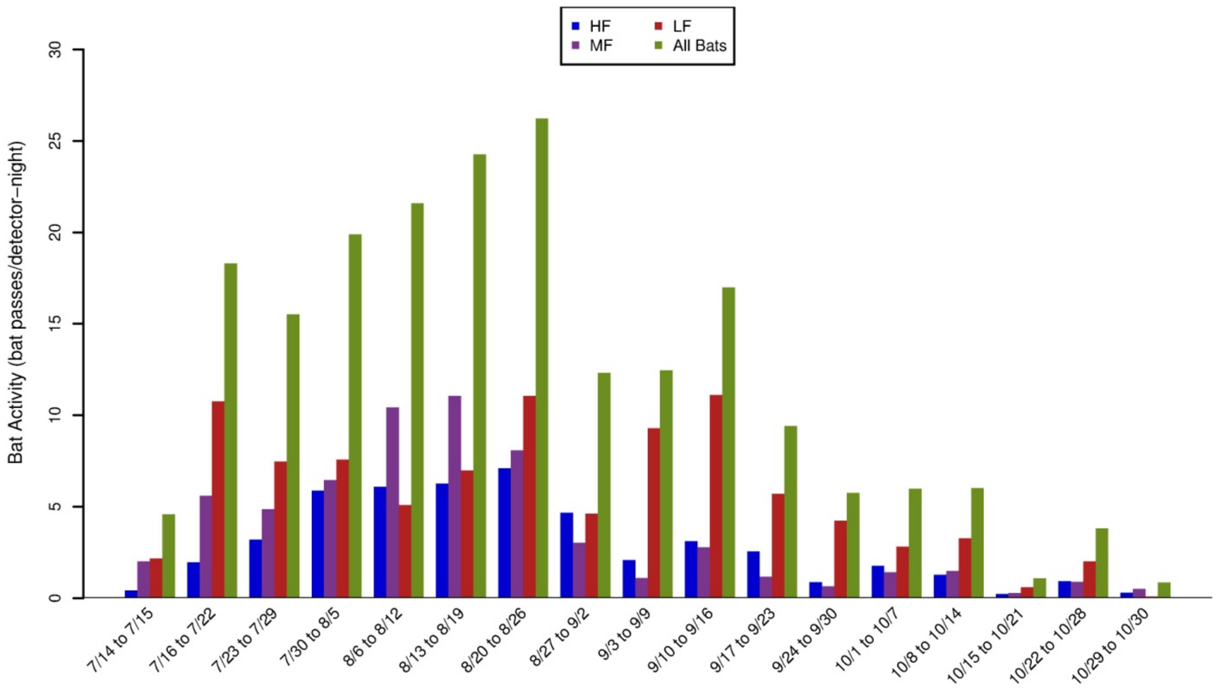

Figure 22. Bat activity, by week, during the fall migration period at the Fowler Ridge Wind Farm. Monitoring of bat activity began at two stations on July 28 that were previously monitored in 2007 and 2010, while monitoring at the base of turbines began July 14.

Table 28. Highest weekly activity rates (bat passes per detector-night), sorted by call frequency (HF=high frequency, MF=mid frequency, LF=low frequency), for the fall study period.

Frequency Group	Week(s) of Highest Passage Rate	Bat activity Rate
All Bats	08/17/11 to 08/23/11	34.21
HF Bats	08/17/11 to 08/23/11	9.25
MF Bats	08/17/11 to 08/23/11	12.93
LF Bats	08/18/11 to 08/24/11	13.04

Activity at raised stations peaked in mid-July and early September, while ground station activity peaked in mid to late August, and again in mid September (Figure 23).

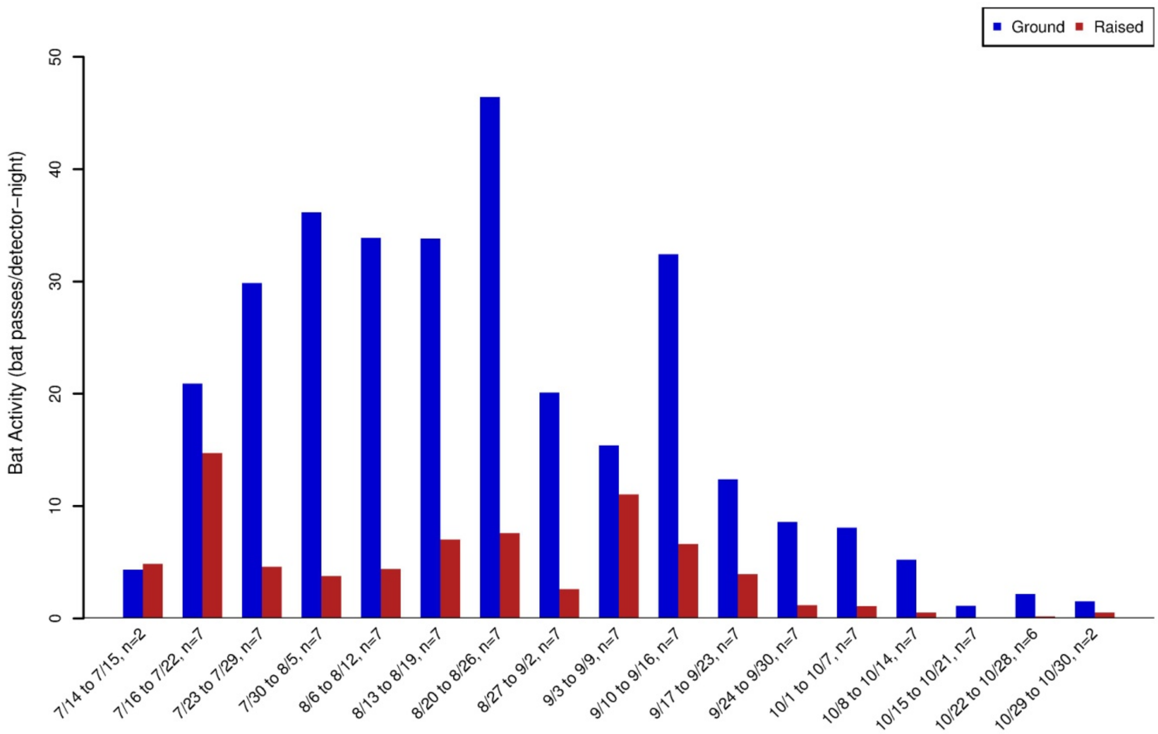

Figure 23. Number of bat passes per detector-night by ground and raised Anabat stations at the Fowler Ridge Wind Farm for the fall study period July 14 – October 31, 2011 when raised and ground units were operational on the same night.

Bat activity rates as a function of hour past sunset are shown in Figure 24. In general, bat activity was recorded throughout the night, except for within one hour of sunset, with the highest rates occurring from one to six hours past sunset for all frequency groups. Activity generally decreased in the latter part of the night, except for LF bats, where another spike of activity appeared around 11 hours past sunset (Figure 24).

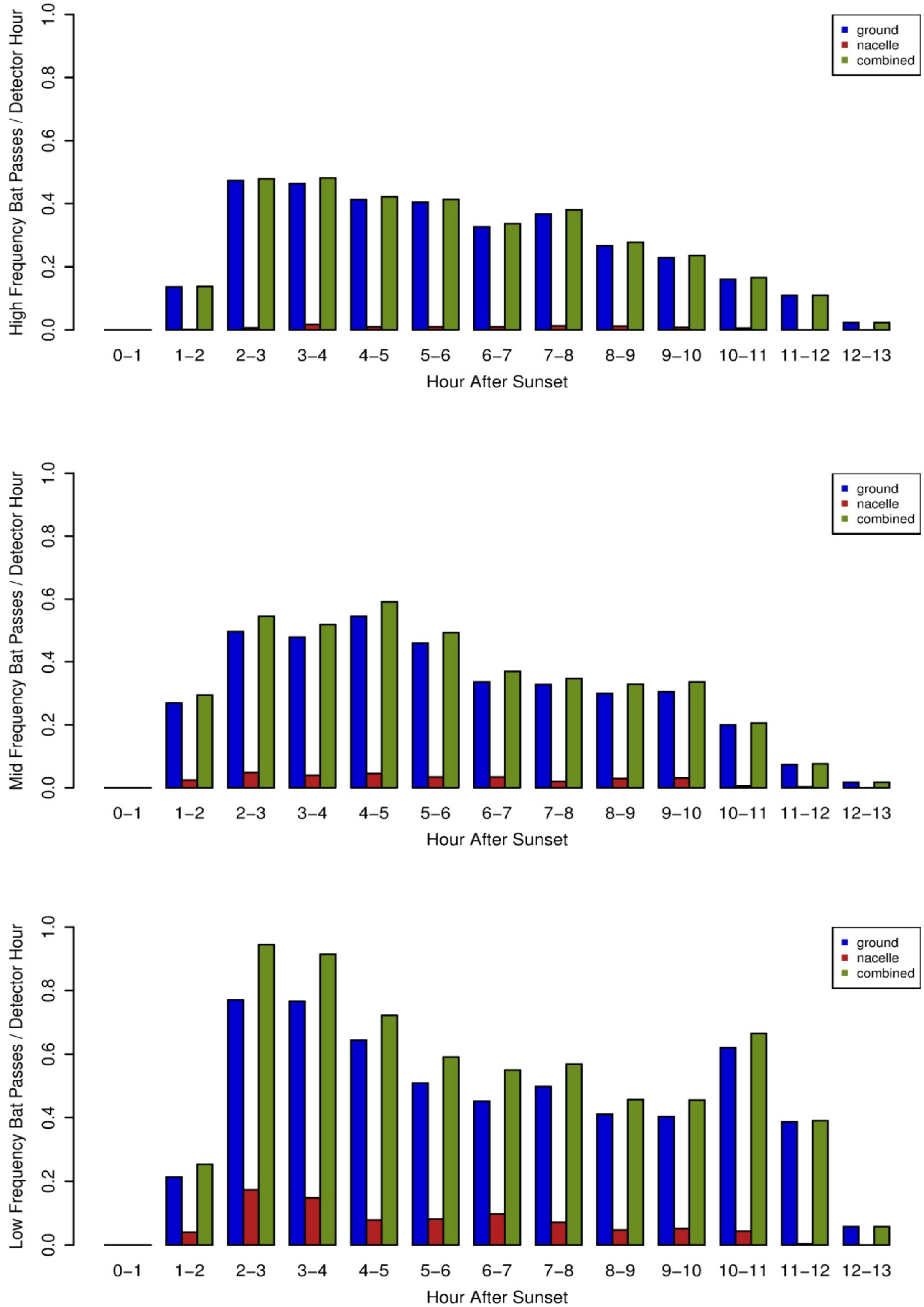

Figure 24. Bat activity rates as a function of hour past sunset at the Fowler Ridge Wind Farm.

Correlation Analyses

The objective of bat mortality and weather modeling was to determine the relationship between measurable daily weather conditions, acoustic bat activity, and turbine operations with bat mortality. Studies conducted at the FRWF during 2010 showed positive correlations between acoustic bat activity, ambient temperature, and barometric pressure with bat mortality (Good et al. 2011). Positive correlations implied that increases in these variables were associated with increases in bat mortality. Studies from the FRWF in the fall of 2010 also showed that nights with higher average wind speeds had less activity and fewer fatalities (Good et al. 2011).

Daily fatality rates at roads and pads of 168 turbines studied at FRWF during the fall of 2011 showed similar relationships. Stepwise variable selection procedures retained the covariates for turbine brand, curtailment level, wind speed, barometric pressure, and acoustic activity as important variables in explaining fatalities. Temperature has also been shown to be associated with changes in bat activity (Good et al. 2011). Stepwise variable selection procedures may have excluded temperature due to collinear associations. The model selected is of the form:

Model A:

$$\begin{aligned}\log\big(mean(fresh\ bat\ fatalities\ per\ search)\big) &= 1470 + 0.58\ \text{Clipper} + 0.96\ \text{Vestas} - 0.86\ \text{Feathered}_{3.5} - 2.4\ \text{Feathered}_{4.5} \\ &\quad - 5.5\ \text{Feathered}_{5.5} + 0.06\ \text{Acoustic Activity} - 0.11\ \text{windspeed}^2 \\ &\quad + 1.25\ \text{windspeed} - 1.5\ \text{barometric pressure} + 0.08\ \text{Feathered}_{3.5} \\ &\quad \times \text{windspeed} + 0.32\ \text{Feathered}_{4.5} \times \text{windspeed} + 0.71\ \text{Feathered}_{5.5} \\ &\quad \times \text{windspeed}\end{aligned}$$

This model indicates that fatalities and wind speed have a quadratic relation. Fatalities were lower when wind speeds were below the turbine feathering speed of 3.5 m/s, 4.5 m/s, or 5.5 m/s, depending on the feathering treatment. Fatality rates increased with wind speed until wind speeds rose to around 5.5 – 6.0 m/s (18.0 – 19.7 ft/s), after which bat activity decreased with higher wind speeds as seen in previous studies (Good et al. 2011; Figure 25). Bat activity on nacelles clearly declined with increasing wind speeds (Table 29). Most bat activity and bat fatalities occurred when mean nightly temperatures were above 15 degrees C (Table 30).

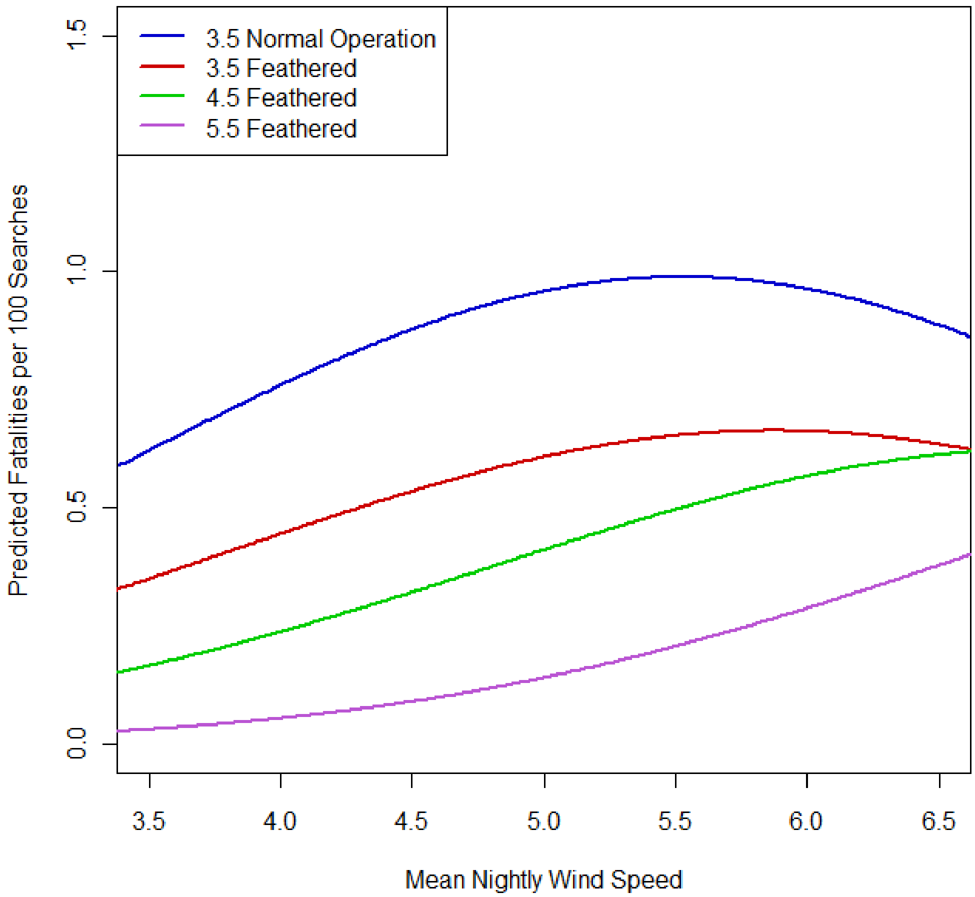

Figure 25. Predicted fatalities per 100 searches by mean nightly wind speed. Predictions from generalized linear regression Model A.

Table 29. Bat fatality counts at control plots and bat activity at varying wind speeds at the Fowler Ridge Wind Farm in 2011.

	Fatality Counts			Ground Acoustic Activity			Raised Acoustic Activity		
Wind Speed (m/s)	**Count**	**% Comp**	**Cumulative % Comp**	**Mean**	**% Comp**	**Cumulative % Comp**	**Mean**	**% Comp**	**Cumulative % Comp**
2-2.5	1	1.0	1.0	26.8	7.2	7.2	12.3	16.1	16.1
2.5-3.0	10	9.5	10.5	66.0	17.8	25.0	11.9	15.7	31.7
3-3.5	16	15.2	25.7	30.1	8.1	33.2	7.6	10.0	41.7
3.5-4.0	9	8.6	34.3	34.2	9.2	42.4	4.8	6.3	48.0
4.0-4.5	20	19.0	53.3	32.2	8.7	51.1	8.3	10.8	58.9
4.5-5.0	11	10.5	63.8	24.0	6.5	57.6	3.9	5.2	64.1
5-5.5	8	7.6	71.4	14.2	3.8	61.4	3.4	4.5	68.6
5.5-6.0	6	5.7	77.1	25.3	6.8	68.2	3.3	4.4	73.0
6.0-6.5	1	1.0	78.1	11.4	3.1	71.3	4.7	6.1	79.1
6.5-7.0	8	7.6	85.7	16.7	4.5	75.8	3.1	4.0	83.1
7.0-7.5	8	7.6	93.3	22.3	6.0	81.8	4.1	5.4	88.6
7.5-8.0	1	1.0	94.3	19.8	5.3	87.1	3.5	4.6	93.1
8.0-8.5	4	3.8	98.1	12.9	3.5	90.6	1.7	2.2	95.3
8.5-9.0	2	1.9	100	29.4	7.9	98.5	2.6	3.4	98.7
9.0-9.5	0	0.0	100	4.0	1.1	99.6	0.5	0.7	99.3

Table 30. Bat fatality counts at control plots and bat activity at varying temperatures at the Fowler Ridge Wind Farm in 2011.

	Fatality Counts			Ground Acoustic Activity			Raised Acoustic Activity			Myotis Activity		
Temp(C)	Count	% Comp	Cumulative % Comp	Mean	% Comp	Cumulative % Comp	Mean	% Comp	Cumulative % Comp	Mean	% Comp	Cumulative % Comp
30-35	3.0	2.9	2.9	28.6	22.1	22.1	21.3	52.4	52.4	0.00	0.0	0.0
25-30	42.0	40.0	42.9	38.4	29.7	51.9	7.4	18.1	70.5	0.02	64.1	64.1
20-25	43.0	41.0	83.8	27.7	21.4	73.3	5.3	13.0	83.5	0.01	35.9	100.0
15-20	12.0	11.4	95.2	14.5	11.2	84.5	3.5	8.7	92.2	0.00	0.0	100.0
10-15	5.0	4.8	100.0	7.9	6.1	90.6	1.2	2.9	95.1	0.00	0.0	100.0
5-10	0.0	0.0	100.0	12.2	9.4	100.0	2.0	4.9	100.0	0.00	0.0	100.0

Mean nightly bat acoustic activity was positively correlated with nightly bat fatality rates. Nights with higher acoustic activity, measured as the number of bat passes per Anabat detector, had higher fatality counts the following day. Predicted fatalities increased by 6.4% for every additional bat pass per detector (Model A; Figure 26). Barometric pressure exhibited a negative correlation with bat mortality. Negative binomial modeling indicated a 22.0% decrease in predicted fatalities for each unit increase in atmospheric pressure (Figure 26). Studies conducted in the fall of 2010 at the FRWF showed a slightly positive correlative between bat activity and barometric pressure (Good et al. 2011). This change in relationship may be due to smaller observed variation in average nightly barometric pressure in the fall of 2011 and also the autocorrelation of weather and activity covariates.

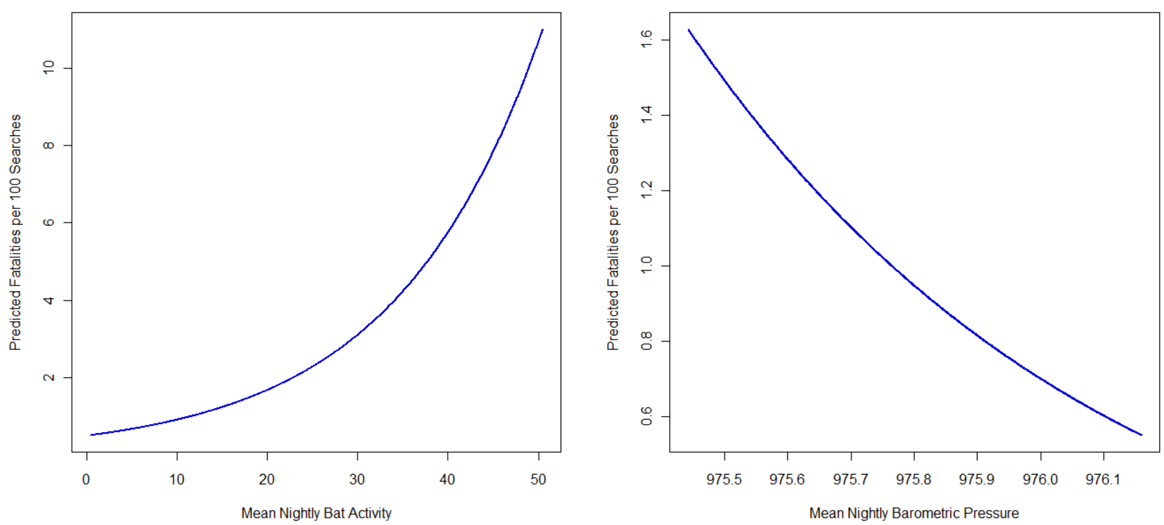

Figure 26. Predicted fatalities per 100 searches by mean nightly acoustic bat activity and barometric pressure. Predictions from generalized linear regression Model A.

DISCUSSION

Blade Feathering Study

The primary objective of the 2011 research was to measure the effectiveness of feathering turbines prior to reaching cut-in speeds for reducing bat fatality rates. The 2010 research study at the FRWF closely followed methods utilized by Arnett et al. (2010) at the Casselman facility in Pennsylvania, including testing of the same two cut-in speed adjustments (5.0 meters/second [m/s; 16.4 ft/s] and 6.5 m/s [21.3 ft/s]). At the time the study was conducted, it was unclear if raising cut-in speeds at the FRWF would also reduce bat fatality rates due to differences in wind regimes, land cover, and turbine types between the Casselman wind energy facility and the FRWF. The primary reason for testing the same cut-in speeds was to generate comparable study results, and to determine if raising cut-in speeds would also be effective for reducing bat fatalities at the FRWF. The results of the 2010 study at the FRWF confirmed that raising cut-in speeds to 5.0 m/s and 6.5 m/s was effective for reducing bat fatality rates, and at rates that were similar to other studies (Baerwald et al. 2009, Arnett et al. 2010, Good et al. 2011).

Further examination of turbine behavior during the 2010 study suggested that while the changes in turbine behavior utilized in 2010 reduced bat fatalities, turbines with raised cut-in speeds had blade tips rotating at 50 miles per hour (mph; 80 kilometers [km] per hour [kph]), or faster prior to reaching cut-in speeds, albeit at a reduced rate compared to control turbines (Figure 27). Management of turbine behavior below cut-in speeds varied by turbine type during the 2010 study. When implementing the raised cut-in speeds, the Clipper turbines (Figure 28) were spinning less, and Vestas (Figure 29) and GE turbines (Figure 30) were spinning at greater speeds prior to reaching raised cut-in speeds. Under normal control operations, all three turbine types were rotating at rates with potentially lethal tip speeds. Higher bat activity at nacelle height was recorded at the FRWF on nights with lower wind speeds, suggesting that feathering of GE and Vestas turbines below cut-in speeds could result in further reductions in bat fatality rates.

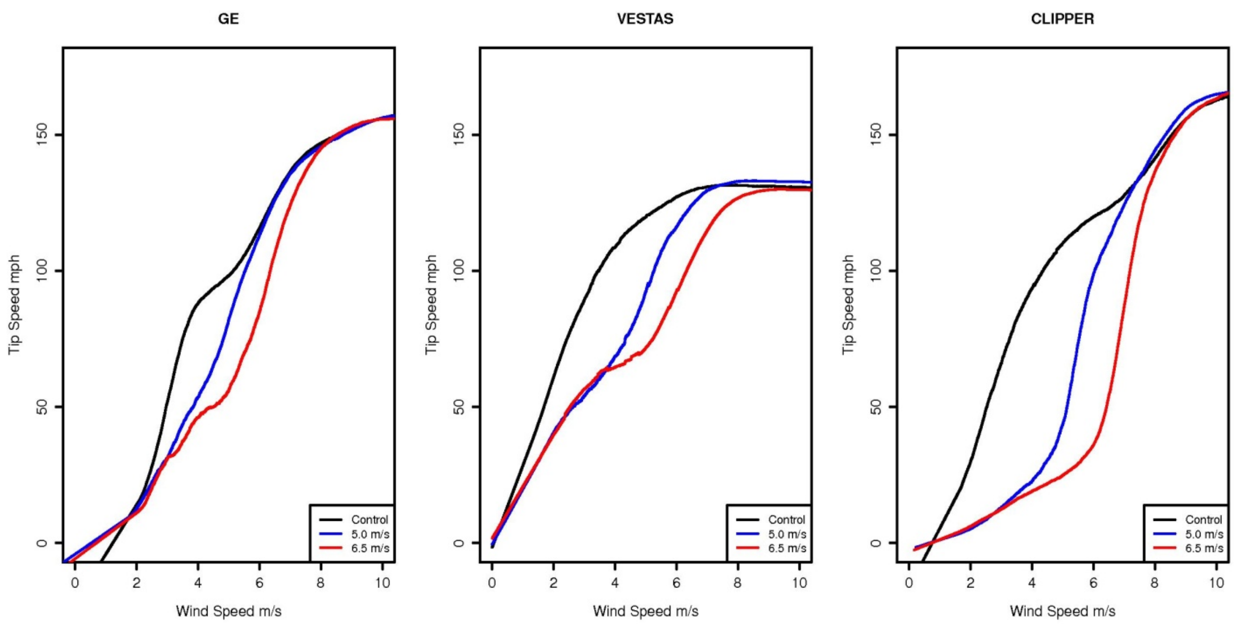

Figure 27. Estimated tip speed by wind speed for 3.5 m/s, 5.0 m/s, and 6.5 m/s cut-in speed adjustments for GE, Clipper, and Vestas wind turbines during the 2010 carcass monitoring at the Fowler Ridge Wind Farm. Estimates were made based on Friedman's SuperSmoother (Friedman 1984).

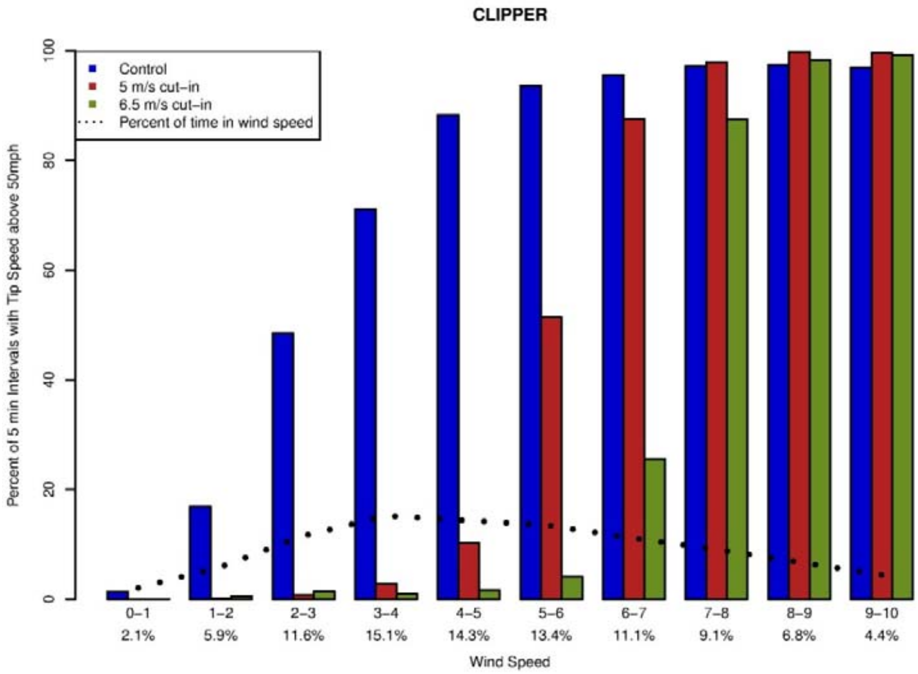

Figure 28. Percent of 5-minute intervals with tip speed above 50 mph for 1-meter intervals of wind speed for Clipper turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. The percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages along the x-axis represent the percent of 5-minute measures of wind speed that fell within that bin.

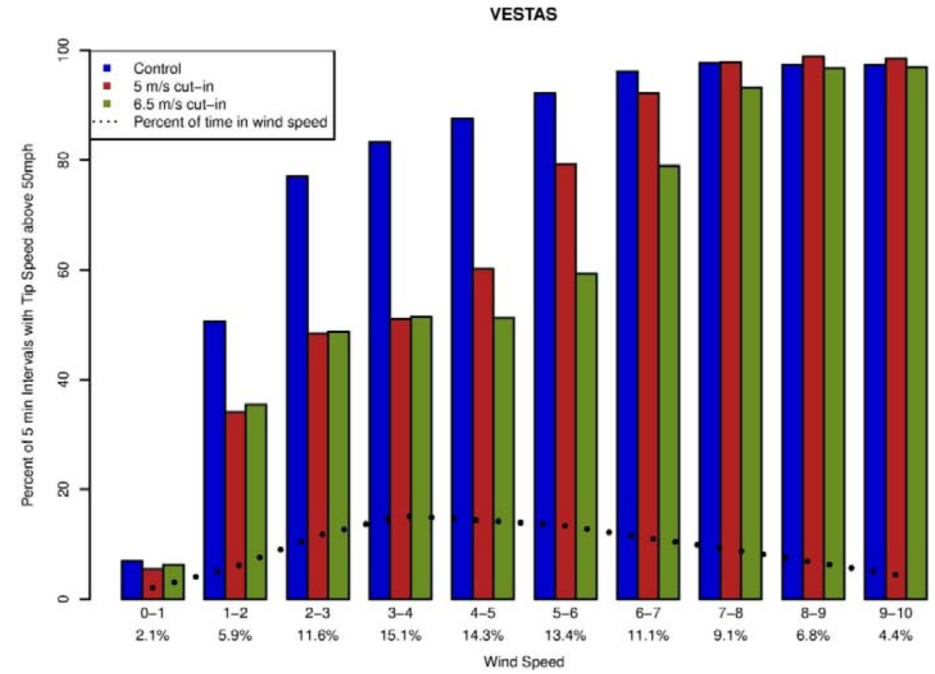

Figure 29. Percent of 5-minute intervals within 1-meter wind speed intervals with tip speed above 50 mph for VESTAS turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. The percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages along the x-axis represent the percent of 5-minute measures of wind speed that fell within that bin.

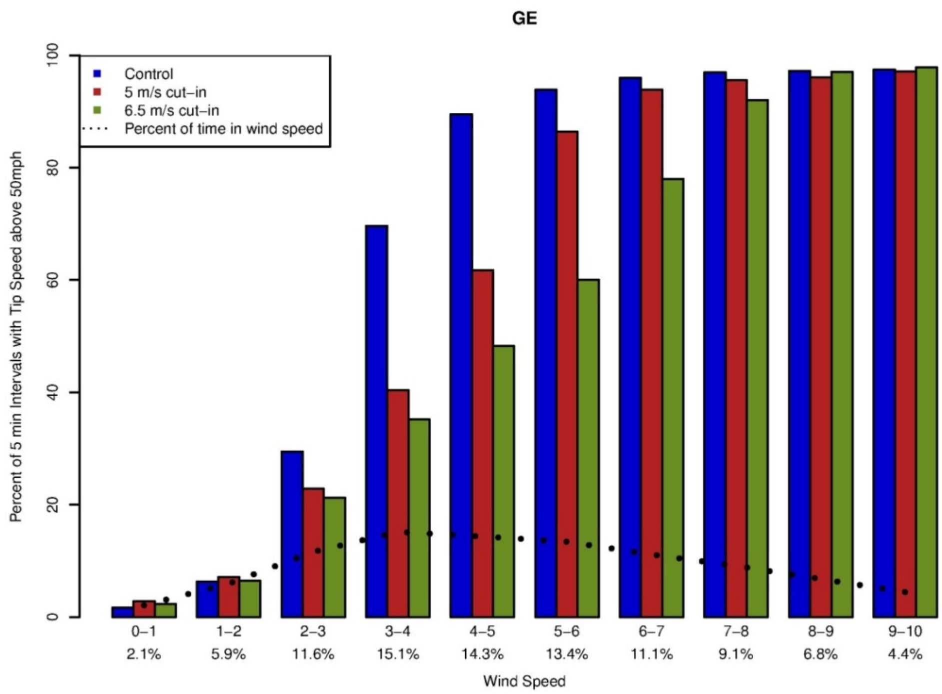

Figure 30. Percent of 5-minute intervals within 1-meter wind speed intervals with tip speed above 50 mph for GE turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. Percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages along the x-axis represent the percent of 5-minute measures of wind speed that fell within that bin.

The results of the 2011 blade feathering experiment show that further reductions in bat fatality rates were realized by feathering blades below cut-in speeds, compared to simply raising cut-in speeds of turbines. Bat fatality rates were reduced 36% in 2011 by feathering turbine blades below baseline (3.5 m/s) cut-in speeds. In 2010, 50% reductions in bat fatality rates were observed by raising cut-in speeds to 5.0 m/s. In 2011, a 56.7% reduction in bat fatality rates was observed by feathering blades below a lower cut-in speed (4.5 m/s). In 2010, a 78% reduction in bat fatality rates was observed by raising cut-in speeds to 6.5 m/s. In 2011, a 73.3% reduction in bat fatality rates was observed by feathering blades below a lower cut-in speed (5.5 m/s).

Research completed at other wind energy facilities also show feathering blades as an effective tool for reducing bat fatalities (Table 31). Young et al. (2011) found that feathering blades before they reached baseline cut-in speeds reduced bat fatalities. Similar results were recently reported by Baerwald et al. (2011) at a wind energy facility in Alberta, Canada. In both of these studies, the turbine blades and rotors were feathered so as to not turn at speeds below the cut-in speeds that were still potentially lethal for bats. In both cases, significant reductions in mortality (about 40 – 50%) were documented by feathering the turbine rotors below the normal cut-in speed of 4.0 m/s (13.1 ft/s).

Table 31. Comparison of available data on effectiveness of changing turbine cut-in speeds or blade feathering on reducing bat mortality

Location	Turbine type	Treatment	Reduction in Bat Casualty (Percent)	Reference
Casselman, PA	GE 1.5-MW	5.0 m/s 6.5 m/s	77.5 75.0	Arnett et al. 2010
Alberta, Canada	Vestas V80 1.8-MW	5.5 m/s idled during low wind speeds	60.0 57.4	Baerwald et al. 2009
Mount Storm, WV		4.0 m/s	22-47% 2nd half vs 1st half of the night	Young et al. 2011
Fowler Ridge, IN 2011	Vestas V82 1.65-MW Clipper C96 2.5-MW GE SLE 1.5-MW	3.5 m/s 4.5 m/s 5.5 m/s	36.3 56.7 73.3	This Study
Fowler Ridge, IN 2010	Vestas V82 1.65-MW Clipper C96 2.5-MW GE SLE 1.5-MW	5.0 m/s 6.5 m/s	50 78	Good et al. 2011
Germany	Unknown	5.5 m/s	~50	O. Behr, unpubl. data

Baseline Bat Fatality Rates

A secondary objective of the 2011 research was to determine if overall fall bat fatality rates were similar to or different from rates recorded in the fall of 2010. Larger cleared plots were sampled in 2011 to better measure the distances bats fell from turbines. Baseline bat fatality rates were similar between 2010 and 2011 after adjusting for bats that fell outside of plots in 2010.

The spring and fall combined fatality estimate in 2011 was 20.18 bats/MW/year. Studies at the FRWF are the first reported fatality estimates from Indiana, making comparisons to nearby wind-energy facilities difficult. Early studies of wind-energy facilities in the Midwest reported lower bat fatality rates than FRWF, and also included searches of standing corn and soybean fields during the growing season (see Appendix F). Searching standing crop fields becomes progressively more physically difficult, and progressively less effective from a searcher efficiency standpoint. Corn and soybean fields in the Midwest are especially difficult to search in August and September, when most bat casualties occur. Thus the most ready comparison of results from the FRWF, based on similarity of methods and landscape, is to the Top of Iowa wind-energy facility in north-central Iowa, the Blue Sky Greenfield facility in Wisconsin, the Forward Wind Energy Center in Wisconsin, the Cedar Ridge wind project in Wisconsin, and the Grand Ridge wind-energy facility in Illinois. With the exception of Grand Ridge, higher bat fatality rates were reported from wind-energy facilities in Wisconsin, Minnesota, Illinois, and Iowa that involved searching areas lacking standing crops, compared to earlier studies that involved searching standing corn and soybean fields (see Appendix F). Bat casualty rates at the FRWF were most similar to rates reported at wind-energy facilities in Wisconsin where crops where cleared for casualty studies.

The 2011 fatality estimate for the FRWF included only the spring and fall seasons, while most fatality estimates from Wisconsin included summer, spring, and fall. Relatively large numbers of bat fatalities would not be expected at the FRWF in the summer, given that most bat fatalities at wind energy facilities across the US usually occur in the fall (Arnett et al. 2010), and the project generally lacks suitable summer roosting and foraging habitat for most bat species.

Similar to other wind energy facilities in the US, the majority of casualties were comprised of eastern red bats, hoary bats, and silver-haired bats (Arnett et al. 2010). *Myotis* casualties were rare at the FRWF, comprising two of the 573 casualties found in 2011. Unlike 2009 and 2010, no Indiana bat casualties were found in 2011 at the FRWF.

Two new species were found as casualties at the FRWF in 2011, the evening bat and Seminole bat. Three of the four evening bat carcasses were found during the summer (May 13, July 19, July 24), suggesting that a summer colony of evening bats is potentially present within the FRWF, while the fourth was found on October 10 and may represent a potential migrant. Evening bats are relatively common in the southeastern US, but rare within Indiana. The evening bat is an Indiana state-listed endangered species (INHDC 2010).The FRWF obtained an incidental take permit from the state of Indiana for the evening bat after discovery of the first casualty.

Three Seminole bat carcasses were found on August 17, August 20, and September 3. The Seminole bat is a resident of the southern US, and typically roosts within Spanish moss (*Tillandsia usneoides*). Few records of the Seminole bat exist for Indiana, most of which were thought to be inadvertently transported to Indiana within Spanish moss transported from the southern US (Whitaker 2009). The FRWF is outside of the known range for the Seminole bat, although the species has been found outside of its range in other states. Discovery of the carcasses between August 17 – September 3 coincide with the post-breeding and migration periods for many bat species.

Timing of Bat Fatalities

Similar to other studies of bat casualties and wind-energy projects, the vast majority of bat casualties at the FRWF occurred during August and September (2005, Arnett et al. 2008), which coincides with the fall migration period for migratory tree bats. Johnson et al. (2010a) also noted that most fatalities occurred in 2009 from August through mid-September. Peaks in bat casualties in 2010 occurred primarily in early August, whereas Johnson et al. (2010a) noted peaks in bat casualties in early August and early September in 2009. Peaks in bat fatalities also generally corresponded with peak bat activity recorded at the FRWF in 2011, and bat activity rate was a significant variable in models predicting bat casualty rates at the FRWF.

Bat Fatalities and Weather

During the fall migration period of 2010, bat casualty rates were highest on nights with higher bat activity, lower mean wind speeds, and higher mean temperature. In other words, higher bat fatalities were associated with warmer, calmer evenings with increased bat activity. The 2011 study involved feathering blades at 126 of the 168 turbines searched on a daily basis. The blade feathering experiment altered the relationship between bat fatalities and wind speed, with fewer bat fatalities occurring when winds were below cut-in speeds of turbines. A total of about 77% of all bat fatalities and about 73% of all bat activity at the height of the nacelles occurred when wind speeds were below 5.5 m/s. This suggests that wind speeds above certain thresholds reduces bats' ability to fly near nacelle height.

In 2011, bat fatality rates were negatively related with increasing barometric pressure. Barometric pressure typically decreases in advance of weather fronts, followed by precipitation events. It is unclear if the relationship observed was the result of bats migrating in front of oncoming weather fronts. The relationship may also be caused by decreases in bat activity and bat fatality rates associated with precipitation and increasing barometric pressure after storm fronts arrive. Bat fatality rates were positively associated with increasing barometric pressure in 2010. The differences in this relationship between 2010 and 2011 seemingly present contradictory results. However; 2010 was one of the driest summer and fall periods on record in Indiana (Scheeringa 2010), and many passages of fronts in 2010 were not followed by precipitation events. The summer and fall of 2011 was closer to the historical average for precipitation (Scheeringa 2011).

Other researchers have also noted relationships between lower wind speeds and passage of weather fronts on bat activity and casualty rates in Tennessee, West Virginia, Iowa, and Wisconsin (Fiedler 2004, Kerns et al. 2005, Jain 2005, Arnett et al. 2008, Gruver et al. 2009). The consistency of results across wind energy facilities and regions suggests it is possible to predict when many of the bat casualties occur, which can serve as a basis for designing strategies to reduce bat casualty rates.

The reasons why lower bat fatalities occur on nights with higher wind speeds has not been well studied. Baerwald and Barclay (2009) suggested that silver-haired and hoary bats in Canada may not be killed as frequently on nights with higher wind speeds because these species may be flying at heights greater than turbines in higher wind speeds. Bats may also not migrate during nights of high wind speeds due to increased energetic costs (Arnett et al. 2008). The results of the 2010 research on bat activity and weather variables suggest that wind speed was a significant variable for predicting bat use on nacelles, but not for ground based units. 2011 activity data on nacelles show a clear decline in activity as wind speed increased, while the relationship was less obvious at ground detectors. This may indicate that bats continue to fly and echolocate in stronger winds, but do so at lower altitudes when winds are strong. It was not possible for WEST to monitor bat use above the heights of turbines prior to construction, and it is not known if bats were migrating or flying above turbine heights in stronger winds, although it seems unlikely that bats would fly higher during stronger winds due to the higher energetic costs.

Bat Fatalities and Turbine Type

Turbine model was a significant predictor of bat fatalities in 2011, with more bat fatalities observed at Vestas and Clipper turbines, and fewer observed at GE turbines. Barclay et al.

(2007) examined patterns of turbine heights and rotor diameter on bird and bat fatalities at existing wind energy facilities, and noted that bat casualty rates increased with increasing tower height, but seemed unaffected by increasing rotor diameter. However, WEST is unaware of any researchers that have examined casualty rates at turbines with the same nacelle height and varying rotor diameters during a concurrent casualty study. Three types of turbines were present within the FRWF. While all turbines had the same nacelle height, the three turbine types had differing rotor diameters. During 2010, observed bat casualty rates were not equal between turbine types, with higher bat casualty rates observed at turbines with greater rotor diameters. This pattern was potentially a function of increasing rotor swept area, and bats may have had an increased probability of colliding with turbines that had greater rotor swept areas.

Although the Clipper turbines had a greater rotor swept area, the Vestas turbines showed a higher per turbine fatality rate in 2011 compared to the Clipper and GE turbines. Further examination in 2011 suggests that turbine behavior prior to reaching cut-in speeds also affected bat fatality rates. Prior to reaching cut-in speeds in 2011, Vestas turbines were spinning more often and at higher speeds than the GE and Clipper turbines. Differences in turbine behavior between turbine types prior to reaching cut-in speeds, as well as the results of the blade feathering experiment, suggest that rotor swept area was not the only factor affecting bat fatality rates between turbines. Bats are more active during lower wind speeds, and decreasing the amount of time turbines are spinning during lower wind speeds significantly decreases bat fatality rates.

Bat Activity

Another objective of the study was to determine if bat activity rates were similar between the fall of 2010 and 2011. Bat activity at the base of turbines (16.72 versus 11.46 bat passes per detector-night) and on nacelles (5.19 versus 3.10 bat passes per detector-night) was higher in 2011 compared to 2010. Detectors were placed at four turbines during each season of study. Three different turbines were sampled in 2011, while turbine 614 was sampled during both years. Differences in activity rates could be attributed to different sampling locations. However, activity at turbine 614 was also higher in 2011 (22.28 bat passes per detector-night at the raised detector and 5.24 bat passes per detector-night at the ground detector) compared to 2010 (8.52 at passes per detector-night at the raised detector and 2.93 at passes per detector-night at the ground detector), suggesting that increases in activity were not due entirely to differences in sampling locations. Relatively little research has been completed regarding between year variation in migratory activity of bats, although it is likely that weather patterns can influence migratory activity. The fall of 2010 was one of the driest in record for Indiana (Scheeringa 2010), while precipitation was closer to historical averages in 2011 (Scheeringa 2011). Differences in weather patterns between years could result in differences in measured bat activity at the FRWF.

Although overall bat activity varied between years, *Myotis* bat activity remained consistently low between 2010 and 2011. A total of five calls were identified by the DF as resembling Indiana bat calls, and only one of the calls passed the Britzke filter. None of the calls identified by the DF were verified by WEST biologists. The results of acoustic monitoring and fatality searches in

2009, 2010, and 2011 suggest that *Myotis* bat activity rates and fatality rates are low compared to other bat species at the FRWF.

Similar to 2010, overall bat activity rates at the base of turbines were higher than recorded at ground locations away from turbines, and higher than recorded in 2007 prior to construction (Good et al. 2011). Cryan and Barclay (2009) hypothesized that relatively high bat casualty rates observed at wind energy facilities were the result of bats being attracted to turbines. Acoustic data collected from the ground at the FRWF before and after the construction of turbines may support this hypothesis. One potentially confounding factor is the lack of bat activity data within the potential rotor swept heights of turbines prior to construction. Data collected in 2010 and 2011 at FRWF, as well as data collected by other researchers (Baerwald et al. 2009), suggest that bat activity within rotor swept areas is more closely related to bat casualty rates than bat activity recorded on the ground. Further research conducted at other wind-energy facilities is needed in order to more fully test if bats are attracted to turbines. The studies conducted at FRWF were not designed to answer questions behind why bats may be attracted to turbines.

Use of Roads and Pads as Searchable Areas

The FRWF and other wind-energy facilities in the Midwest are located within landscapes dominated by productive corn and soybean fields. Corn and soybean fields provide a unique challenge for designing carcass monitoring surveys. From July through October, corn and soybean fields in the Midwest grow rapidly and form overlapping vegetative canopies that greatly reduce that ability of searchers to find carcasses, creating large areas around turbines where searcher efficiency rates are very low. This also coincides with the period when most bat casualties occur at FRWF and at other wind-energy facilities across the U.S. Very low searcher efficiency rates decrease the reliability of bat casualty estimates.

In order to detect fatalities at wind turbines under these conditions, researchers have accounted for very low detection rates within mature crop fields by paying landowners to clear a portion of their crops. This has resulted in landowner concerns over loss of crops and erosion. Corn and soybeans are a valuable commodity in the Midwest, and paying landowners to clear large areas of crops can be expensive. This is especially problematic for large wind-energy facilities where larger sample sizes are needed to calculate bat casualty rates.

The presence of gravel roads and pads underneath turbines provide a more searchable background for carcasses, and do not require extensive crop clearing. There are numerous benefits of road and pad searches:

1. Searcher efficiency estimates are significantly higher on the roads and pads (about 85%) compared to cleared plots containing areas away from roads and pads (about 32%; Good et al. 2011). Higher search detection results in:
    a. More precise estimates of mortality
    b. A better understanding of the effects of the facility on Indiana bats.

2. A more randomized and representative sample can be acquired when only searching road and pads. Logistics for clearing plots are significant and the location of plots is limited to landowners willing to cooperate with the study. Increased randomization strengthens model assumptions for fatality estimation.

3. A much larger sample of individual turbines can be conducted, providing larger spatial coverage. Increased spatial coverage provides additional information regarding possible flyways or areas of high incidence due to land use/land cover. Additional spatial representation also allows for testing and evaluation of a larger number of factors that may influence mortality, including landscape/proximity measures (e.g. distance to water features, shelterbelts, or surrounding crop types).

4. From an agricultural standpoint, searching only roads and pads enables farmers to plant additional acreage as no crops will be lost to clearing for search plots.

Double sampling is a common approach used when the standard sampling effort is very expensive and alternative and correlated sampling is possible. The basic idea of double sampling is that easy-to-measure/economical indicators are measured on a relatively large subset or census of sampling units in the assessment area (Morrison et al 2008). In addition, the expensive/time-consuming indicators are measured on a subset of the sampling units from within the study area.

The results of research conducted at FRWF during 2010 and 2011 show that comparable estimates of overall bat casualty rates can be obtained utilizing roads and pads as the primary sampling unit, under a double sampling strategy, compared to reliance on cleared plots. The results also show that daily searches are not needed to calculate comparable casualty estimates at FRWF assuming the carcass removal rates remain similar in the future. Use of roads and pads as sampling units provide a more cost-effective method for estimating overall bat casualty rates at FRWF compared to reliance on cleared plot searches or searches of standing corn and soybean fields.

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Appendix A. Estimated Time of Death Information Sheet

Previous 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 hallow 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. Discriminant Function Analysis Methods for Fowler

Date: January 30, 2012

To: Rhett Good

Re: Discriminant Function Analysis Methods for Fowler

This memo summarizes the bat species discriminant function developed from a library of known bat calls obtained from Dr. Lynn Robbins (University of Missouri). There were 599 bat calls from 11 bat species used to develop the function. The average number of pulses per call is shown in Table 1. The "HQ3" filter was applied to the data in Analook (© Chris Corben) to remove extraneous data points, and pulse parameters were exported for analysis using standard Analook methods. The call parameters were summarized over all the pulses within a call, and a call was considered the sampling unit in the analysis. We use the mean to summarize each call parameter, and in addition, the variance was used to summarize minimum frequency.

Methods

The call data were evaluated in context of the important assumptions of discriminant function analyses (Manly 2005). Four calls were outliers in multidimensional space and were removed. Four calls had extreme values for at least 3 variables, with extreme values defined as standardized scores greater than 3 (or less than -3). Because the data set had significantly different sample sizes for each of the species, the homogeneity of the variance-covariance matricies was investigated to improve classification. The test for the homogeneity within covariance matricies was rejected ($p<0.0001$), and separate covariance matricies were used during classification. The tests available for evaluating homogeneity within covariance matrices are notoriously sensitive, so a randomization test was used to evaluate the influence of the normality and homogeneity assumptions on the model (Manly 2005).

A canonical discriminate function was developed using a stepwise model selection procedure. There were 13 variables in the candidate variable list: mean duration (Dur), mean maximum frequency (Fmax), mean minimum frequency (Fmin), variance of the minimum frequency (varFmin), mean frequency (Fmean), mean time to inflection point of pulse (Tk), mean frequency at inflection point of pulse (Fk), mean characteristic duration (Dc), mean characteristic time (Tc), mean characteristic frequency (Fc), mean Pmc (a measure of shape) (Pmc), mean initial slope (S1), and mean characteristic slope (Sc). Forward model selection was conducted with significance level to enter set at 0.15 and significance level to stay set at 0.15. Ten-fold cross-validation was used to determine classification rates of the model.

The randomization test (RT) was conducted to determine if the model selection procedure and discriminate function model results were purely a chance effect of observations in a random order (Manly 1997). To conduct the RT, the data were reordered 999 times with the bat species (response in the model) randomly assigned to each observation. The discriminant function was estimated for each reordered data set and 2 statistics were saved from each run: eigenvalues and Wilks' Lambda. The distribution of these 999 values was the randomization distribution and a randomization test statistic was calculated as the number of these values that are as or more extreme than the observed statistic from the model with the actual data. Small values of the test statistic indicate the null hypothesis of chance effects is not true.

The classification equations are used to assign calls to a species group. The classification score for a call is calculated for each classification equation and the call is assigned to the species group for which the classification score is the highest. In the application to the Fowler data, calls were only classified to a species if the classification score (i.e., posterior probability) was at least 0.95, otherwise calls were labeled as "Other". Prior probabilities were assigned to inform the model predictions (Afifi and Clark 1996). Since two bat species, *Myotis grisescens* and *Myotis leibii* were not known to occur in the study area, the prior probability was set to zero. The remaining nine species were assigned equally probable values as prior probabilities. Note that this has the effect of modifying the dividing points between species calls but does not change the linear equations or correct classification rate of the original model.

Results

The model selection procedure resulted in 12 variables entering and staying in the model, all in the candidate variable list except mean time to inflection point of pulse. The model had a correct classification rate of 88% across all 11 species. The correct classification rates for individual species are in Table 2. Wilks' lambda was used to test significance of the discriminant function as a whole. The statistic was significantly large ($p<0.0001$) indicating the model does discriminate among the 11 bat species. The randomization test of Wilks' Lambda also concluded that the model results were not a function of pure chance ($p=0.001$).

The first eigenvalue accounted for 62% of the variance explained with the second accounting for 23% for a cumulative sum across the first two eigenvalues of 85%. The randomization test of the first three eigenvalues concluded that the model results were not a function of pure chance ($p=0.001$). The bat calls were plotted in the space of the first two canonical variates (discriminant functions) to show how they separate the groups (Figure 1). The first variable is positively correlated with minimum frequency, characteristic frequency, frequency at inflection point of pulse, and mean frequency and separates out the three low frequency species from the rest (EPFU, LACI, and LANO). The second and third variables are more important in separating the rest of the species (Figure 2). The second canonical variate is positively correlated with the characteristic slope and mean frequency. The third canonical variate is negatively correlated with frequency at inflection point of pulse and the measure of shape.

The classification equations for this model are in Table 3. Each row in Table 3 represents an equation, with the constant and a coefficient for each variable in the model.

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Table 1. Number of calls and average number of pulses per call for each bat species used in the discriminant function analysis.

Species	Number of Calls	Mean Number of Pulses per Call	95% Confidence Interval Lower	Upper
EPFU	104	21.12	18.48	23.75
LABO	45	24.31	19.35	29.28
LACI	25	17.28	13.14	21.42
LANO	19	17.11	7.89	26.32
MYGR	64	26.56	21.40	31.73
MYLE	12	23.58	16.56	30.60
MYLU	65	20.75	18.15	23.35
MYSE	50	21.46	18.13	24.79
MYSO	89	22.17	19.24	25.10
NYHU	13	16.38	10.05	22.72
PESU	113	17.85	15.76	19.94

Table 2. Proportion of calls correctly classified for each species and all species combined.

Species	Total number of Calls	Number of Correctly Classified Calls	Proportion of Calls Correctly Classified
EPFU	104	94	0.90
LABO	45	38	0.84
LACI	25	19	0.76
LANO	19	15	0.79
MYGR	64	61	0.95
MYLE	12	8	0.67
MYLU	65	54	0.83
MYSE	50	40	0.80
MYSO	89	75	0.84
NYHU	13	10	0.77
PESU	113	112	0.99
Total	599	526	0.88

Table 3. Coefficients of the classification equations for the discriminant function.

Species	Constant	Fmin	Sc	Fk	Dc	Fc	dur	varFmin	Fmean	Pmc	Fmax	S1	Tc
EPFU	-429.83	-5.12	-0.16	-1.19	12.96	36.77	17.35	-1.10	22.60	8.92	-30.45	0.21	-13.63
LABO	-548.37	1.54	-0.29	-2.69	18.48	38.73	18.20	-0.95	14.13	7.75	-24.78	0.18	-18.41
LACI	-384.99	-4.18	-0.11	-2.86	20.96	31.29	30.76	-0.51	25.54	8.17	-29.68	0.26	-29.52
LANO	-369.53	-5.11	-0.19	-2.81	19.11	35.27	14.48	-1.00	21.69	7.95	-27.94	0.24	-14.63
MYGR	-716.98	-8.49	-0.49	-0.67	19.72	43.94	11.76	-1.58	25.27	8.13	-29.16	0.25	-13.38
MYLE	-696.99	-5.77	-0.19	-5.02	19.50	40.30	16.49	-1.77	30.22	7.80	-30.30	0.33	-15.92
MYLU	-601.95	-7.52	-0.36	2.49	13.84	34.27	17.02	-1.50	28.33	7.97	-30.05	0.28	-14.48
MYSE	-609.41	-10.76	-0.13	-6.36	19.96	40.69	16.59	-1.60	34.40	7.85	-30.86	0.29	-16.45
MYSO	-616.78	-9.91	-0.31	-3.77	15.07	39.25	17.04	-1.62	33.66	7.86	-31.15	0.30	-14.95
NYHU	-533.36	-2.49	-0.33	-2.93	19.02	40.45	11.67	-1.27	18.76	8.03	-27.43	0.26	-12.07
PESU	-679.65	-3.11	-0.44	-5.95	25.57	48.78	11.98	-1.60	19.66	8.63	-28.90	0.25	-17.26

Figure 1. Bat calls in the space of the first two canonical variates.

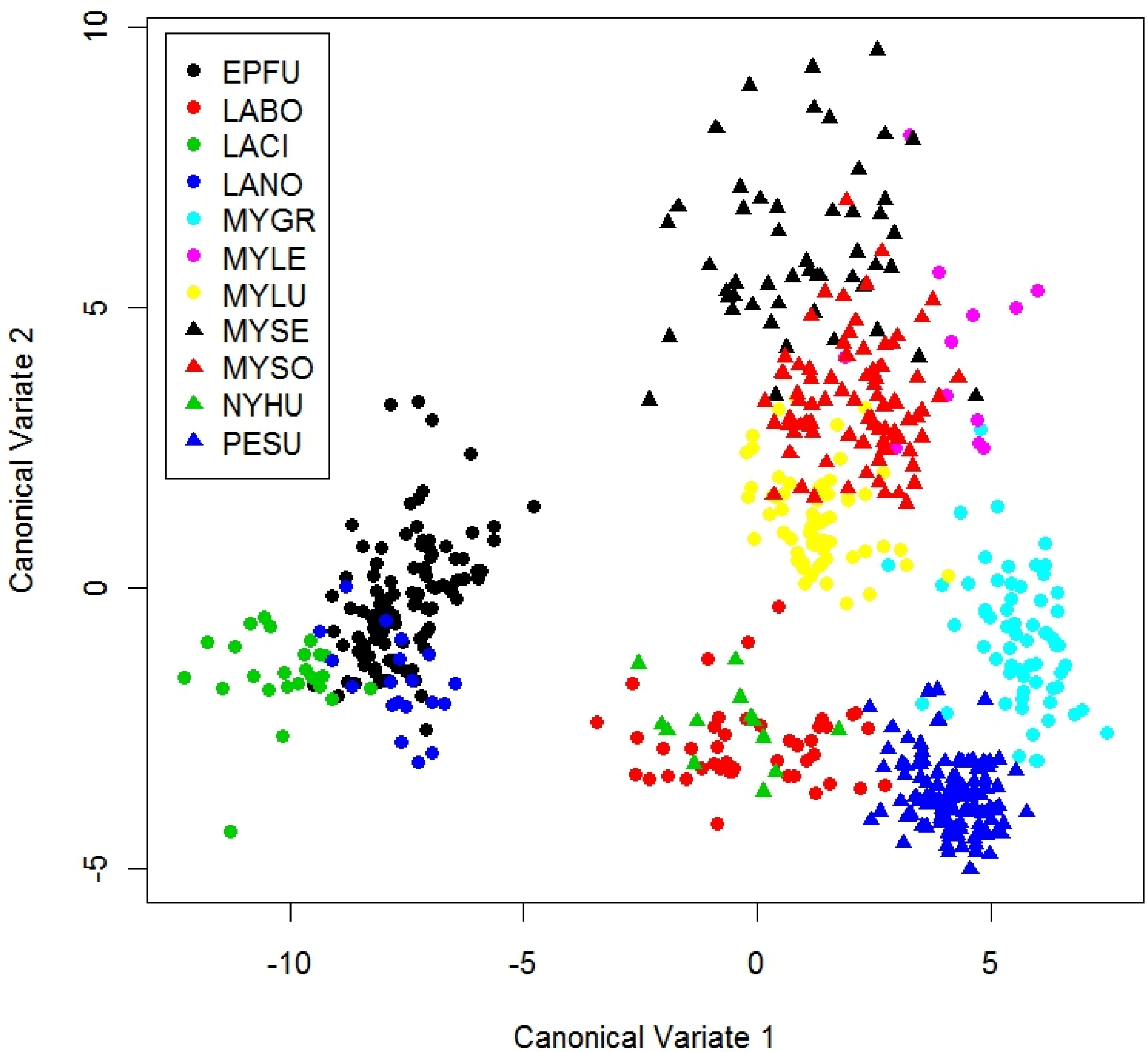
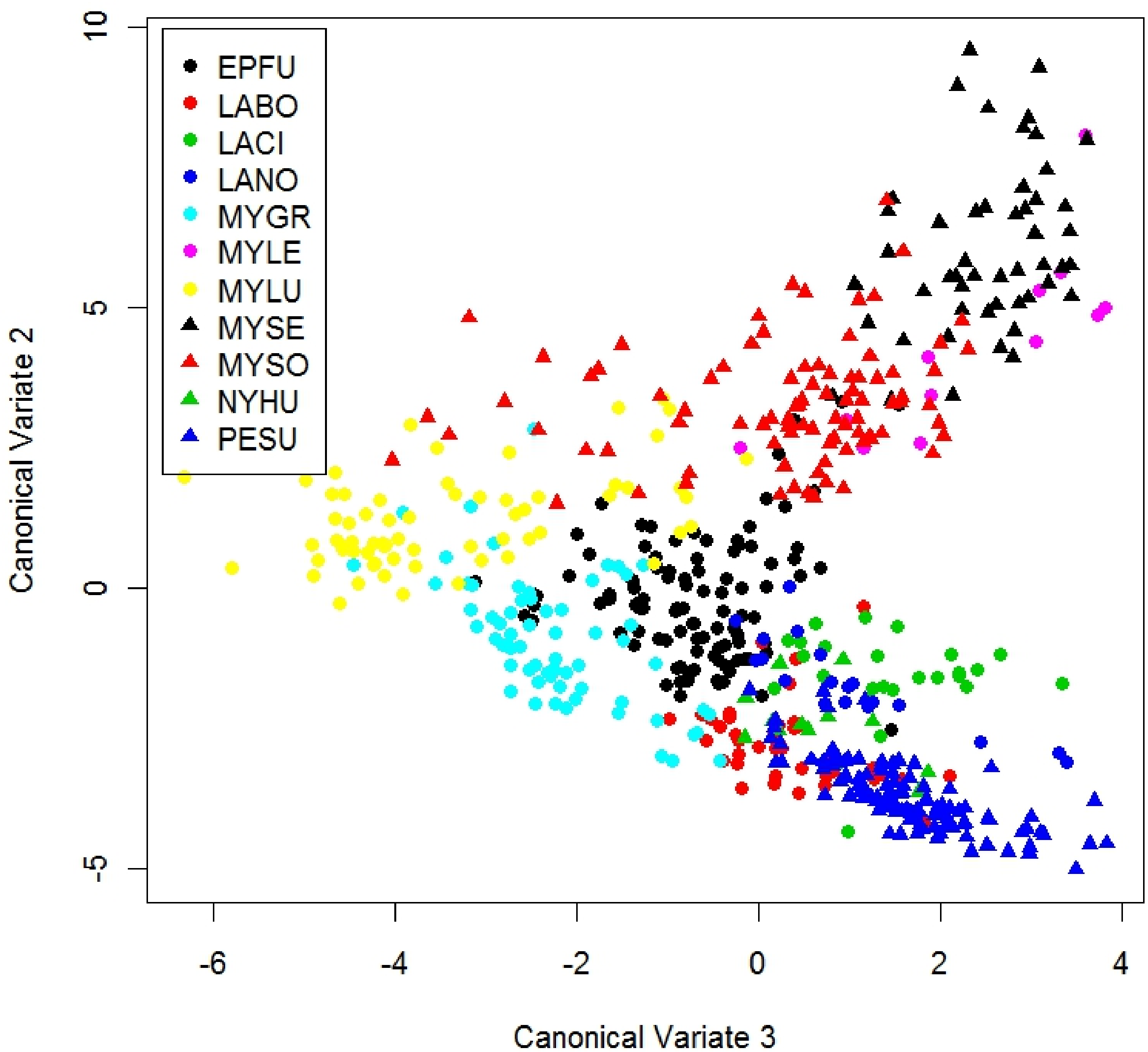


Figure 2. Bat calls in the space of the second and third canonical variates.



Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
4 /1 /2011	European starling	332	7	carcass search	Road & Pad Only	complete
4 /3 /2011	rough-legged hawk	099	48	incidental off plot	Road & Pad Only	complete
4 /5 /2011	unidentified waterfowl	334	80	carcass search	Road & Pad Only	feather spot
4 /7 /2011	European starling	390	19	carcass search	Road & Pad Only	complete
4 /7 /2011	killdeer	603	27	incidental off plot	Road & Pad Only	complete
4 /14/2011	eastern red bat	286	8	carcass search	Road & Pad Only	partial
4 /15/2011	horned lark	443	57	carcass search	Road & Pad Only	partial
4 /15/2011	unidentified waterfowl	639	30	carcass search	Road & Pad Only	feather spot
4 /21/2011	European starling	152	32	carcass search	Road & Pad Only	complete
4 /27/2011	silver-haired bat	642	5	carcass search	Road & Pad Only	complete
4 /27/2011	silver-haired bat	642	6	carcass search	Road & Pad Only	complete
4 /30/2011	unidentified waterfowl	639	9	incidental off plot	Road & Pad Only	scavenged
5 /2 /2011	silver-haired bat	448	27	carcass search	Road & Pad Only	complete
5 /3 /2011	silver-haired bat	641	11	incidental off plot	Road & Pad Only	complete
5 /3 /2011	yellow-throated vireo	121	27	incidental off plot	Road & Pad Only	complete
5 /7 /2011	hoary bat	248	10	incidental off plot	Road & Pad Only	complete
5 /9 /2011	eastern red bat	476	42	incidental off plot	Road & Pad Only	scavenged
5 /11/2011	eastern red bat	403	13	incidental off plot		complete
5 /11/2011	European starling	065	5	carcass search	Road & Pad Only	scavenged
5 /11/2011	hoary bat	203	4	incidental on plot	Road & Pad Only	complete
5 /12/2011	eastern red bat	608	7	incidental off plot		scavenged
5 /12/2011	hoary bat	334	18	carcass search	Road & Pad Only	complete
5 /12/2011	hoary bat	614	15	carcass search	Road & Pad Only	complete
5 /12/2011	silver-haired bat	607	13	carcass search	Road & Pad Only	scavenged
5 /12/2011	unidentified bird (small)	603	9	carcass search	Road & Pad Only	feather spot
5 /13/2011	eastern red bat	354	37	carcass search	Road & Pad Only	complete
5 /13/2011	evening bat	630	4	carcass search	Road & Pad Only	complete
5 /15/2011	eastern red bat	173	15	carcass search	Road & Pad Only	partial
7 /14/2011	eastern red bat	052	3	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	eastern red bat	411	0	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	eastern red bat	460	14	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	eastern red bat	481	14	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	eastern red bat	609	22	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	eastern red bat	622	11	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	hoary bat	426	21	incidental off plot	Road & Pad Only	complete
7 /14/2011	hoary bat	445	17	incidental off plot	Road & Pad Only	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
7 /14/2011	hoary bat	454	7	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	hoary bat	478	40	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	killdeer	129	80	incidental off plot	Road & Pad Only	partial
7 /14/2011	killdeer	229	30	incidental off plot	Road & Pad Only	feather spot
7 /14/2011	mourning dove	628	26	incidental off plot	Cleared Plot	feather spot
7 /14/2011	silver-haired bat	607	0	incidental off plot	Road & Pad Only	scavenged
7 /14/2011	unidentified large bird	640	32	incidental off plot	Road & Pad Only	scavenged
7 /15/2011	eastern red bat	230	15	incidental off plot	Road & Pad Only	scavenged
7 /15/2011	indigo bunting	086	2	incidental off plot		complete
7 /15/2011	unidentified large bird	024	50	carcass search	Cleared Plot	feather spot
7 /16/2011	eastern kingbird	230	27	carcass search	Road & Pad Only	feather spot
7 /16/2011	eastern red bat	429	10	carcass search	Road & Pad Only	complete
7 /16/2011	hoary bat	480	13	carcass search	Cleared Plot	scavenged
7 /17/2011	common grackle	448	7	carcass search	Road & Pad Only	scavenged
7 /17/2011	eastern red bat	439	0	incidental off plot		scavenged
7 /17/2011	killdeer	118	39	carcass search	Road & Pad Only	feather spot
7 /18/2011	eastern red bat	396	55	incidental off plot	Cleared Plot	complete
7 /18/2011	hoary bat	469	8	incidental off plot		scavenged
7 /18/2011	hoary bat	643	6	incidental off plot		scavenged
7 /18/2011	killdeer	082	72	incidental off plot	Road & Pad Only	feather spot
7 /18/2011	killdeer	480	31	carcass search	Cleared Plot	feather spot
7 /18/2011	mourning dove	396	10	carcass search	Cleared Plot	feather spot
7 /19/2011	eastern red bat	024	54	carcass search	Cleared Plot	complete
7 /19/2011	eastern red bat	116	6	carcass search	Road & Pad Only	complete
7 /19/2011	evening bat	478	1	incidental off plot	Road & Pad Only	scavenged
7 /20/2011	big brown bat	147	12	carcass search	Road & Pad Only	complete
7 /20/2011	eastern red bat	455	4	carcass search	Road & Pad Only	partial
7 /20/2011	hoary bat	355	25	carcass search	Road & Pad Only	complete
7 /20/2011	killdeer	230	36	carcass search	Road & Pad Only	feather spot
7 /20/2011	killdeer	230	38	incidental off plot	Road & Pad Only	feather spot
7 /21/2011	eastern red bat	057	3	carcass search	Road & Pad Only	partial
7 /21/2011	eastern red bat	476	6	carcass search	Road & Pad Only	complete
7 /21/2011	eastern red bat	622	35	carcass search	Road & Pad Only	scavenged
7 /21/2011	hoary bat	024	26	carcass search	Cleared Plot	scavenged
7 /21/2011	hoary bat	475	5	incidental off plot		scavenged
7 /21/2011	hoary bat	631	39	carcass search	Road & Pad Only	complete
7 /22/2011	eastern red bat	026	40	carcass search	Road & Pad Only	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
7 /22/2011	eastern red bat	054	37	carcass search	Road & Pad Only	scavenged
7 /22/2011	eastern red bat	405	7	carcass search	Road & Pad Only	complete
7 /22/2011	eastern red bat	433	18	incidental off plot		scavenged
7 /22/2011	hoary bat	047	5	carcass search	Road & Pad Only	complete
7 /22/2011	killdeer	628	63	carcass search	Cleared Plot	scavenged
7 /23/2011	eastern red bat	221	54	incidental off plot	Road & Pad Only	scavenged
7 /23/2011	eastern red bat	631	16	carcass search	Road & Pad Only	complete
7 /23/2011	hoary bat	048	61	carcass search	Cleared Plot	scavenged
7 /23/2011	hoary bat	156	31	carcass search	Road & Pad Only	scavenged
7 /23/2011	hoary bat	203	15	carcass search	Road & Pad Only	complete
7 /24/2011	big brown bat	627	0	carcass search	Road & Pad Only	complete
7 /24/2011	eastern red bat	083	4	carcass search	Road & Pad Only	complete
7 /24/2011	eastern red bat	170	17	carcass search	Road & Pad Only	complete
7 /24/2011	eastern red bat	396	48	carcass search	Cleared Plot	scavenged
7 /24/2011	eastern red bat	631	2	carcass search	Road & Pad Only	complete
7 /24/2011	evening bat	046	7	carcass search	Road & Pad Only	scavenged
7 /24/2011	hoary bat	355	0	carcass search	Road & Pad Only	complete
7 /24/2011	unidentified warbler	388	21	carcass search	Road & Pad Only	scavenged
7 /25/2011	hoary bat	156	24	carcass search	Road & Pad Only	complete
7 /25/2011	hoary bat	248	2	carcass search	Road & Pad Only	complete
7 /25/2011	hoary bat	253	7	carcass search	Road & Pad Only	scavenged
7 /25/2011	little brown bat	611	8	incidental off plot	Road & Pad Only	scavenged
7 /25/2011	rock pigeon	445	77	carcass search	Road & Pad Only	feather spot
7 /26/2011	eastern red bat	090	7	incidental off plot	Road & Pad Only	scavenged
7 /26/2011	hoary bat	411	4	carcass search	Road & Pad Only	scavenged
7 /26/2011	hoary bat	614	33	carcass search	Cleared Plot	complete
7 /26/2011	hoary bat	630	29	carcass search	Cleared Plot	complete
7 /26/2011	hoary bat	630	24	carcass search	Cleared Plot	scavenged
7 /27/2011	eastern red bat	028	0	carcass search	Road & Pad Only	complete
7 /27/2011	eastern red bat	170	32	carcass search	Road & Pad Only	complete
7 /27/2011	eastern red bat	173	4	carcass search	Road & Pad Only	complete
7 /27/2011	eastern red bat	405	27	incidental off plot	Road & Pad Only	scavenged
7 /27/2011	hoary bat	286	13	incidental off plot	Road & Pad Only	complete
7 /27/2011	hoary bat	389	4	incidental off plot		scavenged
7 /27/2011	hoary bat	389	6	incidental off plot		scavenged
7 /27/2011	killdeer	095	63	carcass search	Cleared Plot	feather spot
7 /27/2011	unidentified large bird	625	36	carcass search	Road & Pad Only	scavenged
7 /27/2011	unidentified large	639	54	carcass search	Road & Pad Only	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
	bird					
7 /28/2011	eastern red bat	455	25	carcass search	Road & Pad Only	scavenged
7 /28/2011	hoary bat	628	35	carcass search	Cleared Plot	scavenged
7 /28/2011	killdeer	480	24	carcass search	Cleared Plot	feather spot
7 /29/2011	eastern red bat	076	16	carcass search	Road & Pad Only	complete
7 /29/2011	eastern red bat	095	25	carcass search	Cleared Plot	scavenged
7 /30/2011	eastern red bat	605	1	carcass search	Road & Pad Only	complete
7 /30/2011	eastern red bat	606	32	carcass search	Road & Pad Only	scavenged
7 /31/2011	big brown bat	152	6	carcass search	Road & Pad Only	scavenged
7 /31/2011	eastern red bat	004	8	carcass search	Road & Pad Only	scavenged
7 /31/2011	eastern red bat	286	20	carcass search	Road & Pad Only	complete
7 /31/2011	eastern red bat	305	5	carcass search	Road & Pad Only	complete
7 /31/2011	eastern red bat	477	41	carcass search	Road & Pad Only	complete
7 /31/2011	eastern red bat	637	11	carcass search	Road & Pad Only	scavenged
7 /31/2011	hoary bat	629	23	incidental off plot		scavenged
8 /1 /2011	big brown bat	639	40	carcass search	Road & Pad Only	scavenged
8 /1 /2011	eastern red bat	363	33	incidental off plot		scavenged
8 /1 /2011	eastern red bat	363	5	incidental off plot		scavenged
8 /1 /2011	eastern red bat	620	32	incidental off plot	Road & Pad Only	partial
8 /1 /2011	European starling	052	57	carcass search	Road & Pad Only	feather spot
8 /1 /2011	hoary bat	363	19	incidental off plot		scavenged
8 /1 /2011	hoary bat	480	4	carcass search	Cleared Plot	complete
8 /1 /2011	hoary bat	608	3	incidental off plot		scavenged
8 /2 /2011	eastern red bat	020	38	carcass search	Road & Pad Only	complete
8 /2 /2011	eastern red bat	095	2	carcass search	Cleared Plot	complete
8 /2 /2011	eastern red bat	443	12	carcass search	Road & Pad Only	complete
8 /2 /2011	eastern red bat	606	23	carcass search	Road & Pad Only	complete
8 /2 /2011	hoary bat	218	5	carcass search	Cleared Plot	complete
8 /2 /2011	hoary bat	218	23	carcass search	Cleared Plot	scavenged
8 /2 /2011	hoary bat	642	8	carcass search	Road & Pad Only	complete
8 /2 /2011	killdeer	095	53	carcass search	Cleared Plot	feather spot
8 /3 /2011	eastern red bat	090	1	carcass search	Road & Pad Only	complete
8 /3 /2011	eastern red bat	133	24	carcass search	Road & Pad Only	complete
8 /3 /2011	hoary bat	022	15	carcass search	Road & Pad Only	scavenged
8 /3 /2011	hoary bat	097	40	carcass search	Road & Pad Only	complete
8 /3 /2011	hoary bat	224	51	carcass search	Road & Pad Only	complete
8 /4 /2011	eastern red bat	044	60	incidental off plot		scavenged
8 /4 /2011	eastern red bat	195	7	carcass search	Road & Pad Only	complete
8 /4 /2011	eastern red bat	229	40	carcass search	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /4 /2011	eastern red bat	454	21	carcass search	Road & Pad Only	complete
8 /4 /2011	hoary bat	613	2	incidental off plot		scavenged
8 /5 /2011	eastern red bat	396	59	carcass search	Cleared Plot	complete
8 /5 /2011	eastern red bat	441	1	carcass search	Road & Pad Only	complete
8 /5 /2011	eastern red bat	464	1	carcass search	Road & Pad Only	scavenged
8 /5 /2011	eastern red bat	480	23	carcass search	Cleared Plot	complete
8 /5 /2011	eastern red bat	614	39	carcass search	Cleared Plot	scavenged
8 /5 /2011	European starling	147	14	carcass search	Road & Pad Only	feather spot
8 /5 /2011	hoary bat	152	4	carcass search	Road & Pad Only	scavenged
8 /5 /2011	hoary bat	226	31	carcass search	Road & Pad Only	complete
8 /5 /2011	hoary bat	388	17	carcass search	Road & Pad Only	complete
8 /5 /2011	hoary bat	396	21	carcass search	Cleared Plot	scavenged
8 /5 /2011	hoary bat	464	7	carcass search	Road & Pad Only	complete
8 /6 /2011	big brown bat	459	16	carcass search	Road & Pad Only	complete
8 /6 /2011	big brown bat	476	0	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	048	27	carcass search	Cleared Plot	scavenged
8 /6 /2011	eastern red bat	173	10	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	218	12	carcass search	Cleared Plot	scavenged
8 /6 /2011	eastern red bat	218	45	carcass search	Cleared Plot	scavenged
8 /6 /2011	eastern red bat	221	6	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	309	10	incidental off plot	Road & Pad Only	scavenged
8 /6 /2011	eastern red bat	314	37	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	323	15	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	420	21	carcass search	Road & Pad Only	complete
8 /6 /2011	eastern red bat	625	8	carcass search	Road & Pad Only	complete
8 /6 /2011	hoary bat	218	8	carcass search	Cleared Plot	complete
8 /6 /2011	hoary bat	414	16	carcass search	Road & Pad Only	scavenged
8 /6 /2011	little brown bat	397	3	carcass search	Road & Pad Only	complete
8 /7 /2011	eastern red bat	396	16	carcass search	Cleared Plot	complete
8 /7 /2011	eastern red bat	425	5	carcass search	Road & Pad Only	complete
8 /7 /2011	eastern red bat	458	22	incidental off plot	Road & Pad Only	scavenged
8 /7 /2011	eastern red bat	478	22	carcass search	Road & Pad Only	complete
8 /7 /2011	eastern red bat	625	1	carcass search	Road & Pad Only	complete
8 /7 /2011	hoary bat	432	7	incidental off plot	Road & Pad Only	scavenged
8 /7 /2011	hoary bat	458	17	incidental off plot	Road & Pad Only	scavenged
8 /8 /2011	big brown bat	626	1	incidental off plot		scavenged
8 /8 /2011	eastern red bat	225	14	incidental off plot		scavenged
8 /8 /2011	eastern red bat	334	7	carcass search	Road & Pad Only	complete
8 /8 /2011	eastern red bat	352	12	incidental off plot	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /8 /2011	eastern red bat	390	2	carcass search	Road & Pad Only	complete
8 /8 /2011	eastern red bat	396	24	incidental on plot	Cleared Plot	scavenged
8 /8 /2011	eastern red bat	405	10	carcass search	Road & Pad Only	complete
8 /8 /2011	eastern red bat	609	0	carcass search	Road & Pad Only	complete
8 /8 /2011	eastern red bat	629	15	incidental off plot		scavenged
8 /8 /2011	hoary bat	378	19	carcass search	Road & Pad Only	complete
8 /8 /2011	hoary bat	459	15	carcass search	Road & Pad Only	complete
8 /8 /2011	hoary bat	620	4	carcass search	Road & Pad Only	complete
8 /8 /2011	hoary bat	621	17	incidental off plot		complete
8 /8 /2011	unidentified bird (small)	348	8	carcass search	Road & Pad Only	feather spot
8 /9 /2011	eastern red bat	180	6	incidental off plot		complete
8 /9 /2011	eastern red bat	216	73	carcass search	Road & Pad Only	scavenged
8 /9 /2011	eastern red bat	408	6	incidental off plot		complete
8 /9 /2011	eastern red bat	635	2	carcass search	Road & Pad Only	complete
8 /9 /2011	hoary bat	398	6	carcass search	Road & Pad Only	scavenged
8 /9 /2011	silver-haired bat	420	16	incidental off plot	Road & Pad Only	scavenged
8 /10/2011	big brown bat	363	15	incidental off plot		scavenged
8 /10/2011	big brown bat	635	14	carcass search	Road & Pad Only	complete
8 /10/2011	eastern red bat	348	78	carcass search	Road & Pad Only	complete
8 /10/2011	eastern red bat	348	52	carcass search	Road & Pad Only	complete
8 /10/2011	eastern red bat	363	46	incidental off plot		scavenged
8 /10/2011	eastern red bat	643	29	incidental off plot		scavenged
8 /10/2011	eastern red bat	643	9	incidental off plot		scavenged
8 /11/2011	eastern red bat	081	28	incidental off plot		complete
8 /11/2011	eastern red bat	216	1	carcass search	Road & Pad Only	complete
8 /11/2011	eastern red bat	371	8	carcass search	Road & Pad Only	complete
8 /11/2011	eastern red bat	396	16	carcass search	Cleared Plot	complete
8 /11/2011	eastern red bat	408	26	incidental off plot		complete
8 /11/2011	eastern red bat	629	11	incidental off plot		complete
8 /11/2011	eastern red bat	629	9	incidental off plot		scavenged
8 /11/2011	hoary bat	423	10	carcass search	Road & Pad Only	complete
8 /11/2011	hoary bat	439	4	incidental off plot		complete
8 /12/2011	eastern red bat	227	16	carcass search	Road & Pad Only	complete
8 /12/2011	eastern red bat	439	15	incidental off plot		scavenged
8 /12/2011	eastern red bat	445	36	carcass search	Road & Pad Only	scavenged
8 /12/2011	hoary bat	439	13	incidental off plot		scavenged
8 /12/2011	red-tailed hawk	103	300	incidental off plot	Road & Pad Only	partial
8 /12/2011	tricolored bat	152	12	carcass search	Road & Pad Only	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /13/2011	eastern red bat	088	16	carcass search	Road & Pad Only	complete
8 /13/2011	eastern red bat	119	4	incidental off plot		scavenged
8 /13/2011	eastern red bat	286	7	carcass search	Road & Pad Only	complete
8 /13/2011	eastern red bat	396	33	carcass search	Cleared Plot	complete
8 /13/2011	eastern red bat	637	6	carcass search	Road & Pad Only	complete
8 /13/2011	hoary bat	630	38	carcass search	Cleared Plot	complete
8 /14/2011	big brown bat	620	5	carcass search	Road & Pad Only	complete
8 /14/2011	cliff swallow	419	26	carcass search	Road & Pad Only	complete
8 /14/2011	eastern red bat	152	13	carcass search	Road & Pad Only	scavenged
8 /14/2011	eastern red bat	334	6	incidental off plot	Road & Pad Only	complete
8 /14/2011	eastern red bat	417	11	incidental off plot		complete
8 /15/2011	eastern red bat	170	29	carcass search	Road & Pad Only	complete
8 /15/2011	eastern red bat	216	10	carcass search	Road & Pad Only	complete
8 /15/2011	eastern red bat	390	2	carcass search	Road & Pad Only	complete
8 /15/2011	eastern red bat	445	1	carcass search	Road & Pad Only	scavenged
8 /15/2011	eastern red bat	460	1	carcass search	Road & Pad Only	complete
8 /15/2011	eastern red bat	476	2	carcass search	Road & Pad Only	scavenged
8 /15/2011	eastern red bat	480	56	carcass search	Cleared Plot	partial
8 /15/2011	eastern red bat	628	33	carcass search	Cleared Plot	complete
8 /15/2011	killdeer	614	52	carcass search	Cleared Plot	feather spot
8 /16/2011	hoary bat	048	12	carcass search	Cleared Plot	scavenged
8 /17/2011	eastern red bat	017	4	carcass search	Road & Pad Only	complete
8 /17/2011	eastern red bat	152	1	carcass search	Road & Pad Only	scavenged
8 /17/2011	eastern red bat	196	36	carcass search	Road & Pad Only	complete
8 /17/2011	eastern red bat	354	2	carcass search	Road & Pad Only	complete
8 /17/2011	eastern red bat	417	2	incidental off plot		scavenged
8 /17/2011	eastern red bat	420	56	incidental off plot	Road & Pad Only	scavenged
8 /17/2011	eastern red bat	425	1	carcass search	Road & Pad Only	scavenged
8 /17/2011	eastern red bat	441	7	carcass search	Road & Pad Only	complete
8 /17/2011	eastern red bat	445	4	carcass search	Road & Pad Only	scavenged
8 /17/2011	eastern red bat	614	55	carcass search	Cleared Plot	complete
8 /17/2011	eastern red bat	628	15	carcass search	Cleared Plot	complete
8 /17/2011	eastern red bat	628	38	carcass search	Cleared Plot	scavenged
8 /17/2011	hoary bat	035	10	carcass search	Road & Pad Only	complete
8 /17/2011	hoary bat	630	27	carcass search	Cleared Plot	scavenged
8 /17/2011	Seminole bat	628	30	carcass search	Cleared Plot	complete
8 /18/2011	eastern red bat	048	60	carcass search	Cleared Plot	scavenged
8 /18/2011	eastern red bat	152	7	carcass search	Road & Pad Only	complete
8 /18/2011	eastern red bat	218	21	carcass search	Cleared Plot	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /18/2011	eastern red bat	221	1	incidental off plot	Road & Pad Only	complete
8 /18/2011	eastern red bat	417	17	incidental off plot		complete
8 /18/2011	eastern red bat	423	1	carcass search	Road & Pad Only	complete
8 /18/2011	eastern red bat	448	10	carcass search	Road & Pad Only	complete
8 /18/2011	eastern red bat	620	7	carcass search	Road & Pad Only	complete
8 /18/2011	eastern red bat	638	17	incidental off plot		scavenged
8 /18/2011	eastern red bat	638	10	incidental off plot		scavenged
8 /18/2011	hoary bat	157	22	incidental off plot		scavenged
8 /18/2011	hoary bat	285	1	carcass search	Road & Pad Only	complete
8 /18/2011	silver-haired bat	218	23	carcass search	Cleared Plot	scavenged
8 /18/2011	tricolored bat	156	5	carcass search	Road & Pad Only	complete
8 /19/2011	big brown bat	464	12	carcass search	Road & Pad Only	complete
8 /19/2011	big brown bat	614	26	carcass search	Cleared Plot	complete
8 /19/2011	cliff swallow	281	12	incidental off plot	Road & Pad Only	scavenged
8 /19/2011	eastern red bat	035	3	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	073	25	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	170	17	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	211	14	incidental off plot		scavenged
8 /19/2011	eastern red bat	211	10	incidental off plot		scavenged
8 /19/2011	eastern red bat	222	4	incidental off plot		scavenged
8 /19/2011	eastern red bat	222	9	incidental off plot		complete
8 /19/2011	eastern red bat	227	32	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	329	5	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	369	5	carcass search	Road & Pad Only	scavenged
8 /19/2011	eastern red bat	396	38	carcass search	Cleared Plot	complete
8 /19/2011	eastern red bat	396	46	carcass search	Cleared Plot	scavenged
8 /19/2011	eastern red bat	396	57	carcass search	Cleared Plot	scavenged
8 /19/2011	eastern red bat	396	55	carcass search	Cleared Plot	scavenged
8 /19/2011	eastern red bat	396	27	carcass search	Cleared Plot	complete
8 /19/2011	eastern red bat	414	18	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	457	18	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	477	4	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	605	5	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	622	6	carcass search	Road & Pad Only	complete
8 /19/2011	eastern red bat	628	15	carcass search	Cleared Plot	complete
8 /19/2011	eastern red bat	628	19	carcass search	Cleared Plot	scavenged
8 /19/2011	eastern red bat	628	35	carcass search	Cleared Plot	complete
8 /19/2011	hoary bat	211	0	incidental off plot		scavenged
8 /19/2011	hoary bat	254	8	incidental off plot	Road & Pad Only	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /19/2011	hoary bat	614	45	carcass search	Cleared Plot	scavenged
8 /19/2011	hoary bat	628	45	carcass search	Cleared Plot	scavenged
8 /19/2011	killdeer	396	41	carcass search	Cleared Plot	feather spot
8 /19/2011	ring-necked pheasant	075	230	incidental off plot	Road & Pad Only	scavenged
8 /19/2011	tricolored bat	369	14	carcass search	Road & Pad Only	scavenged
8 /20/2011	eastern red bat	020	16	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	048	27	carcass search	Cleared Plot	complete
8 /20/2011	eastern red bat	095	19	carcass search	Cleared Plot	scavenged
8 /20/2011	eastern red bat	095	24	carcass search	Cleared Plot	scavenged
8 /20/2011	eastern red bat	101	1	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	110	10	incidental off plot	Road & Pad Only	scavenged
8 /20/2011	eastern red bat	218	49	carcass search	Cleared Plot	scavenged
8 /20/2011	eastern red bat	218	41	carcass search	Cleared Plot	scavenged
8 /20/2011	eastern red bat	226	5	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	241	18	incidental off plot		scavenged
8 /20/2011	eastern red bat	260	14	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	309	11	incidental off plot	Road & Pad Only	complete
8 /20/2011	eastern red bat	322	29	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	322	31	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	354	7	carcass search	Road & Pad Only	scavenged
8 /20/2011	eastern red bat	417	42	incidental off plot		scavenged
8 /20/2011	eastern red bat	420	8	carcass search	Road & Pad Only	scavenged
8 /20/2011	eastern red bat	420	18	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	441	6	carcass search	Road & Pad Only	complete
8 /20/2011	eastern red bat	458	8	carcass search	Road & Pad Only	scavenged
8 /20/2011	eastern red bat	464	20	incidental off plot	Road & Pad Only	complete
8 /20/2011	eastern red bat	470	4	incidental off plot		scavenged
8 /20/2011	European starling	476	22	carcass search	Road & Pad Only	feather spot
8 /20/2011	hoary bat	322	26	carcass search	Road & Pad Only	complete
8 /20/2011	hoary bat	637	11	incidental off plot	Road & Pad Only	scavenged
8 /20/2011	Seminole bat	218	20	carcass search	Cleared Plot	scavenged
8 /21/2011	eastern red bat	230	36	incidental off plot	Road & Pad Only	scavenged
8 /21/2011	eastern red bat	388	40	carcass search	Road & Pad Only	complete
8 /21/2011	eastern red bat	628	12	carcass search	Cleared Plot	scavenged
8 /22/2011	big brown bat	216	13	carcass search	Road & Pad Only	complete
8 /22/2011	big brown bat	254	27	carcass search	Road & Pad Only	complete
8 /22/2011	Canada warbler	634	15	carcass search	Road & Pad Only	complete
8 /22/2011	eastern red bat	019	19	incidental off plot		complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /22/2011	eastern red bat	057	36	carcass search	Road & Pad Only	complete
8 /22/2011	eastern red bat	090	7	carcass search	Road & Pad Only	complete
8 /22/2011	eastern red bat	095	14	carcass search	Cleared Plot	complete
8 /22/2011	eastern red bat	332	1	carcass search	Road & Pad Only	complete
8 /22/2011	eastern red bat	443	43	carcass search	Road & Pad Only	complete
8 /22/2011	eastern red bat	480	26	incidental on plot	Cleared Plot	complete
8 /22/2011	eastern red bat	641	1	carcass search	Road & Pad Only	complete
8 /22/2011	hoary bat	095	18	carcass search	Cleared Plot	complete
8 /22/2011	hoary bat	101	23	carcass search	Road & Pad Only	complete
8 /22/2011	hoary bat	245	40	carcass search	Road & Pad Only	complete
8 /22/2011	hoary bat	407	5	carcass search	Road & Pad Only	complete
8 /22/2011	hoary bat	419	5	carcass search	Road & Pad Only	complete
8 /22/2011	hoary bat	429	13	carcass search	Road & Pad Only	complete
8 /23/2011	eastern red bat	237	29	incidental off plot		scavenged
8 /23/2011	eastern red bat	460	6	carcass search	Road & Pad Only	complete
8 /23/2011	eastern red bat	470	3	incidental off plot		complete
8 /23/2011	hoary bat	461	2	incidental off plot		scavenged
8 /23/2011	hoary bat	614	21	carcass search	Cleared Plot	complete
8 /23/2011	hoary bat	628	28	carcass search	Cleared Plot	scavenged
8 /23/2011	silver-haired bat	237	5	incidental off plot		complete
8 /24/2011	eastern red bat	121	2	carcass search	Road & Pad Only	complete
8 /24/2011	eastern red bat	221	41	carcass search	Road & Pad Only	complete
8 /24/2011	hoary bat	024	0	carcass search	Cleared Plot	scavenged
8 /24/2011	hoary bat	120	7	incidental off plot		scavenged
8 /24/2011	hoary bat	625	60	incidental off plot	Road & Pad Only	scavenged
8 /24/2011	rock pigeon	218	75	carcass search	Cleared Plot	feather spot
8 /25/2011	eastern red bat	017	53	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	085	40	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	121	37	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	156	45	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	156	0	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	156	45	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	237	4	incidental off plot		scavenged
8 /25/2011	eastern red bat	237	44	incidental off plot		scavenged
8 /25/2011	eastern red bat	309	35	carcass search	Road & Pad Only	complete
8 /25/2011	eastern red bat	370	27	incidental off plot		complete
8 /25/2011	eastern red bat	444	17	carcass search	Road & Pad Only	scavenged
8 /25/2011	eastern red bat	480	52	carcass search	Cleared Plot	scavenged
8 /25/2011	eastern red bat	623	4	carcass search	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /25/2011	eastern red bat	630	34	carcass search	Cleared Plot	complete
8 /25/2011	eastern red bat	631	30	carcass search	Road & Pad Only	complete
8 /25/2011	mourning dove	614	41	carcass search	Cleared Plot	feather spot
8 /25/2011	silver-haired bat	097	7	carcass search	Road & Pad Only	complete
8 /25/2011	silver-haired bat	237	28	incidental off plot		complete
8 /25/2011	silver-haired bat	371	6	carcass search	Road & Pad Only	partial
8 /25/2011	silver-haired bat	423	6	carcass search	Road & Pad Only	scavenged
8 /25/2011	silver-haired bat	444	13	carcass search	Road & Pad Only	scavenged
8 /25/2011	silver-haired bat	612	23	carcass search	Road & Pad Only	complete
8 /25/2011	silver-haired bat	628	40	carcass search	Cleared Plot	scavenged
8 /26/2011	big brown bat	198	1	carcass search	Road & Pad Only	complete
8 /26/2011	eastern red bat	024	30	carcass search	Cleared Plot	complete
8 /26/2011	eastern red bat	095	43	carcass search	Cleared Plot	complete
8 /26/2011	eastern red bat	226	7	carcass search	Road & Pad Only	complete
8 /26/2011	eastern red bat	419	25	carcass search	Road & Pad Only	complete
8 /26/2011	hoary bat	024	7	carcass search	Cleared Plot	scavenged
8 /26/2011	pine warbler	626	14	incidental off plot		scavenged
8 /26/2011	silver-haired bat	227	6	carcass search	Road & Pad Only	scavenged
8 /26/2011	silver-haired bat	626	4	incidental off plot		complete
8 /27/2011	eastern red bat	369	51	carcass search	Road & Pad Only	partial
8 /27/2011	killdeer	630	52	carcass search	Cleared Plot	feather spot
8 /27/2011	Tennessee warbler	480	5	carcass search	Cleared Plot	scavenged
8 /28/2011	chimney swift	218	40	carcass search	Cleared Plot	scavenged
8 /28/2011	eastern red bat	024	40	carcass search	Cleared Plot	partial
8 /28/2011	eastern red bat	095	74	carcass search	Cleared Plot	complete
8 /28/2011	eastern red bat	627	5	carcass search	Road & Pad Only	complete
8 /28/2011	hoary bat	254	0	carcass search	Road & Pad Only	complete
8 /28/2011	horned lark	095	65	carcass search	Cleared Plot	scavenged
8 /28/2011	silver-haired bat	024	30	carcass search	Cleared Plot	partial
8 /29/2011	eastern red bat	633	4	incidental off plot		scavenged
8 /29/2011	silver-haired bat	361	3	incidental off plot		complete
8 /30/2011	eastern red bat	024	43	carcass search	Cleared Plot	scavenged
8 /30/2011	eastern red bat	048	29	carcass search	Cleared Plot	complete
8 /30/2011	eastern red bat	048	16	carcass search	Cleared Plot	scavenged
8 /30/2011	eastern red bat	095	55	carcass search	Cleared Plot	complete
8 /30/2011	eastern red bat	607	36	carcass search	Road & Pad Only	complete
8 /31/2011	American robin	614	64	carcass search	Cleared Plot	feather spot
8 /31/2011	big brown bat	606	8	incidental on plot	Road & Pad Only	complete
8 /31/2011	eastern red bat	019	18	incidental off plot		scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
8 /31/2011	eastern red bat	078	1	carcass search	Road & Pad Only	complete
8 /31/2011	eastern red bat	087	22	carcass search	Road & Pad Only	complete
8 /31/2011	eastern red bat	455	20	carcass search	Road & Pad Only	complete
8 /31/2011	eastern red bat	478	34	incidental off plot	Road & Pad Only	scavenged
8 /31/2011	hoary bat	419	2	carcass search	Road & Pad Only	complete
8 /31/2011	hoary bat	457	6	carcass search	Road & Pad Only	complete
8 /31/2011	silver-haired bat	221	18	incidental off plot	Road & Pad Only	complete
9 /1 /2011	eastern red bat	095	36	carcass search	Cleared Plot	scavenged
9 /1 /2011	eastern red bat	254	1	carcass search	Road & Pad Only	scavenged
9 /1 /2011	hoary bat	017	2	carcass search	Road & Pad Only	partial
9 /1 /2011	hoary bat	095	46	carcass search	Cleared Plot	complete
9 /1 /2011	hoary bat	095	48	carcass search	Cleared Plot	complete
9 /1 /2011	silver-haired bat	048	60	carcass search	Cleared Plot	scavenged
9 /1 /2011	silver-haired bat	095	45	carcass search	Cleared Plot	complete
9 /2 /2011	eastern red bat	028	6	carcass search	Road & Pad Only	complete
9 /2 /2011	hoary bat	221	28	carcass search	Road & Pad Only	complete
9 /2 /2011	silver-haired bat	612	2	carcass search	Road & Pad Only	complete
9 /3 /2011	eastern red bat	011	5	carcass search	Road & Pad Only	complete
9 /3 /2011	eastern red bat	371	9	carcass search	Road & Pad Only	scavenged
9 /3 /2011	Seminole bat	030	0	carcass search	Road & Pad Only	complete
9 /4 /2011	eastern red bat	088	7	incidental off plot	Road & Pad Only	complete
9 /4 /2011	eastern red bat	254	3	carcass search	Road & Pad Only	complete
9 /4 /2011	eastern red bat	396	7	carcass search	Cleared Plot	complete
9 /4 /2011	eastern red bat	396	26	carcass search	Cleared Plot	complete
9 /4 /2011	eastern red bat	407	22	carcass search	Road & Pad Only	scavenged
9 /4 /2011	eastern red bat	443	0	carcass search	Road & Pad Only	complete
9 /4 /2011	eastern red bat	459	3	carcass search	Road & Pad Only	complete
9 /4 /2011	hoary bat	371	28	carcass search	Road & Pad Only	complete
9 /4 /2011	Tennessee warbler	628	32	carcass search	Cleared Plot	scavenged
9 /5 /2011	eastern red bat	081	37	incidental off plot		complete
9 /5 /2011	eastern red bat	090	30	carcass search	Road & Pad Only	complete
9 /5 /2011	eastern red bat	218	71	carcass search	Cleared Plot	partial
9 /5 /2011	eastern red bat	339	33	carcass search	Road & Pad Only	complete
9 /5 /2011	eastern red bat	370	12	incidental off plot		complete
9 /5 /2011	eastern red bat	460	16	carcass search	Road & Pad Only	complete
9 /5 /2011	eastern red bat	611	46	carcass search	Road & Pad Only	complete
9 /5 /2011	eastern red bat	627	33	carcass search	Road & Pad Only	complete
9 /5 /2011	hoary bat	007	34	carcass search	Road & Pad Only	complete
9 /5 /2011	hoary bat	030	40	carcass search	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
9 /5 /2011	hoary bat	156	4	carcass search	Road & Pad Only	complete
9 /5 /2011	hoary bat	354	18	carcass search	Road & Pad Only	complete
9 /5 /2011	hoary bat	358	47	carcass search	Road & Pad Only	complete
9 /5 /2011	hoary bat	407	18	carcass search	Road & Pad Only	complete
9 /5 /2011	silver-haired bat	075	40	carcass search	Road & Pad Only	complete
9 /5 /2011	silver-haired bat	095	9	carcass search	Cleared Plot	complete
9 /5 /2011	silver-haired bat	388	40	carcass search	Road & Pad Only	complete
9 /5 /2011	silver-haired bat	609	47	carcass search	Road & Pad Only	complete
9 /5 /2011	unidentified warbler	641	12	carcass search	Road & Pad Only	complete
9 /6 /2011	eastern red bat	630	4	carcass search	Cleared Plot	partial
9 /6 /2011	eastern red bat	630	40	carcass search	Cleared Plot	complete
9 /6 /2011	hoary bat	349	8	incidental off plot		scavenged
9 /6 /2011	hoary bat	628	29	carcass search	Cleared Plot	scavenged
9 /7 /2011	eastern red bat	260	46	carcass search	Road & Pad Only	complete
9 /7 /2011	hoary bat	024	23	carcass search	Cleared Plot	scavenged
9 /7 /2011	hoary bat	240	5	incidental off plot		scavenged
9 /7 /2011	hoary bat	403	0	incidental off plot		scavenged
9 /7 /2011	hoary bat	643	2	incidental off plot		complete
9 /7 /2011	killdeer	024	45	carcass search	Cleared Plot	feather spot
9 /9 /2011	hoary bat	460	24	carcass search	Road & Pad Only	complete
9 /10/2011	eastern red bat	095	27	incidental on plot	Cleared Plot	scavenged
9 /10/2011	eastern red bat	109	4	carcass search	Road & Pad Only	complete
9 /10/2011	hoary bat	630	8	carcass search	Cleared Plot	complete
9 /10/2011	Nashville warbler	267	7	carcass search	Road & Pad Only	complete
9 /11/2011	eastern red bat	324	6	carcass search	Road & Pad Only	complete
9 /11/2011	hoary bat	371	26	incidental off plot	Road & Pad Only	scavenged
9 /11/2011	mourning dove	285	1	carcass search	Road & Pad Only	complete
9 /11/2011	silver-haired bat	332	4	carcass search	Road & Pad Only	complete
9 /12/2011	eastern red bat	417	17	incidental off plot		complete
9 /12/2011	hoary bat	224	18	carcass search	Road & Pad Only	complete
9 /12/2011	hoary bat	396	6	carcass search	Cleared Plot	scavenged
9 /12/2011	hoary bat	480	56	carcass search	Cleared Plot	scavenged
9 /12/2011	hoary bat	481	16	carcass search	Road & Pad Only	complete
9 /12/2011	hoary bat	481	30	carcass search	Road & Pad Only	complete
9 /12/2011	hoary bat	634	8	carcass search	Road & Pad Only	complete
9 /12/2011	killdeer	614	37	carcass search	Cleared Plot	feather spot
9 /12/2011	silver-haired bat	476	9	carcass search	Road & Pad Only	complete
9 /13/2011	eastern red bat	048	9	carcass search	Cleared Plot	scavenged
9 /13/2011	eastern red bat	048	40	carcass search	Cleared Plot	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
9 /13/2011	eastern red bat	226	6	carcass search	Road & Pad Only	complete
9 /13/2011	eastern red bat	614	35	incidental on plot	Cleared Plot	complete
9 /13/2011	hoary bat	309	27	carcass search	Road & Pad Only	complete
9 /13/2011	silver-haired bat	024	28	carcass search	Cleared Plot	complete
9 /13/2011	silver-haired bat	024	62	carcass search	Cleared Plot	complete
9 /13/2011	silver-haired bat	095	71	carcass search	Cleared Plot	complete
9 /14/2011	eastern red bat	458	32	incidental off plot	Road & Pad Only	complete
9 /14/2011	eastern red bat	478	1	carcass search	Road & Pad Only	complete
9 /14/2011	hoary bat	103	39	carcass search	Road & Pad Only	complete
9 /14/2011	hoary bat	216	20	carcass search	Road & Pad Only	complete
9 /14/2011	hoary bat	267	8	carcass search	Road & Pad Only	scavenged
9 /14/2011	hoary bat	309	49	incidental off plot	Road & Pad Only	scavenged
9 /14/2011	hoary bat	324	7	incidental off plot	Road & Pad Only	complete
9 /14/2011	hoary bat	388	23	incidental off plot	Road & Pad Only	complete
9 /14/2011	hoary bat	396	28	carcass search	Cleared Plot	partial
9 /14/2011	mourning dove	396	39	carcass search	Cleared Plot	feather spot
9 /15/2011	eastern red bat	608	9	incidental off plot		complete
9 /15/2011	hoary bat	117	5	incidental off plot		scavenged
9 /15/2011	hoary bat	363	15	incidental off plot		scavenged
9 /15/2011	red-tailed hawk	117	23	incidental off plot		scavenged
9 /15/2011	silver-haired bat	098	4	carcass search	Road & Pad Only	complete
9 /15/2011	silver-haired bat	400	0	incidental off plot		complete
9 /15/2011	silver-haired bat	611	28	carcass search	Road & Pad Only	complete
9 /16/2011	hoary bat	092	12	carcass search	Road & Pad Only	complete
9 /16/2011	hoary bat	614	41	carcass search	Cleared Plot	scavenged
9 /16/2011	silver-haired bat	625	10	incidental off plot	Road & Pad Only	scavenged
9 /16/2011	unidentified sparrow	286	31	carcass search	Road & Pad Only	scavenged
9 /17/2011	hoary bat	095	22	carcass search	Cleared Plot	scavenged
9 /17/2011	hoary bat	218	17	carcass search	Cleared Plot	complete
9 /17/2011	red-tailed hawk	419	30	carcass search	Road & Pad Only	partial
9 /18/2011	hoary bat	033	32	carcass search	Road & Pad Only	complete
9 /18/2011	silver-haired bat	193	14	carcass search	Road & Pad Only	complete
9 /19/2011	hoary bat	095	40	carcass search	Cleared Plot	scavenged
9 /19/2011	hoary bat	245	1	carcass search	Road & Pad Only	complete
9 /20/2011	hoary bat	370	26	incidental off plot		complete
9 /20/2011	hoary bat	614	40	carcass search	Cleared Plot	scavenged
9 /20/2011	hoary bat	631	2	carcass search	Road & Pad Only	complete
9 /21/2011	eastern red bat	417	5	incidental off plot		scavenged
9 /21/2011	eastern red bat	448	12	carcass search	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
9 /21/2011	hoary bat	286	10	incidental off plot	Road & Pad Only	scavenged
9 /21/2011	hoary bat	398	3	carcass search	Road & Pad Only	scavenged
9 /21/2011	hoary bat	408	18	incidental off plot		scavenged
9 /21/2011	hoary bat	428	3	incidental off plot		scavenged
9 /21/2011	silver-haired bat	110	6	carcass search	Road & Pad Only	complete
9 /21/2011	silver-haired bat	314	13	carcass search	Road & Pad Only	complete
9 /21/2011	silver-haired bat	375	27	carcass search	Road & Pad Only	complete
9 /21/2011	silver-haired bat	411	1	carcass search	Road & Pad Only	scavenged
9 /21/2011	silver-haired bat	441	29	carcass search	Road & Pad Only	complete
9 /21/2011	silver-haired bat	624	12	incidental off plot		scavenged
9 /22/2011	eastern red bat	113	10	carcass search	Road & Pad Only	complete
9 /22/2011	eastern red bat	216	10	carcass search	Road & Pad Only	complete
9 /22/2011	eastern red bat	480	6	carcass search	Cleared Plot	complete
9 /22/2011	eastern red bat	625	12	carcass search	Road & Pad Only	scavenged
9 /22/2011	hoary bat	037	4	incidental off plot		complete
9 /22/2011	hoary bat	253	11	carcass search	Road & Pad Only	complete
9 /22/2011	hoary bat	359	16	carcass search	Road & Pad Only	complete
9 /22/2011	hoary bat	396	69	carcass search	Cleared Plot	complete
9 /22/2011	hoary bat	480	29	carcass search	Cleared Plot	complete
9 /22/2011	hoary bat	628	19	carcass search	Cleared Plot	complete
9 /22/2011	hoary bat	630	43	carcass search	Cleared Plot	complete
9 /22/2011	ruby-throated hummingbird	459	44	carcass search	Road & Pad Only	complete
9 /22/2011	silver-haired bat	011	2	carcass search	Road & Pad Only	partial
9 /22/2011	silver-haired bat	098	8	carcass search	Road & Pad Only	complete
9 /22/2011	silver-haired bat	396	77	carcass search	Cleared Plot	complete
9 /23/2011	eastern red bat	024	32	carcass search	Cleared Plot	scavenged
9 /23/2011	eastern red bat	100	4	incidental off plot		scavenged
9 /23/2011	eastern red bat	113	13	incidental off plot	Road & Pad Only	complete
9 /23/2011	hoary bat	024	41	carcass search	Cleared Plot	scavenged
9 /23/2011	hoary bat	048	2	carcass search	Cleared Plot	complete
9 /23/2011	hoary bat	048	1	carcass search	Cleared Plot	complete
9 /23/2011	hoary bat	218	31	carcass search	Cleared Plot	complete
9 /23/2011	hoary bat	417	18	incidental off plot		scavenged
9 /23/2011	silver-haired bat	024	37	carcass search	Cleared Plot	scavenged
9 /23/2011	silver-haired bat	048	32	carcass search	Cleared Plot	scavenged
9 /23/2011	silver-haired bat	048	58	carcass search	Cleared Plot	complete
9 /23/2011	silver-haired bat	048	44	carcass search	Cleared Plot	scavenged
9 /23/2011	silver-haired bat	095	59	carcass search	Cleared Plot	scavenged

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
9 /23/2011	silver-haired bat	118	5	carcass search	Road & Pad Only	scavenged
9 /23/2011	silver-haired bat	617	19	incidental off plot	Road & Pad Only	scavenged
9 /24/2011	chimney swift	639	17	carcass search	Road & Pad Only	complete
9 /24/2011	eastern red bat	286	17	incidental off plot	Road & Pad Only	scavenged
9 /24/2011	eastern red bat	614	15	carcass search	Cleared Plot	complete
9 /24/2011	hoary bat	480	5	carcass search	Cleared Plot	complete
9 /24/2011	mourning dove	268	15	carcass search	Road & Pad Only	feather spot
9 /25/2011	eastern red bat	109	5	carcass search	Road & Pad Only	complete
9 /27/2011	silver-haired bat	095	4	carcass search	Cleared Plot	complete
9 /28/2011	eastern red bat	224	12	carcass search	Road & Pad Only	complete
9 /28/2011	eastern red bat	628	33	carcass search	Cleared Plot	complete
9 /28/2011	hoary bat	396	7	carcass search	Cleared Plot	complete
9 /28/2011	Nashville warbler	637	43	carcass search	Road & Pad Only	complete
9 /28/2011	red-eyed vireo	628	49	carcass search	Cleared Plot	complete
9 /28/2011	silver-haired bat	031	58	carcass search	Road & Pad Only	complete
9 /28/2011	silver-haired bat	286	16	carcass search	Road & Pad Only	complete
9 /28/2011	silver-haired bat	614	18	carcass search	Cleared Plot	complete
9 /28/2011	silver-haired bat	630	25	carcass search	Cleared Plot	complete
9 /29/2011	eastern red bat	643	4	incidental off plot		complete
9 /29/2011	killdeer	024	37	carcass search	Cleared Plot	feather spot
9 /29/2011	silver-haired bat	481	0	carcass search	Road & Pad Only	complete
9 /30/2011	eastern red bat	614	7	carcass search	Cleared Plot	complete
9 /30/2011	silver-haired bat	007	37	carcass search	Road & Pad Only	complete
9 /30/2011	silver-haired bat	216	55	carcass search	Road & Pad Only	complete
9 /30/2011	Tennessee warbler	031	60	carcass search	Road & Pad Only	complete
10/1 /2011	silver-haired bat	616	35	carcass search	Road & Pad Only	complete
10/2 /2011	hoary bat	216	9	carcass search	Road & Pad Only	scavenged
10/3 /2011	golden-crowned kinglet	323	43	carcass search	Road & Pad Only	complete
10/3 /2011	silver-haired bat	048	43	carcass search	Cleared Plot	scavenged
10/3 /2011	silver-haired bat	048	32	carcass search	Cleared Plot	complete
10/3 /2011	silver-haired bat	464	18	carcass search	Road & Pad Only	complete
10/4 /2011	eastern red bat	408	11	incidental off plot		complete
10/4 /2011	eastern red bat	614	38	carcass search	Cleared Plot	scavenged
10/4 /2011	hoary bat	614	38	carcass search	Cleared Plot	scavenged
10/4 /2011	hoary bat	630	24	carcass search	Cleared Plot	complete
10/4 /2011	silver-haired bat	230	36	carcass search	Road & Pad Only	complete
10/4 /2011	silver-haired bat	459	13	carcass search	Road & Pad Only	scavenged
10/5 /2011	eastern red bat	024	21	carcass search	Cleared Plot	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
10/5 /2011	eastern red bat	251	4	carcass search	Road & Pad Only	complete
10/5 /2011	killdeer	621	5	incidental off plot		complete
10/5 /2011	silver-haired bat	309	12	carcass search	Road & Pad Only	scavenged
10/6 /2011	eastern red bat	398	38	carcass search	Road & Pad Only	complete
10/6 /2011	eastern red bat	429	5	carcass search	Road & Pad Only	complete
10/6 /2011	eastern red bat	629	4	incidental off plot		scavenged
10/6 /2011	killdeer	477	7	carcass search	Road & Pad Only	complete
10/6 /2011	silver-haired bat	608	3	incidental off plot		scavenged
10/7 /2011	eastern red bat	048	42	carcass search	Cleared Plot	complete
10/7 /2011	eastern red bat	218	12	carcass search	Cleared Plot	scavenged
10/7 /2011	killdeer	458	8	carcass search	Road & Pad Only	scavenged
10/7 /2011	silver-haired bat	048	23	carcass search	Cleared Plot	scavenged
10/7 /2011	silver-haired bat	048	65	carcass search	Cleared Plot	complete
10/7 /2011	silver-haired bat	061	55	carcass search	Road & Pad Only	complete
10/8 /2011	black-throated green warbler	614	4	carcass search	Cleared Plot	complete
10/8 /2011	eastern red bat	334	14	carcass search	Road & Pad Only	complete
10/8 /2011	eastern red bat	480	37	carcass search	Cleared Plot	complete
10/8 /2011	eastern red bat	630	17	incidental on plot	Cleared Plot	scavenged
10/8 /2011	silver-haired bat	628	54	carcass search	Cleared Plot	partial
10/9 /2011	golden-crowned kinglet	622	21	carcass search	Road & Pad Only	scavenged
10/9 /2011	hoary bat	476	14	carcass search	Road & Pad Only	scavenged
10/9 /2011	silver-haired bat	024	54	carcass search	Cleared Plot	complete
10/9 /2011	silver-haired bat	048	10	carcass search	Cleared Plot	scavenged
10/10/2011	evening bat	396	35	carcass search	Cleared Plot	scavenged
10/11/2011	eastern red bat	095	69	carcass search	Cleared Plot	scavenged
10/11/2011	hoary bat	047	12	carcass search	Road & Pad Only	complete
10/11/2011	hoary bat	218	34	carcass search	Cleared Plot	scavenged
10/11/2011	hoary bat	226	14	incidental off plot	Road & Pad Only	scavenged
10/11/2011	silver-haired bat	024	46	carcass search	Cleared Plot	scavenged
10/11/2011	silver-haired bat	218	34	carcass search	Cleared Plot	scavenged
10/11/2011	silver-haired bat	218	15	carcass search	Cleared Plot	complete
10/11/2011	silver-haired bat	603	9	incidental off plot	Road & Pad Only	complete
10/12/2011	silver-haired bat	480	38	carcass search	Cleared Plot	scavenged
10/16/2011	hoary bat	419	31	carcass search	Road & Pad Only	scavenged
10/18/2011	eastern red bat	430	0	incidental off plot		scavenged
10/19/2011	ruby-crowned kinglet	635	3	incidental off plot	Road & Pad Only	complete

Appendix C. Complete listing of carcasses found during 2011 surveys at the Fowler Ridge Wind Farm.

Date	Species	Turbine	Distance from Turbine	Type of Find	Search Type	Condition
10/27/2011	eastern red bat	379	5	incidental off plot	Road & Pad Only	complete

Appendix D. Turbine and Cut-In Speed Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Appendix D. Turbine and Feathering Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Date	Species	Turbine	Brand	Feathering Treatment
7 /16/2011	eastern red bat	429	VESTAS	3.5 Feathered
7 /19/2011	eastern red bat	116	GE	3.5 Feathered
7 /20/2011	big brown bat	147	VESTAS	3.5 Normal Operation
7 /20/2011	eastern red bat	455	VESTAS	3.5 Normal Operation
7 /20/2011	hoary bat	355	VESTAS	3.5 Normal Operation
7 /21/2011	eastern red bat	057	GE	4.5 Feathered
7 /21/2011	eastern red bat	476	VESTAS	3.5 Feathered
7 /21/2011	eastern red bat	622	CLIPPER	3.5 Feathered
7 /21/2011	hoary bat	631	CLIPPER	5.5 Feathered
7 /22/2011	eastern red bat	405	VESTAS	4.5 Feathered
7 /22/2011	hoary bat	047	GE	3.5 Feathered
7 /23/2011	hoary bat	156	VESTAS	3.5 Feathered
7 /23/2011	hoary bat	203	VESTAS	3.5 Feathered
7 /24/2011	big brown bat	627	CLIPPER	5.5 Feathered
7 /24/2011	eastern red bat	083	GE	3.5 Normal Operation
7 /24/2011	eastern red bat	170	VESTAS	4.5 Feathered
7 /24/2011	eastern red bat	631	CLIPPER	3.5 Normal Operation
7 /24/2011	hoary bat	355	VESTAS	3.5 Feathered
7 /25/2011	hoary bat	156	VESTAS	3.5 Normal Operation
7 /25/2011	hoary bat	248	VESTAS	3.5 Normal Operation
7 /25/2011	hoary bat	253	VESTAS	3.5 Normal Operation
7 /27/2011	eastern red bat	028	GE	3.5 Normal Operation
7 /27/2011	eastern red bat	170	VESTAS	3.5 Feathered
7 /27/2011	eastern red bat	173	VESTAS	3.5 Feathered
7 /28/2011	eastern red bat	455	VESTAS	3.5 Normal Operation
7 /29/2011	eastern red bat	076	GE	3.5 Normal Operation
7 /30/2011	eastern red bat	605	CLIPPER	3.5 Feathered
7 /31/2011	big brown bat	152	VESTAS	3.5 Normal Operation
7 /31/2011	eastern red bat	286	VESTAS	3.5 Normal Operation
7 /31/2011	eastern red bat	305	VESTAS	3.5 Normal Operation
7 /31/2011	eastern red bat	477	VESTAS	3.5 Normal Operation
7 /31/2011	eastern red bat	637	CLIPPER	3.5 Normal Operation
8 /2 /2011	eastern red bat	020	GE	3.5 Normal Operation
8 /2 /2011	eastern red bat	443	VESTAS	3.5 Normal Operation
8 /2 /2011	eastern red bat	606	CLIPPER	3.5 Normal Operation
8 /2 /2011	hoary bat	642	CLIPPER	3.5 Normal Operation
8 /3 /2011	eastern red bat	090	GE	5.5 Feathered
8 /3 /2011	eastern red bat	133	GE	3.5 Normal Operation
8 /3 /2011	hoary bat	022	GE	3.5 Feathered
8 /3 /2011	hoary bat	097	GE	4.5 Feathered
8 /3 /2011	hoary bat	224	VESTAS	3.5 Normal Operation
8 /4 /2011	eastern red bat	195	VESTAS	3.5 Normal Operation
8 /4 /2011	eastern red bat	229	VESTAS	4.5 Feathered
8 /4 /2011	eastern red bat	454	VESTAS	5.5 Feathered
8 /5 /2011	eastern red bat	441	VESTAS	3.5 Feathered
8 /5 /2011	eastern red bat	464	VESTAS	4.5 Feathered
8 /5 /2011	hoary bat	226	VESTAS	3.5 Feathered
8 /5 /2011	hoary bat	388	VESTAS	3.5 Normal Operation
8 /5 /2011	hoary bat	464	VESTAS	4.5 Feathered
8 /6 /2011	big brown bat	459	VESTAS	3.5 Normal Operation
8 /6 /2011	big brown bat	476	VESTAS	3.5 Normal Operation
8 /6 /2011	eastern red bat	173	VESTAS	3.5 Normal Operation

Appendix D. Turbine and Feathering Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Date	Species	Turbine	Brand	Feathering Treatment
8 /6 /2011	eastern red bat	221	VESTAS	3.5 Normal Operation
8 /6 /2011	eastern red bat	314	VESTAS	4.5 Feathered
8 /6 /2011	eastern red bat	323	VESTAS	3.5 Normal Operation
8 /6 /2011	eastern red bat	420	VESTAS	3.5 Normal Operation
8 /6 /2011	eastern red bat	625	CLIPPER	3.5 Feathered
8 /6 /2011	little brown bat	397	VESTAS	3.5 Feathered
8 /7 /2011	eastern red bat	425	VESTAS	4.5 Feathered
8 /7 /2011	eastern red bat	478	VESTAS	3.5 Feathered
8 /7 /2011	eastern red bat	625	CLIPPER	3.5 Normal Operation
8 /8 /2011	eastern red bat	334	VESTAS	3.5 Normal Operation
8 /8 /2011	eastern red bat	390	VESTAS	3.5 Normal Operation
8 /8 /2011	eastern red bat	405	VESTAS	3.5 Normal Operation
8 /8 /2011	eastern red bat	609	CLIPPER	3.5 Normal Operation
8 /8 /2011	hoary bat	378	VESTAS	3.5 Feathered
8 /8 /2011	hoary bat	459	VESTAS	3.5 Normal Operation
8 /8 /2011	hoary bat	620	VESTAS	3.5 Normal Operation
8 /9 /2011	eastern red bat	635	CLIPPER	4.5 Feathered
8 /9 /2011	hoary bat	398	VESTAS	3.5 Feathered
8 /10/2011	big brown bat	635	CLIPPER	4.5 Feathered
8 /10/2011	eastern red bat	348	VESTAS	3.5 Normal Operation
8 /10/2011	eastern red bat	348	VESTAS	3.5 Normal Operation
8 /11/2011	eastern red bat	216	VESTAS	3.5 Normal Operation
8 /11/2011	eastern red bat	371	VESTAS	3.5 Normal Operation
8 /11/2011	hoary bat	423	VESTAS	3.5 Normal Operation
8 /12/2011	eastern red bat	227	VESTAS	4.5 Feathered
8 /12/2011	tricolored bat	152	VESTAS	3.5 Feathered
8 /13/2011	eastern red bat	088	GE	3.5 Feathered
8 /13/2011	eastern red bat	286	VESTAS	3.5 Normal Operation
8 /13/2011	eastern red bat	637	CLIPPER	4.5 Feathered
8 /14/2011	big brown bat	620	VESTAS	3.5 Normal Operation
8 /15/2011	eastern red bat	170	VESTAS	5.5 Feathered
8 /15/2011	eastern red bat	216	VESTAS	3.5 Feathered
8 /15/2011	eastern red bat	390	VESTAS	3.5 Feathered
8 /15/2011	eastern red bat	460	VESTAS	3.5 Feathered
8 /17/2011	eastern red bat	017	GE	3.5 Normal Operation
8 /17/2011	eastern red bat	196	VESTAS	3.5 Normal Operation
8 /17/2011	eastern red bat	354	VESTAS	4.5 Feathered
8 /17/2011	eastern red bat	441	VESTAS	3.5 Normal Operation
8 /17/2011	eastern red bat	445	VESTAS	3.5 Feathered
8 /17/2011	hoary bat	035	GE	4.5 Feathered
8 /18/2011	eastern red bat	152	VESTAS	3.5 Normal Operation
8 /18/2011	eastern red bat	423	VESTAS	3.5 Normal Operation
8 /18/2011	eastern red bat	448	VESTAS	3.5 Normal Operation
8 /18/2011	eastern red bat	620	VESTAS	3.5 Normal Operation
8 /18/2011	hoary bat	285	VESTAS	3.5 Normal Operation
8 /18/2011	tricolored bat	156	VESTAS	3.5 Normal Operation
8 /19/2011	big brown bat	464	VESTAS	3.5 Normal Operation
8 /19/2011	eastern red bat	035	GE	3.5 Normal Operation
8 /19/2011	eastern red bat	073	GE	3.5 Feathered
8 /19/2011	eastern red bat	170	VESTAS	3.5 Normal Operation
8 /19/2011	eastern red bat	227	VESTAS	3.5 Normal Operation
8 /19/2011	eastern red bat	329	VESTAS	3.5 Normal Operation

Appendix D. Turbine and Feathering Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Date	Species	Turbine	Brand	Feathering Treatment
8 /19/2011	eastern red bat	369	VESTAS	4.5 Feathered
8 /19/2011	eastern red bat	414	VESTAS	3.5 Normal Operation
8 /19/2011	eastern red bat	457	VESTAS	3.5 Feathered
8 /19/2011	eastern red bat	477	VESTAS	4.5 Feathered
8 /19/2011	eastern red bat	605	CLIPPER	4.5 Feathered
8 /19/2011	eastern red bat	622	CLIPPER	3.5 Feathered
8 /19/2011	tricolored bat	369	VESTAS	4.5 Feathered
8 /20/2011	eastern red bat	020	GE	4.5 Feathered
8 /20/2011	eastern red bat	101	GE	3.5 Normal Operation
8 /20/2011	eastern red bat	226	VESTAS	3.5 Normal Operation
8 /20/2011	eastern red bat	260	VESTAS	3.5 Feathered
8 /20/2011	eastern red bat	322	VESTAS	3.5 Feathered
8 /20/2011	eastern red bat	322	VESTAS	3.5 Feathered
8 /20/2011	eastern red bat	354	VESTAS	3.5 Normal Operation
8 /20/2011	eastern red bat	420	VESTAS	3.5 Normal Operation
8 /20/2011	eastern red bat	441	VESTAS	3.5 Normal Operation
8 /20/2011	hoary bat	322	VESTAS	3.5 Feathered
8 /21/2011	eastern red bat	388	VESTAS	3.5 Normal Operation
8 /22/2011	big brown bat	216	VESTAS	3.5 Feathered
8 /22/2011	big brown bat	254	VESTAS	3.5 Feathered
8 /22/2011	eastern red bat	057	GE	3.5 Normal Operation
8 /22/2011	eastern red bat	090	GE	4.5 Feathered
8 /22/2011	eastern red bat	332	VESTAS	3.5 Feathered
8 /22/2011	eastern red bat	443	VESTAS	3.5 Feathered
8 /22/2011	eastern red bat	641	CLIPPER	3.5 Normal Operation
8 /22/2011	hoary bat	101	GE	3.5 Feathered
8 /22/2011	hoary bat	245	VESTAS	5.5 Feathered
8 /22/2011	hoary bat	407	VESTAS	4.5 Feathered
8 /22/2011	hoary bat	419	VESTAS	3.5 Normal Operation
8 /22/2011	hoary bat	429	VESTAS	3.5 Feathered
8 /23/2011	eastern red bat	460	VESTAS	3.5 Normal Operation
8 /24/2011	eastern red bat	121	GE	5.5 Feathered
8 /24/2011	eastern red bat	221	VESTAS	3.5 Normal Operation
8 /25/2011	eastern red bat	017	GE	4.5 Feathered
8 /25/2011	eastern red bat	085	GE	3.5 Feathered
8 /25/2011	eastern red bat	121	GE	3.5 Normal Operation
8 /25/2011	eastern red bat	156	VESTAS	5.5 Feathered
8 /25/2011	eastern red bat	156	VESTAS	5.5 Feathered
8 /25/2011	eastern red bat	156	VESTAS	5.5 Feathered
8 /25/2011	eastern red bat	309	VESTAS	3.5 Feathered
8 /25/2011	eastern red bat	444	VESTAS	4.5 Feathered
8 /25/2011	eastern red bat	623	CLIPPER	3.5 Normal Operation
8 /25/2011	eastern red bat	631	CLIPPER	5.5 Feathered
8 /25/2011	silver-haired bat	097	GE	4.5 Feathered
8 /25/2011	silver-haired bat	371	VESTAS	5.5 Feathered
8 /25/2011	silver-haired bat	423	VESTAS	3.5 Feathered
8 /25/2011	silver-haired bat	444	VESTAS	4.5 Feathered
8 /25/2011	silver-haired bat	612	CLIPPER	3.5 Feathered
8 /26/2011	big brown bat	198	VESTAS	3.5 Normal Operation
8 /26/2011	eastern red bat	226	VESTAS	3.5 Normal Operation
8 /26/2011	eastern red bat	419	VESTAS	3.5 Feathered
8 /28/2011	eastern red bat	627	CLIPPER	3.5 Normal Operation

Appendix D. Turbine and Feathering Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Date	Species	Turbine	Brand	Feathering Treatment
8 /28/2011	hoary bat	254	VESTAS	5.5 Feathered
8 /30/2011	eastern red bat	607	CLIPPER	3.5 Normal Operation
8 /31/2011	big brown bat	606	CLIPPER	4.5 Feathered
8 /31/2011	eastern red bat	078	GE	3.5 Normal Operation
8 /31/2011	eastern red bat	087	GE	5.5 Feathered
8 /31/2011	eastern red bat	455	VESTAS	4.5 Feathered
8 /31/2011	hoary bat	419	VESTAS	3.5 Normal Operation
8 /31/2011	hoary bat	457	VESTAS	5.5 Feathered
9 /1 /2011	hoary bat	017	GE	3.5 Normal Operation
9 /2 /2011	eastern red bat	028	GE	3.5 Normal Operation
9 /2 /2011	hoary bat	221	VESTAS	4.5 Feathered
9 /2 /2011	silver-haired bat	612	CLIPPER	4.5 Feathered
9 /3 /2011	eastern red bat	011	GE	4.5 Feathered
9 /3 /2011	Seminole bat	030	GE	3.5 Normal Operation
9 /4 /2011	eastern red bat	254	VESTAS	3.5 Feathered
9 /4 /2011	eastern red bat	407	VESTAS	3.5 Normal Operation
9 /4 /2011	eastern red bat	443	VESTAS	4.5 Feathered
9 /4 /2011	eastern red bat	459	VESTAS	3.5 Normal Operation
9 /4 /2011	hoary bat	371	VESTAS	3.5 Feathered
9 /5 /2011	eastern red bat	090	GE	5.5 Feathered
9 /5 /2011	eastern red bat	339	VESTAS	3.5 Normal Operation
9 /5 /2011	eastern red bat	460	VESTAS	5.5 Feathered
9 /5 /2011	eastern red bat	611	CLIPPER	3.5 Feathered
9 /5 /2011	eastern red bat	627	CLIPPER	3.5 Normal Operation
9 /5 /2011	hoary bat	007	GE	5.5 Feathered
9 /5 /2011	hoary bat	030	GE	4.5 Feathered
9 /5 /2011	hoary bat	156	VESTAS	5.5 Feathered
9 /5 /2011	hoary bat	354	VESTAS	3.5 Feathered
9 /5 /2011	hoary bat	358	VESTAS	5.5 Feathered
9 /5 /2011	hoary bat	407	VESTAS	3.5 Feathered
9 /5 /2011	silver-haired bat	075	GE	3.5 Normal Operation
9 /5 /2011	silver-haired bat	388	VESTAS	4.5 Feathered
9 /7 /2011	eastern red bat	260	VESTAS	3.5 Normal Operation
9 /9 /2011	hoary bat	460	VESTAS	4.5 Feathered
9 /10/2011	eastern red bat	109	GE	3.5 Normal Operation
9 /11/2011	eastern red bat	324	VESTAS	3.5 Normal Operation
9 /11/2011	silver-haired bat	332	VESTAS	3.5 Normal Operation
9 /12/2011	hoary bat	224	VESTAS	3.5 Feathered
9 /12/2011	hoary bat	481	VESTAS	3.5 Normal Operation
9 /12/2011	hoary bat	481	VESTAS	3.5 Normal Operation
9 /12/2011	hoary bat	634	CLIPPER	3.5 Normal Operation
9 /12/2011	silver-haired bat	476	VESTAS	3.5 Feathered
9 /13/2011	eastern red bat	226	VESTAS	3.5 Feathered
9 /13/2011	hoary bat	309	VESTAS	4.5 Feathered
9 /14/2011	eastern red bat	478	VESTAS	3.5 Normal Operation
9 /14/2011	hoary bat	103	GE	3.5 Feathered
9 /14/2011	hoary bat	216	VESTAS	3.5 Feathered
9 /15/2011	silver-haired bat	098	GE	4.5 Feathered
9 /15/2011	silver-haired bat	611	CLIPPER	4.5 Feathered
9 /16/2011	hoary bat	092	GE	5.5 Feathered
9 /18/2011	hoary bat	033	GE	3.5 Feathered
9 /18/2011	silver-haired bat	193	VESTAS	3.5 Normal Operation

Appendix D. Turbine and Feathering Treatment for Fresh Carcasses Found at the Fowler Ridge Wind Farm During 2011 Surveys.

Date	Species	Turbine	Brand	Feathering Treatment
9 /19/2011	hoary bat	245	VESTAS	3.5 Normal Operation
9 /20/2011	hoary bat	631	CLIPPER	3.5 Feathered
9 /21/2011	eastern red bat	448	VESTAS	3.5 Normal Operation
9 /21/2011	silver-haired bat	110	GE	5.5 Feathered
9 /21/2011	silver-haired bat	314	VESTAS	5.5 Feathered
9 /21/2011	silver-haired bat	375	VESTAS	4.5 Feathered
9 /21/2011	silver-haired bat	411	VESTAS	4.5 Feathered
9 /21/2011	silver-haired bat	441	VESTAS	4.5 Feathered
9 /22/2011	eastern red bat	113	GE	3.5 Feathered
9 /22/2011	eastern red bat	216	VESTAS	3.5 Feathered
9 /22/2011	hoary bat	253	VESTAS	3.5 Normal Operation
9 /22/2011	hoary bat	359	VESTAS	3.5 Feathered
9 /22/2011	silver-haired bat	011	GE	3.5 Normal Operation
9 /22/2011	silver-haired bat	098	GE	3.5 Normal Operation
9 /25/2011	eastern red bat	109	GE	3.5 Feathered
9 /28/2011	eastern red bat	224	VESTAS	3.5 Normal Operation
9 /28/2011	silver-haired bat	031	GE	3.5 Normal Operation
9 /28/2011	silver-haired bat	286	VESTAS	3.5 Feathered
9 /29/2011	silver-haired bat	481	VESTAS	3.5 Feathered
9 /30/2011	silver-haired bat	007	GE	4.5 Feathered
9 /30/2011	silver-haired bat	216	VESTAS	5.5 Feathered
10/1 /2011	silver-haired bat	616	CLIPPER	5.5 Feathered
10/3 /2011	silver-haired bat	464	VESTAS	3.5 Normal Operation
10/4 /2011	silver-haired bat	230	VESTAS	3.5 Feathered
10/5 /2011	eastern red bat	251	VESTAS	3.5 Feathered
10/6 /2011	eastern red bat	398	VESTAS	3.5 Normal Operation
10/6 /2011	eastern red bat	429	VESTAS	3.5 Feathered
10/7 /2011	silver-haired bat	061	GE	3.5 Feathered
10/8 /2011	eastern red bat	334	VESTAS	3.5 Feathered
10/11/2011	hoary bat	047	GE	3.5 Normal Operation

Appendix E. Adjusted Fatality Estimates Based on Shoenfeld and Empirical PI

Appendix E. (Table A). Adjusted fatality estimates based on Shoenfeld.

	Spring Weekly Road & Pad Searches								
	Clipper			Vestas			GE		
		90% CI			90% CI			90% CI	
	mean	ll	ul	mean	ll	ul	mean	ll	ul
Search Area Adjustment									
Bats	7.54	5.30	11.14	7.54	5.30	11.14	7.54	5.30	11.14
Average Search Interval									
Bats	5.84	--	--	5.78	--	--	5.88	--	--
Observer Detection									
Bats	0.74	0.52	0.98	0.74	0.52	0.98	0.74	0.52	0.98
Average Removal Time									
Bats	15.10	12.23	18.51	15.10	12.23	18.51	15.10	12.23	18.51
Observed Fatality Rates (fatalities/turbine/turbine type/season)									
Bats	0.23	0.05	0.41	0.07	0.02	0.11	0.00	--	--
Average Probability of Carcass Availability and Detected									
Bats	0.74	0.63	0.83	0.75	0.63	0.83	0.74	0.63	0.83
Adjusted Fatality Estimates (fatalities/turbine/turbine type/season)									
Bats	2.30	0.67	4.93	0.68	0.24	1.37	0.00	--	--

	Control Turbines July 15- July 31, 2011 (80m circular plots - Every other day)								
	Clipper			Vestas			GE		
		90% CI			90% CI			90% CI	
	mean	ll	ul	mean	ll	ul	mean	ll	ul
Search Area Adjustment									
Bats	1.00	--	--	1.00	--	--	1.00	--	--
Average Search Interval									
Bats	2.00	--	--	2.00	--	--	2.00	--	--
Observer Detection									
Bats	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44
Average Removal Time									
Bats	13.02	9.20	18.00	13.02	9.20	18.00	13.02	9.20	18.00
Observed Fatality Rates (fatalities/turbine/turbine type/season)									
Bats	1.33	1.00	1.67	1.67	0.67	3.00	1.33	1.00	1.67
Average Probability of Carcass Availability and Detected									
Bats	0.69	0.50	0.80	0.69	0.50	0.80	0.69	0.50	0.80
Adjusted Fatality Estimates (fatalities/turbine/turbine type/season)									
Bats	1.94	1.33	3.00	2.42	0.89	4.32	1.94	1.31	3.01

	Fall Control Turbines August 1 - October 15, 2011 (80m circular plots - Every other day)								
	Clipper			Vestas			GE		
		90% CI			90% CI			90% CI	
	mean	ll	ul	mean	ll	ul	mean	ll	ul
Search Area Adjustment									
Bats	1.00	--	--	1.00	--	--	1.00	--	--
Average Search Interval									
Bats	2.00	--	--	2.00	--	--	2.02	--	--
Observer Detection									
Bats	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44
Average Removal Time									
Bats	13.02	9.20	18.00	13.02	9.20	18.00	13.02	9.20	18.00
Observed Fatality Rates (fatalities/turbine/turbine type/season)									
Bats	12.67	11.00	14.33	14.67	11.67	17.67	18.33	16.67	20.00
Average Probability of Carcass Availability and Detected									
Bats	0.69	0.50	0.80	0.69	0.50	0.80	0.69	0.50	0.80
Adjusted Fatality Estimates (fatalities/turbine/turbine type/season)									
Bats	18.39	14.66	25.18	21.29	15.02	30.20	26.69	22.17	35.93

Seasonal Adjusted Fatality Rate (fatalities/turbine/season)

		90% Confidence Interval			90% Confidence Interval			90% Confidence Interval	
	mean	lower limit	upper limit	mean	lower limit	upper limit	mean	lower limit	upper limit
Bats	0.61	0.32	1.06	2.18	1.32	3.26	22.99	19.21	29.35

Overall Adjusted Fatality Rate (fatalities/turbine/season)

		90% Confidence Interval	
	mean	lower limit	upper limit
Bats	25.78	22.51	32.37

Appendix E. (Table B). Adjusted fatality estimates based on Empirical PI.

	Spring Weekly Road & Pad Searches									Control Turbines July 15- July 31, 2011 (80m circular plots - Every other day)									Fall Control Turbines August 1 - October 15, 2011 (80m circular plots - Every other day)								
	Clipper			Vestas			GE			Clipper			Vestas			GE			Clipper			Vestas			GE		
		90% CI			90% CI			90% CI			90% CI			90% CI			90% CI			90% CI			90% CI			90% CI	
	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul	mean	ll	ul
Search Area Adjustment																											
Bats	7.54	5.30	11.14	7.54	5.30	11.14	7.54	5.30	11.14	1.00	--	--	1.00	--	--	1.00	--	--	1.00	--	--	1.00	--	--	1.00	--	--
Observed Fatality Rates (fatalities/turbine/turbine type/season)																											
Bats	0.23	0.05	0.41	0.07	0.02	0.11	0.00	--	--	1.33	1.00	1.67	1.67	0.67	3.00	1.33	1.00	1.67	12.67	11.00	14.33	14.67	11.67	17.67	18.33	16.67	20.00
Average Probability of Carcass Availability and Detected																											
Bats	0.69	0.55	0.83	0.69	0.55	0.83	0.69	0.55	0.83	0.52	0.39	0.64	0.52	0.39	0.64	0.52	0.39	0.64	0.52	0.39	0.64	0.52	0.39	0.64	0.52	0.39	0.64
Adjusted Fatality Estimates (fatalities/turbine/turbine type/season)																											
Bats	2.49	0.55	5.47	0.74	0.26	1.49	0.00	0.00	0.00	2.57	1.70	3.73	3.22	1.03	5.74	2.57	1.70	3.73	24.46	19.17	32.24	28.32	20.14	40.00	35.40	28.00	44.80

Seasonal Adjusted Fatality Rate (fatalities/turbine/season)

		90% Confidence Interval			90% Confidence Interval			90% Confidence Interval	
	mean	lower limit	upper limit	mean	lower limit	upper limit	mean	lower limit	upper limit
Bats	0.66	0.32	1.17	2.90	1.57	4.22	30.54	25.40	37.45

Overall Adjusted Fatality Rate (fatalities/turbine/season)

		90% Confidence Interval	
	mean	lower limit	upper limit
Bats	34.10	28.64	41.37

Appendix F. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Midwest					
Cedar Ridge, WI (2009)	10.0 [C,E,F]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI	7.7 [F]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	10.0 [C,E,F]	7/16/07-09/30/07	24.12	41	68
Forward Energy Center, WI	6.97	8/5/08-11/08/08	18.17	86	129
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Crystal Lake II, IA			7.42	80	200
Top of Iowa, IA (2003)			7.16	89	80
Kewaunee County, WI			6.45	31	20.46
Ripley, Ont. (2008)			4.67	38	76
Winnebago, IA			4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2 [D]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2 [D]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL			3.27	33	54.45
Buffalo Ridge, MN (Phase III; 1999)			2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)			2.59	143	107.25
Morraine II, MN			2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)			2.16	143	107.25
Prairie Winds (Minot), ND			2.13	80	115.5
Grand Ridge, IL			2.10	66	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9 [D]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9 [D]	6/15/02-9/15/02	1.64	143	107.25
Elm Creek, MN			1.49	67	100
Wessington Springs, SD			1.48	34	51
NPPD Ainsworth, NE			1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)			0.74	73	25
Buffalo Ridge I, SD (2010)			0.16	24	50.4
Southern Plains					
Barton Chapel, TX			3.06	60	120
Buffalo Gap II, TX			0.14	155	233
Buffalo Gap I, TX			0.1	67	134
Southeast					
Buffalo Mountain, TN (2005)			39.70	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7 [E]		31.54	3	1.98

Appendix F. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Northeast					
Mountaineer, WV	38.3 [E]	8/1/04-9/14/04	31.69	44	68
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	24.32	132	264
Mount Storm, WV (2010)	44.12	4/18/10-10/15/10	15.18	132	264
Casselman, PA (Spring & Fall 2008)			12.61	23	34.5
Maple Ridge, NY (2006)			11.21	120	198
Maple Ridge, NY (2007)			9.42	195	321.75
Cohocton/Dutch Hill, NY (2009)			8.62	50	125
Noble Bliss, NY (2008)			7.80	67	100
Mount Storm, WV (Fall 2008)	35.2	7/20/08-10/12/08	6.62	82	164
Wolfe Island, Ont (July-December 2009)			6.42	86	197.8
Maple Ridge, NY (2008)			4.96	195	321.75
Noble Clinton, NY (2009)	1.9 [C]	8/1/09-09/31/09	4.50	67	100
Noble Ellenburg, NY (2009)	16.1 [C]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)			3.85	67	100
Lempster, NH (2010)			3.57	12	24
Noble Ellenburg, NY (2008)			3.46	54	80
Noble Clinton, NY (2008)	2.1 [C]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)			3.11	12	24
Mars Hill, ME (2007)			2.91	28	42
Munnsville, NY (2008)			1.93	23	34.5
Stetson Mountain, ME (2009)	28.5; 0.3[G]	7/10/09-10/15/09	1.40	38	57
Mars Hill, ME (2008)			0.45	28	42
Rocky Mountains					
Summerview, Alb. (2008)	7.7 [D]	07/15/06-07-09/30/06-07	11.42	39	70.2
Judith Gap, MT			8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)			3.97	69	41.4
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2 [D,E]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2 [D,E]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
Dry Lake, AZ	8.8	4/29/10-11/10/10	4.29	30	63
California					
Shiloh I, CA			3.92	100	150
High Winds, CA (2004)			2.51	90	162
Dillon, CA			2.17	45	45
High Winds, CA (2005)			1.52	90	162
Alite, CA			0.24	8	24

Appendix F. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
		Pacific Northwest			
Biglow Canyon, OR (Phase II; 2009/2010)			2.71	65	150
Nine Canyon, WA			2.47	37	48.1
Stateline, OR/WA 2003			2.29	454	263
Biglow Canyon, OR (Phase I; 2008)			1.99	76	125.4
Leaning Juniper, OR			1.98	67	100.5
Big Horn, WA			1.90	133	199.5
Combine Hills, OR			1.88	41	41
Pebble Springs, OR			1.55	47	98.7
Hopkins Ridge, WA (2008)			1.39	87	156.6
Elkhorn, OR (2008)			1.26	61	101
Vansycle, OR			1.12	38	24.9
Klondike III, OR			1.11	122	375
Stateline, OR/WA 2002			1.09	454	263
Tuolumne (Windy Point I), WA			0.94	62	136.6
Klondike, OR			0.77	16	24
Hopkins Ridge, WA (2006)			0.63	83	150
Biglow Canyon, OR (Phase I; 2009)			0.58	76	125.4
Hay Canyon, OR			0.53	48	100.8
Klondike II, OR			0.41	50	75
Wild Horse, WA			0.39	127	229
Goodnoe, WA			0.34	47	94
Marengo II, WA (2009)			0.27	39	70.2
Marengo I, WA (2009)			0.17	39	70.2
Klondike IIIa, OR			0.16	125	375

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
C = Activity rate based on data collected at various heights all other activity rates are from ground-based units only
D = Activity rate was averaged across phases and/or years
E = Activity rate calculated by WEST from data presented in referenced report
F= Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
G = The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

Appendix F1 (*continued*). Wind energy facilities in North America with comparable activity and fatality data for bats.

Data from the following sources:

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA		Chatfield et al. 2010	Klondike, OR		Johnson et al. 2003
Barton Chapel, TX		WEST 2011	Klondike II, OR		NWC and WEST 2007
Big Horn, WA		Kronner et al. 2008	Klondike III, OR		Gritski et al. 2009a
Biglow Canyon, OR (Phase I; 08)		Jeffrey et al. 2009a	Klondike IIIa, OR		Gritski et al. 2009b
Biglow Canyon, OR (Phase I; 09)		Enk et al. 2010	Leaning Juniper, OR		Kronner et al. 2007
Biglow Canyon, OR (Phase II; 09/10)		Enk et al. 2011	Lempster, NH (2009)		Tidhar et al. 2010
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Lempster, NH (2010)		Tidhar et al. 2011
Buffalo Gap, TX		Tierney 2007	Maple Ridge, NY (2006)		Jain et al. 2007
Buffalo Gap II, TX		Tierney 2009	Maple Ridge, NY (2007)		Jain et al. 2008
Buffalo Mountain, TN (2000-03)	Fiedler 2004	Nicholson et al. 2005	Maple Ridge, NY (2008)		Jain et al. 2009c
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Marengo I, WA (2009)		URS Corporation 2010b
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Marengo II, WA (2009)		URS Corporation 2010c
Buffalo Ridge, MN (Phase II; 98)		Johnson et al. 2000	Mars Hill, ME (2007)		Stantec 2008
Buffalo Ridge, MN (Phase II; 99)		Johnson et al. 2000	Mars Hill, ME (2008)		Stantec 2009a
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Moraine II, MN		Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 2008)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase III; 99)		Johnson et al. 2000	Mount Storm, WV (2009)	Young et al. 2010a	Young et al. 2009a, 2010a
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (2010)	Young et al. 2010b; 2011	Young et al. 2010b, 2011
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV	Arnett et al. 2005b, Arnett pers. comm.	Arnett et al. 2005b
Buffalo Ridge I, SD (2010)		Derby et al. 2010b	Munnsville, NY (2008)		Stantec 2009b
Casselman, PA (Spring & Fall 2008)		Arnett et al. 2009	Nine Canyon, WA		Erickson et al. 2003
Cedar Ridge, WI (2009)	BHE Environmental 2008	BHE Environmental 2010	Noble Bliss, NY (2008)		Jain et al. 2009d
Cedar Ridge, WI (2010)	BHE Environmental 2008	BHE Environmental 2011	Noble Bliss, NY (2009)		Jain et al. 2010a
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	Noble Clinton, NY (2008)	Reynolds 2010a	Jain et al. 2009b
Combine Hills, OR		Young et al. 2006	Noble Clinton, NY (2009)	Reynolds 2010a	Jain et al. 2010b
Crescent Ridge, IL		Kerlinger et al. 2007	Noble Ellenburg, NY (2008)		Jain et al. 2009a
Crystal Lake II, IA		Derby et al. 2010a	Noble Ellenburg, NY (2009)	Reynolds 2010b	Jain et al. 2010c
Dillon, CA		Chatfield et al. 2009	NPPD Ainsworth, NE		Derby et al. 2007
Dry Lake, AZ	Thompson et al. 2011	Thompson et al. 2011	Pebble Springs, OR		Gritski and Kronner 2010b
Elkhorn, OR (2008)		Jeffrey et al. 2009b	Prairie Winds (Minot), ND		Derby et al. 2011
Elm Creek, MN		Derby et al. 2010c	Ripley, Ont (2008)		Jacques Whitford 2009
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003	Shiloh I, CA		Kerlinger et al. 2010
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003	Stateline, OR/WA 2002		Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 2001-02)	Gruver 2002	Young et al. 2003	Stateline, OR/WA 2003		Erickson et al. 2004
Forward Energy Center, WI	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain, ME (2009)	Stantec 2009c	Stantec 2009c
Goodnoe, WA		URS Corporation 2010a	Summerview, Alb (2008)	Baerwald 2008	Baerwald 2008
Grand Ridge, IL		Derby et al. 2010g	Top of Iowa, IA (2003)		Jain 2005
Hay Canyon, OR		Gritski and Kronner 2010a	Top of Iowa, IA (2004)	Jain 2005	Jain 2005
High Winds, CA (2004)		Kerlinger et al. 2006	Tuolumne (Windy Point I), WA		Enz and Bay 2010
High Winds, CA (2005)		Kerlinger et al. 2006	Vansycle, OR		Erickson et al. 2000
Hopkins Ridge, WA (2006)		Young et al. 2007	Wessington Springs, SD		Derby et al. 2010f
Hopkins Ridge, WA (2008)		Young et al. 2009c	Wild Horse, WA		Erickson et al. 2008
Judith Gap, MT		TRC 2008	Winnebago, IA		Derby et al. 2010e
Kewaunee County, WI		Howe et al. 2002	Wolfe Island, Ont (July-December 2009)		Stantec Ltd. 2010b

Appendix F2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Alite, CA	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
Barton Chapel, TX	3.06	Agriculture/forest	WEST 2011
Big Horn, WA	1.9	Agriculture/grassland	Kronner et al. 2008
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009a
Biglow Canyon, OR (Phase I; 2009)	0.58	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009/2010)	2.71	Agriculture	Enk et al. 2011
Blue Sky Green Field, WI	24.57	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX	0.14	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	Forest	Fiedler et al. 2007
Buffalo Ridge I, SD (2010)	0.16	Agriculture/grassland	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1999)	0.74	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	Agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 1999)	2.72	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	Agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	Agriculture	Derby et al. 2010b
Casselman, PA (Spring & Fall 2008)	12.61	Forest	Arnett et al. 2009
Cedar Ridge, WI (2009)	30.61	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	8.62	Agriculture/forest	Stantec 2010
Combine Hills, OR	1.88	Agriculture/grassland	Young et al. 2006
Crescent Ridge, IL	3.27	Agriculture	Kerlinger et al. 2007
Crystal Lake II, IA	7.42	Agriculture	Derby et al. 2010a
Dillon, CA	2.17	Desert	Chatfield et al. 2009
Dry Lake, AZ	4.29	Desert grassland/forested	Thompson et al. 2011
Elkhorn, OR (2008)	1.26	Shrub/scrub	Jeffrey et al. 2009b
Elm Creek, MN	1.49	Agriculture	Derby et al. 2010c
Foote Creek Rim, WY (Phase I; 1999)	3.97	Grassland	Young et al. 2003
Foote Creek Rim, WY (Phase I; 2000)	1.05	Grassland	Young et al. 2003
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	Grassland	Young et al. 2003
Forward Energy Center, WI	18.17	Agriculture	Grodsky and Drake 2011
Goodnoe, WA	0.34	Grassland and shrub-steppe	URS Corporation 2010a

Appendix F2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Grand Ridge, IL	2.1	Agriculture	Derby et al. 2010g
Hay Canyon, OR	0.53	Agriculture	Gritski and Kronner 2010a
High Winds, CA (2004)	2.51	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2005)	1.52	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	0.63	Agriculture/grassland	Young et al. 2007
Hopkins Ridge, WA (2008)	1.39	Agriculture/grassland	Young et al. 2009c
Judith Gap, MT (2006/2007)	8.93	Agriculture/grassland	TRC 2008
Kewaunee County, WI	6.45	Agriculture	Howe et al. 2002
Klondike II, OR	0.41	Agriculture/grassland	Johnson et al. 2003
Klondike III, OR	1.11	Agriculture/grassland	NWC and WEST 2007
Klondike IIIa, OR	0.16	Grassland/shrub-steppe and agriculture	Gritski et al. 2009a
Klondike, OR	0.77	Agriculture/grassland	Gritski et al. 2009b
Leaning Juniper, OR	1.98	Agriculture	Kronner et al. 2007
Lempster, NH (2009)	3.08	Grasslands & rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	Grasslands & rocky embankments	Tidhar et al. 2011
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	9.42	Agriculture/forested	Jain et al. 2008
Maple Ridge, NY (2008)	4.96	Agriculture/forested	Jain et al. 2009c
Marengo I, WA (2009)	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009)	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Moraine II, MN	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (2009)	24.32	Forest	Young et al. 2009b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2009a, 2010a
Mount Storm, WV (Fall 2008)	6.62	Forest	Young et al. 2010b, 2011
Mountaineer, WV	31.69	Forest	Arnett et al. 2005
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Nine Canyon, WA	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al. 2009d
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010a
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009b
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009a
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010c
NPPD Ainsworth, NE	1.16	Agriculture/grassland	Derby et al. 2007

Appendix F2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/year)	Predominant Habitat Type	Citation
Pebble Springs, OR	1.55	Grassland	Gritski and Kronner 2010b
Prairie Winds (Minot), ND	2.13	Agriculture	Derby et al. 2011
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Shiloh I, CA	3.92	Agriculture/grassland	Kerlinger et al. 2010
Stateline, OR/WA 2002	1.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA 2003	2.29	Agriculture/grassland	Erickson et al. 2004
Stetson Mountain, ME (2009)	1.4	Forest	Stantec 2009c
Summerview, Alb (2006)		Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2008)	11.42	Agriculture/grassland	Baerwald 2008
Top of Iowa, IA (2003)	7.16	Agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	Agriculture	Jain 2005
Tuolumne (Windy Point I), WA	0.94	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR	1.12	Agriculture/grassland	Erickson et al. 2000
Wessington Springs, SD	1.48	Grassland	Derby et al. 2010f
Wild Horse, WA	0.39	Grassland	Erickson et al. 2008
Winnebago, IA	4.54	Agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Ltd. 2010b

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