Appendix A

Fowler Ridge Wind Farm Fatality Monitoring Reports

FINAL REPORT

Bird and Bat Fatality Studies
Fowler Ridge I Wind-Energy Facility
Benton County, Indiana

April 6 – October 30, 2009

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EXECUTIVE SUMMARY

BP Wind Energy North America, Inc. (BPWENA) is developing a wind-energy facility in five separate phases for a total build out capacity of 1,000 megawatts (MW) in Benton County, Indiana. Currently, the first three phases have a total energy capacity of 750 MW. The first phase of the facility, Fowler Ridge I, is jointly owned by BPWENA and Dominion Energy, Inc. and has a nameplate capacity of 301 MW. The Fowler Ridge I Wind–Energy Facility (FRWEF-I) is located approximately 0.5 miles (0.8 km) south and east of Fowler, Indiana, and consists of 122 Vestas V82 1.65-MW turbines and 40 Clipper C96 2.5-MW turbines. BPWENA contracted Western Ecosystems Technology, Inc. (WEST) to conduct a post-construction fatality monitoring study at the Fowler Ridge I facility. The study was designed to assess the level of impacts to birds and bats (i.e., high, moderate, low) relative to other regional projects from operation of the wind-energy facility. Because not all turbines were sampled and because all study plots were not completely cleared of crops, the study was not designed to quantify mortality with a high degree of accuracy for the entire wind energy facility, nor was it designed to detect every wind turbine casualty present on the site. Monitoring at the Fowler Ridge I facility occurred from April 6 to October 30, 2009.

FRWEF-I is located in western Indiana in Benton County. The topography of the site is mostly flat to slightly rolling and there are no hills, ridges, or other areas of starkly elevated topography. Habitat within and surrounding the FRWEF-I is dominated by tilled agriculture, with corn and soybeans being the dominant crops. Of the roughly 29,000 acres (about 43 mi^2) within the FRWEF-I and half-mile (0.8-km) buffer, row crops compose 93%, developed areas compose 5.7%, pastures/hayfields compose 1.7%, grasslands compose 0.1%, and forested areas compose 0.4% of the land cover.

The monitoring study for the FRWEF-I consisted of the following components: 1) standardized carcass surveys of selected turbines within a square plot centered on the turbine; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that carcasses remain in the field for possible detection; and 4) adjusted fatality estimates based on the results of searcher efficiency trials and carcass removal trials and proportion of the plot searched.

Twenty-five wind turbines were included in the study, and nine of those had crops cleared in late summer within the search plot to facilitate conducting surveys in mature corn and soybean fields. To the extent possible, turbines were selected for sampling using a systematic design with a random start so that the search effort was spread throughout the entire wind-energy facility. However, some modifications to turbine sample selection had to be made to accommodate landowners who did not wish to participate in the study. Square plots 160 by 160 meters (525 by 525 feet) in size were established around the 25 turbines and systematically searched for carcasses. Standardized carcass surveys were conducted anywhere from twice a week to twice a month, with more intensive surveys conducted during the spring and fall migration periods.

Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (bird carcasses only)

and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias. Carcass removal studies were conducted during each season, outside of the carcass search plots (i.e., near turbines that were not included in the standard search plots). Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study plots, correcting for removal bias.

A total of 778 turbine searches were conducted over the course of the fatality monitoring study. Twenty-eight birds and 156 bats were found during standardized carcass surveys or incidentally. Twenty-four birds comprised of 11 identified species were found during scheduled searches, and four additional bird fatalities were found incidentally. The most common bird species found as a casualty at the site was killdeer (four fatalities), followed by tree swallow (three), red-tailed hawk (three) and unidentified large bird (three); two unidentified ducks were also found as fatalities. The three unidentified large birds and two unidentified ducks found during the study consisted entirely of a few large bones with no feathers or flesh remaining. The ducks were identified to type based on skull characteristics, but no skulls were found associated with the remaining three unidentified large birds. The FRWEF-I is near an area designated as an Important Bird Area (IBA) due to high concentrations of staging American golden plovers during spring migration. Although concerns have been raised over the potential for collision mortality, no American golden plover fatalities were found during this study.

Of all the bird fatalities, 35.6% were found within 30 m (99 feet) of the turbine, 28.5% were found from 31 to 60 m (100 to 197 feet), and 35.7% were found more than 60 m from the turbine. Most (64.2%) of the bird fatalities occurred during fall migration (September 3 to October 29), 25.0% occurred during spring migration (April 6 to May 25), and 10.7% occurred during the breeding season (June 10 to August 14).

A total of 107 bat fatalities comprised of six species were found during scheduled searches, and an additional 49 bats were found incidentally. Most (94.2%) of the bat fatalities were migratory tree bats, including 56 eastern red bats (35.9%), 48 hoary bats (30.8%), 42 silver-haired bats (26.9%) and one unidentified *Lasiurus* spp. (either hoary or eastern red bat). The other bat fatalities included four big brown bats, three little brown bats, one northern long-eared bat, and one Indiana bat. The Indiana bat is listed as an endangered species by the US Fish and Wildlife Service. The Indiana bat casualty was collected as an incidental casualty on September 11, 2009. The majority (88.2%) of bat fatalities were found within 40 m (131 feet) of the turbines, and most (73.7%) of the bat fatalities occurred from August 1 to September 15, with an additional 12.8% found between September 16 and October 30.

A total of 89 carcasses (17 large birds, 12 small birds, and 60 bats) were placed in the field during searcher efficiency trials conducted on 11 separate dates. Observer detection rates were 64.3% for large birds, 37.5% for small birds, and 56.0% for bats. A total of 82 carcasses were placed in study area throughout the duration of the monitoring period for carcass removal trials, including 16 large birds, 12 small birds, and 54 bats. By day ten, approximately 30% of the bats remained, while approximately 20% of the large birds and nearly 35% of the small birds remained.

Seven turbines surveyed during the study season were lit with Federal Aviation Administration (FAA) mandated aviation strobe lights and 18 were unlit. There were no significant differences in the number of bird or bat fatalities occurring at turbines with or without FAA lighting.

The estimated fatality rate and 90% confidence interval (CI) for the entire study period (all three study seasons) was 5.26 birds/turbine (90% CI = 3.52, 10.25) and 15.03 bats/turbine (10.89, 20.52). Given the 301-MW nameplate capacity of the FRWEF-I, the overall fatality estimate for the entire study period (all three study seasons) was 2.83 bird fatalities/MW and 8.09 bat fatalities/MW.

The estimated bird fatality rate of 2.83 birds/MW is lower than average compared to other wind-energy facilities in the Midwest. Overall bird fatality estimates at seven Midwest wind-energy facilities located in Nebraska, Wisconsin, Minnesota, Iowa and Illinois have ranged from 0.6 to 7.2 and averaged 4.28 birds/MW/year. The estimated bat fatality rate of 8.09 bats/MW would be considered moderate when compared to other wind-energy facilities in North America, and is somewhat below average based on the regional average for reported bat fatality estimates at seven wind energy facilities in the Midwest, where bat fatality estimates ranged from 0.8 to 30.6, and averaged 9.8 bats/MW/year.

Species composition of bat fatalities was similar to that at most other wind-energy facilities, in that the majority (94.2%) of identified bat fatalities was comprised of three species of migratory tree bats, namely the hoary, eastern red and silver-haired bat. These three species typically comprise over 75% of bat fatalities at wind-energy facilities throughout North America. Based on the timing of fatalities for these three species and the lack of forest cover that might provide habitat for resident bats, most of the fatalities were apparently migrants through the area, as is the case at virtually all other wind energy facilities in North America. It seems unlikely that the FRWEF-I is located along a concentrated tree bat migration route, as there are no topographical features or large expanses of forested areas that would tend to concentrate migrating bats.

Pre-construction ground-based bat acoustical surveys were conducted at the Fowler Ridge Wind Resource Area from August 15 – October 19, 2007 and from July 17 – October 15, 2008, time periods that cover the time frame during which most bat mortality at wind energy facilities occurs throughout North America. Overall bat detections were low to moderate for sites in the Midwest, ranging from 4.7 bat calls/detector-night in 2007 to 6.45 bat calls/detector-night in 2008. Although only 3.2% of the bat casualties found at the FRWEF-I in 2009 were high-frequency species (i.e., *Myotis* spp.), high-frequency bats comprised 49.0% of bat calls in 2007 and 34.2% of bat calls recorded in 2008, suggesting that high frequency species such as *Myotis* bats may be much less susceptible to turbine collisions.

The discovery of an Indiana bat turbine casualty at a wind-energy facility sited in a corn and soybean agroecosystem was unexpected. To our knowledge, this is the first Indiana bat related casualty documented at a wind-energy facility in North America, as well as the first documented casualty of a federally-listed bat species at a wind-energy facility. The Indiana bat casualty found during this study is also apparently the first record of Indiana bat in Benton County, Indiana. Based on the lack of Indiana bat summer habitat at or near the FRWEF-I, and the time frame that

the Indiana bat casualty occurred (estimated to be September 9, 2009), this individual was likely a migrant through the area.

To date there have been fewer than 10 studies conducted to estimate bird and bat fatalities from wind turbine operations in the Midwest, and studies at the Fowler Ridge Wind Energy Facility represent the first such studies in Indiana. Results of this study further contribute to our understanding of wind-energy impacts to birds and bats. As more wind-energy facilities are built in the region, and additional studies become available, a clearer picture of the impacts to birds and bats will emerge.

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INTRODUCTION

BP Wind Energy North America, Inc. (BPWENA) is developing a wind-energy facility in five separate phases for a total build out capacity of 1,000 megawatts (MW) in Benton County, Indiana. Currently, the first three phases have a total energy capacity of 750 MW. The first phase of the facility, Fowler Ridge I, jointly owned by BPWENA and Dominion Energy, with a nameplate capacity of 301 MW, is located approximately 0.5 miles (0.8 km) south and east of Fowler, Indiana, and consists of 122 Vestas V82 1.65-MW turbines and 40 Clipper C96 2.5-MW turbines. BPWENA contracted Western Ecosystems Technology, Inc. (WEST) to conduct a post-construction fatality monitoring study at the Fowler Ridge I wind-energy facility to assess the level of impacts to birds and bats (i.e., high, moderate, low) relative to other regional facilities from operation of the Fowler Ridge I Wind-Energy Facility (FRWEF-I). Monitoring at the FRWEF-I occurred from April 6 to October 30, 2009, a time period that covered spring and fall migration as well as the summer breeding season.

The monitoring study for the FRWEF-I consisted of the following components:

1) Standardized carcass surveys of selected turbines within a square plot centered on the turbine;
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;
3) Carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and
4) Adjusted fatality estimates based on the results of searcher efficiency trials, carcass removal trials, and the proportion of the plot searched.

STUDY AREA

The FRWEF-I is located in western Indiana in Benton County (Figure 1). The project area is within the Tipton Tall Plain physiographic region that includes much of central Indiana. It occurs within the Grand Prairie Natural Region that includes a small section of north central Indiana (Mumford and Whitaker 1982). The topography of the FRWEF-I is mostly flat to slightly rolling and there are no hills, ridges, or other areas of starkly elevated topography. Elevations in the project area range from approximately 700-800 ft (213-244 m). The project area averages 40 inches (102 centimeters [cm]) of precipitation per year and temperatures range from 19 – 45 °F (-7.2 – 7.3 °C) in January to 65 – 86 °F (18 – 30 °C) in July. Soils in the project area 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 FRWEF-I is dominated by tilled agriculture, with corn (*Zea mays*) and soybeans (*Glycine max*) being the dominant crops. Of the roughly 29,000 acres (about 43 square miles [mi^2]) of the Fowler Ridge I facility and a half-mile (0.80 km) buffer, row crops compose about 93% of the area (Homer et al. 2004; Table 1; Figure 2). After tilled agriculture, the next most common land use within the FRWEF-I and the buffer is developed areas, which compose 5.7% of the total, and pastures/hayfields, which compose 1.7%. There are 14.8 acres (0.02 mi^2) of grasslands,

composing only 0.1% of the study area. Grasslands in the study area are limited primarily to strips along drainages, railroad rights-of-way (ROW), and ROWs along county and state roads. There are also a few grass-lined waterways within cultivated fields in the area. Trees in the study area occur at homesteads, along some of the drainages and fencerows, and in some pastures. Several tree rows planted as wind breaks also occur in the area. Forested areas are rare within the study area based on 2001 data (Homer et al. 2004), and the 118.1 acres (0.18 mi^2) of forest compose only 0.4% of the total. Small amounts of barren ground, open water, and woody wetlands are also present.

METHODS

The primary objective of the monitoring study was to estimate the level (high, moderate, or low) of bird and bat mortality attributable to collisions with wind turbines relative to other regional wind-energy facilities for the entire FRWEF-I. Because not all turbines were sampled and because completely cleared plots were not used for all turbines sampled in the study, the study was not designed to quantify mortality with a high degree of accuracy for the entire wind energy facility, nor was it designed to detect every wind turbine casualty present on the site. The monitoring study began after the wind-energy facility became fully operational. Monitoring began on April 6 and continued through October 30, 2009, to cover the spring and fall migration, as well as the summer breeding season. The methods for the fatality study were broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species calculated using the results from searcher efficiency trials, carcass removal trials, and proportion of the plot searched to estimate the total number of bird and bat fatalities within the FRWEF-I.

There are three scenarios under which casualties were found in the FRWEF-I: 1) during the standardized surveys for the study; 2) while observers were on site, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others on-site for other purposes, such as turbine maintenance. All casualties found by study personnel regardless of timing (i.e., during a standardized survey or not) were recorded by the methods described below. However, only casualties found on established search plots during scheduled searches were used to estimate total mortality for the wind energy facility.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent found), and proportion of the survey plot searched. For carcasses where the cause of death was not apparent, the assumption that the casualty was a wind turbine collision casualty was made for the analysis. This approach likely led to an overestimate of the true number of facility-related avian fatalities, but most studies of wind-energy facilities have used this conservative approach because of the relatively high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000).

Field Methods

The protocol developed for the study suggested that 32 turbines, or 20% of those available, be included in the study. Most of the turbines were placed in corn and soybean fields. Because searcher efficiency in these crop types would be extremely low from early summer until the crops are harvested in late October, the protocol suggested that half (16) of the 32 turbines have crops cleared to facilitate conducting fatality surveys, similar to the methods used to clear crops for searching turbines at the Top of Iowa wind-energy facility in Iowa (Jain 2005). However, due to difficulties with numerous landowners not wishing to participate in the study, or not wanting crops cleared around study turbines, 25 turbines (15.4% of those available) were ultimately included in the study, and nine of those had crops cleared. To the extent possible, turbines were selected for sampling using a systematic design with a random start so that the search effort was spread throughout the entire FRWEF-I. However, some modifications to turbine sample selection had to be made to accommodate landowners who did not wish to participate in the study (Figure 3).

Square plots were established around the 25 turbines and systematically searched for carcasses. Search plots at turbines were 160 m (525 ft) on a side to ensure all areas within 80 m (262 ft) of the turbine were searched. Studies at facilities with other large turbines, such as the Klondike wind-energy facility in Oregon (Johnson et al. 2003b), the Combine Hills facility, also in Oregon (Young et al. 2005), and the Crescent Ridge facility in Illinois (Kerlinger et al. 2007), indicate most of the fatalities are found within the area that is roughly equivalent to the height of the turbine tower.

Prior to when corn and soybean crops began to mature (April 6 to July 3, 2009), the entire 160-m^2 (6.3-acre) plot was searched for all turbines. After July 3, search plots were created by mowing established crops. One of the nine cleared turbines had the entire 160 m^2 search plot cleared of vegetation, whereas in each of the remaining eight turbine plots five strips were cleared of vegetation. Each cleared strip was 500 feet (152-m) long and 10 feet (3 m) wide. One cleared strip was centered vertically on the turbine, and the other four strips were placed horizontally at varying distances from the turbine. Half the turbines had these strips placed 10, 30, 50 and 70 m (33, 98, 164, and 230 ft) from the turbine; the other half had strips placed at 20, 40, 60 and 80 m (66, 131, 197, and 262 ft) from the turbine (see example in Figure 4). This design ensured that all distances from 0 to 80 m away from the turbine were covered during searches. In addition to searching the cleared strips, the portion of the turbine access road within 80 m of the turbine and the turbine pad were also searched. Sixteen of the turbines did not have any crops cleared for searching and the entire 160-m^2 plot was searched from April 6 to August 16, 2009. After August 16, only clear areas, including the turbine pad, access road within 80 m of the turbine, and any other portions of the plot without crops (i.e., areas disturbed by recent construction or flooded areas where crops would not grow), were searched at these turbines because the ability to detect a carcass within the mature corn and soybean fields was greatly reduced. A global positioning system (GPS) was used to measure the total area (cleared strips, turbine pads, access roads, etc.) actually searched at each turbine.

From the start of the study on April 6 through May 21 (spring migration), half of the plots were searched weekly, including the one plot scheduled to have the entire search area cleared, three plots scheduled to have cleared search strips, and eight plots with no scheduled crop clearing. The other half of the plots were searched once every two weeks, including five plots scheduled to have cleared strips and eight plots with no clearing. From May 22 through August 15 (summer), all 25 plots were

searched twice a month. Beginning on August 16 and continuing through the end of the study on October 30, all 25 plots were searched twice a week.

Standardized Carcass Surveys

The objective of the standardized carcasses surveys was to systematically search the wind-energy facility for bird and bat casualties that were attributable to collision with project facilities. Study personnel were trained in proper search techniques prior to conducting the carcass surveys.

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

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- Scavenged - an entire carcass, which shows 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 has been heavily infested by insects.
- Feather Spot - ten or more feathers or two or more primaries at one location indicating a bird fatality had been there.

All carcasses were labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass was maintained with the bagged and frozen carcass at all times. For all casualties found, data recorded included species, sex and age when possible, date and time collected, GPS location, condition (intact, scavenged, feather spot), and any comments that indicated possible cause of death. All casualties were photographed as found.

Casualties found outside the formal search area were treated following the above protocol as closely as possible. Casualties observed in non-search areas (generally at turbines not included in the study) were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Casualties found by wind turbine maintenance personnel and others not conducting the formal searches were similarly documented and included in the overall dataset.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by searchers. Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (only bird carcasses) and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias.

Searcher efficiency trials were conducted 11 times throughout the study period. Observers conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. A total of 89 carcasses (17 large birds, 12 small birds, and 60 bats) were placed on 11 dates. Carcasses used for searcher efficiency trials were primarily non-native/non-protected or commercially available species, such as house sparrows (*Passer domesticus*), northern bobwhites (*Colinus virginianus*), ring-necked pheasants (*Phasianus*

colchicus), and mallards (*Anas platyrhynchos*). The 60 bats used for the trials were all fresh, non-*myotis* species previously found during the study. All searcher efficiency trial carcasses were placed at random locations within the search area prior to that day's scheduled carcass survey. Each trial carcass was discreetly marked (e.g., thread or tape) so that the carcass could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Removal Trials

The objective of carcass removal trails was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by predation or scavenging, or removal by other means, such as being plowed into a field. Carcass removal studies were conducted during each season. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study plots, correcting for removal bias.

Trials were spread throughout the study period to incorporate the effects of varying weather, climatic conditions, and scavenger densities. A total of 82 carcasses were placed throughout the duration of the monitoring period (May 1 through October 19, 2009), including 16 large birds, 12 small birds, and 54 bats. Carcass composition was similar to that used for searcher efficiency trials.

Removal trial carcasses were not placed in the standardized search plots in order to minimize the chance of confusing a trial carcass with a turbine casualty. Turbines not included in the standardized carcass surveys were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots.

Personnel conducting carcass searches monitored the trial birds over a 40-day period, checking the carcasses every day for the first four days of the trial, and then on day 7, day 10, day 14, day 20, day 30, and day 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Search Area

The third factor to be determined in order to adjust the number of fatalities found was the proportion of the turbine plot searched. From April 6 to July 3, the entire 160-m^2 plot was searched at all 25 turbines. After July 3, as crops began to mature, for those nine turbines with cleared crops, the entire 160-m^2 plot was searched at the one turbine that had the entire search plot cleared of crops, whereas only the five cleared search strips, and the bare gravel turbine pads and turbine access road surfaces within 80 m of the turbine were searched at the remaining eight turbines. The total area encompassed by the five cleared search strips in each plot was 2,447.6 m^2. The proportion of area searched decreased as distance from the turbine increased. For example, on average approximately 87% of the area within 10 m of a turbine was searched, whereas only approximately 21% of the area between 71 and 80 m was searched (Figure 5). The distance each casualty was found from the

turbine was used to adjust for the search area. For the 16 turbine plots without cleared strips, the entire 160-m^2 plot was searched from April 6 to August 16, at which time the crops had grown to the point that they could no longer be effectively searched. After August 16, only the gravel pad, access road within 80 m of the turbine, and any other areas where visibility was acceptable were searched.

Statistical Methods

Statistical Methods for Fatality Estimates

Estimates of facility-related fatalities were based on:

(1) Observed number of carcasses found during standardized searches during the monitoring period for which the cause of death was either unknown or was probably facility-related;

(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 searchers during removal trials; and

(3) Searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

Fatality estimates were calculated for all birds, large birds, and bats. The numbers of bird and bat carcasses found incidentally and during scheduled searches were reported. All carcasses located within areas surveyed, regardless of species, were recorded and, if possible, a cause of death was determined based on a cursory field necropsy. Total numbers of bird and bat carcasses were estimated by adjusting for scavenger removal, searcher efficiency, and proportion of the plot searched. If the cause of death was not apparent, a "worst case" presumption was made by attributing the mortality to the operation of the wind-energy facility.

Definition of Variables

The following variables are used in the equations below:

c_i the number of carcasses detected at plot i for the study period of interest, for which the cause of death is either unknown or is attributed to the facility

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 remain in the study area after 30 days

se standard error (square of the sample variance of the mean)

t_i the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials

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

d the total number of carcasses placed in searcher efficiency trials

p the estimated proportion of detectable carcasses found by searchers, 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

$\hat{\pi}$ the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials

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 for the entire monitoring period is:

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

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:

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

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were expressed as p, the proportion of trial carcasses that were detected by searchers during the searcher efficiency trials. These rates were estimated by carcass size and season.

Estimation of Facility-Related Fatality Rates

The estimated per turbine annual fatality rate (m) was calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

where $\hat{\pi}$ included 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 $\hat{\pi}$.

$\hat{\pi}$ was 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). 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 CI for complicated test statistics. For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and m were calculated. A total of 5,000 bootstrap samples were used. The reported estimates were the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of the 90% CI.

RESULTS

Standardized Carcass Surveys

Twenty-five wind turbines were searched over the course of the fatality monitoring study, for a total of 778 turbine searches. Twenty-eight birds and 156 bats were found during standardized carcass surveys or incidentally (Table 2).

Bird Fatalities

Twenty-four birds comprised of 11 identified species were found during scheduled searches (Table 2 and Figure 6), and four additional bird fatalities were found incidentally. The most common bird species found as a casualty at the site was killdeer (*Charadrius vociferus*; four fatalities), followed by tree swallow (*Tachycineta bicolor*; three), red-tailed hawk (*Buteo jamaicensis*; three) and unidentified large bird (three); two unidentified ducks were also found. The three unidentified large birds and the two unidentified ducks found during the study consisted entirely of a few large bones with no feathers or flesh remaining. The ducks were identified to type based on skull characteristics, but no skulls were found associated with the three unidentified large birds.

The greatest number of bird fatalities found at any one turbine was six at Turbine 629 (Figure 7). These included one blue-winged teal (*Anas discors*), two unidentified ducks, and one unidentified large bird found during the initial phases of the study (April 10 to May 6, 2009).). Turbine 629 had a large pool of water (approximately 200-m [656-ft] long by 30-m [98-ft] wide) within the search plot, which may have attracted waterfowl. None of the other turbines had persistent water present during surveys. Turbine 152 had three fatalities, whereas all other search

turbines had none, one, or two fatalities (Figure 7). No bird fatalities were found at Turbine 249, which had the entire search plot cleared of vegetation. With the exception of Turbine 629, bird mortality did not appear to be concentrated within any portion of the study area. Of the bird fatalities, 35.6% were found within 30 m of the turbine, 28.5% were found from 31-60 m, and 35.7% were found beyond 60 m of the turbine (Table 3 and Figure 8). Most (64.2%) of the bird fatalities occurred during fall migration (September 3 to October 29), 25.0% occurred during spring migration (April 6 to May 25), and 10.7% occurred during the breeding season (June 10 to August 14; Figure 9). Of the bird fatalities, 39.3% were intact, 39.3% were scavenged, and 21.4% were feather spots (Appendix A).

Bat Fatalities

A total of 107 bat fatalities comprised of six species were found during scheduled searches and an additional 49 bats were found incidentally (Table 2; Figure 10). Most (94.2%) of the fatalities were migratory tree bats, including 56 eastern red bats (*Lasiurus borealis*; 35.9%), 48 hoary bats (*Lasiurus cinereus*; 30.8%), 42 silver-haired bats (*Lasionycteris noctivagans*; 26.9%) and one unidentified *Lasiurus* spp. (either hoary or eastern red bat). The other bat fatalities included four big brown bats (*Eptisecus fuscus*), three little brown bats (*Myotis lucifugus*), one northern long-eared bat (*Myotis septentrionalis*), and one Indiana bat (*Myotis sodalis*).

The Indiana bat is listed as an endangered species by the US Fish and Wildlife Service (USFWS; USFWS 2010). The casualty was found by a BPWENA turbine maintenance worker and reported to WEST on September 10, 2009. WEST collected the bat as an incidental casualty on September 11, 2009. It was located 16 m (52 feet) from Turbine 230 (Figure 10). The carcass was a female and was intact. Although it was slightly decomposed, the bat was estimated to have been killed the night prior to when it was first discovered, or on September 9, 2009. The bat was stored in a WEST freezer until being tentatively identified as an Indiana bat on November 13, 2009 while a WEST field biologist was reviewing all bird and bat casualties at the end of the field study to confirm identifications. The identification was confirmed by Jeremy Jackson with Jackson Environmental on November 16, 2009. On November 17, 2009, voicemail messages were left notifying both the USFWS and IDNR of the Indiana bat casualty. On November 18, 2009, both the USFWS and IDNR returned the previous call and were notified of the potential Indiana bat find. On November 18, 2009, WEST sent a skin sample from the bat for DNA testing to Portland State University, and the bat was transferred on November 19, 2009 to Mike Litwin of the USFWS. On December 12, 2009, the DNA lab notified WEST that the specimen was positive for Indiana bat; this information was then relayed to the USFWS and IDNR on December 28, 2009. The USFWS conducted a necropsy of the bat carcass, which found that due to desiccation of the limbs it could not be determined whether the identified fractures of the ribs, right clavicle, left wing and left mandible occurred after the bat had died or were the result of injuries sustained at the time of death.

The greatest number of bat fatalities found at any one turbine was 18 fatalities at Turbine 606. Thirteen fatalities were found at Turbine 265, while fatalities at other turbines ranged from none to nine (Figure 11). Six bat fatalities were found at Turbine 249, which had the entire search plot cleared of vegetation. The majority of bat fatalities (88.2%) were found within 40 m of the turbines (Table 3 and Figure 12). Most (73.7%) of the bat fatalities occurred from August 1 to September 15 (Figure 13). An additional 12.8% were found between September 16 and October

30; therefore, 86.5% of all fatalities were found from August 1 to October 30. Thirteen bat fatalities were found between April 6 and May 25, and only eight were found in June and July. Most (85.8%) of the bat fatalities were intact while 14.2% were scavenged (Appendix A).

Searcher Efficiency Trials

A total of 89 carcasses (17 large birds, 12 small birds, and 60 bats) were placed in the field during searcher efficiency trials conducted on 11 separate dates (Table 4). Observer detection rates were 64.3% for large birds, 37.5% for small birds, and 56.0% for bats (Table 4).

Carcass Removal Trials

A total of 82 carcasses were placed in study area throughout the duration of the monitoring period, including 16 large birds, 12 small birds, and 54 bats. By day ten, approximately 30% of the bats remained, while approximately 20% of the large birds and nearly 35% of the small birds remained (Figure 14).

For weekly searches, approximately 92.5% of the bat and 58.8% of the bird fatalities were estimated to have been killed within the previous seven days (Table 5). For biweekly searches, it was estimated that 96.4% of the bat and 62.5% of the bird fatalities had been present less than a week (Table 5).

Adjusted Fatality Estimates

Fatality estimates, standard errors, and CI were calculated for birds and bats (Appendices B and C). The fatality estimates were adjusted based on the corrections for carcass removal, observer detection bias, and the proportion of the plot searched. Based on searcher efficiency and the carcass removal rate at the site, the estimated average probability for all search intervals that a casualty would remain in the plot until a scheduled search and would be found was 51% for small birds, 62% for large birds, and 56% for bats (Table 6).

Because all three raptors found during the study were found as incidental fatalities and not during standardized searches, separate fatality estimate for raptors could not be calculated. The estimated fatality rate and 90% CI for the entire study period (all three study seasons) was 5.26 birds/turbine (3.52, 10.25) and 15.03 bats/turbine (10.89, 20.52; Table 6). Given the 1.65 and 2.5-MW capacity of turbines at the FRWEF-I, the overall fatality estimate for the entire study period was 2.83 bird fatalities/MW and 8.09 bat fatalities/MW. Given that the project is 301 MW in size, the estimated number of fatalities during the study period for the entire facility was 852 birds and 2,435 bats.

Lighting Effects and Turbine Location Effects

Seven turbines surveyed during the study season were lit with mandated Federal Aviation Administration (FAA) aviation strobe lights and 18 were unlit. Not including incidental finds, four bird carcasses were found at lit turbines (0.57 fatalities/turbine), compared to 21 at unlit turbines (1.17 fatalities/turbine; Table 7). The difference in means between lit and unlit turbines was -0.59 with a 90% CI of -1.65 to 0.46 (Table 7). Because the 90% CI included the value 0, this indicates that presence of turbine lighting had no effect on bird fatality rates.

Not including incidental finds, 39 bat carcasses were found at lit turbines (5.57 fatalities/turbine) and 73 were found at unlit turbines (4.06 fatalities/turbine). The difference of means between lit and unlit turbines was 1.52 with a 90% CI of -1.77 to 4.80 (Table 7), again indicating that turbine lighting had no effect on bat fatality rates.

DISCUSSION

Fatality Estimates

The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, total area searched, proportion of area searched at specific distances from the turbine, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate fatality rates. We accounted for this by conducting scavenging trials throughout the monitoring period. We also estimated searcher efficiency rates throughout the study period to account for any biases associated with changes in conditions.

We calculated separate estimates of bird and bat fatality rates based on search interval. For both birds and bats, overlapping CI for overall fatality estimates based on weekly and biweekly search intervals (Tables 6 and 7) indicate that the estimates were consistent regardless of search interval. However, given the estimated scavenging rates of birds and bats, the weekly estimates are likely more reliable.

There are numerous factors that could contribute to both positive and negative biases in estimating fatality rates (Erickson 2006). The design of this study incorporated several assumptions or factors that may affect the results of the fatality estimates. It was assumed that all carcasses found during this study were due to collision with wind turbines; however, the true cause of death is unknown for most of the bird fatalities. It is possible that some of the bird fatalities were caused by predators, and some of the casualties included in the data pool were potentially due to natural causes (background mortality). In contrast, it is unlikely that any of the bat fatalities were due to factors not related to interactions with wind turbines.

There are some other potential negative biases. For example, no adjustments were made for fatalities possibly occurring outside of the square plot boundaries, which were established a minimum distance of 80 m from the turbines. The search plot distance for this study was selected based on results of other studies (Higgins et al. 1996; Johnson et al. 2002, 2003a, 2004; Erickson et al. 2004; Young et al. 2003b, 2005; Kerlinger et al. 2007) in which a distance equal to the approximate height of the turbine hub appeared to capture the vast majority of fatalities. Based on the distribution of fatalities as a function of distance from turbines (Figures 8 and 12), a small percentage of bird and bat fatalities possibly fell outside the search plots and may have been missed. This factor would lead to an underestimate of fatality rates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials in terms of whether or not they are representative of actual turbine fatalities. If the types of birds used are larger or smaller than turbine fatalities, or more or less

cryptic in color than actual fatalities, then the potential for biased estimates increases. House sparrows, northern bobwhites, ring-necked pheasants, and mallards were used to represent the range of bird fatalities expected. It is believed that this range of species and sizes of birds captured the range of sizes and other characteristics of actual fatalities and should result in reasonable estimates of scavenging rates and searcher efficiency for birds as a group. Because we used fresh bat carcasses found during the study for searcher efficiency and scavenger removal studies, no biases should be associated with these data for the species most commonly found (eastern red, hoary and silver-haired bats). However, because *Myotis* bats are smaller and more cryptically colored than the tree bats, searcher efficiency rates may be lower than estimated for *Myotis* bats, although bats in this genus comprised only a minor amount (3.2%) of the fatalities.

Concern has also been raised regarding how the number of carcasses placed in the field for carcass removal trials on a given day could lead to biased estimates of scavenging rates. Hypothetically, this would lead to underestimating true scavenging rates if the scavenger densities are low enough such that scavenging rates for the placed carcasses are lower than for actual fatalities. The logic is that if the trials are based on too many carcasses on a given day, scavengers are unable to access all trial carcasses, whereas they could access all wind turbine collisions. If this is the case, and the trial carcass density is much greater than actual turbine casualty density, the trials would underestimate scavenging rates compared to scavenging rates of actual fatalities. In this study, 82 carcasses were placed for scavenger trials during the study period and we believe this was not a high enough density to create a significant bias.

Bird Fatalities

The estimated overall bird fatality rate of 2.83 birds/MW is below average compared to other wind-energy facilities in the Midwest (Figure 15). The range of overall bird fatality estimates for 48 studies at wind-energy facilities across North America ranged from no fatalities to 13.93 birds/MW/year. Compared to these other facilities, the FRWEF-I ranked 17th (Figure 15). Overall bird fatality estimates at seven Midwest wind-energy facilities located in Nebraska, Wisconsin, Minnesota, Iowa, and Illinois (BHE Environmental, Inc. 2010, Derby et al. 2007; Gruver et al. 2009; Howe et al. 2002; Johnson et al. 2000, 2002; Jain 2005; Kerlinger et al. 2007) have ranged from 0.6 to 7.2, and averaged 4.28 birds/MW/year (Figure 15).

The FRWEF-I is near an area designated as an Important Bird Area (IBA) due to high concentrations of staging American golden plovers (*Pluvialis dominica*) during spring migration. Although concerns have been raised over the potential for collision mortality, no American golden plover fatalities were found during this study. No species of birds found as fatalities at the FRWEF-I are state or federally listed species, and all are relatively common birds in Indiana. Based on the relatively small estimate of per-turbine avian mortality at the FRWEF-I, and the fact that this mortality occurred throughout the year and did not disproportionately affect any one species, it is unlikely that operation of this facility will result in any significant impacts to bird populations, as has been the case at other operating wind-energy facilities in North America (Johnson and Stephens 2010).

Bat Fatalities

The estimated bat fatality rate at FRWEF-I of 8.09 bats/MW/year would be considered moderate when compared to other wind-energy facilities in North America (Figure 16), and is somewhat

below average based on the regional average for reported bat fatality estimates at wind-energy facilities in the Midwest. Bat fatality estimates from 48 studies at other wind-energy facilities across North America ranged from none to 39.7 fatalities/MW/year. Compared to these other facilities, the FRWEF-I ranked 16th (Figure 16). At seven other wind-energy facilities in the Midwest (BHE Environmental Inc. 2010, Derby et al. 2007; Gruver et al. 2009; Howe et al. 2002; Johnson et al. 2003, 2004; Jain 2005; Kerlinger et al. 2007), bat fatality estimates ranged from 0.8 to 30.6, and averaged 9.8 fatalities/MW/year (Figure 16). With the exception of two facilities in Wisconsin (both of which were also located in a corn and soybean agroecosystem), where estimated bat mortality was 24.6/MW/year (Gruver et al. 2009) and 30.6/MW/year (BHE Environmental, Inc. 2010), the highest fatality estimates for bats have come from the eastern US, particularly the Appalachian region where estimates have ranged from 15.7 to 39.7 bats/MW/year (Arnett et al. 2008).

Six of the seven fatality monitoring studies from the Midwest were conducted primarily in a matrix of corn and soybeans, similar to conditions at the FRWEF-I. However, only BHE Environmental Inc. (2010), Jain (2005) and Gruver et al. (2009) attempted to maintain a portion of the search plots in a low- or no-vegetative condition as we did in this study. During the growing season, searching in un-mowed crop fields becomes progressively more physically difficult, and progressively less effective from a searcher efficiency standpoint. Thus the most ready comparison of results from the FRWEF-I, based on similarity of methods and habitat, is to the Top of Iowa wind-energy facility in north-central Iowa (Jain 2005), the Blue Sky Greenfield facility in Wisconsin (Gruver et al. 2009), and the Cedar Ridge wind project in Wisconsin (BHE Environmental, Inc. 2010). Interestingly, Jain (2005), Gruver et al. (2009), BHE Environmental, Inc. (2010) and this study reported higher numbers of fatalities than any of the other studies conducted in the Midwest that did not clear crops for searching.

Pre-construction ground-based bat acoustical surveys were conducted at the Fowler Ridge Wind Resource Area from August 15 – October 19, 2007 (Gruver et al. 2007) and from July 17 – October 15, 2008 (Carder et al. 2009), time periods that cover the time frame during which most bat mortality at wind energy facilities occurs throughout North America. Overall bat detections were low to moderate for sites in the Midwest, ranging from 4.7 bat calls/detector night in 2007 to 6.45 bat calls/detector night in 2008. Although only 3.2% of the bat casualties found at the FRWEF-I in 2009 were high-frequency species (i.e., *Myotis* spp.), high-frequency bats comprised 49.0% of bat calls in 2007 and 34.2% of bat calls recorded in 2008, suggesting that high frequency species such as *Myotis* bats may be much less susceptible to turbine collisions.

Landscape and habitat context have both been proposed as hypotheses to explain bat fatalities at wind-energy facilities. For example, in the eastern US, clearings cut into the forested ridges on which some wind-energy facilities are built are thought to contribute to the relatively high numbers of bat fatalities at these sites, as clearings create potential foraging habitat, and ridges may serve as attractive linear features during foraging, commuting, or migration (Kunz et al. 2007). None of those features are present at the FRWEF-I. However, the relatively large numbers of bat fatalities reported in Wisconsin (BHE Environmental, Inc. 2010, Gruver et al. 2009), Iowa (Jain 2005), and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality.

Species composition of bat fatalities at the FRWEF-I was similar to that at most other wind-energy facilities, in that the majority (94.2%) of bat fatalities was composed of three migratory tree bat species, namely the hoary, eastern red, and silver-haired bat. These three species typically compose over 75% of bat fatalities at wind-energy facilities throughout North America (Johnson 2005, Arnett et al. 2008). Based on the timing of fatalities for these three species and the lack of forest cover that might provide summer habitat for bats, most of the fatalities were apparently migrants through the FRWEF-I, as is the case at virtually all other wind-energy facilities in North America (Johnson 2005, Arnett et al. 2008). Although it is known that most bat mortality occurs during fall migration, it is not known if migrating bats are particularly susceptible, or if other aspects of their behavior, such as mating or feeding behavior, change during the fall and therefore make bats more susceptible to turbine collisions whether they are migrating or not (Cryan and Barclay 2009).

It seems unlikely that the FRWEF-I is located along a concentrated tree bat migration route, as there are no topographical features or large expanses of forested areas that would tend to concentrate migrating bats. However, for hibernating bats, such as *Myotis* spp., migration routes between summer areas and hibernacula may be present regardless of the habitat and topography. This study was not designed to address that question, and obtaining information on migratory routes by bats (assuming they exist) has proven to be very difficult to date (Arnett et al. 2008). However, Baerwald and Barclay (2009) monitored bat activity in the fall at seven proposed or existing wind-energy facilities across southern Alberta and found that activity of migratory bats varied among the sites, suggesting that migrating bats may concentrate along certain routes rather than migrate in a dispersed fashion across a broad area.

Because migratory tree bats are primarily solitary tree dwellers that do not hibernate, it has not been possible to develop any suitable field methods to estimate their population sizes. As a result, impacts on these bat species caused by wind energy development cannot be put into perspective from a population impact standpoint. To help solve this problem, population genetic analyses of DNA sequence and microsatellite data are being conducted to provide effective population size estimates, to determine if populations are growing or declining, and to see if these populations are comprised of one large population or several discrete subpopulations that use spatially segregated migration routes (Dr. Amy L. Russell, Assistant Professor, Grand Valley State University, Allendale, Michigan, pers. comm.). To date, initial analyses have been conducted only for eastern red bat using mitochondrial DNA. Based on these analyses, it appears that this species fits a model of a single, very large population with a history of strong population growth (Vonhof and Russell in prep). The data do not suggest there are multiple populations separated by distinct migratory corridors. Although the point estimate for the eastern red bat population size in North America is 3.3 million, according to Dr. Russell (pers. comm.), the true population size is likely “millions to tens of millions” in size.

Additional research will be required to determine what impact wind-energy facilities have on migratory tree bat populations. Specifically, population size estimates similar to those available for eastern red bat need to be determined for hoary bat and silver-haired bat.

The discovery of an Indiana bat turbine casualty at a wind-energy facility located in a corn and soybean agroecosystem was unexpected. To our knowledge, this is the first Indiana bat turbine

collision related casualty documented in North America, as well as the first documented casualty of a federally-listed bat species. As recommended by the USFWS draft interim guidelines for wind-energy development (USFWS 2003), the FRWEF-I was sited in a highly altered landscape, as tilled agriculture composes 93% of the study area. BPWENA commissioned a Site Characterization Study (SCS) to characterize environmental issues associated with construction of a wind-energy facility within the Fowler Ridge Wind Resource Area (FRWRA; Johnson and Poulton 2007). The SCS addressed the potential for impacts to Indiana bat based on literature and database searches, contacts with the Indiana Department of Natural Resources (IDNR) and the USFWS, habitat mapping, and a site visit. At the time the SCS was prepared in 2007, there were no records of Indiana bat in Benton County. Therefore, the casualty found during this study is likely the first documented occurrence of Indiana bat in Benton County. Based on the lack of forest cover in and surrounding the project area (<1%), and evidence that Indiana bat breeding records in Indiana occur primarily in the southern half of the state (Mumford and Whitaker 1982), the SCS concluded that the Indiana bat is not likely to occur within the FRWRA during the summer. In addition, there are no known Indiana bat hibernacula near the project area; the closest is in Greene County, Indiana, approximately 100 miles (161 km) south of the FRWEF-I. The SCS also concluded that even if resident Indiana bats were to occur in the region, the risk of turbine collisions was considered low because: 1) foraging Indiana bats select for forested habitats and riparian areas and against agricultural and grassland habitats in relation to habitat availability (Menzel et al. 2005); 2) in Indiana, Indiana bats forage primarily along wooded riparian areas and forest edges, with no foraging being documented in open pastures, cornfields, upland hedgerows, or along creeks where trees had been removed (Humphrey et al. 1977); and 3) foraging by Indiana bats was confined to air space from 2 to 30 m (6 to 98 ft) high (Humphrey et al. 1977), which is below the rotor-swept area of modern wind turbines proposed for the project. The USFWS conducted a desktop review of aerial photographs, topographic maps, and other information, and also concluded that there does not appear to be much suitable summer bat habitat within the project area (letter dated October 13, 2006 to Ms. Victoria Poulton, WEST, Inc., from Michael Litwin, USFWS).

Although the SCS concluded that impacts to summer populations of Indiana bats were not likely, the SCS did state that because the FRWRA is within the range of Indiana bat, some potential existed for Indiana bats to migrate through the proposed wind resource area between summer ranges and winter hibernacula. The SCS further stated that any wind-energy facility located in the 25 US states within the potential range of the Indiana bat had some potential for collisions of migrating Indiana bats. Based on the lack of summer habitat at or near the FRWEF-I, and the time frame that the Indiana bat casualty occurred (September 09, 2009), this individual was likely a migrant through the area.

To date there have been fewer than 10 studies conducted to estimate bird and bat fatalities from wind turbine operations in the Midwest, and studies at the Fowler Ridge Wind Energy Facility represent the first such studies in Indiana. Results of this study further contribute to our understanding of wind-energy impacts to birds and bats. As more wind-energy facilities are built in the region, and additional studies become available, a clearer picture of the impacts to birds and bats will emerge.

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Table 1. Landcover classification at the Fowler Ridge I Wind-Energy Facility in Benton County, Indiana (from Homer et al. 2004).

Land Cover	Acres	% Composition
Open Water	15.77	0.1
Developed, Open Space	648.33	2.2
Developed, Low Intensity	967.62	3.3
Developed, Medium Intensity	36.68	0.1
Developed, High Intensity	14.81	0.1
Barren	10.02	<0.1
Deciduous Forest	118.09	0.4
Grassland	14.79	0.1
Pasture/Hay	494.40	1.7
Crops	26,692.40	92.90
Woody Wetlands	1.23	<0.1
Total	**29,014.15**	**100**

Table 2. Total number of bird and bat casualties and the composition of casualties discovered at the Fowler Ridge I Wind-Energy Facility from April 6 – October 30, 2009.

	Scheduled Searches		Total	
Species	**Total**	**% Composition**	**Total**	**% Composition**
Birds				
killdeer	4	16.7	4	14.3
tree swallow	3	12.5	3	10.7
unidentified large bird	3	12.5	3	10.7
red-tailed hawk	0	0.0	3	10.7
Tennessee warbler	2	8.3	2	7.1
unidentified duck	2	8.3	2	7.1
blue-winged teal	1	4.2	1	3.6
brown-headed cowbird	1	4.2	1	3.6
green-winged teal	1	4.2	1	3.6
horned lark	1	4.2	1	3.6
house wren	1	4.2	1	3.6
mourning dove	1	4.2	1	3.6
red-eyed vireo	1	4.2	1	3.6
unidentified bird	1	4.2	1	3.6
unidentified passerine	1	4.2	1	3.6
yellow-rumped warbler	1	4.2	1	3.6
American robin	0	0.0	1	3.6
Overall	**24**	**100**	**28**	**100**
Bats				
eastern red bat	43	40.2	56	35.9
silver-haired bat	30	28.0	42	26.9
hoary bat	29	27.1	48	30.8
big brown bat	2	1.9	4	2.6
little brown bat	2	1.9	3	1.9
northern long-eared bat	1	0.9	1	0.6
Indiana bat	0	0.0	1	0.6
unid. *Lasiurus* bat	0	0.0	1	0.6
Overall	**107**	**100**	**156**	**100**

Table 3. Distribution of distances of bird and bat casualties from turbines at the Fowler Ridge I Wind-Energy Facility.

Distance to Turbine (m)	% Bird Casualties	% Bat Casualties
0 – 10	7.1	29.4
11 – 20	7.1	24.2
21 – 30	21.4	19.6
31 – 40	7.1	15.0
41 – 50	10.7	3.9
51 – 60	10.7	3.9
>60	35.7	3.9

Table 4. Searcher efficiency results at the Fowler Ridge I Wind-Energy Facility as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Large Birds	4/30/2009	4	2	1	50.0
	5/27/2009	4	4	4	100.0
	6/26/2009	4	4	3	75.0
	7/21/2009	4	4	1	25.0
	8/4/2009	1	0	0	0
	Overall	**17**	**14**	**9**	**64.3**
Small Birds	4/30/2009	4	2	2	100.0
	5/27/2009	4	4	1	25.0
	7/21/2009	4	2	0	0
	Overall	**12**	**8**	**3**	**37.5**
Bats	6/26/2009	4	2	1	50.0
	8/4/2009	7	4	3	75.0
	8/25/2009	7	5	1	20.0
	9/8/2009	8	7	3	42.9
	9/14/2009	8	7	2	28.6
	9/28/2009	10	10	8	80.0
	10/6/2009	8	7	5	71.4
	10/19/2009	8	8	5	62.5
	Overall	**60**	**50**	**28**	**56.0**

Table 5. Estimated time since death of bird and bat carcasses for weekly and bi-weekly search schedules.

Species	Estimated Time	% Found During Bi-Weekly Searches	% Found During Weekly Searches
Birds	last night	0	5.9
	2-3 days	12.5	35.3
	4-7 days	50.0	17.6
	7-14 days	0	5.9
	>2 weeks	0	0
	> month	0	29.4
	unknown	37.5	5.9
Bats	last night	35.7	37.0
	2-3 days	41.1	29.6
	4-7 days	19.6	25.9
	7-14 days	1.8	1.9
	>2 weeks	0	1.85
	> month	0	0
	unknown	1.8	3.7

Table 6. Bird and bat average probability of carcass availability and detection and overall bird and bat mortality estimates for the Fowler Ridge I Wind-Energy Facility.

Size	Avg. Probability of Carcass Availability and Detection with 90% Confidence Interval
Small Birds	0.51 (0.21 – 0.71)
Large Birds	0.62 (0.42 – 0.79)
Bats	0.56 (0.45 – 0.66)
Species	**Fatalities/turbines/study period**
All Birds	5.26 (3.52 – 10.25)
Bats	15.03 (10.89 – 20.52)

Table 7. Average number of bird and bat carcasses found at turbines lit with FAA aviation strobe lights compared to those at unlit turbines at the Fowler Ridge I Wind-Energy Facility.

Species		Lit Turbines	Unlit Turbines	Overall
Birds	# of Turbines	7	18	25
	# of Fatalities	4	21	25
	Mean # of Fatalities	0.57	1.17	n/a
	Difference of Means	-0.60		n/a
	Confidence Interval	-1.65 – 0.46		n/a
Bats	# of Turbines	7	18	25
	# of Fatalities	39	73	112
	Mean # of Fatalities	5.57	4.06	n/a
	Difference of Means	1.52		n/a
	Confidence Interval	-1.77 – 4.80		n/a

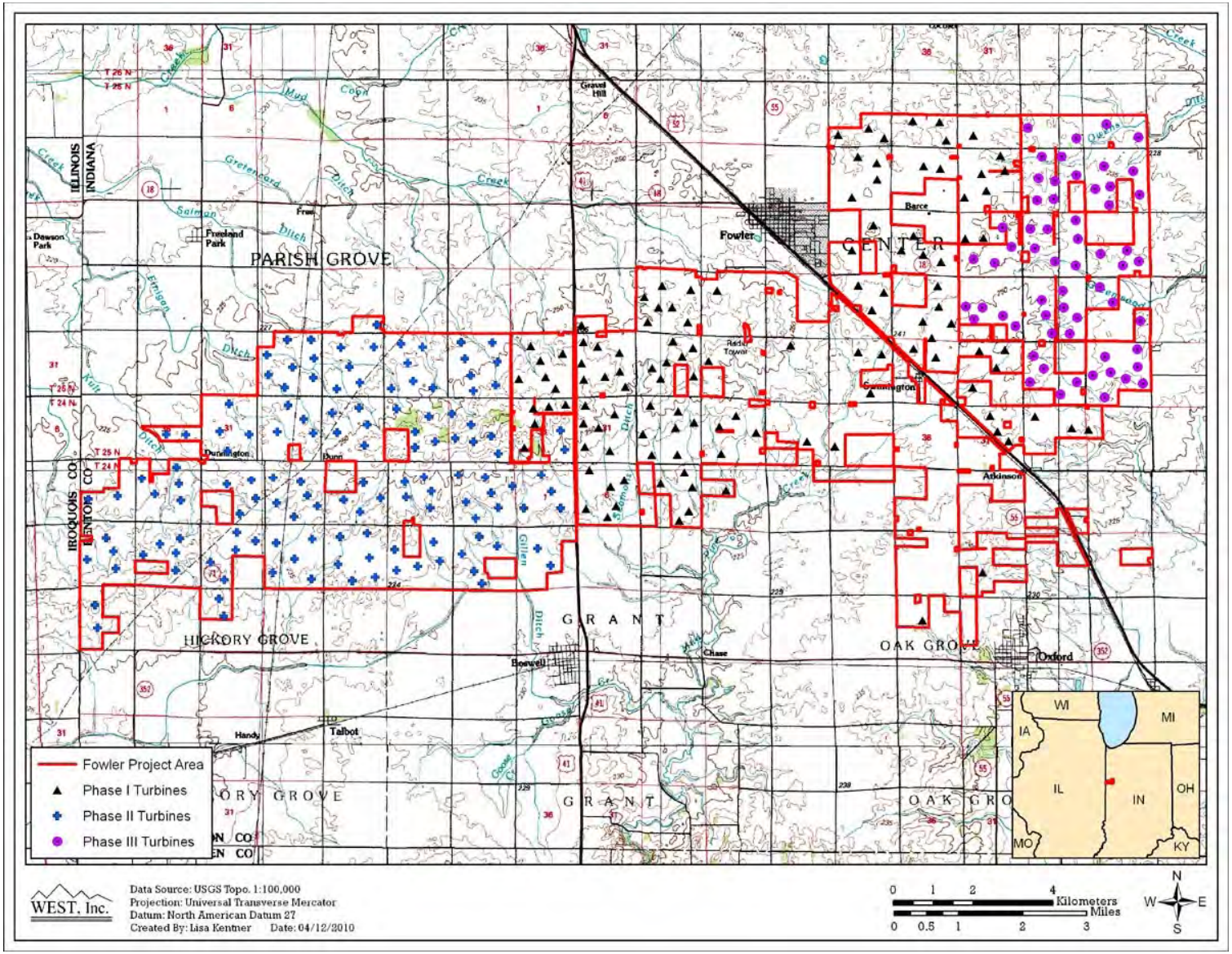

Figure 1. Location of the Fowler Ridge Wind-Energy Facility in Benton County, Indiana.

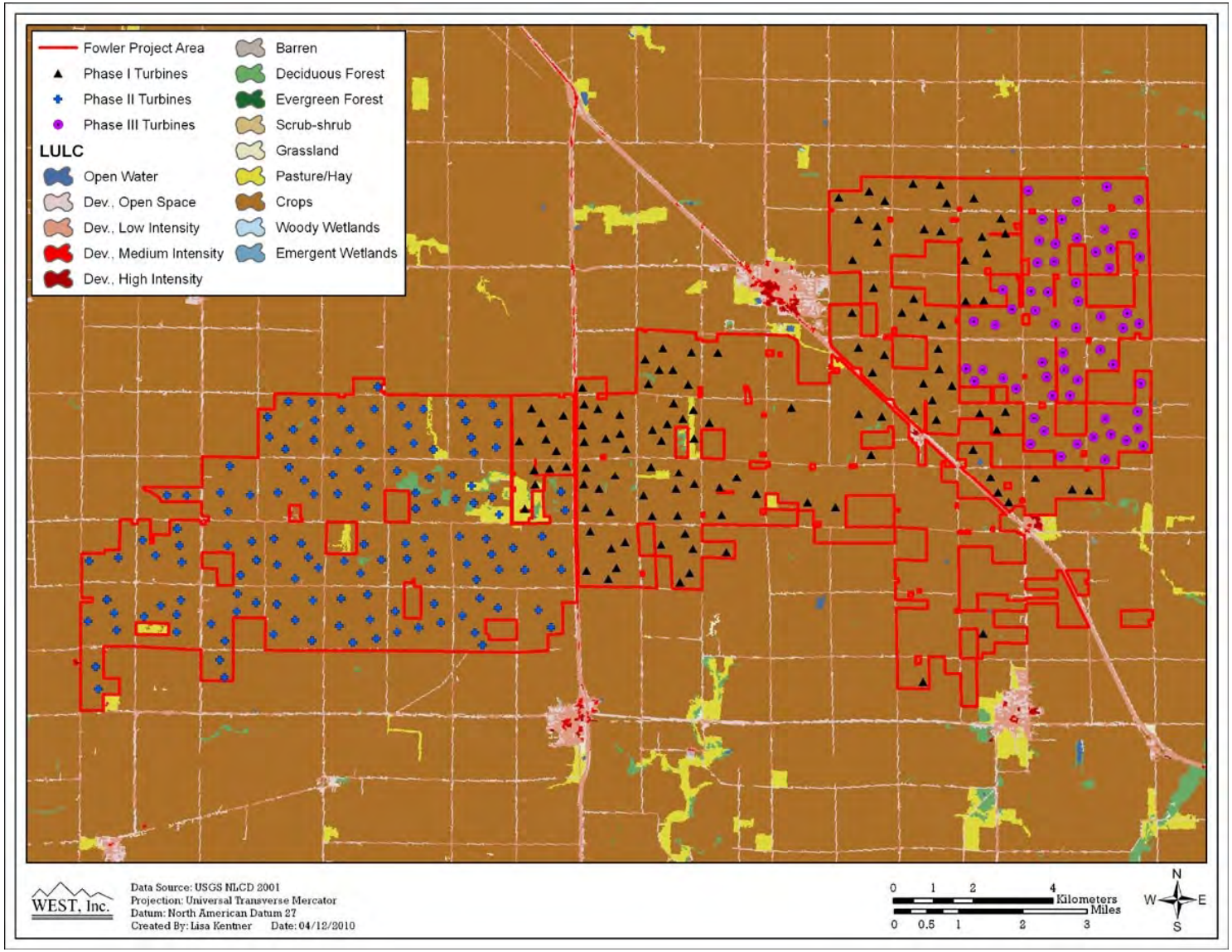

Figure 2. Landcover types at the Fowler Ridge I Wind-Energy Facility.

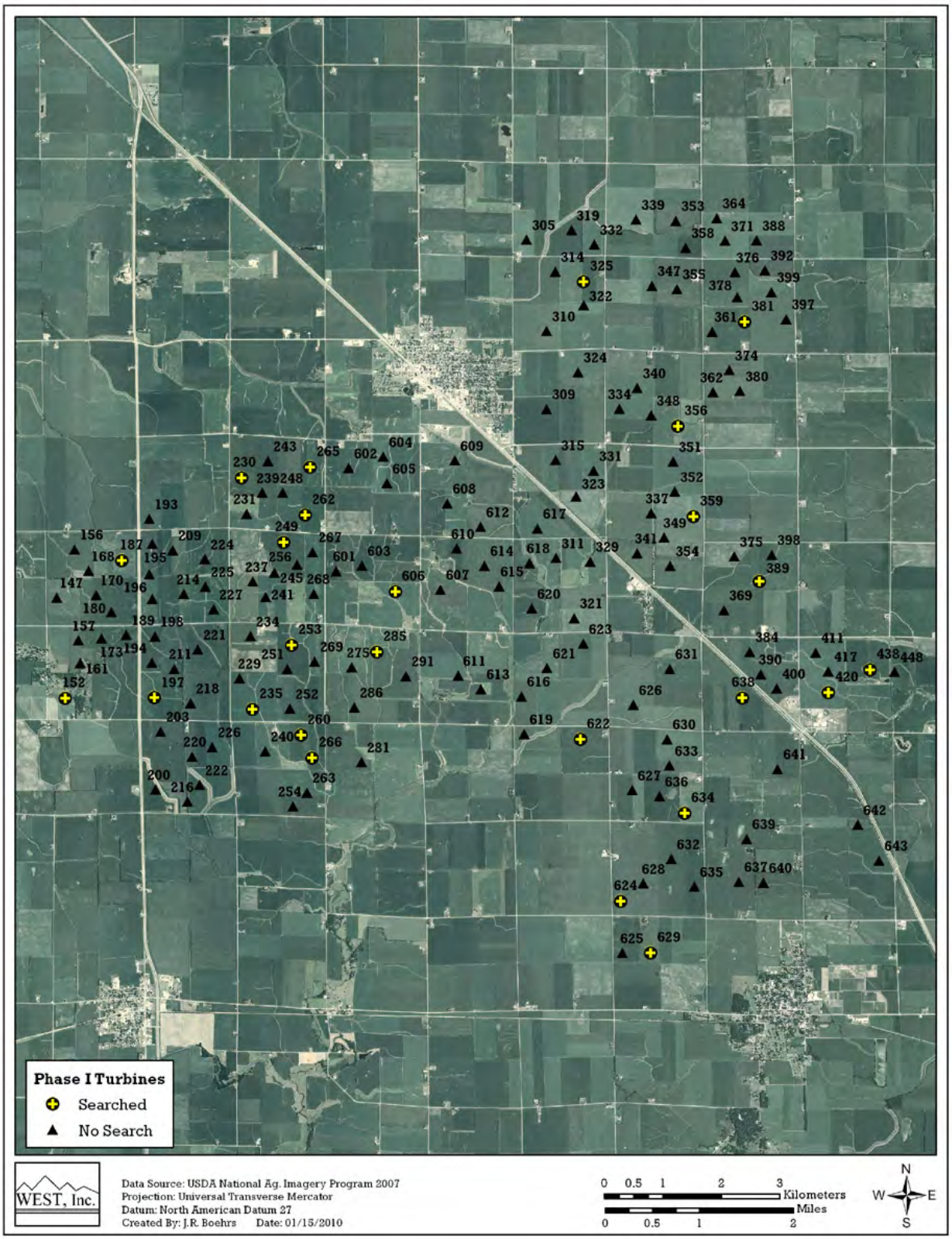

Figure 3. Location of carcass search plots at the Fowler Ridge I Wind-Energy Facility.

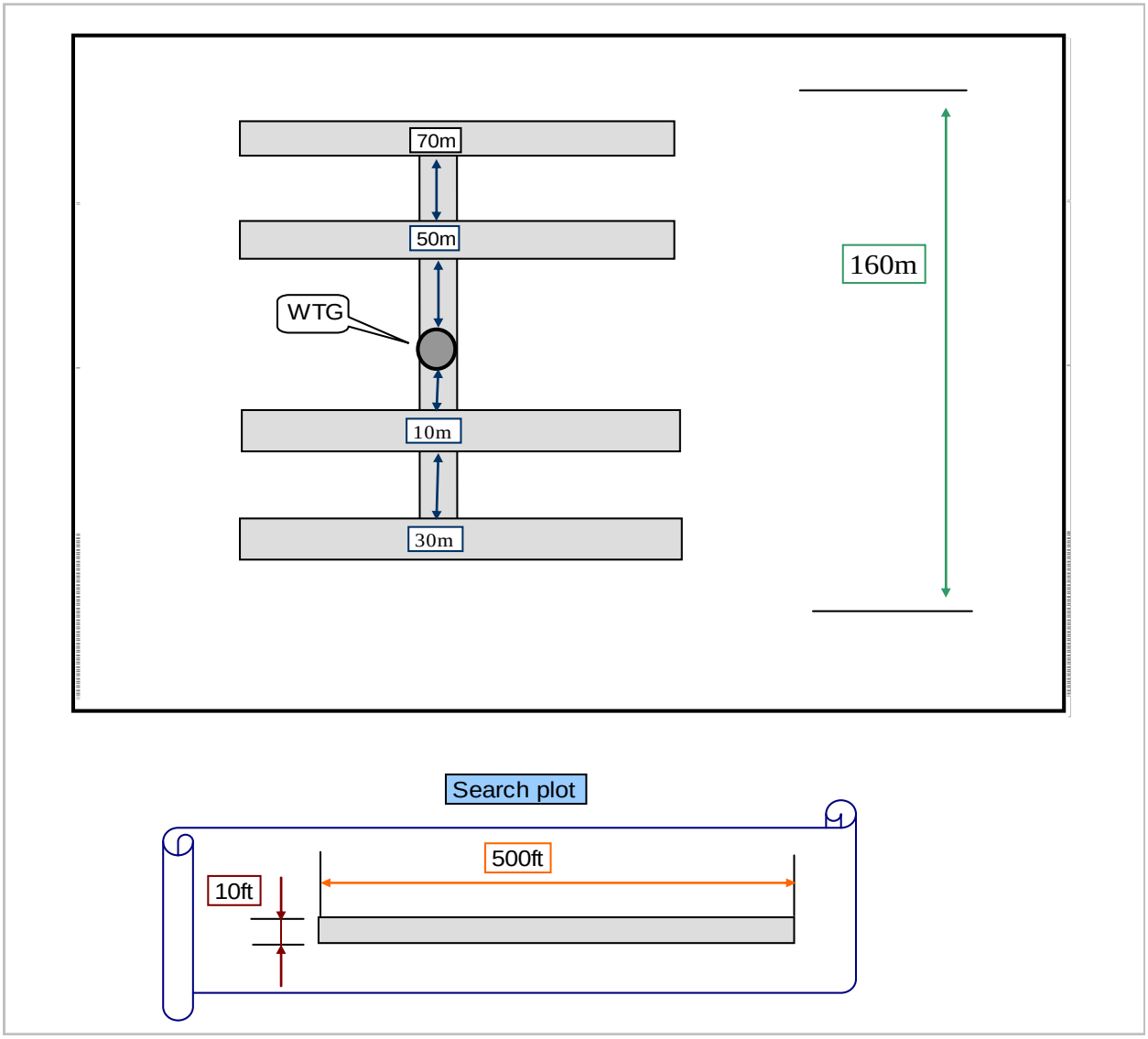

Figure 4. Example layout of carcass search transects.

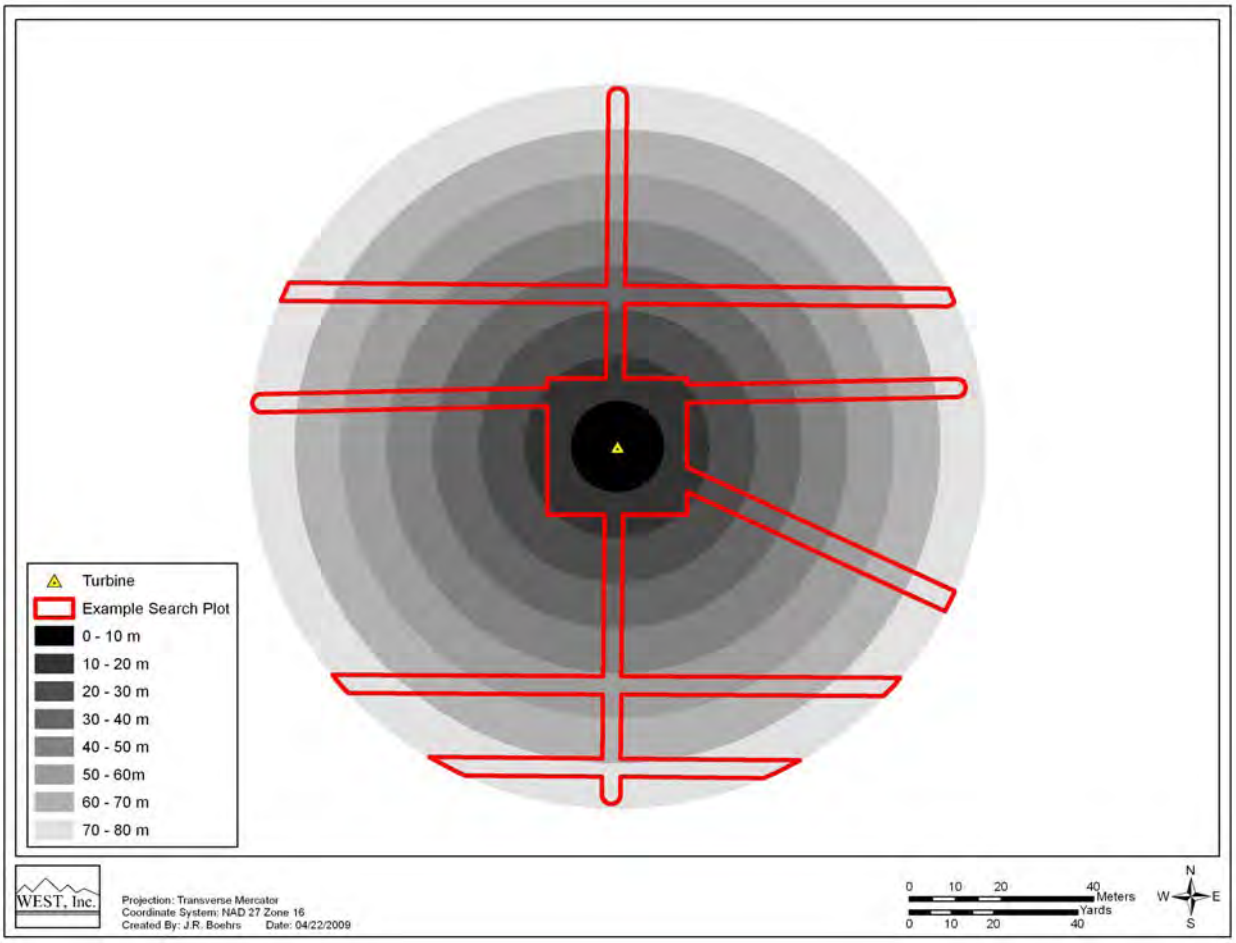

Figure 5. Illustration of proportion of each plot searched at varying distances from the turbine at the Fowler Ridge I Wind-Energy Facility.

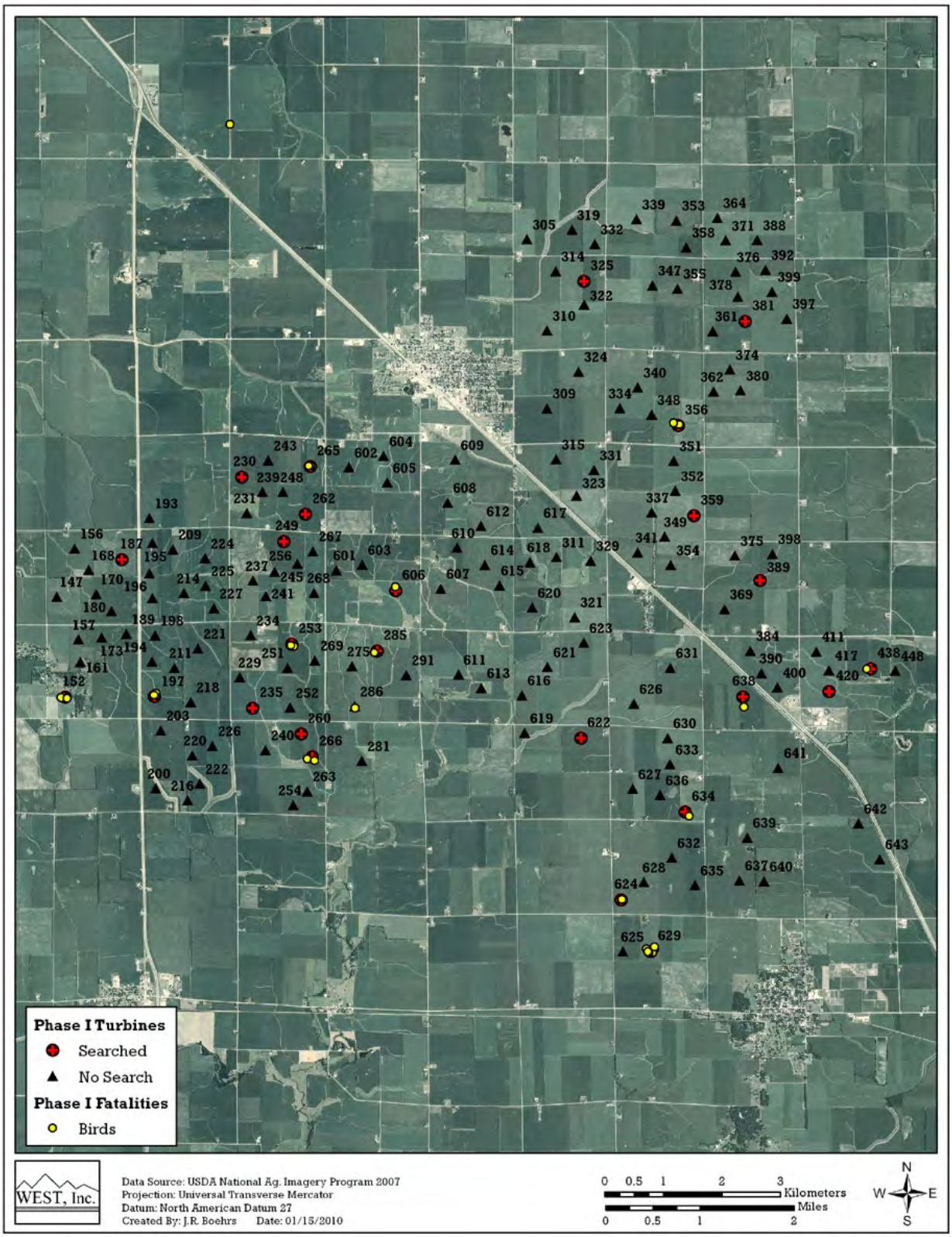

Figure 6. Location of bird casualties found at the Fowler Ridge I Wind-Energy Facility.

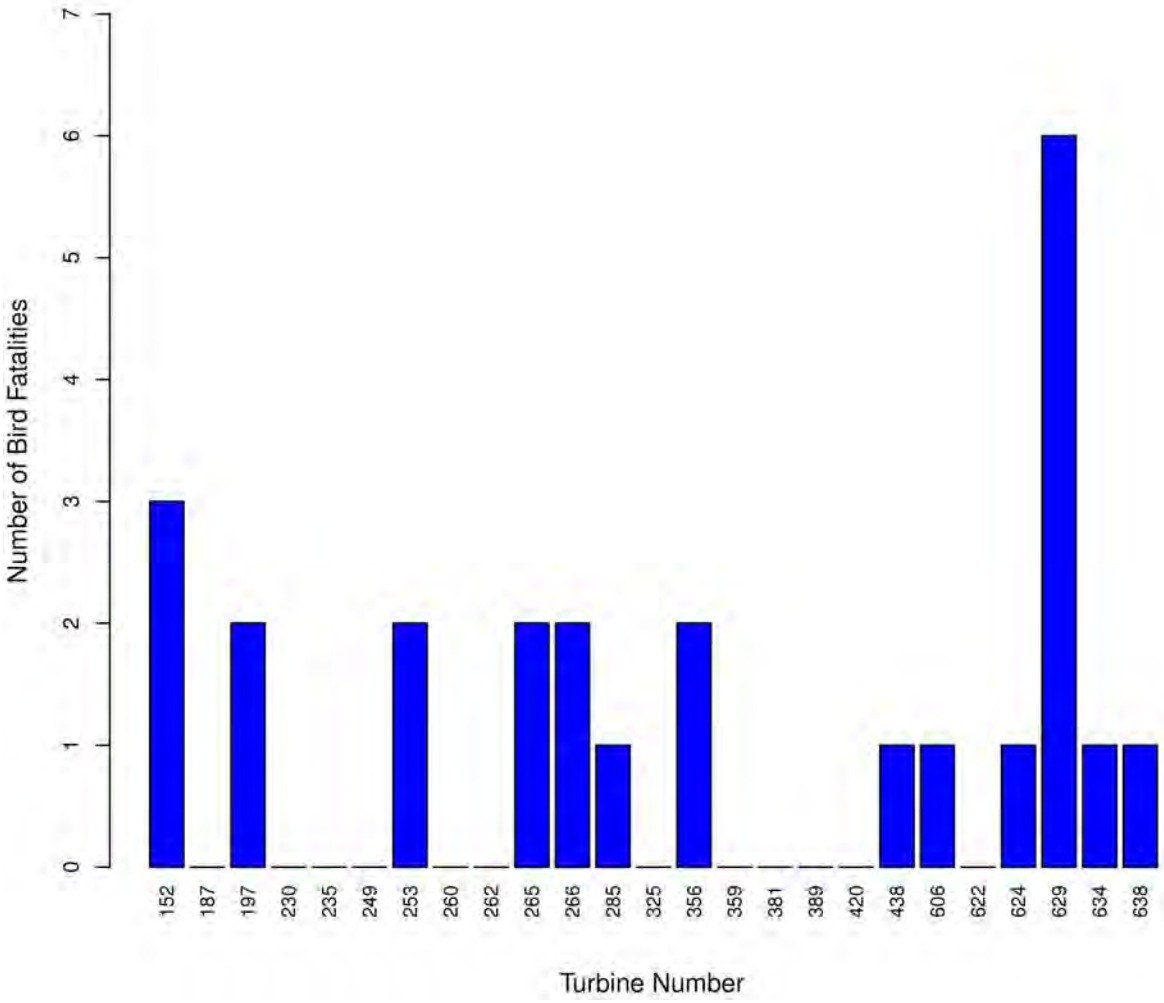

Figure 7. Number of bird fatalities by turbine at the Fowler Ridge I Wind-Energy Facility.

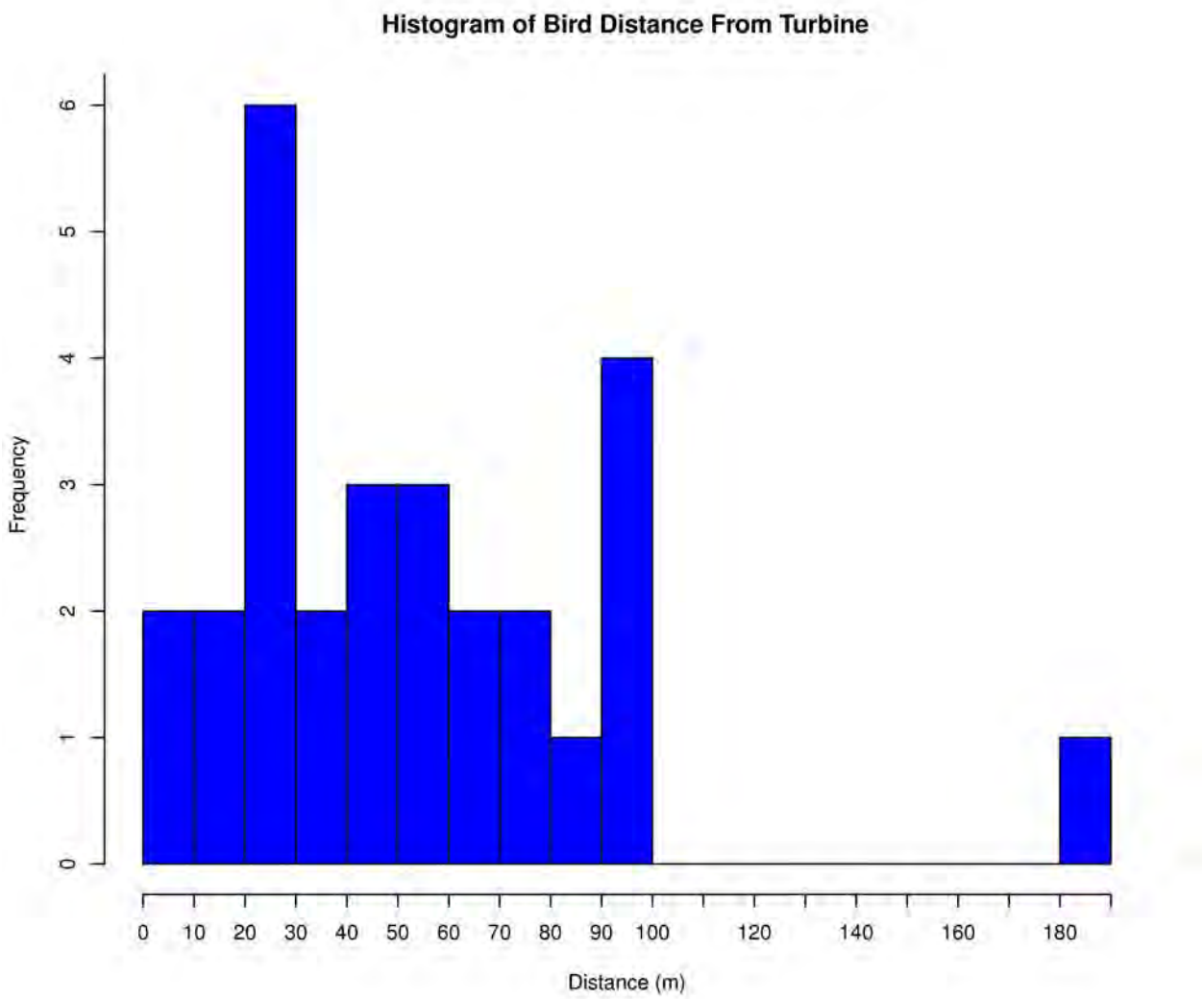

Figure 8. Distance of bird fatalities from the turbine at the Fowler Ridge I Wind-Energy Facility.

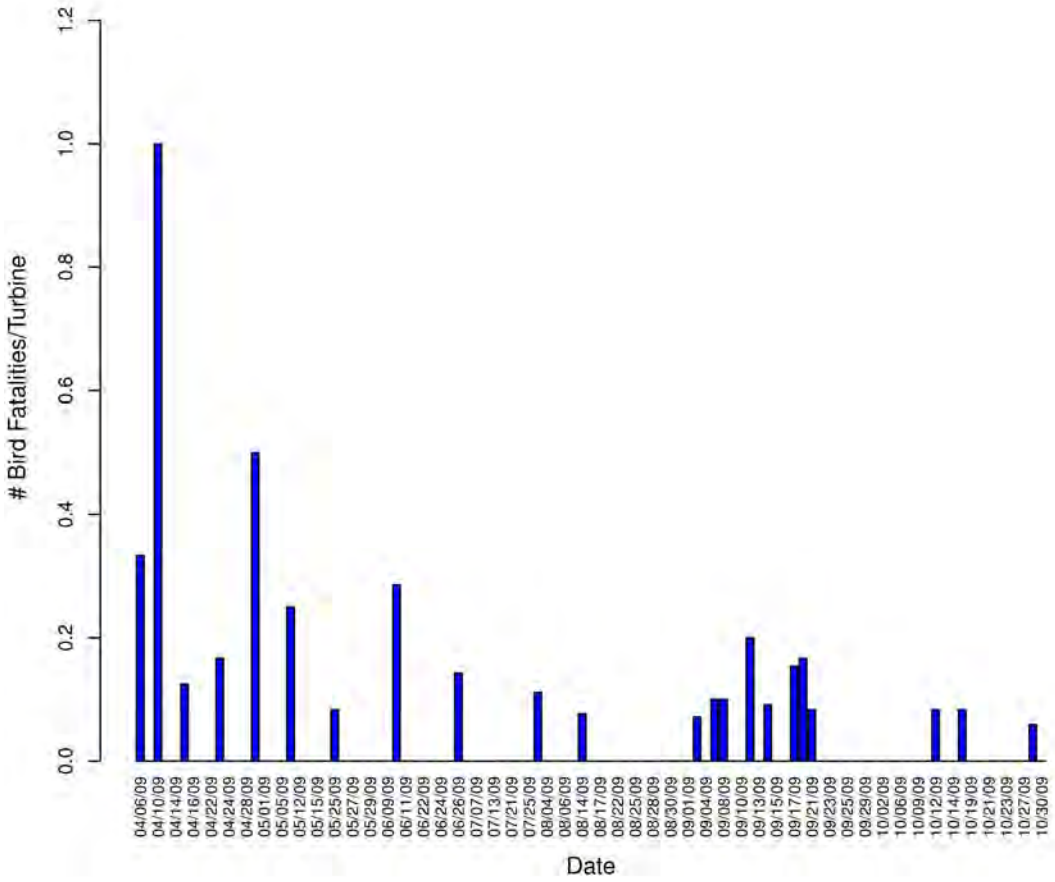

Figure 9. Timing of bird fatalities by turbine at the Fowler Ridge I Wind-Energy Facility.

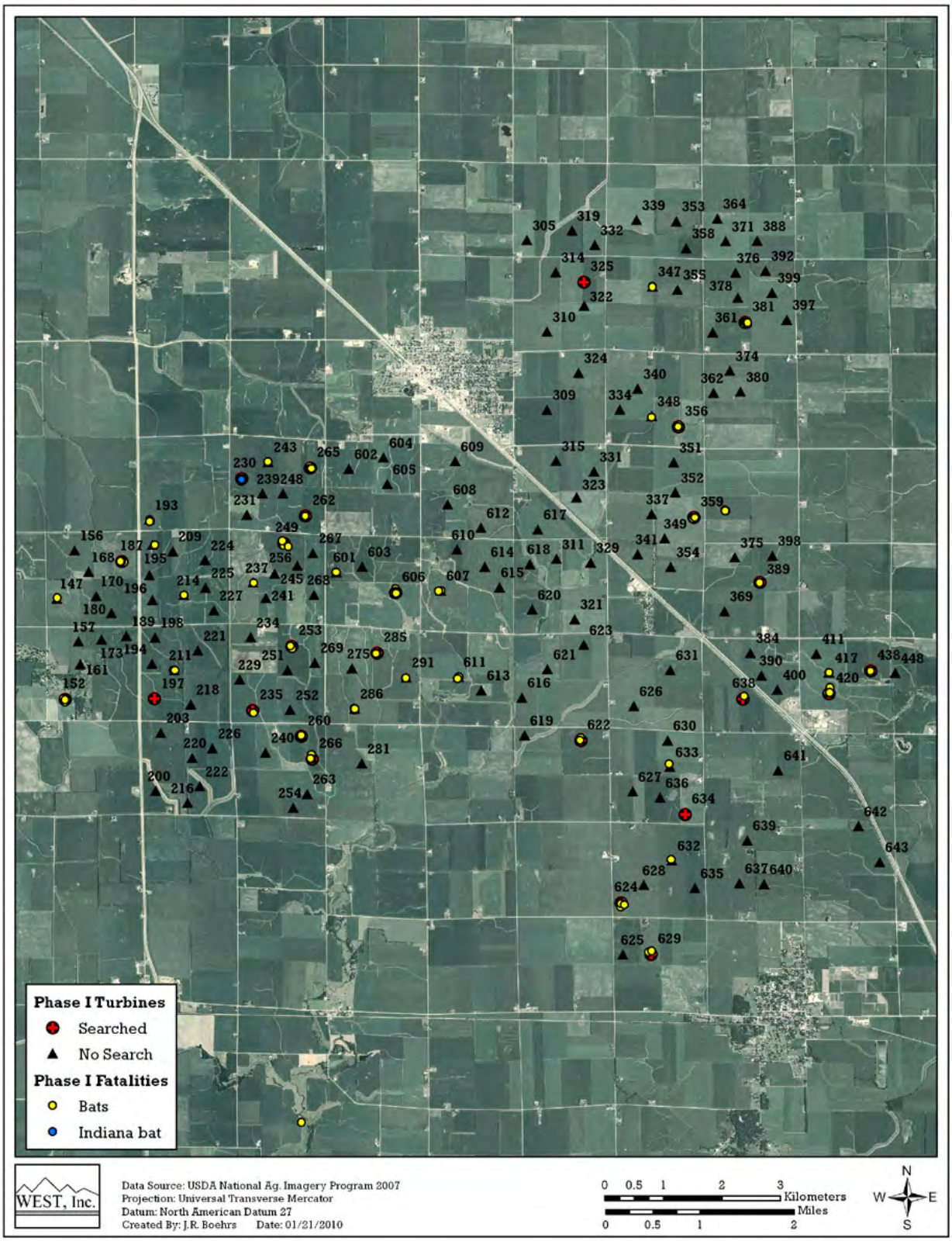

Figure 10. Location of bat casualties found at the Fowler Ridge I Wind-Energy Facility.

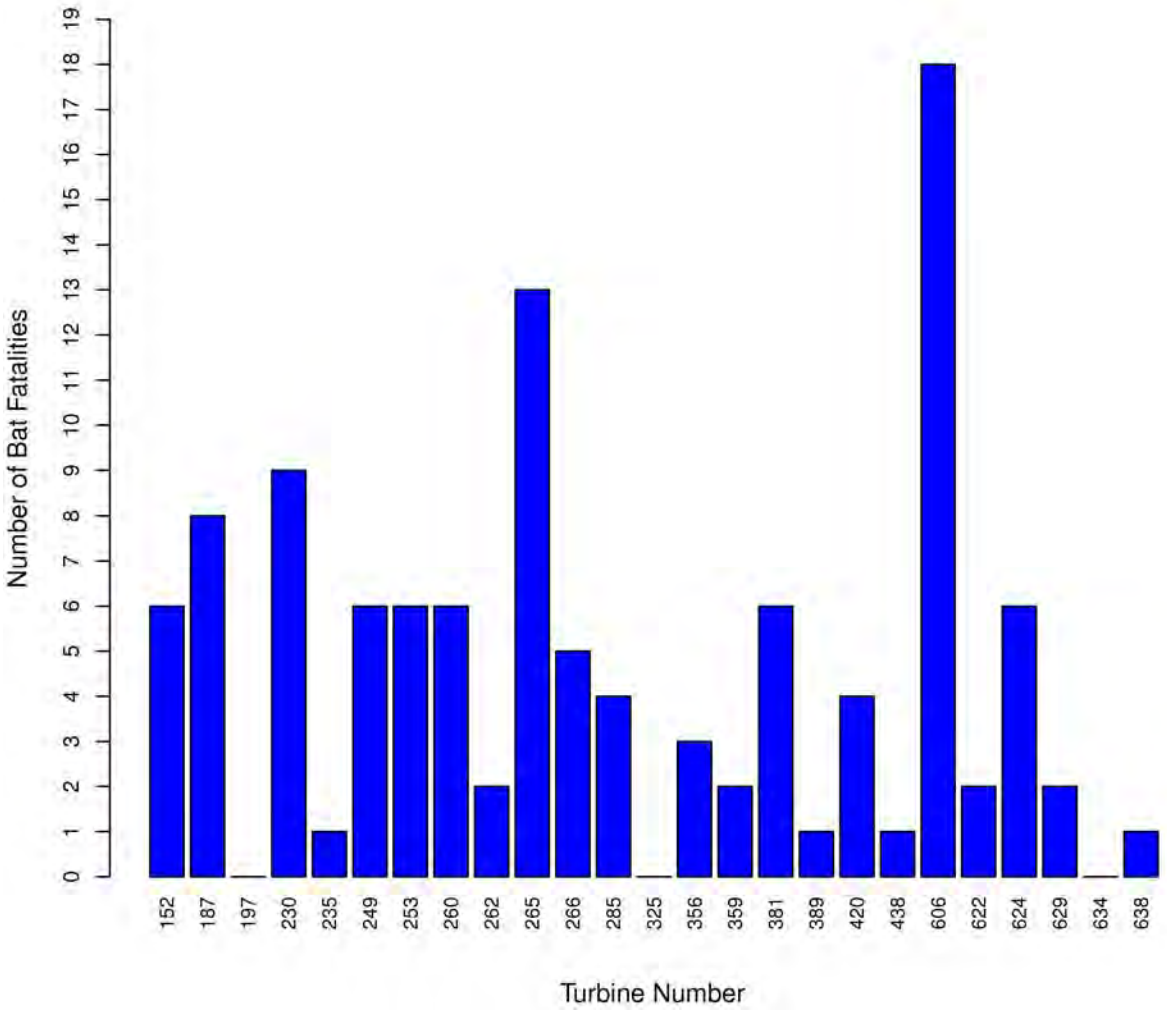

Figure 11. Number of bat fatalities by turbine at the Fowler Ridge I Wind-Energy Facility.

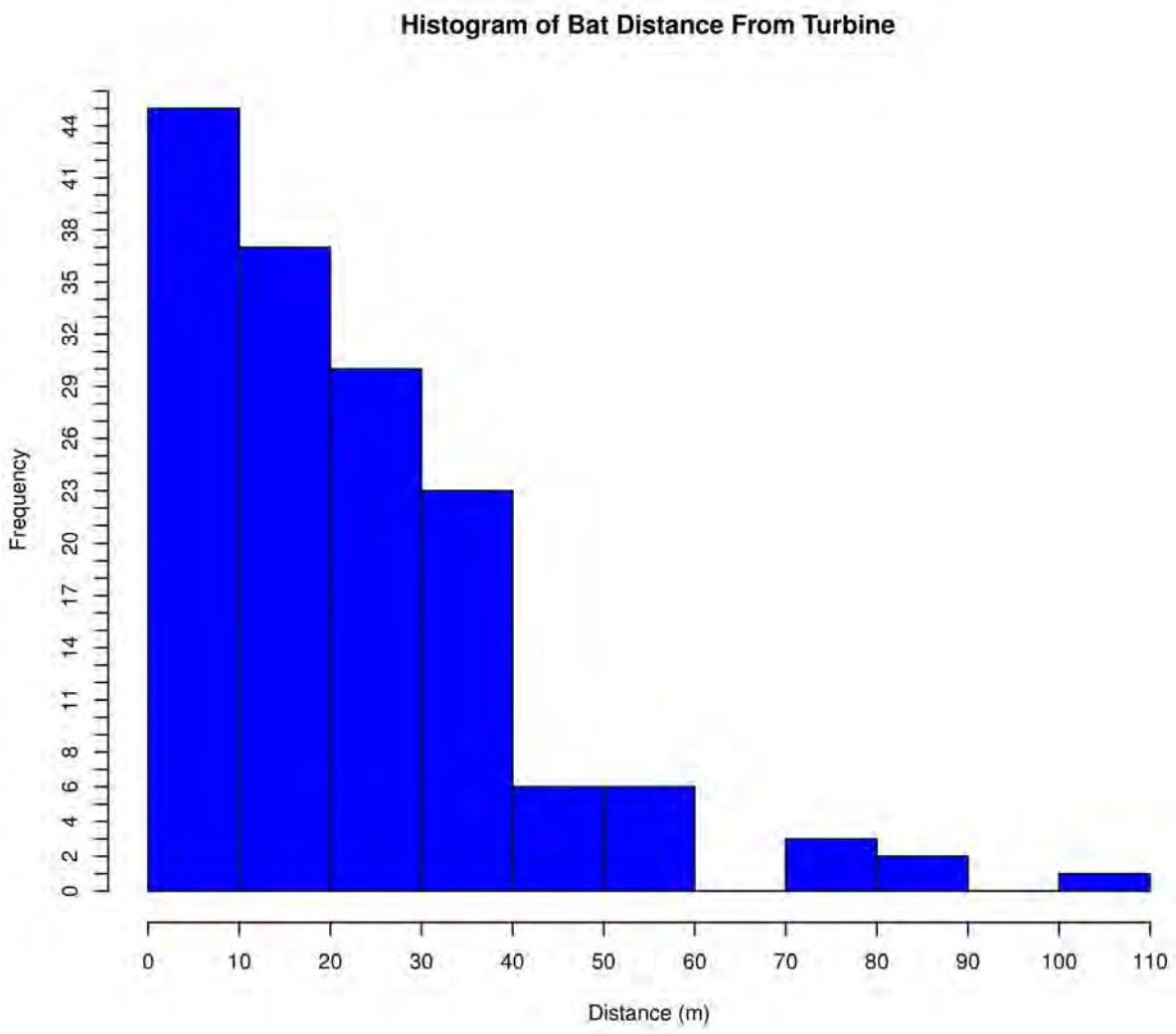

Figure 12. Distance of bat fatalities from the turbine at the Fowler Ridge I Wind-Energy Facility.

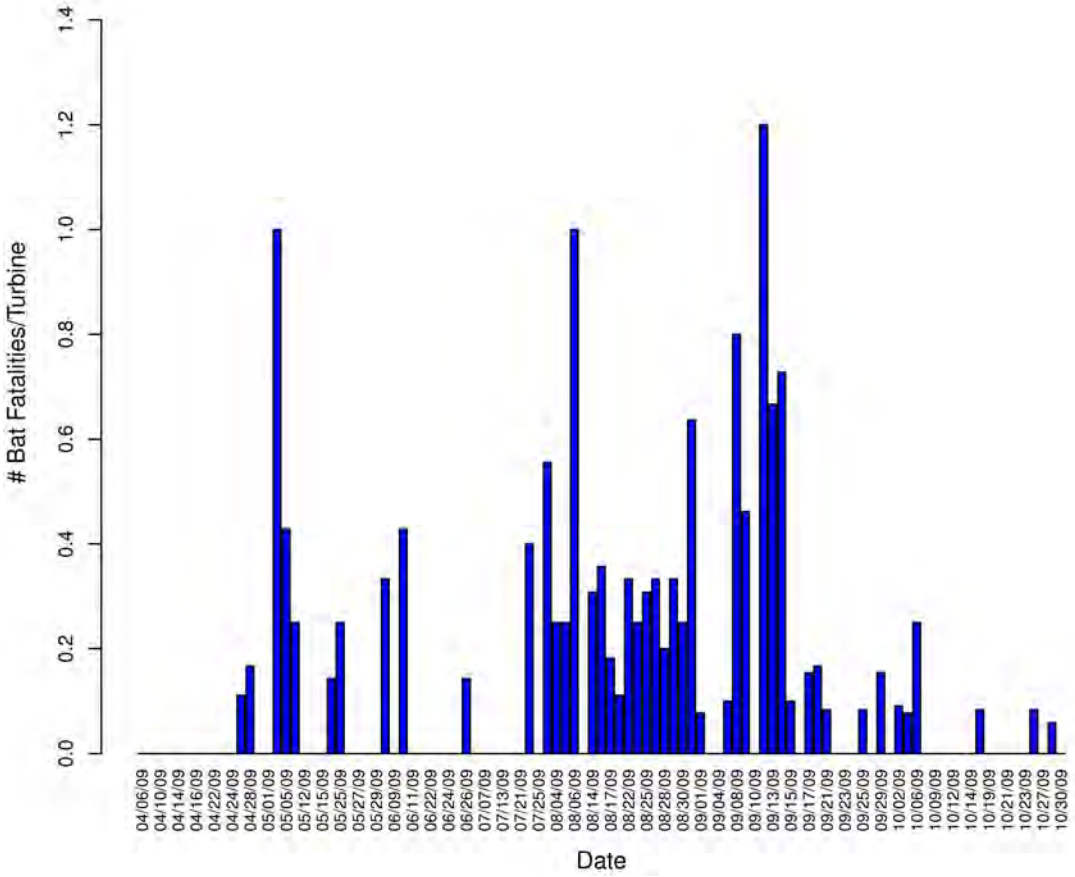

Figure 13. Timing of bat fatalities by turbine at the Fowler Ridge I Wind-Energy Facility.

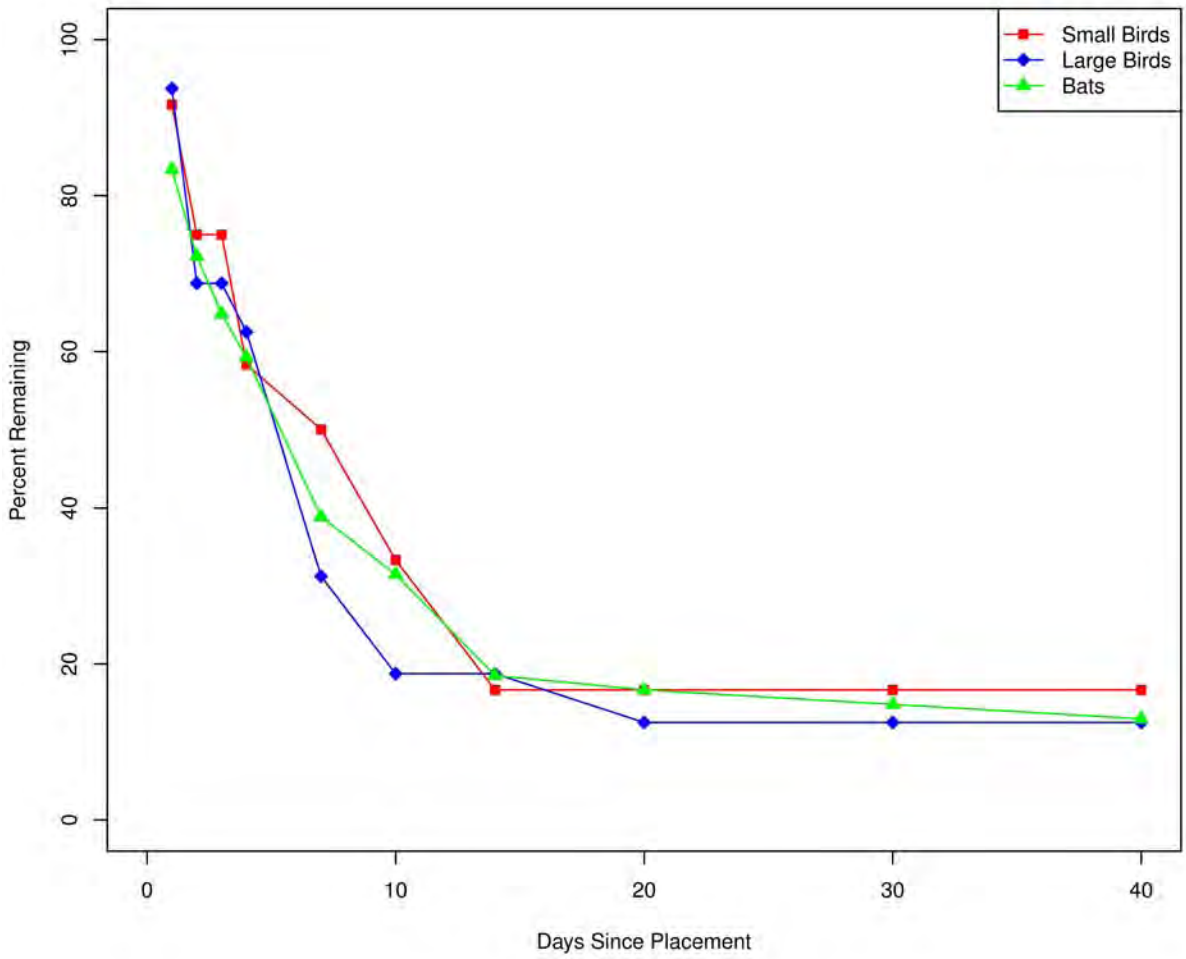

Figure 14. Carcass removal rates at the Fowler Ridge I Wind-Energy Facility.

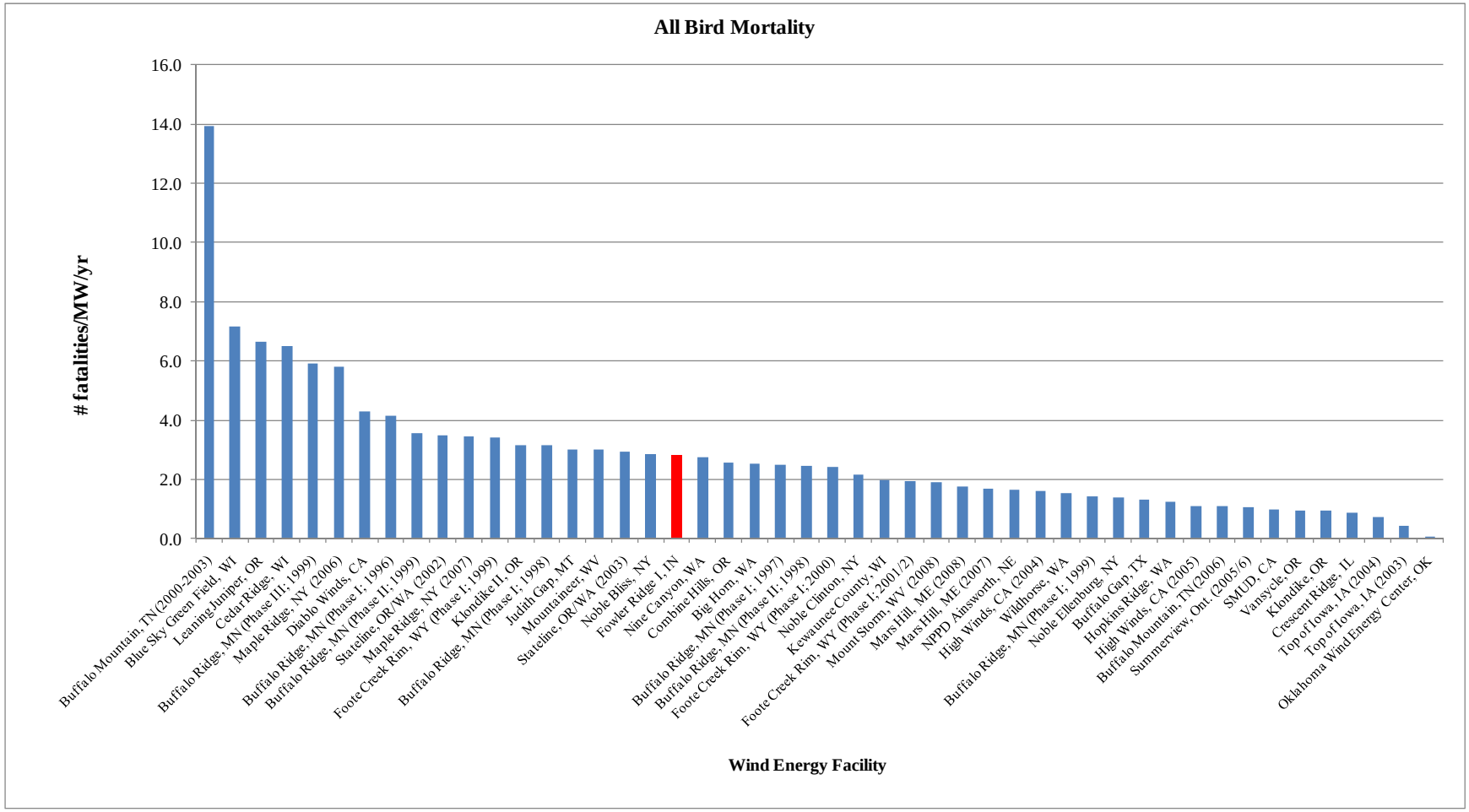

Figure 15. Bird mortality estimates across North America. The Fowler Ridge I Wind-Energy Facility is highlighted in red.

Figure 15 data sources:

Fowler Ridge I, IN	This study				
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Nine Canyon, WA	Erickson et al. 2003	Noble Ellenburg, NY	Jain et al. 2009a
Blue Sky Green Field, WI	Gruver et al. 2010	Combine Hills, OR	Erickson et al. 2003	Buffalo Gap, TX	Tierney 2007
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Big Horn, WA	Kronner et al. 2008	Hopkins Ridge, WA	Young et al. 2007
Maple Ridge, NY (2006)	Jain et al. 2007	Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	High Winds, CA (05)	Kerlinger et al. 2006
Diablo Winds, CA	WEST 2008	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Buffalo Mountain, TN (06)	Fiedler et al. 2007
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Summerview, Ont. (05/06)	Brown and Hamilton 2006
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Noble Clinton, NY	Jain et al. 2009b	SMUD, CA	URS et al. 2005
Stateline, OR/WA (02)	Erickson et al. 2004	Kewaunee County, WI	Howe et al. 2002	Vansycle, OR	Erickson et al. 2000
Maple Ridge, NY (07)	Jain et al. 2008	Foote Creek Rim, WY (Phase I; 01/02)	Young et al. 2003a	Klondike, OR	Johnson et al. 2003b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	Mount Storm, WV (08)	Young et al. 2009	Crescent Ridge, IL	Kerlinger et al. 2007
Klondike II, OR	NWC and WEST 2007	Mars Hill, ME (08)	Stantec 2009	Top of Iowa, IA (04)	Jain 2005
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Mars Hill, ME (07)	Stantec 2008	Erie Shores, Ont.	James 2008
Judith Gap, MT	TRC 2008	NPPD Ainsworth, NE	Derby et al. 2007	Top of Iowa, IA (03)	Jain 2005
Mountaineer, WV	Kerns and Kerlinger 2004	High Winds, CA (04)	Kerlinger et al. 2006	Oklahoma Wind Energy Center, OK	Piorkowski 2006
Stateline, OR/WA (03)	Erickson et al. 2004	Wildhorse, WA	Erickson et al. 2008	Searsburg, VT	Kerlinger 2002
Noble Bliss, NY	Jain et al. 2009c	Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000		

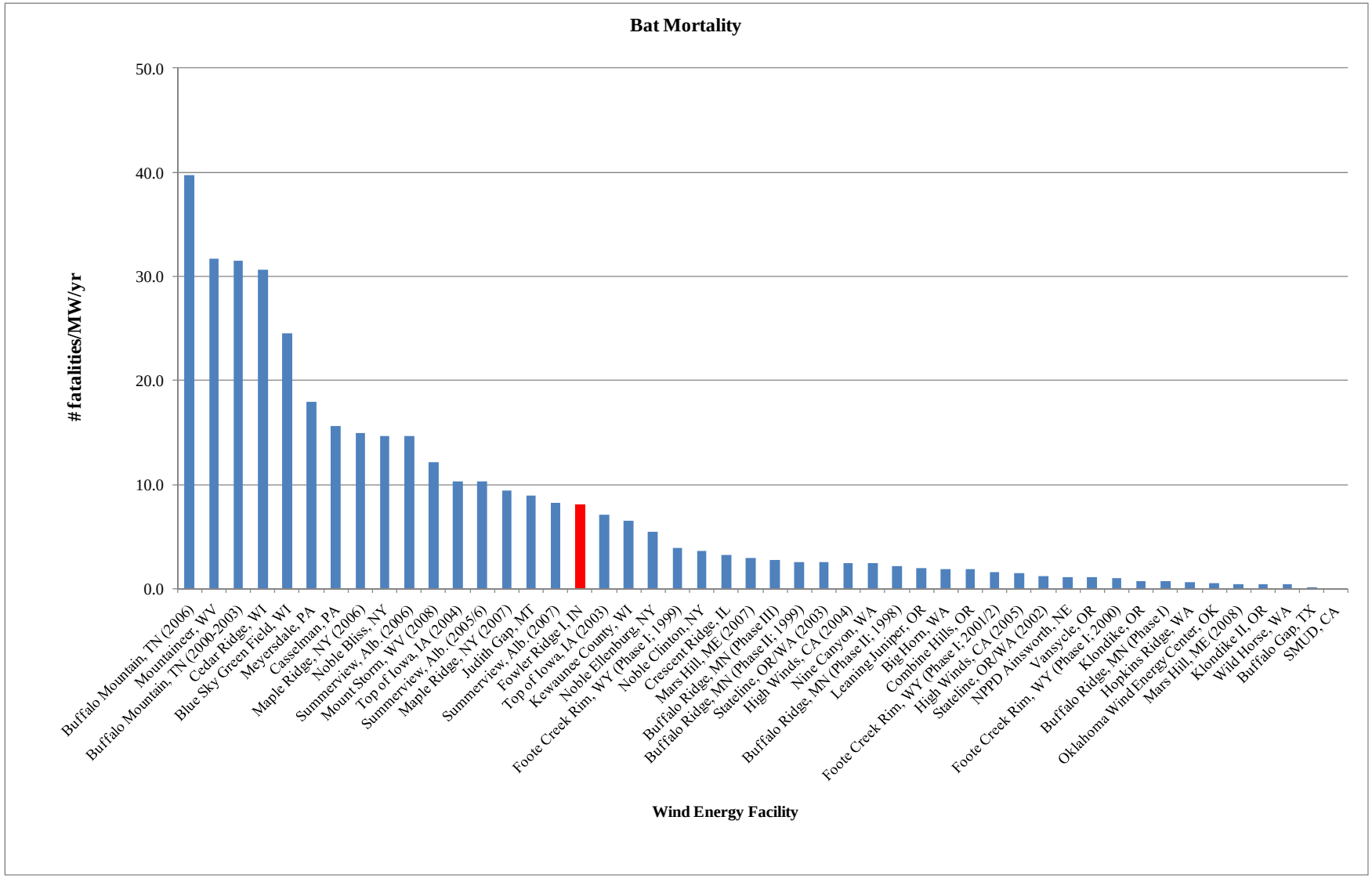

Figure 16. Bat mortality estimates across North America. The Fowler Ridge I Wind-Energy Facility is highlighted in red.

Figure 16 data sources:

Fowler Ridge I, IN	This study				
Buffalo Mountain, TN (06)	Fiedler et al. 2007	Kewaunee County, WI	Howe et al. 2002	Erie Shores, Ont.	James 2008
Mountaineer, WV	Kerns and Kerlinger 2004	Noble Ellenburg, NY	Jain et al. 2009a	Stateline, OR/WA (02)	Erickson et al. 2004
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	NPPD Ainsworth, NE	Derby et al. 2007
Blue Sky Green Field, WI	Gruver et al. 2010	Noble Clinton, NY	Jain et al. 2009b	Vansycle, OR	Erickson et al. 2000
Meyersdale, PA	Arnett et al. 2005	Crescent Ridge, IL	Kerlinger et al. 2007	Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a
Casselman, PA	Arnett et al. 2009	High Winds, CA (04)	Kerlinger et al. 2006	Klondike, OR	Johnson et al. 2003b
Maple Ridge, NY (06)	Jain et al. 2007	Mars Hill, ME (07)	Stantec 2008	Buffalo Ridge, MN (Phase I)	Johnson et al. 2000
Noble Bliss, NY	Jain et al. 2009c	Buffalo Ridge, MN (Phase III)	Johnson et al. 2000	Hopkins Ridge, WA	Young et al. 2007
Summerview, Alb. (06)	Baerwald 2008	Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Oklahoma Wind Energy Center, OK	Piorkowski 2006
Mount Storm, WV (08)	Young et al. 2009	Stateline, OR/WA (03)	Erickson et al. 2004	Mars Hill, ME (08)	Stantec 2009
Top of Iowa, IA (04)	Jain 2005	Nine Canyon, WA	Erickson et al. 2003	Klondike II, OR	NWC and WEST 2007
Summerview, Alb. (05/06)	Brown and Hamilton 2006	Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Wild Horse, WA	Erickson et al. 2008
Maple Ridge, NY (07)	Jain et al. 2008	Big Horn, WA	Kronner et al. 2008	Buffalo Gap, TX	Tierney 2007
Judith Gap, MT	TRC 2008	Combine Hills, OR	Young et al. 2006	SMUD, CA	URS et al. 2005
Summerview, Alb. (07)	Baerwald 2008	High Winds, CA (05)	Kerlinger et al. 2006	Searsburg, VT	Kerlinger 2002
Top of Iowa, IA (03)	Jain 2005	Foote Creek Rim, WY (Phase I; 01/02)	Young et al. 2003a		

Appendix A. Bird and Bat Casualties Found at the Fowler Ridge I Wind Energy Facility, Benton County, Indiana, April 6 – October 30, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/ Incidental
Birds					
4/6/2009	unidentified large bird	356	25	scavenged	carcass search
4/10/2009	unidentified large bird	629	60	scavenged	carcass search
4/15/2009	unidentified duck	629	35	scavenged	carcass search
4/23/2009	unidentified duck	629	85	scavenged	carcass search
4/29/2009	unidentified large bird	356	94	scavenged	carcass search
5/6/2009	blue-winged teal	629	43	scavenged	carcass search
5/25/2009	red-eyed vireo	197	59	intact	carcass search
6/10/2009	American robin	638	185	scavenged	incidental find
6/10/2009	unidentified bird	634	91	feather spot	carcass search
6/26/2009	brown-headed cowbird	197	21	intact	carcass search
8/3/2009	killdeer	253	49	scavenged	carcass search
8/14/2009	unidentified passerine	266	80	feather spot	carcass search
9/3/2009	killdeer	266	93	feather spot	carcass search
9/7/2009	mourning dove	629	97	feather spot	carcass search
9/8/2009	killdeer	606	68	feather spot	carcass search
9/8/2009	red-tailed hawk	286	36	intact	incidental find
9/11/2009	killdeer	265	16	intact	carcass search
9/14/2009	tree swallow	285	44	intact	carcass search
9/17/2009	tree swallow	253	24	intact	carcass search
9/17/2009	horned lark	624	14	intact	carcass search
9/18/2009	tree swallow	152	28	intact	carcass search
9/18/2009	Tennessee warbler	438	64	intact	carcass search
9/21/2009	Tennessee warbler	629	52	intact	carcass search
10/12/2009	green-winged teal	152	73	feather spot	carcass search
10/16/2009	house wren	152	30	scavenged	carcass search
10/20/2009	red-tailed hawk	354	8	scavenged	incidental find
10/26/2009	red-tailed hawk	470	8	scavenged	incidental find
10/29/2009	yellow-rumped warbler	265	30	intact	carcass search
Bats					
4/27/2009	silver-haired bat	266	74	scavenged	carcass search
4/28/2009	silver-haired bat	622	48	intact	carcass search
5/1/2009	silver-haired bat	632	12	intact	incidental find
5/4/2009	silver-haired bat	420	34	intact	carcass search
5/5/2009	little brown bat	265	32	intact	carcass search
5/5/2009	silver-haired bat	249	39	intact	carcass search
5/5/2009	silver-haired bat	265	29	intact	carcass search
5/6/2009	silver-haired bat	629	59	intact	carcass search
5/9/2009	silver-haired bat	633	56	scavenged	incidental find
5/21/2009	eastern red bat	629	60	intact	carcass search
5/25/2009	eastern red bat	187	40	intact	carcass search
5/25/2009	eastern red bat	253	35	intact	carcass search

Appendix A. Bird and Bat Casualties Found at the Fowler Ridge I Wind Energy Facility, Benton County, Indiana, April 6 – October 30, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/ Incidental
5/25/2009	silver-haired bat	249	31	intact	carcass search
6/8/2009	eastern red bat	420	17	intact	carcass search
6/10/2009	silver-haired bat	638	50	intact	carcass search
6/10/2009	silver-haired bat	624	31	intact	carcass search
6/10/2009	silver-haired bat	622	17	intact	carcass search
6/26/2009	hoary bat	265	12	intact	carcass search
7/23/2009	eastern red bat	187	1	intact	carcass search
7/23/2009	eastern red bat	187	3	intact	carcass search
7/28/2009	eastern red bat	286	2	intact	incidental find
8/3/2009	eastern red bat	265	19	intact	carcass search
8/3/2009	hoary bat	265	18	intact	carcass search
8/3/2009	hoary bat	606	21	intact	carcass search
8/3/2009	hoary bat	152	25	intact	carcass search
8/3/2009	eastern red bat	253	4	scavenged	carcass search
8/4/2009	hoary bat	260	3	intact	carcass search
8/5/2009	eastern red bat	381	11	intact	carcass search
8/5/2009	hoary bat	624	3	intact	carcass search
8/6/2009	hoary bat	482	37	intact	incidental find
8/6/2009	hoary bat	285	21	intact	incidental find
8/6/2009	hoary bat	482	3	intact	incidental find
8/14/2009	eastern red bat	187	8	intact	carcass search
8/14/2009	eastern red bat	249	38	intact	carcass search
8/14/2009	eastern red bat	265	11	intact	carcass search
8/14/2009	hoary bat	265	30	intact	carcass search
8/16/2009	eastern red bat	265	26	intact	carcass search
8/16/2009	eastern red bat	606	16	intact	carcass search
8/16/2009	hoary bat	262	30	intact	carcass search
8/16/2009	hoary bat	606	71	intact	carcass search
8/16/2009	hoary bat	260	15	intact	carcass search
8/17/2009	eastern red bat	356	37	scavenged	carcass search
8/17/2009	hoary bat	420	105	intact	carcass search
8/19/2009	eastern red bat	332	85	intact	incidental find
8/19/2009	eastern red bat	332	25	intact	incidental find
8/21/2009	eastern red bat	249	40	intact	carcass search
8/21/2009	hoary bat	356	10	scavenged	carcass search
8/22/2009	eastern red bat	260	5	intact	carcass search
8/22/2009	little brown bat	253	1	intact	carcass search
8/24/2009	eastern red bat	624	17	intact	carcass search
8/24/2009	eastern red bat	381	32	intact	carcass search
8/24/2009	silver-haired bat	381	1	intact	carcass search
8/25/2009	eastern red bat	265	32	scavenged	carcass search
8/25/2009	eastern red bat	606	19	intact	carcass search

Appendix A. Bird and Bat Casualties Found at the Fowler Ridge I Wind Energy Facility, Benton County, Indiana, April 6 – October 30, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/ Incidental
8/25/2009	hoary bat	265	14	intact	carcass search
8/25/2009	hoary bat	237	12	intact	incidental find
8/25/2009	northern long-eared bat	249	87	intact	carcass search
8/27/2009	eastern red bat	606	23	intact	carcass search
8/27/2009	eastern red bat	285	23	intact	carcass search
8/27/2009	hoary bat	249	53	scavenged	carcass search
8/27/2009	little brown bat	193	18	intact	incidental find
8/28/2009	big brown bat	193	4	intact	incidental find
8/28/2009	eastern red bat	266	21	intact	carcass search
8/28/2009	hoary bat	260	20	intact	carcass search
8/28/2009	silver-haired bat	348	13	intact	incidental find
8/29/2009	big brown bat	147	15	intact	incidental find
8/29/2009	silver-haired bat	381	27	intact	carcass search
8/30/2009	eastern red bat	417	2	intact	incidental find
8/30/2009	silver-haired bat	420	17	intact	carcass search
8/31/2009	eastern red bat	260	18	intact	carcass search
8/31/2009	eastern red bat	606	24	intact	carcass search
8/31/2009	eastern red bat	606	2	intact	carcass search
8/31/2009	hoary bat	260	26	intact	carcass search
8/31/2009	hoary bat	611	35	intact	incidental find
8/31/2009	hoary bat	611	0	intact	incidental find
8/31/2009	hoary bat	607	1	intact	incidental find
8/31/2009	hoary bat	607	35	intact	incidental find
8/31/2009	silver-haired bat	235	51	intact	carcass search
8/31/2009	silver-haired bat	606	13	intact	carcass search
8/31/2009	silver-haired bat	624	13	intact	carcass search
9/1/2009	hoary bat	152	26	scavenged	carcass search
9/7/2009	big brown bat	356	6	scavenged	carcass search
9/8/2009	eastern red bat	286	35	intact	incidental find
9/8/2009	eastern red bat	266	12	intact	carcass search
9/8/2009	eastern red bat	266	12	intact	carcass search
9/8/2009	eastern red bat	266	27	scavenged	carcass search
9/8/2009	eastern red bat	285	16	scavenged	carcass search
9/8/2009	hoary bat	230	48	intact	incidental find
9/8/2009	hoary bat	230	44	intact	incidental find
9/8/2009	hoary bat	606	8	intact	carcass search
9/8/2009	silver-haired bat	286	2	intact	incidental find
9/8/2009	silver-haired bat	286	33	intact	incidental find
9/8/2009	silver-haired bat	606	2	intact	carcass search
9/9/2009	eastern red bat	187	3	intact	carcass search
9/9/2009	hoary bat	230	30	intact	carcass search
9/9/2009	hoary bat	230	26	scavenged	carcass search

Appendix A. Bird and Bat Casualties Found at the Fowler Ridge I Wind Energy Facility, Benton County, Indiana, April 6 – October 30, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/ Incidental
9/9/2009	hoary bat	193	30	intact	incidental find
9/9/2009	hoary bat	187	23	scavenged	carcass search
9/9/2009	hoary bat	347	4	intact	incidental find
9/9/2009	silver-haired bat	438	2	intact	carcass search
9/9/2009	silver-haired bat	389	6	intact	carcass search
9/9/2009	silver-haired bat	347	16	scavenged	incidental find
9/10/2009	eastern red bat	372	24	intact	incidental find
9/10/2009	eastern red bat	372	21	intact	incidental find
9/10/2009	eastern red bat	470	12	intact	incidental find
9/10/2009	hoary bat	372	11	intact	incidental find
9/10/2009	hoary bat	372	17	intact	incidental find
9/11/2009	eastern red bat	243	3	intact	incidental find
9/11/2009	eastern red bat	606	4	intact	carcass search
9/11/2009	eastern red bat	291	1	intact	incidental find
9/11/2009	eastern red bat	291	9	nr[a]	incidental find
9/11/2009	hoary bat	230	25	intact	incidental find
9/11/2009	hoary bat	214	3	intact	incidental find
9/11/2009	hoary bat	211	17	intact	incidental find
9/11/2009	hoary bat	211	7	intact	incidental find
9/11/2009	hoary bat	262	1	intact	carcass search
9/11/2009	Indiana bat	230	16	intact	incidental find
9/11/2009	silver-haired bat	187	3	intact	carcass search
9/11/2009	silver-haired bat	214	3	intact	incidental find
9/11/2009	silver-haired bat	606	10	scavenged	carcass search
9/11/2009	silver-haired bat	195	47	intact	incidental find
9/13/2009	eastern red bat	601	8	intact	incidental find
9/13/2009	hoary bat	152	37	intact	carcass search
9/13/2009	hoary bat	152	43	intact	carcass search
9/13/2009	silver-haired bat	601	1	intact	incidental find
9/14/2009	eastern red bat	230	4	intact	carcass search
9/14/2009	eastern red bat	606	40	intact	carcass search
9/14/2009	eastern red bat	606	nr	intact	carcass search
9/14/2009	eastern red bat	285	22	intact	carcass search
9/14/2009	eastern red bat	152	33	intact	carcass search
9/14/2009	hoary bat	265	25	intact	carcass search
9/14/2009	hoary bat	253	19	intact	carcass search
9/14/2009	silver-haired bat	265	14	scavenged	carcass search
9/15/2009	hoary bat	417	3	scavenged	incidental find
9/15/2009	silver-haired bat	624	23	intact	carcass search
9/15/2009	silver-haired bat	417	6	scavenged	incidental find
9/17/2009	eastern red bat	606	33	intact	carcass search
9/17/2009	eastern red bat	253	34	intact	carcass search

Appendix A. Bird and Bat Casualties Found at the Fowler Ridge I Wind Energy Facility, Benton County, Indiana, April 6 – October 30, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/ Incidental
9/18/2009	hoary bat	187	15	intact	carcass search
9/18/2009	hoary bat	381	59	intact	carcass search
9/21/2009	hoary bat	359	27	intact	carcass search
9/25/2009	eastern red bat	253	16	intact	carcass search
9/25/2009	unident. *Lasiurus* bat	355	1	scavenged	incidental find
9/25/2009	eastern red bat	371	5	scavenged	incidental find
9/29/2009	silver-haired bat	624	74	intact	carcass search
9/29/2009	silver-haired bat	381	40	intact	carcass search
9/29/2009	silver-haired bat	425	nr	scavenged	incidental find
10/2/2009	eastern red bat	230	3	intact	carcass search
10/5/2009	silver-haired bat	359	18	intact	carcass search
10/6/2009	eastern red bat	152	30	intact	carcass search
10/6/2009	silver-haired bat	606	7	scavenged	carcass search
10/6/2009	silver-haired bat	230	27	intact	carcass search
10/12/2009	silver-haired bat	428	2	intact	incidental find
10/16/2009	silver-haired bat	265	24	intact	carcass search
10/26/2009	big brown bat	606	30	intact	carcass search
10/29/2009	silver-haired bat	606	14	intact	carcass search

[a] Found by turbine maintenance worker; not recorded.

Appendix B. Fatality estimates and components for birds at the Fowler Ridge I Wind-Energy Facility.

			90% C.I.				90% C.I.				90% C.I.	
Parameter	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**
		Spring				**Summer**				**Fall**		
Search Area Adjustment												
A (small)		1.00				1.00				3.67		
A (large)		1.00				1.00				9.63		
Observer Detection												
p (small)	0.38	0.14	0.17	0.58	0.38	0.14	0.17	0.58	0.38	0.14	0.17	0.58
p (large)	0.64	0.12	0.44	0.81	0.64	0.12	0.44	0.81	0.64	0.12	0.44	0.81
Observed Fatality Rates (Fatalities/turbine)												
Small birds												
$\bar{c}_i$ (Set 1[a])	0	0	0	0	0.33	0.19	0.08	0.69	0.25	0.13	0.07	0.46
$\bar{c}_i$ (Set 2[b])	0	0	0	0	0.08	0.08	0	0.21	0.38	0.18	0.11	0.69
Large birds												
$\bar{c}_i$ (Set 1)	0.08	0.08	0	0.21	0.08	0.08	0	0.22	0.25	0.12	0.08	0.47
$\bar{c}_i$ (Set 2)	0	0	0	0	0	0	0	0	0.15	0.13	0	0.43
All Birds												
$\bar{c}_i$ (Set 1)	0.08	0.08	0	0.21	0.42	0.20	0.12	0.82	0.5	0.17	0.25	0.81
$\bar{c}_i$ (Set 2)	0	0	0	0	0.08	0.08	0	0.21	0.54	0.22	0.25	0.97
Average Probability of Carcass Availability and Detection												
Small birds												
$\hat{\pi}_i$ (Set 1)	0.46	0.16	0.18	0.71	0.32	0.14	0.11	0.55	0.64	0.16	0.32	0.83
$\hat{\pi}_i$ (Set 2)	0.31	0.14	0.1	0.56	0.31	0.14	0.2	0.55	0.64	0.16	0.32	0.83
Large birds												
$\hat{\pi}_i$ (Set 1)	0.58	0.13	0.33	0.76	0.41	0.12	0.21	0.61	0.74	0.1	0.53	0.85
$\hat{\pi}_i$ (Set 2)	0.41	0.12	0.2	0.61	0.41	0.12	0.21	0.6	0.74	0.1	0.53	0.85
Adjusted Fatality Estimates (Fatalities/turbine)												
Small birds												
m_i (Set 1)	0	0	0	0	1.06	1.88	0.19	3.78	1.44	1.15	0.33	3.60

Appendix B. Fatality estimates and components for birds at the Fowler Ridge I Wind-Energy Facility.

			90% C.I.				90% C.I.				90% C.I.	
Parameter	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**
		Spring				**Summer**				**Fall**		
m_i (Set 2)	0	0	0	0	0.25	0.6	0	1.13	2.22	1.76	0.68	5.64
Large birds												
m_i (Set 1)	0.14	0.17	0	0.45	0.2	0.25	0	0.69	3.26	1.75	1.13	6.78
m_i (Set 2)	0	0	0	0	0	0	0	0	2.01	1.91	0	6.05
All birds												
m_i (Set 1)	0.14	0.17	0	0.45	1.25	1.9	0.33	3.92	4.7	2.09	2.41	9.14
m_i (Set 2)	0	0	0	0	0.25	0.6	0	1.13	4.23	2.61	1.81	9.57
Daily Fatality Estimates (Fatalities/turbine/day)												
Small birds												
m_i (Set 1)	0	0	0	0	0.012	0.022	0.002	0.044	0.019	0.015	0.004	0.047
m_i (Set 2)	0	0	0	0	0.003	0.007	0	0.013	0.029	0.023	0.009	0.073
Large birds												
m_i (Set 1)	0.004	0.004	0	0.011	0.002	0.003	0	0.008	0.042	0.023	0.015	0.088
m_i (Set 2)	0	0	0	0	0	0	0	0	0.026	0.022	0	0.07
All birds												
m_i (Set 1)	0.004	0.004	0	0.011	0.015	0.022	0.004	0.046	0.061	0.027	0.031	0.119
m_i (Set 2)	0	0	0	0	0.003	0.007	0	0.013	0.055	0.034	0.024	0.124

[a]Set 1 comprises of turbines with weekly, bi-weekly, and twice a week search intervals during spring, summer, and fall, respectively (Turbines 187, 197, 249, 253, 265, 266, 356, 381, 389, 420, 629, 634).

[b]Set 2 comprises of turbines with bi-weekly, bi-weekly, and twice a week search intervals during spring, summer, and fall, respectively (Turbines 152, 230, 235, 260, 262, 285, 325, 359, 438, 606, 622, 624, 638).

Appendix C. Fatality estimates and components for bats at the Fowler Ridge I Wind-Energy Facility.

			90% C.I.				90% C.I.				90% C.I.	
Parameter	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**
		Spring				**Summer**				**Fall**		
Search Area Adjustment												
A		1.00				1.00				2.45		
Observer Detection												
p	0.56	0.07	0.44	0.69	0.56	0.07	0.44	0.69	0.56	0.07	0.44	0.69
Observed Fatality Rates (Fatalities/turbine)												
$\bar{c}_i$ (Set 1[a])	0.5	0.18	0.2	0.79	1.33	0.47	0.64	2.18	2.67	0.52	1.87	3.54
$\bar{c}_i$ (Set 2[b])	0.08	0.08	0	0.21	0.62	0.16	0.38	0.9	3.77	1.27	1.92	6
Average Probability of Carcass Availability and Detected												
$\hat{h}_i$ (Set 1)	0.51	0.06	0.40	0.61	0.35	0.06	0.25	0.45	0.35	0.06	0.25	0.45
$\hat{h}_i$ (Set 2)	0.34	0.06	0.25	0.44	0.35	0.06	0.25	0.45	0.68	0.06	0.58	0.77
Adjusted Fatality Estimates (Fatalities/turbine)												
m_i (Set 1)	0.99	0.38	0.38	1.65	3.81	1.62	1.74	6.86	9.61	2.07	6.46	13.35
m_i (Set 2)	0.22	0.23	0	0.66	1.78	0.59	1.03	2.96	13.60	4.84	6.67	22.51
Daily Fatality Estimates (Fatalities/turbine/day)												
d_i (Set 1)	0.02	0.01	0.01	0.04	0.04	0.02	0.02	0.08	0.12	0.03	0.08	0.17
d_i (Set 2)	0.01	0.01	0	0.02	0.02	0.01	0.01	0.03	0.18	0.06	0.09	0.29

[a]Set 1 comprises of turbines with weekly, bi-weekly, and twice a week search intervals during spring, summer, and fall, respectively (Turbines 187, 197, 249, 253, 265, 266, 356, 381, 389, 420, 629, 634).

[b]Set 2 comprises of turbines with bi-weekly, bi-weekly, and twice a week search intervals during spring, summer, and fall, respectively (Turbines 152, 230, 235, 260, 262, 285, 325, 359, 438, 606, 622, 624, 638).

Bird and Bat Fatality Studies
Fowler Ridge III Wind-Energy Facility
Benton County, Indiana

April 2 – June 10, 2009

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April 12, 2010

EXECUTIVE SUMMARY

BP Wind Energy North America, Inc. (BPWENA) is developing a wind-energy facility in five separate phases for a total build out capacity of 1,000 megawatts (MW) in Benton County, Indiana. Currently, the first three phases have a total energy capacity of 750 MW. The third phase of the facility, Fowler Ridge III, is owned entirely by BPWENA and is located approximately two miles (3.2 km) east of Fowler, Indiana, and consists of 60 Vestas V82 1.65-MW turbines with a nameplate capacity of 99 MW.

BP Wind Energy North America contracted Western Ecosystems Technology, Inc. (WEST) to develop a post-construction fatality monitoring study at the Fowler I and Fowler III facilities to assess the level of impacts to birds and bats (i.e., high, moderate, low) relative to other wind-energy facilities from operation of the Fowler Ridge I and Fowler Ridge III facilities. Monitoring at the Fowler Ridge III Wind-Energy Facility occurred during the spring migration and early breeding season (April 2 through June 10, 2009), while monitoring of the Fowler I Wind-Energy Facility occurred from April 6 to October 30, 2009. This report presents results of monitoring conducted only at the Fowler III Wind-Energy Facility. Summer and fall migration surveys at the Fowler III Wind-Energy Facility were not conducted due to project-related budget constraints and the expectation that a more robust study would be conducted the second year.

The primary objective of the monitoring study was to determine the level of bird and bat mortality (i.e., relatively high, moderate, or low mortality) attributable to collisions with wind turbines compared to other regional wind-energy facilities. Because not all turbines were sampled, the study was not designed to quantify mortality with a high degree of accuracy for the entire wind energy facility, nor was it designed to detect every wind turbine casualty present on the site. The monitoring study consisted of four components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for birds and bats, calculated using the results from searcher efficiency trials and carcass removal trials, to estimate the approximate level of bird and bat mortality within the Fowler Ridge III Wind-Energy Facility.

Twenty percent of the available turbines (12 turbines) were scheduled to be searched either weekly or biweekly throughout the monitoring period. Search plots 160 meters (525 feet) on a side were established around each turbine to ensure all areas within 80 meters (262 feet) of a turbine were searched. Most of the turbines were located in corn and soybean fields; however, these crops were either not present or very immature during the time frame of the study (April 2 – June 10) and therefore no clearing of crops was conducted for this study. Surveyors walked parallel transects within the search plots while scanning the ground for fatalities or injured birds or bats.

The objective of the standardized carcass surveys was to systematically search selected turbines for bird and bat casualties attributable to collision with project facilities. During the study, three birds were found. All three of the fatalities were comprised only of a few bones without any feathers or fleshy parts remaining. Two of the fatalities were identifiable only as ducks based on

skull characteristics, while the remaining casualty was only identifiable as a large bird because no skull was present; that casualty was likely also a species of waterfowl. No bird fatalities were found incidentally. The FRWEF-III is near an area designated as an Important Bird Area (IBA) due to high concentrations of staging American golden plovers during spring migration. Although concerns have been raised over the potential for collision mortality, no American golden plover fatalities were found during this study.

Two of the bird fatalities (the unidentified large bird and one unidentified duck) were found at Turbine 432 and the remaining unidentified duck casualty was found at Turbine 435. All bird fatalities were found greater than 60 meters (197 feet) from the turbines.

Five bat fatalities comprised of four species were found, including two hoary bats and one each of the following species: eastern red bat, silver-haired bat, and big brown bat. No bat casualties were found incidentally. Bat fatalities were all found at Turbines 387, 432, 435, 444, and 464. Two of the bat fatalities were found between 10 and 20 meters (33-66 feet) from the turbines, two were found between 40 and 50 meters (131-164 feet) from the turbines, and one was found more than 60 meters (197 feet) from the turbine. Bat fatalities were evenly distributed throughout the duration of the study season. Three bat fatalities were intact, one was scavenged, and one was found alive and was subsequently released.

Pre-construction ground-based bat acoustical surveys were conducted at the Fowler Ridge Wind Resource Area from August 15 – October 19, 2007 and from July 17 – October 15, 2008, time periods that cover the time frame during which most bat mortality at wind energy facilities occurs throughout North America. Overall bat detections were low to moderate for sites in the Midwest, ranging from 4.7 bat calls/detector-night in 2007 to 6.45 bat calls/detector-night in 2008. Although none of the bat casualties found at the FRWEF-III in 2009 were high-frequency species (e.g., *Myotis* spp.), high-frequency bats comprised 49.0% of bat calls in 2007 and 34.2% of bat calls recorded in 2008, suggesting that high frequency species such as *Myotis* bats may be much less susceptible to turbine collisions.

Searcher efficiency data from the adjacent Fowler Ridge Phase I Wind-Energy Facility were combined with data from this study to increase sample sizes, whereas all carcass removal data for the Fowler Ridge Phase I Wind-Energy Facility were used for this study. For searcher efficiency trials, 16 carcasses (eight large birds and eight small birds) were placed in the field during searcher efficiency trials conducted on two separate dates. Observer detection rates were 83.3% for large birds and 50.0% for small birds.

For carcass removal trials, 16 carcasses were placed in the Fowler Ridge Phase I Wind-Energy Facility, including eight large bird and eight small birds. By day ten, approximately 25% of the large birds remained, while approximately 35% of the small birds remained.

Because all three birds found during the study were estimated to have died well before the study was initiated, no estimates of avian mortality could be made. The estimated number of bat fatalities and associated 90% confidence limits for the study period from April 2 – June 10 was 3.03 bat fatalities/turbine (90% confidence interval of 0.71 to 6.58 bat fatalities/turbine). Based on the 1.65-megawatt capacity of turbines at the Fowler Ridge Phase III Wind-Energy Facility,

the estimated number of bat fatalities was 1.84 bat fatalities per megawatt during the April 2 to June 10 study time period, or a total of 182 estimated bat fatalities for the entire 99-MW facility.

To date there have been fewer than 10 studies conducted to estimate bird and bat fatalities from wind turbine operations in the Midwest, and studies at the Fowler Ridge Wind Energy Facility represent the first such studies in Indiana. Results of this study further contribute to our understanding of wind-energy impacts to birds and bats. As more wind-energy facilities are built in the region, and additional studies become available, a clearer picture of the impacts to birds and bats will emerge.

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Appendix A - Bird and Bat Casualties Found at the Fowler Ridge III Wind Energy Facility, Benton County, Indiana, April 2–June 10, 2009

INTRODUCTION

BP Wind Energy North America, Inc. (BPWENA) is developing a wind-energy facility in five separate phases for a total build out capacity of 1,000 megawatts (MW) in Benton County, Indiana. Currently, the first three phases have a total energy capacity of 750 MW. The third phase of the facility, Fowler Ridge III, is owned entirely by BPWENA and is located approximately two miles (3.2 km) east of Fowler, Indiana, and consists of 60 Vestas V82 1.65-MW turbines with a nameplate capacity of 99 MW. The first and second phases of the wind-energy facility, Fowler I and Fowler II, are located directly west of the Fowler Ridge III Wind-Energy Facility (FRWEF-III). Fatality monitoring of the Fowler I Wind-Energy Facility (FRWEF-I) occurred from April 6 to October 30, 2009.

BPWENA contracted Western Ecosystems Technology, Inc. (WEST) to conduct a post-construction fatality monitoring study at the FRWEF-III to estimate the level of bird and bat mortality (i.e., relatively high, moderate, low mortality compared to other wind-energy facilities) during spring migration and the early summer breeding season. Fatality monitoring was conducted at the FRWEF-III from April 2 through June 10, 2009, during the spring migration and early summer breeding season. Summer and fall migration surveys at the Fowler III Wind-Energy Facility were not conducted due to project-related budget constraints and the expectation that a more robust study would be conducted the second year.

The monitoring study for the FRWEF-III consisted of the following components:

1) Standardized carcass surveys of selected turbines within a square plot centered on the turbine;

2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers;

3) Carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and

4) Adjusted fatality estimates based on the results of searcher efficiency trials and carcass removal trials.

STUDY AREA

The Fowler Ridge Wind Resource Area (FRWRA) is located in western Indiana in Benton County (Figure 1), and lies within the Tipton Tall Plain physiographic region that includes much of central Indiana. This region was once heavily forested, but has lost almost all of its woodlands over the last 100 years (Mumford and Whitaker 1982). The topography of the FRWRA is mostly flat to slightly rolling and there are no hills, ridges, or other areas of starkly elevated topography. Elevations in the FRWRA range from approximately 700-800 ft (213-244 m). The area averages 40 inches (102 centimeters [cm]) of precipitation per year and temperatures range from 19 – 45 ^{0}F (-7.2-7.3 °C) in January to 65 – 86 ^{0}F (18-30 °C) in July. Soils in the area 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 FRWRA is dominated by tilled agriculture, with corn (*Zea mays*) and soybeans (*Glycine max*) being the dominant crops. Of the roughly 80,400 acres (126.63 square miles [mi^2]) within the FRWRA, row crops compose about 90% of the area (Figure 2). After tilled agriculture, the next most common land use within the FRWRA area is pastures/hayfields, which compose 7.0%. There are 247 acres (0.39 mi^2) of grasslands, composing only 0.2% of the FRWRA. Grasslands in the project area are limited primarily to strips along drainages, railroad rights-of-way (ROW), and ROW along county and state roads. There are also a few grass-lined waterways within cultivated fields in the area. Trees in the FRWRA occur at homesteads, along some of the drainages and fencerows, and in some pastures. Several tree rows planted as wind breaks also occur in the area. Forested areas are rare within the FRWRA, and based on 1992 data, the 596 acres of forest present compose 0.7%.

METHODS

The primary objective of the monitoring study was to estimate the level (relatively high, moderate, or low) of bird and bat mortality attributable to collisions with wind turbines for the FRWEF–III during the spring migration and early summer breeding season. Because not all turbines were sampled, the study was not designed to quantify mortality with a high degree of accuracy for the entire wind energy facility, nor was it designed to detect every wind turbine casualty present on the site. The monitoring study began after the wind-energy facility became fully operational and monitoring began on April 2 and continued through June 10, 2009. The methods for the fatality study are broken into four primary components: 1) standardized carcass surveys of selected turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the FRWEF-III.

There were three scenarios under which casualties were found in the FRWEF-III: 1) during the standardized surveys for the study; 2) while observers were at the FRWEF-III, but not conducting a standardized search (i.e., an incidental find); and 3) by facility personnel or others at the FRWEF-III for other purposes, such as turbine maintenance. All casualties found by study personnel, regardless of timing (i.e., during a standardized survey or not), were recorded by the methods described below. However, only casualties found on established search plots during scheduled searches were used to estimate total mortality for the wind-energy facility.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), and searcher efficiency bias (percent found). For carcasses where the cause of death was not apparent, the assumption that the casualty was a wind turbine collision casualty was made for the analysis. This approach likely led to an overestimate of the true number of facility-related avian fatalities, but most wind-energy facilities have used this conservative approach because of the relatively high costs associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000).

Field Methods

Square plots were established around 12 turbines (20% of the turbines) at the FRWEF-III and systematically searched for carcasses. Search plots at turbines were 160 m (525 ft) on a side to ensure all areas within 80 m (262 ft) from the turbine were searched. The entire search plot was 6.3 acres (0.01 mi^2) in size. Studies at other facilities with large turbines, such as the Klondike wind-energy facility in Oregon (Johnson et al. 2003a), the Combine Hills facility, also in Oregon (Young et al. 2005), and the Crescent Ridge facility in Illinois (Kerlinger et al. 2007) indicate most fatalities are found within the area that is roughly equivalent to the height of the turbine tower. Most of the turbines were located in corn and soybean fields; however, these crops were either not present or very immature during the time frame of the study (April 2 – June 10) and therefore no clearing of crops was conducted as visibility on the search plots was considered adequate for detecting carcasses that may have been present.

During the spring migration period for most birds and bats (April 2 to May 15, 2009) standardized carcass surveys were conducted every seven days. The number of turbines searched each week during this period ranged from six to 12 turbines. For the last four weeks of surveys, all 12 turbines were searched every other week. To the extent possible, turbines were selected for sampling using a systematic design with a random start to ensure the search effort was spread throughout the entire wind-energy facility (Figure 3). However, some deviations in the turbine sampling design had to be made to accommodate landowners who did not wish to participate in the study.

Standardized Carcass Surveys

The objective of the standardized carcasses surveys was to systematically search wind turbines for bird and bat casualties that were attributable to collision with the turbines. Study personnel were trained in proper search techniques prior to conducting the carcass surveys.

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

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.

- Scavenged - an entire carcass, which shows 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 has been heavily infested by insects.

- Feather Spot - ten or more feathers or two or more primaries at one location indicating a bird casualty had been there.

All carcasses were labeled with a unique number, bagged and frozen for future reference and possible necropsy. A copy of the data sheet for each carcass was maintained with the bagged and frozen carcass at all times. For all casualties found, data recorded included species, sex and age (when possible), date and time collected, Global Positioning System (GPS) location, condition (intact, scavenged, feather spot), and any comments that indicated possible cause of death. All casualties were photographed as found.

Casualties found outside the formal search area by carcass search technicians were treated following the above protocol as closely as possible. Casualties observed in non-search areas (e.g., near a turbine not included in the search area), or observed within search areas but outside of the standard search period, were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Casualties found by maintenance personnel and others not conducting the formal searches were similarly documented and included in the overall dataset.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties found by searchers. Searcher efficiency trials were conducted in the same areas as carcass surveys and searcher efficiency was estimated by the type of carcass (bird or bat), size of carcass (birds only) and season. Estimates of searcher efficiency were used to adjust the total number of carcasses found for those missed by searchers, allowing for a correction for detection bias.

Data from searcher efficiency trials conducted for the adjacent FRWEF-I study during the overlapping time period (April 2 to June 10) were combined with searcher efficiency data collected at the FRWEF-III to increase sample sizes. The same personnel conducted searches at both wind-energy facilities. Searcher efficiency trials were conducted on April 30 and May 27, 2009. Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. A total of 32 carcasses (16 large birds and 16 small birds) were placed for the two trials. Carcasses used for searcher efficiency trials were primarily non-native/non-protected or commercially available species such as house sparrows (*Passer domesticus*), northern bobwhites (*Colinus virginianus*), ring-necked pheasants (*Phasianus colchicus*), and mallards (*Anas platyrhynchos*). Because only four dead bats were found during the study, sample sizes were not sufficient to use bats for searcher efficiency trials. Therefore, we used searcher efficiency data from small birds to adjust the estimated bat fatality rates.

All searcher efficiency trial carcasses were placed at random locations within the search area prior to that day's scheduled carcass survey. Each trial carcass was discreetly marked (e.g., tape or thread around the leg of the carcass) so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey was recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Removal Trials

The objective of carcass removal trails was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by predation or scavenging, or removal by other means such as being plowed into a field. Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Data from carcass removal trials conducted for the FRWEF-I study were used for the FRWEF-III study. A total of 16 carcasses were placed in the FRWEF-I twice during the monitoring period (May 1 and May 28), including eight large birds and eight small birds. Carcass composition was similar to that used for searcher efficiency trials. Because only four dead bats were found during this study, sample sizes were not sufficient to use bats for scavenger removal trials. We therefore

assumed that removal rates for small birds would be similar to bats and used scavenger removal data for small birds to adjust the bat fatality estimate.

Removal trial birds were not placed in the standardized search plots in order to minimize the chance of confusing a trial bird with a turbine casualty. Turbines not included in the standardized carcass surveys were randomly selected for inclusion in the removal trials. Trial carcasses were randomly placed at selected turbines within a plot of similar size to the actual search plots.

Personnel conducting carcass searches monitored the trial birds over a 40-day period, checking the carcasses every day for the first four days of the trial, and then on day 7, day 10, day 14, day 20, day 30, and day 40. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 40-day period, any remaining evidence of the carcass was removed.

Statistical Methods

Statistical Methods for Fatality Estimates

Estimates of facility-related fatalities are based on:

(1) Observed number of carcasses found during standardized searches during the monitoring period for which the cause of death is either unknown or is probably facility-related;

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

(3) Searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

The numbers of carcasses found incidentally and during scheduled searches were reported. All carcasses located within areas surveyed, regardless of species, were recorded and, if possible, a cause of death determined based on a cursory field necropsy. Total numbers of bird and bat carcasses were estimated by adjusting for removal and searcher efficiency bias. If the cause of death was not apparent, a “worst case” presumption was made by attributing the mortality to the operation of the wind-energy facility.

Definition of Variables

The following variables are used in the equations below:

c_i the number of carcasses detected at plot i for the study period of interest, for which the cause of death is either unknown or is attributed to the facility
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 remain in the study area after 30 days
se	standard error (square of the sample variance of the mean)
t_i	the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
$\bar{t}$	the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
d	the total number of carcasses placed in searcher efficiency trials
p	the estimated proportion of detectable carcasses found by searchers, 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
$\hat{\pi}$	the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials
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 is determined by:

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

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 ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

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

Estimation of Searcher Efficiency Rates

Searcher efficiency rates are expressed as *p*, the proportion of trial carcasses that are detected by searchers in the searcher efficiency trials. These rates were estimated by carcass size.

Estimation of Facility-Related Fatality Rates

The estimated per turbine annual fatality rate (*m*) is calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

where $\hat{\pi}$ 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 $\hat{\pi}$.

$\hat{\pi}$ 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). The final reported estimates of *m* and associated standard errors and 90% confidence intervals 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 are calculated. A total of 5,000 bootstrap samples were used and the reported estimates are the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

RESULTS

Standardized Carcass Surveys

The 12 turbines representing 20% of all turbines within the FRWEF-III were searched over the course of the fatality monitoring study for a total of 83 turbine searches. A total of three birds and five bats were found during standardized carcass surveys, and no additional fatalities were found incidentally (Appendix A). One of the bats (hoary bat [*Lasiurus cinereus*]) was found alive, and was subsequently released after discovery. The number, species, location, other characteristics of the bird and bat fatalities, and the fatality estimates adjusted for searcher efficiency and carcass removal biases are discussed below.

Bird Fatalities

During the study, three birds were found. All three of the fatalities were comprised only of a few bones without any feathers or fleshy parts remaining. Two of the fatalities were identifiable only as ducks based on skull characteristics, while the one remaining casualty was only identifiable as a large bird because the skull was not present; however, this casualty was likely also a duck. No

bird fatalities were found incidentally. The bird fatalities were found on April 13, 22, and 30, 2009.

Two of the birds (the unidentified large bird and one unidentified duck) were found at Turbine 432, and the remaining unidentified duck casualty was found at Turbine 435 (Figure 4). All bird fatalities were found more than 60 m (197 ft) from the turbines. All bird fatalities were estimated to have been present at least two weeks to one month before the study was initiated.

Bat Fatalities

Five bat fatalities comprised of four species were found, including two hoary bats and one each of the following species: eastern red bat (*Lasiurus borealis*), silver-haired bat (*Lasionycteris noctivagans*), and big brown bat (*Eptesicus fuscus*; Appendix A). No bat casualties were found incidentally.

The five bat fatalities were found at Turbines 387, 432, 435, 444, and 464 (Figure 5). Given the small number of bats found, no statistical tests were conducted to compare fatalities among different locations. Of the bat fatalities, two (40.0%) were found between 10-20 m (33-66 ft) from the turbines, two (40.0%) were found between 40-50 m (131-164 ft) from the turbines, and one (20.0%) was found more than 60 m from the turbine.

Bat fatalities were found on April 30 (three fatalities), May 26 (one), and June 10, 2009 (one). Three bat fatalities were intact, one was scavenged, and one hoary bat was found alive and was subsequently released. Two of the fatalities were estimated to have occurred the previous night and two were estimated to have died from four to seven days before they were found.

Searcher Efficiency Trials

A total of 16 carcasses (eight large birds and eight small birds) were placed in the field during searcher efficiency trials conducted on two separate dates (April 30 and May 27). Observer detection rates were 83.3% for large birds and 50.0% for small birds (Table 1).

Carcass Removal Trials

A total of 16 carcasses were placed in the field during the study period (May 1 and May 28), including eight large birds and eight small birds. By day ten, approximately 25% of the large birds remained, while approximately 35% of the small birds remained (Figure 6).

Adjusted Fatality Estimates

Because all three birds found during the study were estimated to have died well before the study was initiated, no estimates of avian mortality could be made. Fatality estimates, standard errors, and confidence intervals were calculated for bats (Table 2). Based on searcher efficiency and the carcass removal rate at the site, the estimated average probability that a bird casualty would remain in the plot until a scheduled search and would be found during the study season, when turbines were searched weekly, was about 50% for large birds and about 39% for small birds. For turbines searched biweekly, these probabilities were approximately 30% for small birds and about 39% for large birds. The estimated average probability a bat casualty would remain until a

scheduled search and be found was about 43% for turbines searched weekly and approximately 34% for turbines search biweekly.

The estimated number of bat fatalities and associated 90% confidence limits for the April 2 – June 10 study period was 3.03 bat fatalities/turbine (90% confidence interval of 0.71 to 6.58 bat fatalities/turbine; Table 2). Based on the 1.65-MW capacity of turbines at the FRWEF-III, the estimated number of bat fatalities was 1.84 bat fatalities per MW during the April 2 to June 10 study time period, or a total of 182 bat fatalities for the entire 99-MW facility.

DISCUSSION

Fatality Estimation

The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, total area searched, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given area and must be accounted for when attempting to estimate fatality rates. We accounted for this by conducting scavenging trials throughout the study period. We also estimated searcher efficiency rates throughout the study period to account for any biases associated with changes in conditions.

We calculated separate estimates of bat fatality rates based on the search interval. Overlapping confidence intervals for overall fatality estimates based on weekly and biweekly search intervals (Table 2) indicate that the estimates were consistent regardless of search interval. However, estimates derived from the weekly searches are likely most reliable.

There are numerous factors that could contribute to both positive and negative biases in estimating fatality rates (Erickson 2006). The overall design of this study incorporates several assumptions or factors that affect the results of the fatality estimates. First, all bird casualties found within the standardized search plots during the study were included in the analysis. No carcasses found during this study were found incidentally within a search plot during other activities at the FRWEF-III. Second, it was assumed that all carcasses found during the study were due to collision with wind turbines. True cause of death is unknown for most of the bird fatalities. It is possible that some of the bird fatalities were caused by predators, and some of the casualties included in the data pool were potentially due to natural causes (background mortality). It is unlikely that any of the bat fatalities were due to factors not related to interactions with wind turbines.

There are some other potential negative biases. For example, no adjustments were made for fatalities possibly occurring outside of the square plot boundaries. Plot boundaries were established a minimum distance of 80 m from the turbines. The search plot distance for this study was selected based on results of other studies (Erickson et al. 2004; Johnson et al. 2002, 2003b, 2004; Kerlinger et al. 2007; Higgins et al. 1996; Young et al. 2003, 2005) in which a distance equal to the approximate height of the turbine appeared to contain a vast majority of fatalities. Based on the distribution of fatalities as a function of distance from turbines, a small

percentage of bird and bat fatalities possibly fell outside the search plots and may have been missed. This factor would lead to an underestimate of fatality rates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials and whether or not they are representative of actual carcasses. This may occur if the types of birds used are larger or smaller than the carcasses of actual fatalities, or if the trial carcasses are more or less cryptic in color than the actual fatalities. Mallards, ring-necked pheasants, northern bobwhites, and house sparrows were used to represent the range of bird fatalities expected. It is believed that this range captures the range of sizes and other characteristics of actual fatalities and should be a reasonable representation of scavenging rates of the birds as a group. Additionally, due to a lack of bat fatalities to use for trials, data from small birds were used to estimate searcher efficiency and scavenging rates for bats. Although small birds were likely a good surrogate for bats in searcher efficiency trials, scavenging rates may differ between small birds and bats.

Bird Fatalities

Of the three birds that were found during scheduled searches (none found incidentally), there were no identifiable raptors or sensitive or protected species. Because all three birds were estimated to have died well before the study was initiated, it was not possible to estimate total avian fatality. Given that no birds were found that were estimated to have died during the study period, it appears that avian fatality at the FRWEF-III was very low during the April 2 – June 10 time period that this study was conducted. Overall bird fatality estimates at seven Midwest wind-energy facilities located in Nebraska, Wisconsin, Minnesota, Iowa, and Illinois (BHE Environmental, Inc. 2010, Derby et al. 2007; Gruver et al. 2009; Howe et al. 2002; Johnson et al. 2000, 2002; Jain 2005; Kerlinger et al. 2007) have ranged from 0.6 to 7.2, and averaged 4.28 birds/MW/year. The FRWEF-III is near an area designated as an Important Bird Area (IBA) due to high concentrations of staging American golden plovers (*Pluvialis dominica*) during spring migration. Although concerns have been raised over the potential for collision mortality, no American golden plover fatalities were found during this study.

Based on the apparently very low avian mortality during the time frame of this study at the FRWEF-III, and assuming that mortality during other portions of the year is not substantially higher, then it is unlikely that operation of this facility will result in any significant impacts to bird populations, as has been the case at other wind-energy facilities across North America (Johnson and Stephens 2010).

Bat Fatalities

The estimated bat fatality rate at the FRWEF-III of 1.84 bats/MW during the study period is likely an underestimate of actual bat mortality as this study did not cover the fall migration period, when most bat mortality occurs at other wind-energy facilities across North America (Arnett et al. 2008, Johnson 2005). Therefore, bat mortality estimates from the FRWEF-I, which was studied during the spring, summer, and fall (Johnson et al. 2010), likely provide a better indicator of actual bat mortality at the FRWEF-III. At seven other wind-energy facilities in the Midwest (BHE Environmental Inc. 2010, Derby et al. 2007; Gruver et al. 2009; Howe et al. 2002; Johnson et al. 2003, 2004; Jain 2005; Kerlinger et al. 2007), bat fatality estimates ranged from 0.8 to 30.6, and averaged 9.8 fatalities/MW/year. With the exception of two facilities in

Wisconsin (both of which were also located in a corn and soybean agroecosystem), where estimated bat mortality was 24.6/MW/year (Gruver et al. 2009) and 30.6/MW/year (BHE Environmental, Inc. 2010), the highest fatality estimates for bats have come from the eastern US, particularly the Appalachian region where estimates have ranged from 15.7 to 39.7 bats/MW/year (Arnett et al. 2008).

Pre-construction ground-based bat acoustical surveys were conducted at the Fowler Ridge Wind Resource Area from August 15 – October 19, 2007 (Gruver et al. 2007) and from July 17 – October 15, 2008 (Carder et al. 2009), time periods that cover the time frame during which most bat mortality at wind energy facilities occurs throughout North America. Overall bat detections were low to moderate for sites in the Midwest, ranging from 4.7 bat calls/detector night in 2007 to 6.45 bat calls/detector night in 2008. Although none of the bat casualties found at the FRWEF-III in 2009 were high-frequency species (i.e., *Myotis* spp.), high-frequency bats comprised 49.0% of bat calls in 2007 and 34.2% of bat calls recorded in 2008, suggesting that high frequency species such as *Myotis* bats may be much less susceptible to turbine collisions.

Landscape and habitat context have both been proposed as hypotheses to explain bat fatalities at wind-energy facilities. For example, in the eastern US, clearings cut into the forested ridges on which some wind-energy facilities are built are thought to contribute to the relatively high numbers of bat fatalities at these facilities, as clearings create potential foraging habitat, and ridges may serve as attractive linear features during foraging, commuting, or migration (Kunz et al. 2007). None of those features are present at the FRWEF-III. However, the relatively large numbers of bat fatalities reported in Wisconsin (BHE Environmental, Inc. 2010, Gruver et al. 2009), Iowa (Jain 2005), and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality.

Species composition of fatalities at the FRWEF-III was similar to that at most other wind-energy facilities, in that 80% of the fatalities were comprised of migratory tree bats, namely the hoary and eastern red bat. Based on the timing of fatalities for these species and the lack of forest cover that might provide habitat for resident bats, most of the fatalities were apparently migrants through the FRWEF-III, as is the case at virtually all other wind-energy facilities in North America (Johnson 2005, Arnett et al. 2008). Although it is known that most bat mortality occurs during fall migration, it is not known if migrating bats are particularly susceptible, or if other aspects of their behavior, such as mating or feeding behavior, change during the fall and therefore make bats more susceptible to turbine collisions whether they are migrating or not (Cryan and Barclay 2009).

It seems unlikely that the FRWEF-III is located along a concentrated bat migration route, as there are no topographical features or large expanses of forested areas that would tend to concentrate migrating bats. This study was not designed to address that question, and obtaining information on migratory routes by bats (assuming they exist) has proven to be very difficult to date (Arnett et al. 2008). However, Baerwald and Barclay (2009) monitored bat activity in the fall at seven proposed or existing wind-energy facilities across southern Alberta and found that activity of migratory bats varied among sites, suggesting that migrating bats may concentrate along certain routes rather than migrate in a dispersed fashion across a broad area.

Because migratory tree bats are primarily solitary tree dwellers that do not hibernate, it has not been possible to develop any suitable field methods to estimate their population sizes. As a result, impacts on these bat species caused by wind energy development cannot be put into perspective from a population impact standpoint. To help solve this problem, population genetic analyses of deoxyribonucleic acid (DNA) sequences and microsatellite data are being conducted to provide effective population size estimates to determine if populations are growing or declining, and to see if these populations are comprised of one large population or several discrete subpopulations that use spatially segregated migration routes (Amy L. Russell, Assistant Professor, Grand Valley State University, Allendale, Michigan, pers. comm.). To date, initial analyses have been conducted only for the eastern red bat using mitochondrial DNA. Based on these analyses, it appears that this species fits a model of a single, very large population with a history of strong population growth (Vonhof and Russell in prep). The data do not suggest there are multiple populations separated by distinct migratory corridors. Although the point estimate for the eastern red bat population size in North America is 3.3 million, according to Dr. Russell (pers. comm.), the true population size is likely "millions to tens of millions" in size.

Additional research will be required to determine what impact wind-energy facilities have on migratory tree bat populations. Specifically, population size estimates similar to those available for eastern red bat need to be determined for hoary bat and silver-haired bat.

To date there have been fewer than 10 studies conducted to estimate bird and bat fatalities from wind turbine operations in the Midwest, and studies at the Fowler Ridge Wind Energy Facility represent the first such studies in Indiana. Results of this study further contribute to our understanding of wind-energy impacts to birds and bats. As more wind-energy facilities are built in the region, and additional studies become available, a clearer picture of the impacts to birds and bats will emerge.

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Table 1. Searcher efficiency results at the Fowler Ridge III Wind-Energy Facility as a function of season and carcass size.

Size	Date	# Placed	# Available	# Found	% Found
Small Birds	4/30/2009	4	2	2	100
	5/27/2009	4	4	1	25
	Overall	**8**	**6**	**3**	**50**
Large Birds	4/30/2009	4	2	1	50
	5/27/2009	4	4	4	100
	Overall	**8**	**6**	**5**	**83.3**

Table 2. Fatality estimates and components for bats for the Fowler Ridge III Wind-Energy Facility.

			90% C.I.				90% C.I.	
Parameter	**mean**	**se**	**ll**	**ul**	**mean**	**se**	**ll**	**ul**
Search Area Adjustment								
A	1.00							
Observer Detection								
p	0.51	0.18	0.25	0.75				
	Weekly Searches				**Biweekly Searches**			
Observed Fatality Rates (Fatalities/turbine)								
$\bar{c}_i$	0.34	0.20	0	0.67	0.51	0.20	0.20	0.83
Average Probability of Carcass Availability and Detected								
$\hat{\pi}_i$	0.43	0.17	0.17	0.70	0.34	0.15	0.11	0.60
Adjusted Fatality Estimates (Fatalities/turbine)								
m_i	0.96	0.91	0	2.46	2.04	1.86	0.50	4.69
Daily Fatality Rates (Fatalities/turbine/day)								
d_i	0.014	0.013	0	0.035	0.029	0.027	0.007	0.067
Overall (All Turbines Combined) Adjusted Fatality Estimates (Fatalities/turbine)								
	3.03	**2.84**	**0.71**	**6.58**				

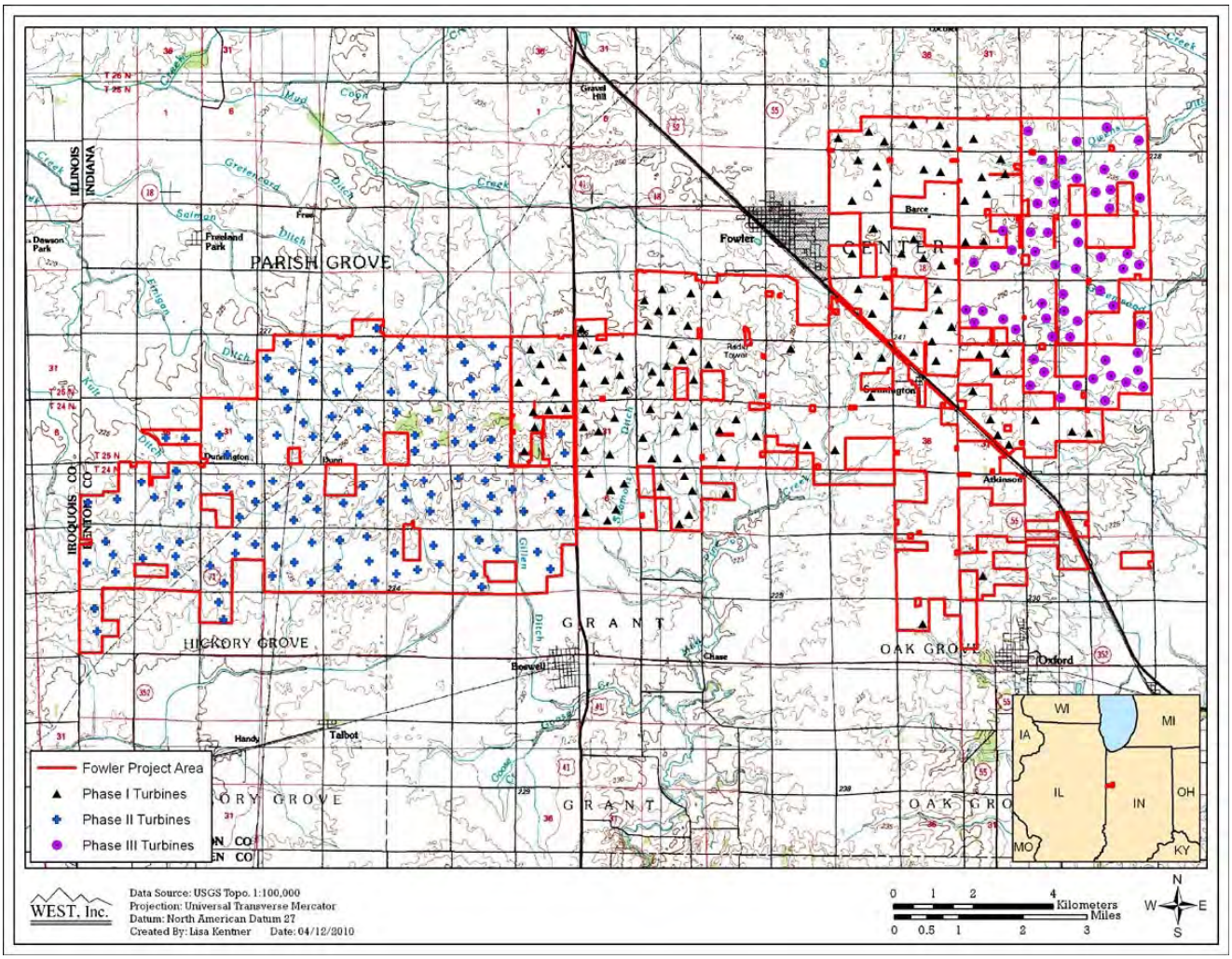

Figure 1. Location of the Fowler Ridge Wind-Energy Facility in Benton County, Indiana.

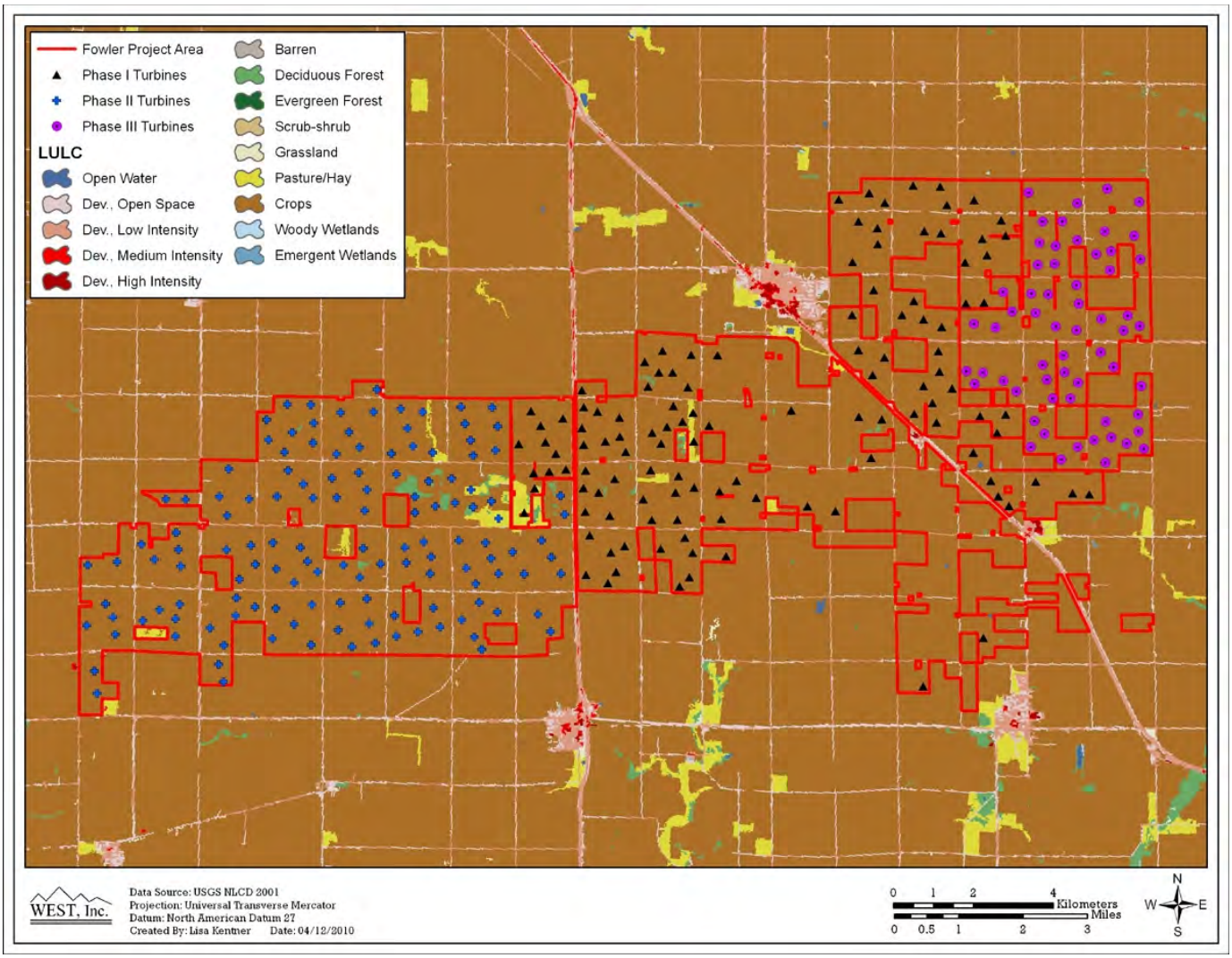

Figure 2. Landcover types at the Fowler Ridge III Wind-Energy Facility.

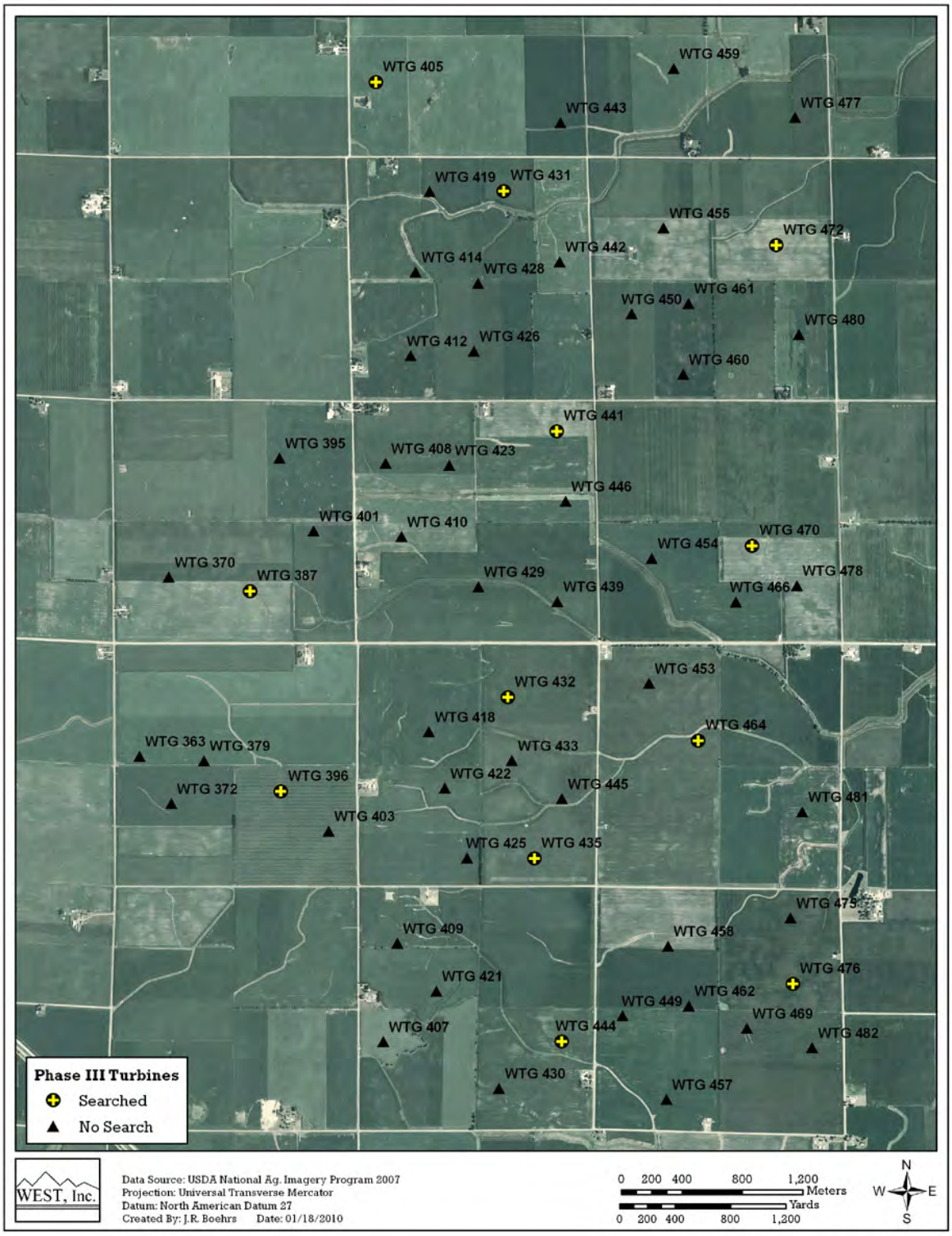

Figure 3. Location of carcass search plots at the Fowler Ridge III Wind-Energy Facility.

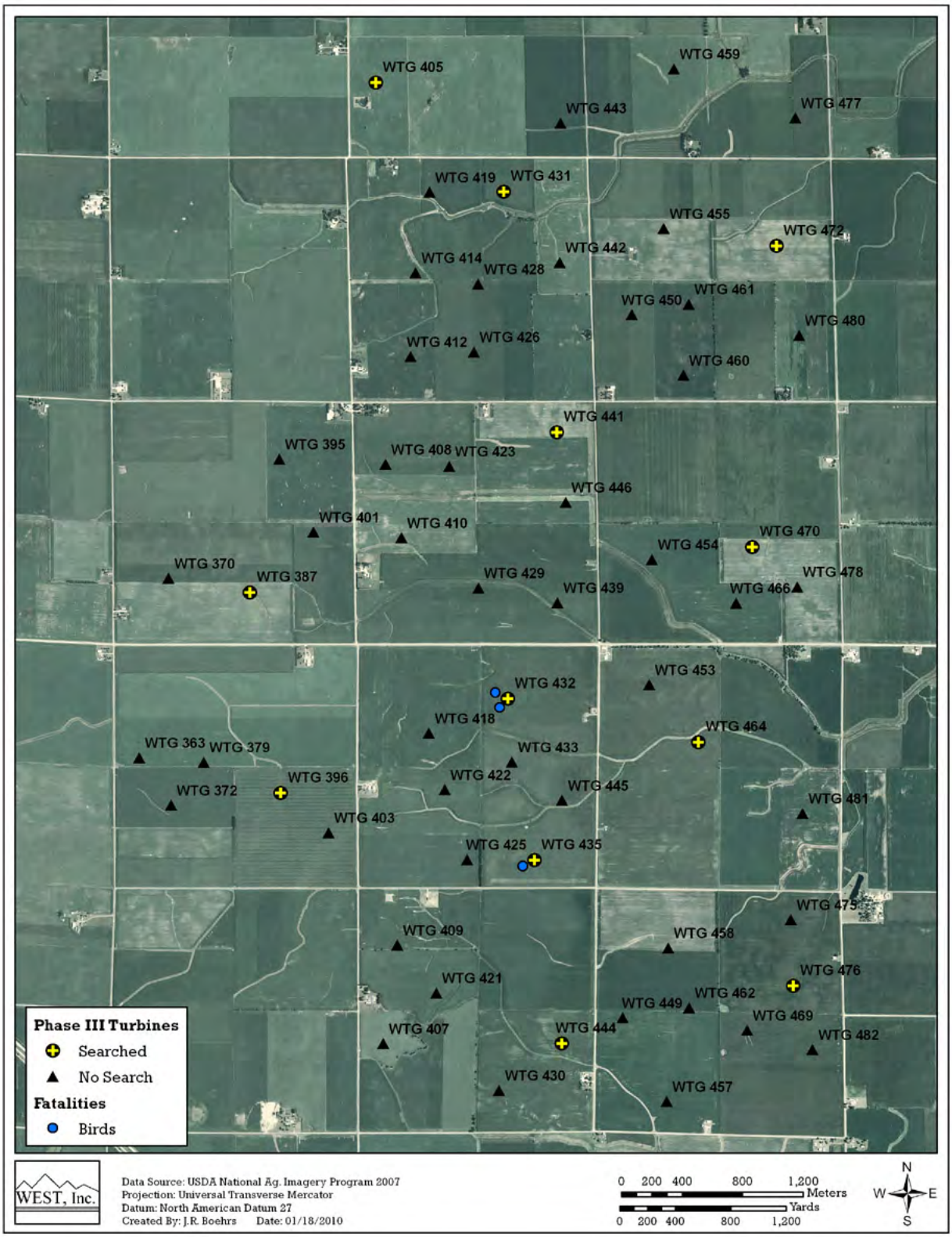

Figure 4. Location of bird casualties found at the Fowler Ridge III Wind-Energy Facility.

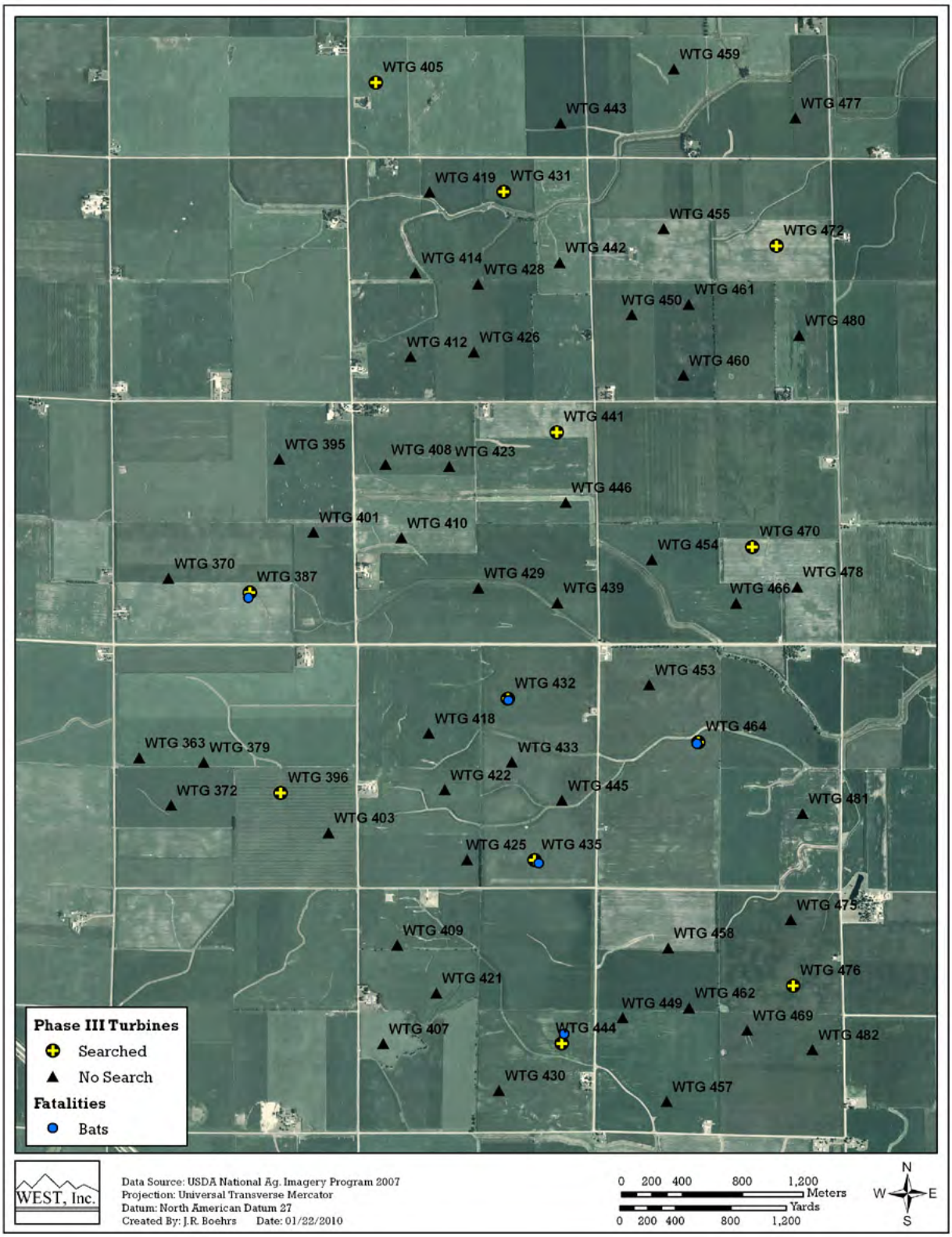

Figure 5. Location of bat casualties found at the Fowler Ridge III Wind-Energy Facility.

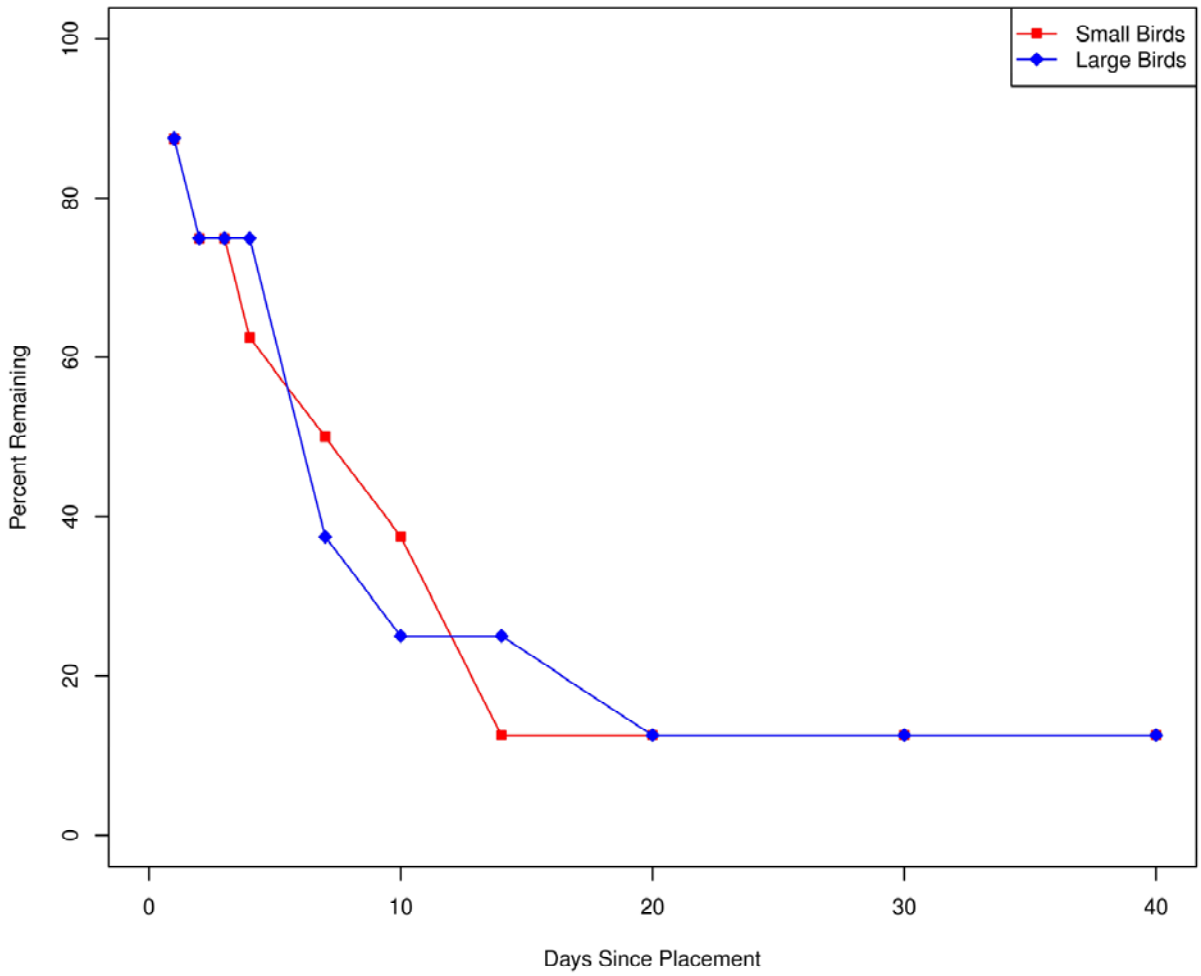

Figure 6. Scavenger removal rates for the Fowler III Wind Energy Facility during the April 2 to June 10, 2009 study period.

Appendix A - Bird and Bat Casualties Found at the Fowler Ridge III Wind Energy Facility, Benton County, Indiana, April 2–June 10, 2009

Appendix A - Bird and bat casualties found at the Fowler Ridge III Wind Energy Facility, Benton County, Indiana, April 2–June 10, 2009.

Date	Species	Turbine	Distance to Turbine	Carcass Condition	Scheduled/Incidental
Birds					
4/13/2009	unidentified large bird	432	88	scavenged	carcass search
4/22/2009	unidentified duck	435	89	scavenged	carcass search
4/30/2009	unidentified duck	432	76	scavenged	carcass search
Bats					
4/30/2009	hoary bat	432	16	intact	carcass search
4/30/2009	hoary bat	435	45	injured-released	carcass search
4/30/2009	big brown bat	464	16	intact	incidental find
5/26/2009	silver-haired bat	444	61	scavenged	carcass search
6/10/2009	eastern red bat	387	41	intact	carcass search

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

April 13 – October 15, 2010

Prepared for:

Fowler Ridge Wind Farm

Prepared by:

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January 28, 2011

WEST Inc.

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

The Fowler Ridge Wind Farm (FRWF) is collectively owned by BP Wind Energy, Sempra Generation, and Dominion Energy, and is being developed in five separate phases for a total of 1,000 megawatts (MW). The project currently consists of 355 wind turbines in three phases in Benton County, Indiana. A post-construction casualty study of birds and bats was conducted within Phases I and III during 2009 by Western EcoSystems Technology, Inc (WEST). One carcass of an Indiana bat (*Myotis sodalis*), a federally endangered species, was found by wind plant personnel during the fall of 2009. As a result of this discovery, the US Fish and Wildlife Service (USFWS) Field Office in Bloomington, Indiana, has recommended that the FRWF develop a Habitat Conservation Plan (HCP). Consequently, the owners of the FRWF requested that WEST conduct further research of potential bat casualty and use rates at the FRWF during 2010 for use in completing a HCP and obtaining an Incidental Take Permit (ITP) from Region 3 of the USFWS. The results presented in this report were collected under a Scientific Research and Recovery Permit for the Indiana bat (TE15075A).

Studies at the FRWF were comprised of two components: a bat casualty study and an acoustical bat survey. The goals of the casualty study were: 1) to determine if Indiana bat fatalities were widespread and if fatalities occurred at levels that may reduce the viability of Indiana bat populations; and 2) determine if facility operation management can be utilized as an effective tool for reducing bat casualty rates. The goals of the bat use study were to: 1) measure the overall rates of use of the FRWF by Indiana bats and other bat species; and to 2) provide information that may help to better define periods when potential mitigation and minimization measures for Indiana bats may be most effective.

Casualty searches were conducted during the spring (April 13 – May 15, 2010) and fall (August 1 – October 15, 2010) migration periods. Casualty searches were completed on two types of plots: 1) 80 x 80-meter (m; 262 x 262-foot [ft]) square plots centered on 36 turbines and cleared of vegetation; and 2) roads and turbine gravel pads within 40 m (131 ft) of 100 additional turbines. Carcass searches were conducted daily at the 36 square plots, and weekly at the road and pad plots. During the spring, 128 turbines were sampled during the study. Surveys were unable to be completed on eight turbines originally selected for road and pad searches as part of the study plan due to construction activities. Surveys were completed at all 136 turbines in the fall.

Turbines were selected for carcass searches using a systematic sampling design with a random start. During the fall migration period the effectiveness of raising turbine cut-in speeds was tested at a sample of the daily searched turbines. Bat casualty rates were measured at two different cut-in speed adjustments or “treatments” and two sets of “control” or “reference” turbines with no turbine cut-in speed adjustment. Nine turbines were randomly selected from the sample of 36 daily searched turbines for use as a “control” sample, and had no treatments for the duration of the study. Treatments for cut-in speed adjustment and a second set of “control” turbines were rotated on a weekly basis between the remaining 27 daily search

turbines, with nine turbines assigned to each group. The treatments included turbines with cut-in speeds raised to a lower level (5 m/s), and turbines with cut-in speeds raised to higher level (6.5 m/s). Turbines were randomly assigned to control and treatment groups among the 27 turbines, and treatments were distributed to ensure each turbine received 3 - 4 weeks of each treatment or control status.

During the spring migration period (April 13, 2010 – May 15, 2010) 80 x 80-m square plots were surveyed 33 times for a total of 1,169 searches. A total of 423 surveys were completed at roads and pads during spring 2010. Thirty-six bat casualties (18 silver-haired bats [*Lasionycteris noctivagans*], 15 eastern red bats [*Lasiurus cinereus*], two hoary bats [*Lasiurus borealis*], and one big brown bat [*Eptesicus fuscus*]) were found during the spring. Of the 36 bat casualties found, 32 were found during scheduled searches and four were found incidentally. All fresh, non-myotis bat casualties were collected and utilized in searcher efficiency and carcass removal trials. Four raptor casualties (three red-tailed hawks [*Buteo jamaicensis*] and one rough-legged hawk [*Buteo lagopus*]), eight small bird casualties (two European starlings [*Sturnus vulgaris*], one horned lark [*Eremophila alpestris*], one Tennessee warbler [*Vermivora peregrina*], one common yellowthroat [*Geothlypis trichas*], one unidentified dove and two unidentified birds) were also found during spring migration searches.

During the fall 3,871 plot surveys were conducted during 110 visits to the study area at the 36 daily search turbines, with an additional 1,618 surveys being conducted during 17 visits to the facility at the 100 turbines selected for road and pad surveys. A total of 556 bats were found during regularly scheduled searches, with an additional 25 bats found incidentally at turbine search plots. The remaining 228 bat carcasses were found outside of the study period during clearing searches or not on scheduled search turbines and were not included in the casualty estimates. The most commonly found bat species during scheduled searches was eastern red bat (353 fatalities, 63.49% of fatalities), followed by silver haired bat (98 fatalities, 17.62%), hoary bat (84 fatalities, 15.11%), and big brown bat (16 fatalities, 2.88%). Two tri-colored bats (*Perimyotis subflavus*), two little brown bats (*Myotis lucifigus*) and one Indiana bat (*Myotis sodalis*) were also found during scheduled searches.

During these studies, some casualties may have been missed on search plots because either searchers missed them, or scavengers removed them prior to the search. Experimental trials were conducted to estimate these adjustment factors, including an estimate of the probability a carcass is available to be found during a search (i.e. not removed by scavengers) and is detected by observers. A total of 222 fresh bat carcasses were used in calculating an empirical estimate of the probability of availability and detection. These carcasses were allowed to remain where placed for a 28 day period and the date when searchers found the carcasses was noted. Of the 222 carcasses placed 77 were placed on turbines where only the road and pad was searched and 145 were placed on turbines where cleared plots were searched. The empirical estimate for the probability of available and detected on road/pad searches was 0.51 for weekly searches and 0.58 for cleared plot turbines (i.e. daily searches)

Two casualty estimators were used. The Schoenfeld method utilizes a formula to estimate the probability of a carcass being available and detected by search, and is typically used for studies with infrequent search intervals. The Schoenfeld estimate was calculated to ensure a casualty estimate could be compared to the 2009 bat casualty estimate. The 2nd estimator used, the empirical estimate, was based on daily checks of bat carcasses, and represents an actual measure of carcass availability and detectability.

The estimated number of bat fatalities per turbine (based on Shoenfeld"s pi estimates) was 0.91 for daily search plots and 0.43 for weekly search plots during the spring season. These estimates increased during the fall season, with 17.69 bat fatalities per turbine per season at daily search turbines and 15.73 bats per turbine at weekly searches. Adjusted casualty estimates based on empirical estimates for the probability of available and detected were 1.25 bats per turbine for daily search turbines and 0.55 bats per turbine for weekly searches in the spring and 24.17 bats per turbine for daily search turbines and 20.96 per turbine for weekly searches in the fall, with an overall adjusted casualty estimate of 22.20 bats per turbine for the study period.

Bat casualty rates were lower at turbines where cut-in speeds were adjusted. Bat casualty rates and corresponding 90% bootstrap confidence intervals of 14.0 (11.6 - 16.5), 7.0 (7.0 - 9.1), and 3.0 (1.8 - 4.2) bats/turbine/season were recorded at control, 5.0 m/s, and 6.5 m/s treatment conditions respectively. Non-overlapping confidence intervals for observed casualty rates under each cut-in speed condition indicate a significant difference between treatments. An approximate 50% reduction in overall bat mortality was realized by raising the cut-in speed by 1.5 m/s (from 3.5 m/s to 5.0 m/s). An approximate 78% reduction in overall bat mortality was realized by raising the cut-in speed by 3.0 m/s (from 3.5 m/s to 6.5 m/s).

Relationships between bat casualty rates and weather factors were evaluated utilizing Poisson regression during the fall migration period of 2010. Bat casualty rates were highest on nights with higher bat activity, lower mean wind speeds, higher mean temperature and increasing variance in temperature, and increasing barometric pressure. In other words, higher bat fatalities were associated with warmer, calmer evenings prior to or after the passage of weather fronts and increasing bat activity. Bat casualty rates were also related to turbine type, with higher bat casualty rates observed at turbines with greater rotor swept areas.

Bat activity was monitored at the base of four daily search turbines on 36 nights during the spring period of April 9 through May 14. Bat activity was monitored at ground locations previously monitored during 2007 on 95 nights during the fall period of July 15 through October 18, 2010. Turbine locations were monitored at the base from August 1 through October 18, 2010; and nacelle units from August 17 through October 18, 2010. Anabat units recorded 185 bat passes on 137 detector-nights during the spring, and 5,721 bat passes on 685 detector-nights during the fall. The average bat activity for ground stations was 1.34 ± 0.29 bat passes per detector-night in the spring, and 11.46 ± 1.29 at ground stations and 3.10 ± 0.42 at raised stations during the fall.

Calls were placed in three groups, based on call frequency. During the spring study season, passes by low-frequency bats (LF; 46.5% of all bat passes) outnumbered passes by mid-frequency bats (MF; 28.1%) and high-frequency bats (HF; 25.4%), and this pattern was consistent among ground stations. Temporal patterns of use were similar among all three species groups during the study period, with the highest periods of use occurring during the first two weeks in August. During the fall study season, passes by LF bats (55.2% of all bat passes) outnumbered passes by HF (22.4%), and MF (22.3%), and this pattern was consistent among ground stations. Among raised stations, LF bats comprised 71.6% of passes. LF and MF comprised a greater proportion, and HF comprised a lower proportion, of calls recorded on the nacelle of turbines compared to ground stations. Temporal patterns of use were similar among all three species groups during the study period.

Using a call library, *Myotis* bat calls were analyzed to determine if call characteristics resembled Indiana bat calls. Three methods were utilized to identify potential Indiana bat calls, including a Discriminant Function Analysis, the "Britzke" filter, and a qualitative analysis by WEST biologists. Thirty calls were identified by the Discriminant Function Analysis as resembling calls made by Indiana bats in 2010, two calls passed the Britzke filter, and WEST biologists identified all 30 calls as being made by *Myotis,* but were not able to conclusively determine if calls were made by Indiana or little brown bat. Most potential *Myotis* calls were identified as occurring on the evening of August 9-10, 2010 at a ground-based station located away from turbines. Based on the presence of multiple potential calls, *Myotis* were present on the evening of August 9-10 at Station 2 (located away from turbine locations), and some potential exists that these calls were made by Indiana bats. The recording of individual potential *Myotis sodalis* calls identified by the Discriminant Function Analysis on other nights and stations does not provide strong evidence of *Myotis sodalis* activity due to the potential for incorrect identifications.

Bat activity was also actively sampled during both the spring and fall study seasons by driving east-west transects across the study area twice per week and recording calls at water sources and other potential bat habitat features. During the spring study period (five detector nights), active bat monitoring efforts recorded five HF bat passes, one MF bat pass, and nine LF bat passes. During the fall study season (21 detector-nights), active bat monitoring efforts recorded 32 HF bat passes, 59 MF bat pass, and 43 LF bat passes. None of the passes were identified as Indiana bat.

Bat activity was positively correlated with observed casualty rates, although other factors, such as weather and turbine type also played a role in observed bat casualty rates. Correlation between bat activity (number of bat passes per detector night) recorded with Anabat units located on the nacelles of selected turbines and observed casualty rates of fresh bat carcass finds was stronger than the correlation of casualty rates to Anabat detectors located at the base of turbines (Pearson"s correlation coefficients; 0.45 and 0.07 respectively).

The primary goals of the 2010 casualty study were to: 1) determine if Indiana bat fatalities were widespread, and if fatalities occurred at levels that may reduce the viability of Indiana bat populations; and 2) determine if facility operation management can be utilized as an effective

tool for reducing bat casualty rates. Despite the increased survey effort over studies conducted in 2009, and despite reasonable probabilities of detecting bat carcasses during the study, very few *Myotis* carcasses were found, with only one Indiana bat carcass found during the study. Very few *Myotis* calls were recorded during the course of the study, and multiple calls potentially resembling Indiana bat calls were recorded at a single station on one evening during the fall migration period. It is clear that Indiana bat casualties were not widespread and did not occur at a high rate during the spring and fall migration period of Indiana bats. The data collected during this study also provide a reasonable estimate of overall bat casualties within the FRWF. More detailed estimates of Indiana bat casualties for future operations of the FRWF will be calculated within a Habitat Conservation Plan, currently being prepared for the FRWF.

The data collected at the FRWF show bat casualty rates were affected by bat activity, weather, turbine types, and habitat. These observed relationships provide a baseline for developing additional hypotheses for implementing and testing measures to reduce bat casualty rates. The results also show that Indiana bat fatalities occur at the FRWF, albeit at an extremely low rate. While the low rate of Indiana bat fatalities likely indicate impacts of operation of the FRWF are also low, the low casualty rates also make it difficult to recommendations specific measures for Indiana bats. Thus, recommendations provided in this report are aimed at providing a basis for designing a strategy for reducing overall bat casualty rates under the assumption that Indiana bat casualty rates will also be reduced.

Raising turbine cut-in speeds showed a reduction in bat casualty rates at FRWF during the fall of 2010, and similar reductions in bat casualty rates have also been documented by researchers at other wind-energy facilities. However; correlations observed between weather variables and bat fatalities suggest that focusing or adjusting cut-in speeds during periods when bats may be at most risk, or at locations where bats may be more likely to be found as fatalities, may provide similar reductions in bat fatalities.

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INTRODUCTION AND BACKGROUND

The Fowler Ridge Wind Farm (FRWF) is collectively owned by BP Wind Energy North America (BPWENA), Sempra Generation, and Dominion Energy and is being developed in five separate phases for a total of 1,000 megawatts (MW). The project currently consists of 355 wind turbines in three phases in Benton County, Indiana (Figure 1). A post-construction casualty study of birds and bats was conducted within Phases I and III during 2009 by Western EcoSystems Technology, Inc (WEST, Inc.; Johnson et al. 2010a, 2010b). One carcass of an Indiana bat (*Myotis sodalis*), a federally endangered species, was reported by FRWF personnel during the fall of 2009 (Johnson et al. 2010b, USFWS 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 potential casualty rates at the FRWF for use in completing a HCP and obtaining an Incidental Take Permit (ITP) from Region 3 of the USFWS. The results presented in this report were collected under a Scientific Research and Recovery Permit for the Indiana bat (TE15075A).

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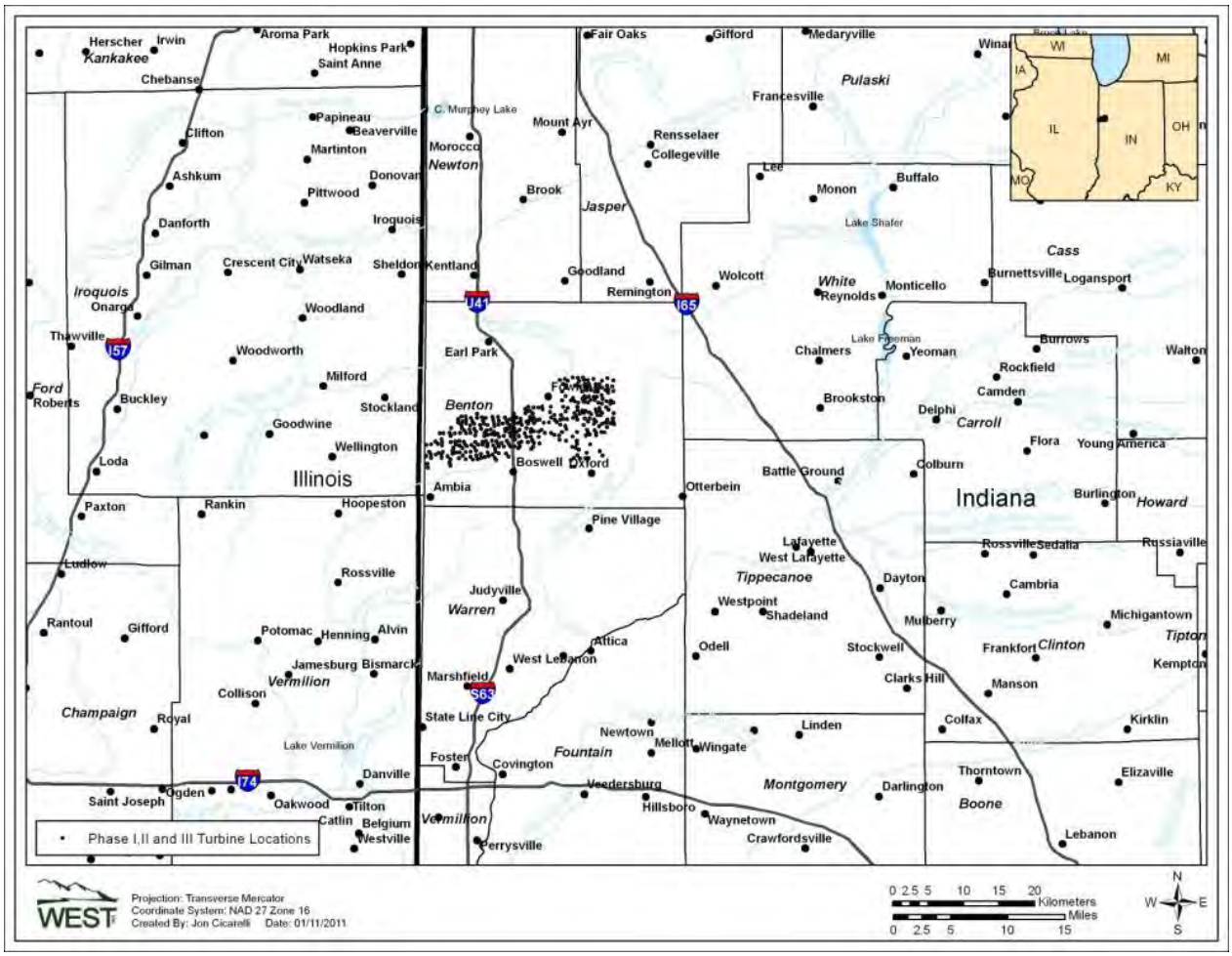

Figure 1. Location of the Fowler Ridge Wind Farm.

STUDY AREA

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

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

Turbine Model	MW	Turbine Height (m)	Rotor Diameter (m)	Standard cut-in speed (m/s)
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 (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, with corn (*Zea mays*) and soybeans (*Glycine max*) being the dominant crops (Figure 3). Of the roughly 54,880 acres (about 86 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 (USGS NLCD 2001; 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 comprise 5.0% of the total, and pastures/hayfields, which comprise 1.4% of the total. There are 22.8 acres (0.04 mi^2) of grasslands which compose less than 0.1% of the study area. Grasslands in the study area are limited primarily to strips along drainages, railroad rights-of-way (ROW), and ROWs along county and state roads. There are also a few grass-lined waterways within cultivated fields in the 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 249.3 acres (0.39 mi^2) of forest comprise 0.5% of the total area. Small amounts of barren ground, open water, and woody wetlands are also present.

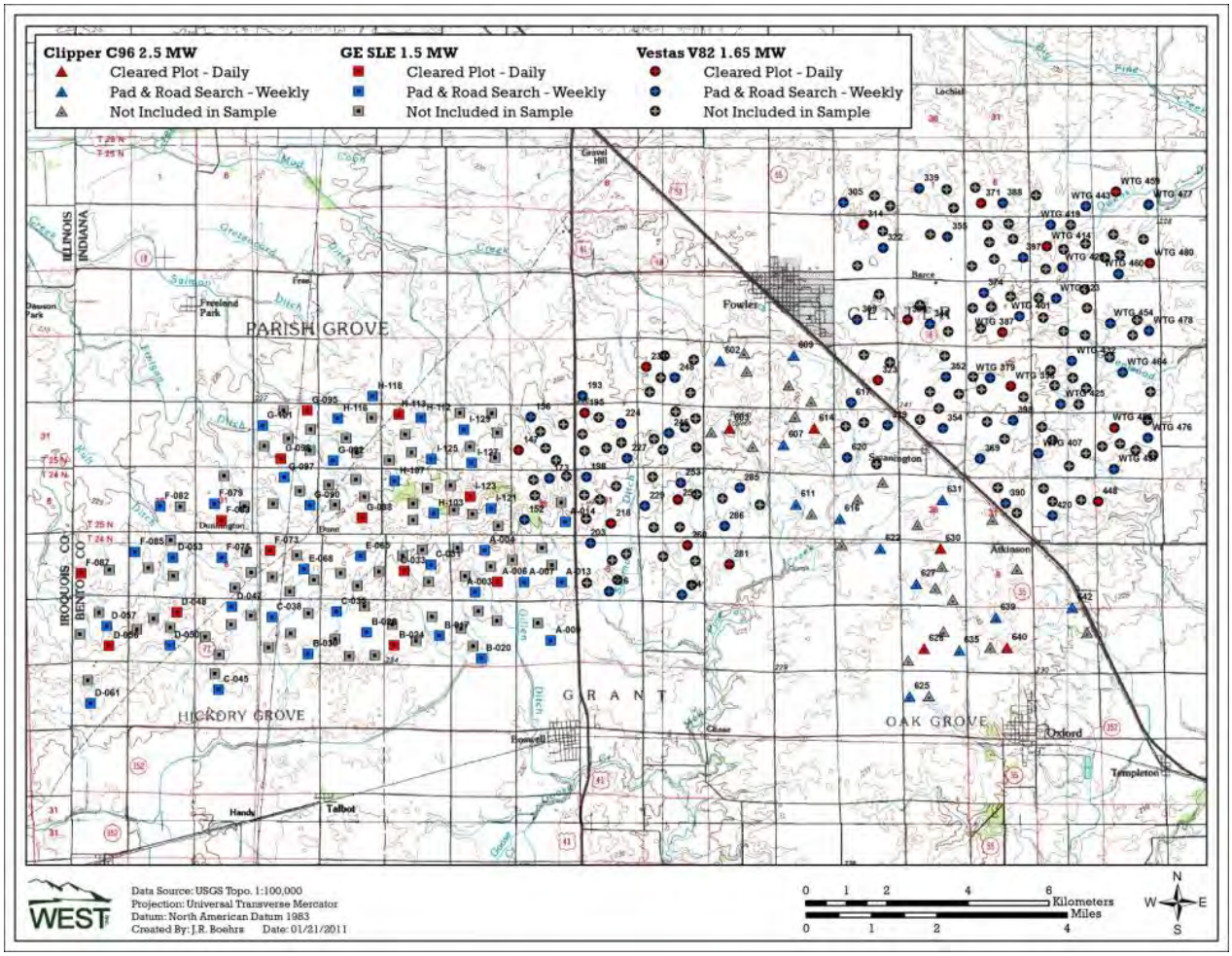

Figure 2. Elevation and topography of the Fowler Ridge Wind Farm.

Table 2. Land cover types within the Fowler Ridge Wind Farm.

Habitat Type	Acres	Percent Composition
Crops	51013.03	92.95%
Developed, Low Intensity	1505.60	2.74%
Developed, Open Space	1245.02	2.27%
Pasture/Hay	751.97	1.37%
Deciduous Forest	249.35	0.45%
Developed; Medium Intensity	47.60	0.09%
Grassland	22.79	0.04%
Open Water	17.02	0.03%
Developed, High Intensity	16.40	0.03%
Barren	10.02	0.02%
Emergent Wetlands	1.23	<0.01
Overall	**54,880.05**	**100**

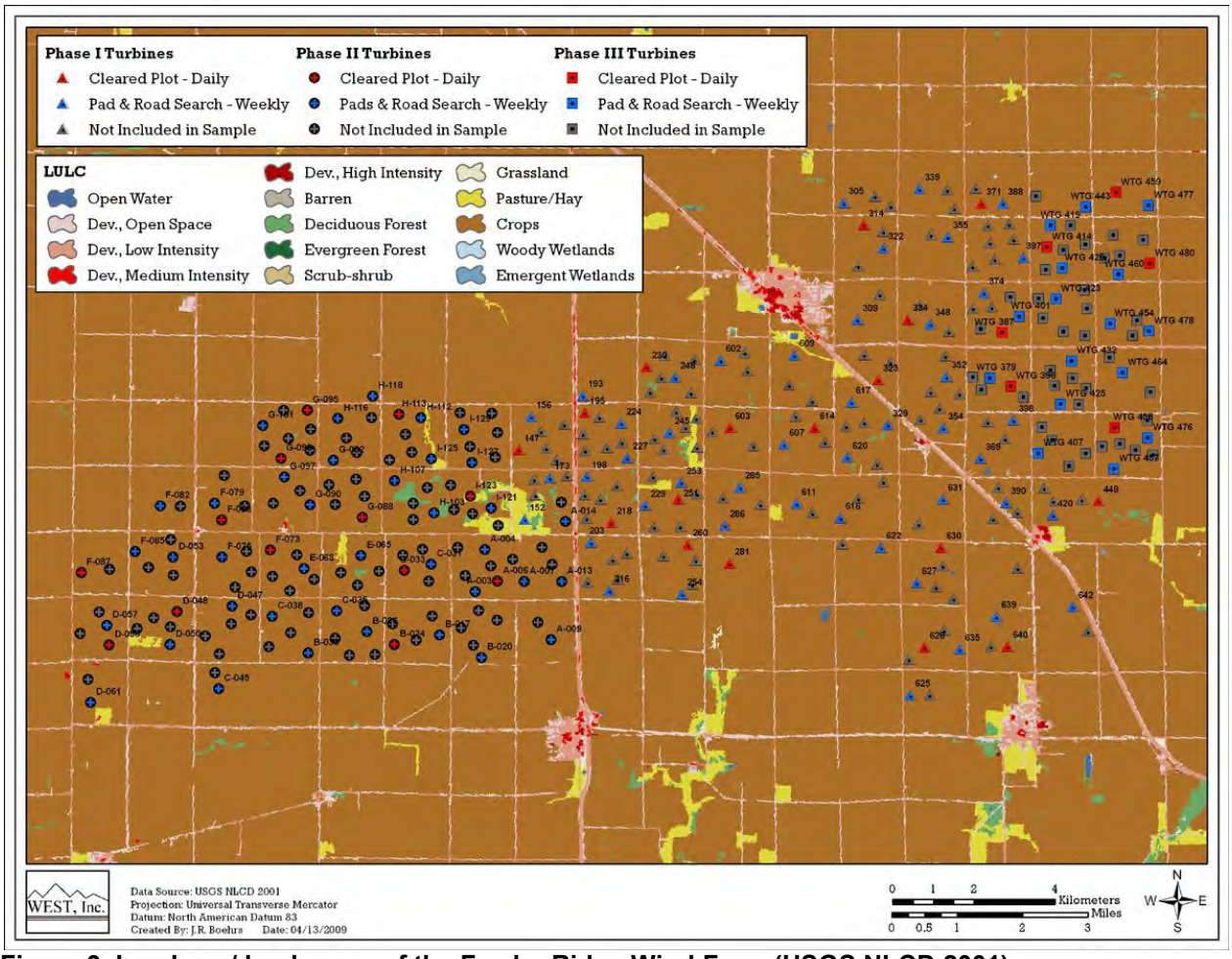

Figure 3. Land use/ land cover of the Fowler Ridge Wind Farm (USGS NLCD 2001).

METHODS

Bat Casualty Surveys

The primary objectives of the bat casualty study included:

1) Estimate the overall bat casualty rates within the FRWF in Phases I, II and III in order to make a scientifically defensible estimate of annual Indiana bat casualty rates.

2) Determine if statistical relationships exist between bat casualty rates and weather factors (e.g., wind speed, temperature).

3) Test the effectiveness of facility operations management for reducing bat casualty rates.

Seasons

The 2010 casualty study occurred during the spring (April 12 – May 15) and fall (August 1 – October 15) 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 original Indiana bat carcass was found on September 11, 2009 (see USFWS 2010), and based on timing and land cover surrounding the carcass and turbine, the bat was assumed to have been a fall migrant. The vast majority of bat fatalities of other species at Fowler I 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; Johnsonet al. 2010a, 2010b).

Search Plot and Sample Size

The FRWF is composed of 355 turbines. One-hundred-thirty-six turbines (about 38% of all turbines) were sampled during the study (Figure 2). Square 80 x 80 m plots at 36 turbines were maintained relatively free of vegetation in order to increase searcher efficiency rates (Figure 4). Plots were maintained throughout the study through the use of herbicides and mowing. The 80 x 80 m plot size was chosen based on the distances bats typically fall from turbines (Johnson et al. 2010b).

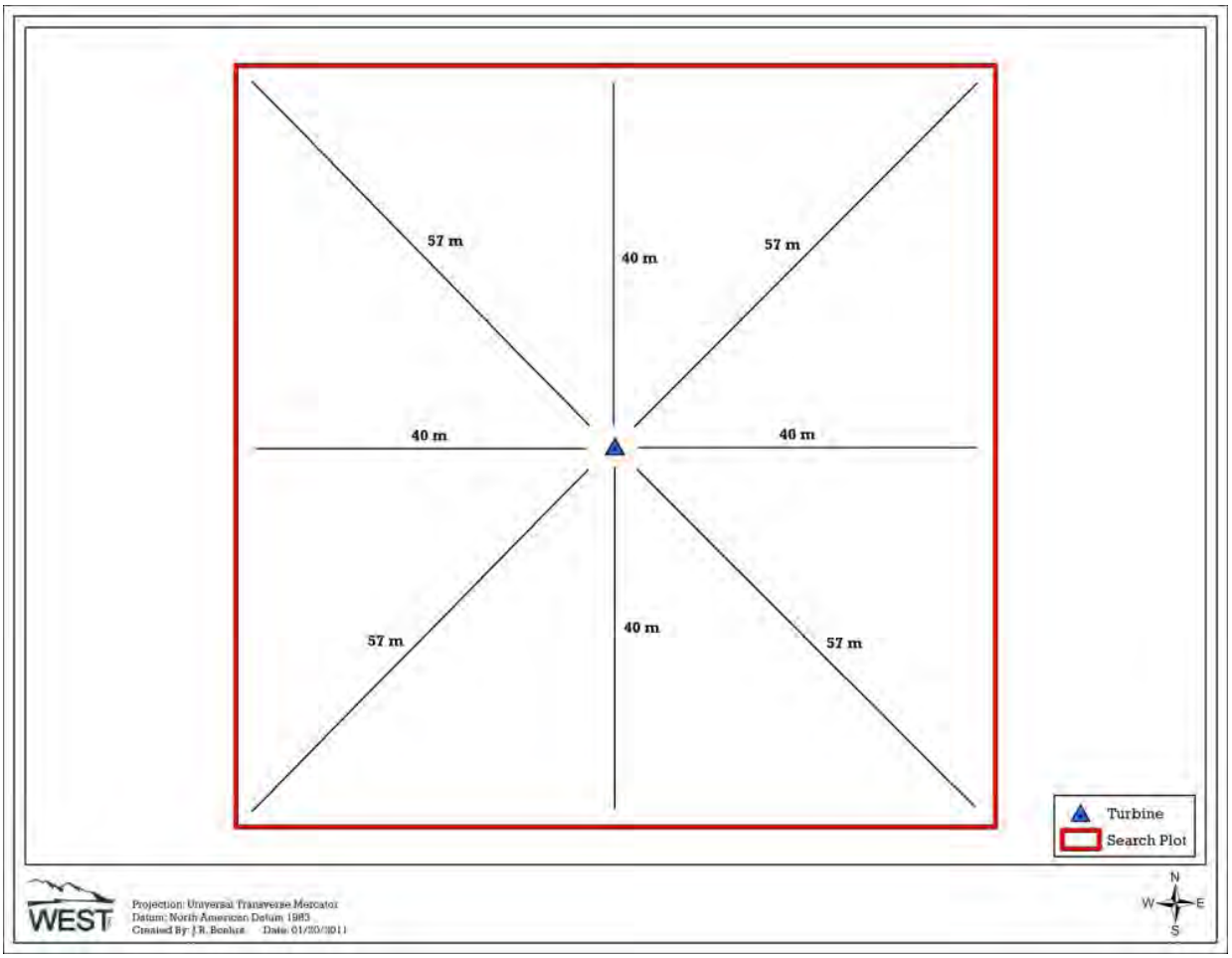

Figure 4. Example diagram of a search plot surrounding a turbine at the Fowler Ridge Wind Farm.

Carcass searches at an additional 100 turbines were conducted along access roads and turbine pads within 40 meters measured using sub-meter Global Positioning Systems (GPS). Roads

and pads were searched at these additional turbines in order to increase the spatial coverage of sampling efforts and to increase the probability of detecting an Indiana bat casualty. This proposed sampling approach assumes that representative casualty rates can be calculated by searching only road and turbine pads. This assumption was tested using a double-sampling approach within the 36 cleared plots described above. The locations of carcasses within the cleared plots were recorded (i.e., on turbine pad and road versus off turbine pads and roads) for use in analyses.

The 36 turbines with cleared plots were searched daily throughout the sampling period. The remaining 100 turbines without cleared plots were searched on a weekly basis. The search intervals proposed for the 2010 study season were based on the results of the 2009 casualty study. During 2009, the average length of stay for bat carcasses at the FRWF was 6.1 days (Johnson et al. 2010b).

Turbines were selected for sampling using a systematic design with a random start from a sample of turbines where landowners were willing to participate in the study. In this fashion, the search effort was spread across the entire FRWF.

Facilities Management Study

The effectiveness of altering turbine cut-in speeds in reducing bat casualty rates was evaluated during the fall of 2010. Facility management studies were limited to the fall because few bat fatalities were expected during the spring of 2010 (see Johnson et al. 2010a), potentially reducing our ability to detect significant differences in casualty rates between treatments.

Bat casualty rates were measured at two different cut-in 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 daily searched turbines for use as a “control” or “reference” sample for the duration of the study. Treatments for cut-in speed adjustment and a second set of “control” turbines were rotated on a weekly basis between the remaining 27 daily search turbines, with nine turbines assigned to each group. The treatments included turbines with cut-in speeds raised to 5 m/s, and turbines with cut-in speeds raised to 6.5 m/s. Turbines were randomly assigned to control and treatment groups among the 27 turbines, and treatments were distributed temporally to ensure each turbine received 3 - 4 weeks of treatment or control status.

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 side sides out to approximately 2.5 m (about eight ft) for casualties as they walked each transect. All bat carcasses were recorded and collected. Bird carcasses were recorded, but left in the field. Searches began after 7am each morning, and were completed by

sunset, with most searches completed by early afternoon. The order of turbines searched, as well as the orientation of search transects, was changed on a daily basis.

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

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.

- Scavenged - an entire carcass, which shows 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 has been heavily infested by insects.

- Feather Spot (for bird carcasses only) - 10 or more feathers at one location indicating predation or scavenging.

Fresh bat carcasses found were collected, identified, and utilized during searcher efficiency and carcass removal trials (except for *Myotis*; 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, 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.

All *Myotis* carcasses found 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. In order to verify field identifications of *Myotis* that could not be conclusively identified, skin samples were sent to Jan Zink at Portland State University for identification via deoxyribonucleic acid (DNA).

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.

Only freshly killed bats conclusively identified as non-*Myotis* 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 redistributed only the fresh bats at 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, distance and direction from turbine. Carcasses were identified as bias trials through the removal of the upper canine or placement of small, indistinct black zip ties on bat wings.

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 days during daily 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 canine teeth or 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, for a maximum of 28 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 2010 surveys, a second bat casualty rate was calculated utilizing an estimate of the probability of detection that doesn"t separate out the influence of scavenging versus searcher detection. This empirical estimate is based on the overall ratio of the number of trial carcasses found by searchers to the number placed. Only bats found at turbines with no cut-in speed adjustments 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; and

2) The probability that a carcass was present during a scheduled carcass search and detected by searchers. This probability was estimated both empirically and using Shoenfeld"s estimator. Shoenfeld"s estimate for the probability of availability and detection was based on non-removal rates, expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the observers during removal trials; and searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials. Empirical estimates of the probability a carcass was available and detected were calculated based on the overall detection of planted carcasses over a 28 day period.

Definition of Variables

The following variables are 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 remain in the study area after 30 days
se	standard error (square of the sample variance of the mean)
t_i	the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
$\bar{t}$	the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
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 is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials
$\hat{\pi}_e$	the empirical estimate for the probability that a carcass is both available to be found during a search and is found, as determined by the ratio of trial carcasses found over a 28 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:

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

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 ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

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

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*) is calculated by:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

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 are 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 $\hat{\pi}_E$ are caculated by the following equation.

$$\hat{\pi} = \frac{number\ of\ trial\ carcasses\ detected}{number\ of\ trial\ carcasses\ placed} \widehat{\pi\pi}_E = \frac{number\ of\ trial\ carcasses\ detected}{number\ of\ trial\ carcasses\ placed}$$

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 is the estimated standard error. The lower 5th and upper 95th percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

Effects of Raising Cut-In Speeds

Casualty rates for each cut-in speed were calculated along with corresponding 90% bootstrap confidence intervals. Estimates without overlapping confidence intervals were considered significantly different. In addition to using adjusted casualty estimates differences in cut-in speed were examined by building a Poisson model to determine the relative difference in casualty rates based on cut-in speed. The magnitude of model coefficients represents the relative ratio of casualty rates between curtailed treatments and those with no cut-in speed adjustment. Tests for variable selection were used to assess the statistical significance of the cut-in speed covariates. The estimated time since death for each bat carcass found was evaluated to determine which curtailment condition the bat casualty occurred during. Carcasses of bats that were estimated to have died prior to the start of the fall casualty search survey were not included in the analysis along with carcasses where the length of time since death could not accurately be determined.

Correlation Analyses

<u>Weather and Bat Casualty</u>

Weather data from casualty search turbines and a meteorological (met) tower were used to assess fall mortality rates at the FRWF in relation to weather variables (Table 3). Wind speed, wind direction, ambient temperature, and humidity were obtained from the anemometers on the met towers, while rotor speed, active power production, barometric pressure and additional wind speed data were collected at turbines. These analyses are considered exploratory analyses since explicit hypotheses were not developed a priori. General hypotheses based on previous knowledge of bat fatalities at wind projects have suggested negative relationships between wind speed and bat fatalities, as well as factors related to passage of weather fronts (e.g. temperature, humidity and barometric pressure).

Table 3. Descriptions of predictor variables used in the analyses for associations between weather characteristics and mortality

Predictor Variable [abbreviation]	Description
Wind Speed (m/s)	
[mean.ws]	Mean nightly wind speed; measured at and averaged across turbines and met towers
[sd.ws]	Standard deviation of the mean nightly wind speed across the 5 minute intervals
Wind Direction	
[mean.wd]	Mean nightly wind direction. 0 represents wind blowing toward the north ; measured at and averaged across met towers
Ambient Temperature (ºc)	
[mean.at]	Mean temperature measured at the met tower taken every 5 minutes for the entire 24 hour period before corresponding searches
[sd.at]	Standard deviation of the temperature for the 24 hour pervious previous to corresponding searches
[mean.nat]	Mean nightly temperature measured at the met tower taken every 5 minutes for the night previous to corresponding searches
[sd.nat]	Standard deviation of the nightly temperature for the night previous to corresponding searches
Humidity	
[mean.hu]	Mean humidity measured at the met tower taken; every 5 minutes for the 24 hour period before corresponding searches
[sd.hu]	Standard deviation of the humidity for the 24 hour period previous to corresponding searches
[mean.nhu]	Mean nightly humidity measured at the met tower; taken every 5 minutes for the night previous to corresponding searches
[sd.nhu]	Standard deviation of the nightly humidity for the night previous to corresponding searches
Rotor Speed (rpm)	
[mean.rs]	Mean nightly rotor speed; measured at and averaged across turbines and the 5 minute intervals
[sd.rs]	Standard deviation of the mean nightly rotor speed across the 5 minute intervals
Active Power	
[mean.ap]	Mean active power generated nightly; measured at and averaged across turbines and the 5 minute intervals
[sd.ap]	Standard deviation of active power generated nightly across the 5 minute intervals

Table 3. Descriptions of predictor variables used in the analyses for associations between weather characteristics and mortality

Predictor Variable [abbreviation]	Description
Barometric Pressure	
[mean.bp]	Mean barometric pressure measured at the met tower; taken every 5 minutes for the 24 hour period before corresponding searches
[sd.bp]	Standard deviation of the barometric pressure for the 24 hour period previous to corresponding searches
[range.bp]	Range of the barometric pressure measures taken 24 hours previous to corresponding searches; A negative value implies a drop in barometric pressure; Positive values corresponding with increases in barometric pressure
[mean.nbp]	Mean nightly barometric pressure measured at the met tower; taken every 5 minutes for the night previous to corresponding searches
[sd.nbp]	Standard deviation of the barometric pressure for the night previous to corresponding searches
[range.nbp]	Range of the nightly barometric pressure measures; A negative value implies a drop in barometric pressure; Positive values corresponding with increases in barometric pressure

Associations between turbine and weather characteristics and fresh bat casualties were investigated using Poisson modeling with the response variable being the count of fresh bat casualties found during each fall survey date with an offset term for the corresponding number of turbines searched. The fitted Poisson models all had log link and were of the form:

$$\log(\mu) = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon$$

which related the behavior of the natural logarithm of the mean number of fresh bat mortalities per turbine, 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 is a random error term. The statistical software R was used to fit all possible Poisson models with 8 or fewer explanatory variables. Akaike's information criterion (AIC) was used to determine the best fitting Poisson models. To avoid the negative effects of colinearity, variables with pairwise correlations ≥ 0.6 were not allowed to be present in the models at the same time. Residuals of selected models were plotted to determine goodness of fit.

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 keyed 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

The objectives of the bat acoustic surveys included:

1) Develop predictive models of bat use by species or species groups, based on weather variables;

2) Determine if bat use rates by species or species group were related to bat casualty rates;

3) Determine if the Anabat ultrasonic bat detector was an effective tool for predicting bat casualty rates;

4) Determine periods of time during which minimization measures may be most effective; and

5) Determine if relatively large amounts of Indiana bat activity occurred during spring and fall migration.

Bat surveys were conducted utilizing passive sampling techniques at turbines and locations that were previously sampled in 2007, and surveys were also conducted utilizing active sampling within the general project area. Passive sampling occurred at the base of turbines during spring migration (Figure 5), and at the base and on top of nacelles of four turbines searched daily during the fall migration period, to explore relationships between bat pass rates, bat casualty rates, and weather variables (Figure 6). Monitoring at Anabat stations during the fall period began August 1 for stations located below turbines. Monitoring on nacelle units began 17 days later on August 18 due to equipment malfunctions. Bat use was also monitored at locations that were sampled in 2007 from July 15 – October 15 in order to determine if bat pass rates were similar before and after construction of the FRWF (Figure 6). Additional active acoustic bat sampling was conducted during the migration periods in order to increase the probability of detecting Indiana bat calls if Indiana bats were present.

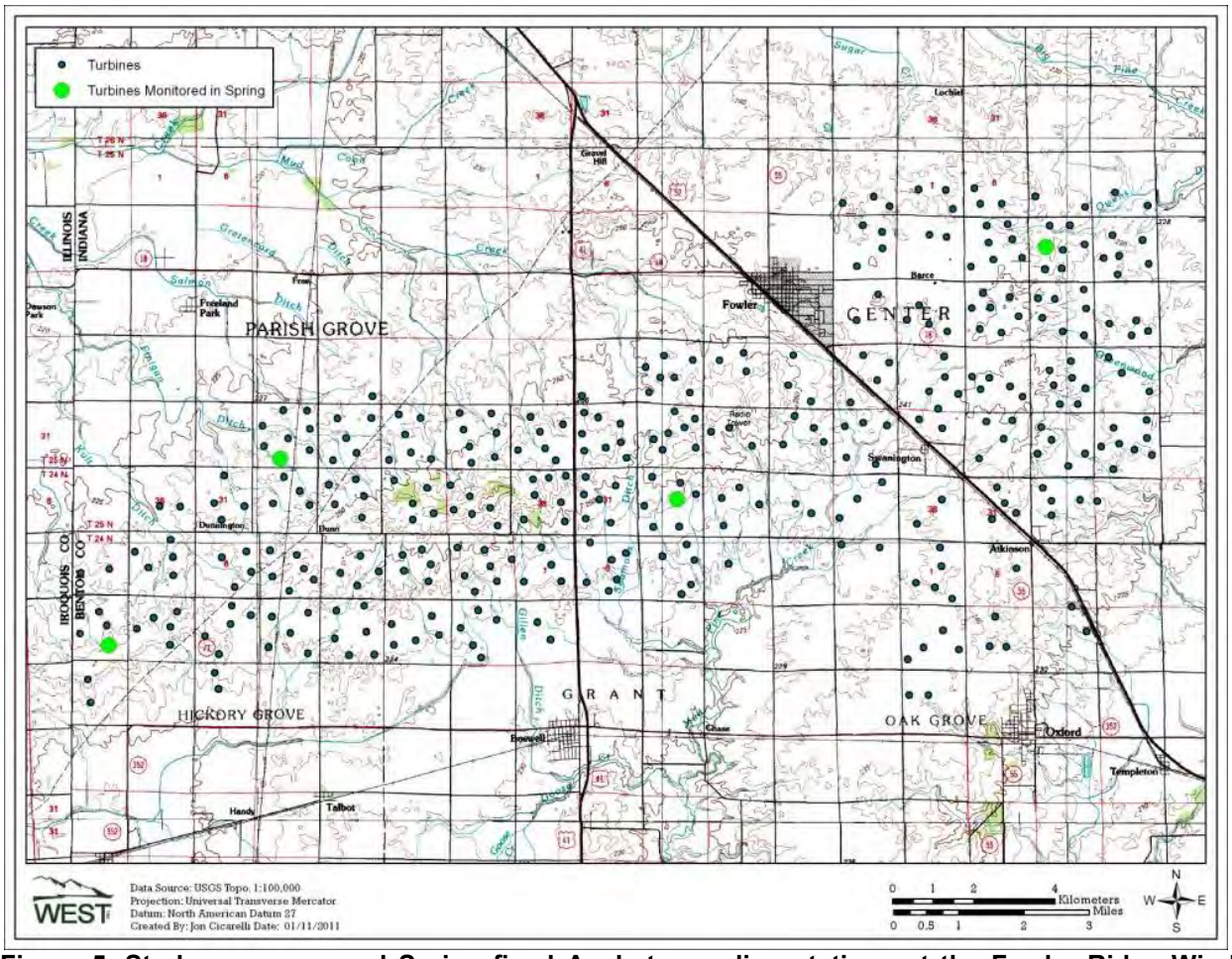

Figure 5. Study area map and Spring fixed Anabat sampling stations at the Fowler Ridge Wind Farm.

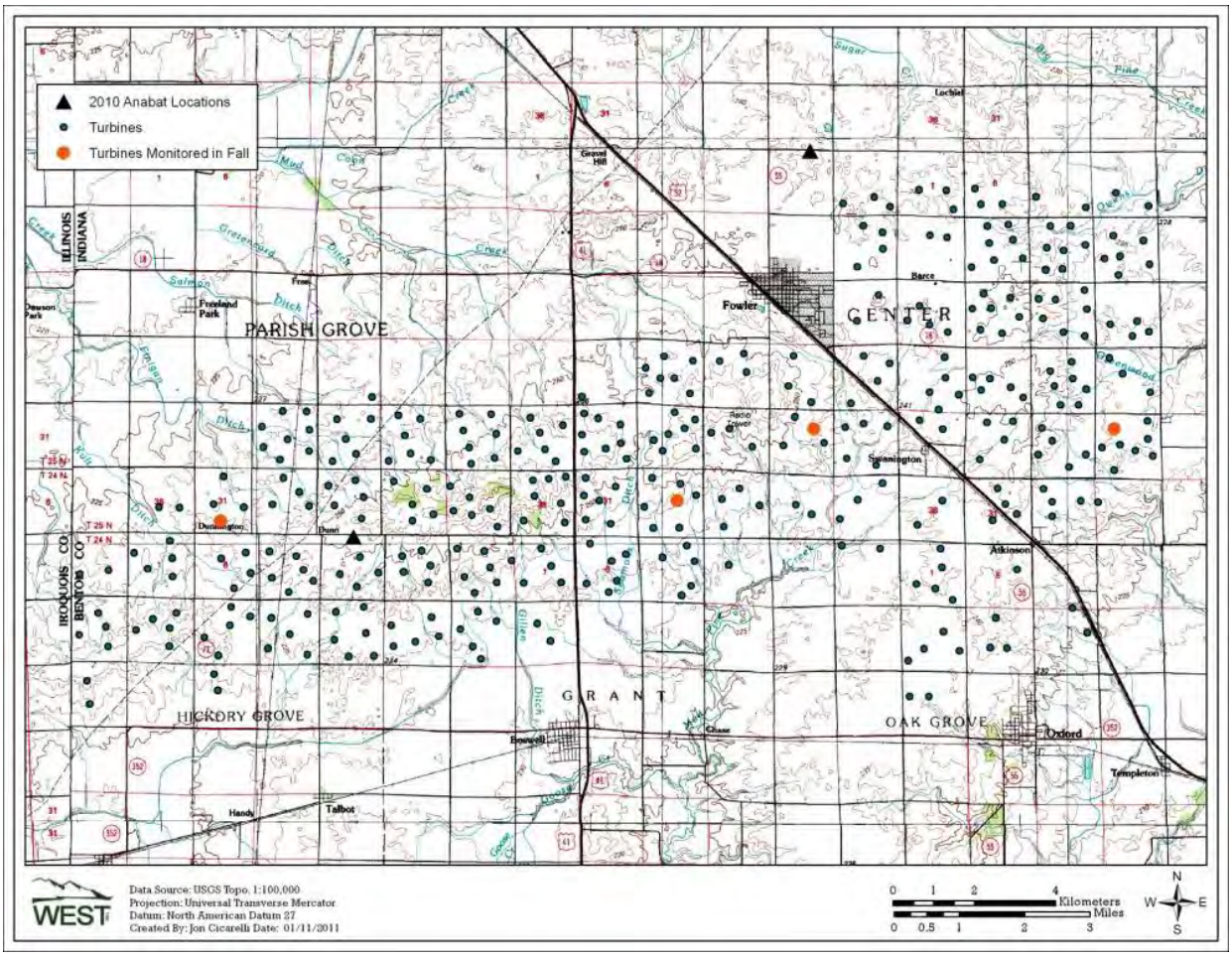

Figure 6. Study area map and Fall fixed Anabat sampling stations at the Fowler Ridge Wind Farm. Triangles depict locations that were monitored in 2007 and 2010.

Bats were surveyed using Anabat™ II bat detectors (Titley Scientific™, Australia) coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Scientific™, Australia), 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. 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) on 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.

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 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 (262 ft) 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.

Acoustic Surveys for Indiana Bats

Active Anabat surveys were conducted twice per week during the spring and fall. Surveys were conducted on relatively warm and calm nights, which focused survey efforts when bat activity was expected to be highest. The objective of the surveys was to provide additional information for understanding the extent of Indiana bat migration through the FRWF. Active surveys were conducted by driving east-west transects along county roads across the study area and recording bat calls utilizing Anabat technology. During each survey night, biologists stopped for 5 – 10 minutes and recorded bat calls at areas expected to attract bats, such as water sources, shelterbelts, and woodlots. Surveys were conducted for a total of at least five hours each survey night with surveys starting at sunset and ending five hours after sunset, the period when bat activity was expected to be highest. All bat passes were identified to species or species group, and potential calls made by Indiana bats were identified using methods described below.

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, we classified calls as being given by high-frequency (HF; > 40 kHz), mid-frequency (MF; 30 kHz - 40 kHz), or low-frequency (LF; < 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 4; Harvey et al. 1999, BCI 2011). 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 4. Bat species with ranges that overlap with the Fowler Ridge Wind Farm, sorted by call frequency (Harveyet al. 1999, BCI 2011).

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
*= Federally listed endangered species

All high-frequency (above 40 kilohertz (kHz)) bat calls were 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, Wolf et al. 2009).

The DF Model has been developed based on a library of 663 known bat call files from 11 species that occur in the Midwest, including 93 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 (Murrayet al. 2001, O"Farrell et al. 1999, 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.

Bat Acoustical Activity and Casualties

Acoustical bat activity (number of bat passes per detector night) taken from Anabat units located at the base and on nacelles of selected turbines was also investigated in relation to observed casualty rates at FRWF through the use of graphical methods, linear regression lines, and Pearson"s correlation coefficients. Correlations between activity at ground and nacelle detectors and casualties were restricted to dates past the night of August 18, 2010 when nacelle units were in place. Acoustic activity rates for ground and combined ground and nacelle activity rates from the beginning of fall surveys (August 1, 2010) were also included with weather variables in the Poisson modeling process and a similar process was used to determine the effectiveness of predicting observed casualty rates by ground and/or nacelle Anabat detectors. Only bat fatalities occurring at turbines with no cut-in speed adjustments were used in these analyses.

RESULTS

The following sections contain the results of studies conducted under permit TE15075A. 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), detailed information in nightly operating parameters of each turbine searched and which specimens were salvaged at each turbine (Appendix E), and nightly wind speeds and weather (Appendix F). Other information required under permit TE15075A can be found below.

Bat Fatalities

A total of 3,871 plot surveys were conducted during 110 visits to the study area at the 36 daily search turbines, with an additional 1,618 surveys being conducted during 17 visits to the facility at the 100 turbines selected for road and pad surveys. A total of 809 bat carcasses were found, of which 556 bats were found during regularly scheduled searches, with an additional 25 bats being found incidentally at turbine search plots. The remaining 228 bat carcasses were found outside of the study period during clearing searches or not on scheduled search turbines and were not included in the casualty estimates (Table 5).

Table 5. Total number of bat carcasses and percent composition of carcasses discovered at the Fowler Ridge Wind Farm from April 13 – May 15, 2010 and July 30 – October 15, 2010.

Species	Scientific Name	Scheduled Search Fatalities	Incidental Fatalities During the Study[1]	Other Incidental Fatalities[2]	Total Fatalities	% Comp.
eastern red bat	*Lasiurus borealis*	353	15	147	515	63.66
hoary bat	*Lasiurus cinereus*	84	7	55	146	18.05
silver-haired bat	*Lasionycteris noctivagans*	98	0	13	111	13.72
big brown bat	*Eptesicus fuscus*	16	3	12	31	3.83
tri-colored bat	*Perimyotis subflavus*	2	0	1	3	0.37
Indiana bat	*Myotis sodalis*	1	0	0	1	0.12
little brown bat	*Myotis lucifugus*	2	0	0	2	0.25
Overall	***7 species***	**556**	**25**	**228**	**809**	**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

The most commonly found bat species was eastern red bat (515 fatalities, 63.66% of fatalities), followed by hoary bat (146 fatalities, 18.05%), silver haired bat (111 fatalities, 13.72%), and big brown bat (31 fatalities, 3.83%). Three tri-colored bats, two little brown bats, and one Indiana bat carcass were also found (Table 5). More male than female bat carcasses were found during 2010 casualty searches (Table 6).

Relative species composition varied between the spring and fall seasons. Silver-haired bats were the most commonly found species in the spring, while eastern red bats were the most common casualty in the fall (Table 7).

Table 6. Gender composition by species found during 2010 carcass searches at the Fowler Ridge Wind Farm.

Species	Scientific Name	Gender	Number of Individuals	% Total	% Comp.
big brown bat	*Eptesicus fuscus*	Female	7	0.9	22.6
big brown bat		Male	11	1.4	35.5
big brown bat		Unknown	13	1.6	41.9
Total			**31**	**3.8**	**100**
eastern red bat	*Lasiurus borealis*	Female	102	12.6	19.8
eastern red bat		Male	141	17.4	27.4
eastern red bat		Unknown	272	33.6	52.8
Total			**515**	**63.7**	**100**
hoary bat	*Lasiurus cinereus*	Female	32	4.0	21.9
hoary bat		Male	40	4.9	27.4
hoary bat		Unknown	74	9.1	50.7
Total			**146**	**18.0**	**100**
Indiana bat	*Myotis sodalis*	Female	1	0.1	100
Indiana bat		Male	0	0	0
Indiana bat		Unknown	0	0	0
Total			**1**	**0.1**	**100**

Table 6. Gender composition by species found during 2010 carcass searches at the Fowler Ridge Wind Farm.

Species	Scientific Name	Gender	Number of Individuals	% Total	% Comp.
little brown bat	*Myotis lucifugus*	Female	0	0	0
little brown bat		Male	0	0	0
little brown bat		Unknown	2	0.2	100
Total			**2**	**0.2**	**100**
silver-haired bat	*Lasionycteris noctivagans*	Female	28	3.5	25.2
silver-haired bat		Male	46	5.7	41.4
silver-haired bat		Unknown	37	4.6	33.3
Total			**111**	**13.7**	**100**
tri-colored bat	*Perimyotis subflavus*	Female	1	0.1	33.3
tri-colored bat		Male	0	0	0
tri-colored bat		Unknown	2	0.2	66.7
Total			**3**	**0.4**	**100**
Overall			**809**	**100**	

Table 7. Composition of species by season for all bat carcasses found or reported at the Fowler Ridge Wind Farm.

Species		Spring	Fall	Overall
eastern red bat	*Lasiurus borealis*	15	500	515
hoary bat	*Lasiurus cinereus*	2	144	146
silver-haired bat	*Lasionycteris noctivagans*	18	93	111
big brown bat	*Eptesicus fuscus*	1	30	31
tri-colored bat	*Perimyotis subflavus*	0	3	3
little brown bat	*Myotis lucifugus*	0	2	2
Indiana bat	*Myotis sodalis*	0	1	1
Total		**36**	**773**	**809**

Eastern red bats comprised a higher percentage of the bat fatalities in 2010 compared to data from 2009 at Phase I (63.7% vs. 35.9%). Hoary bats and silver-haired bats comprised a lower percentage of the bat fatalities in 2010 (18.05% and 13.72%) compared to 2009 (30.8% and 26.9%, respectively; Johnson et al. 2010a).

A total of 60 birds were also discovered during carcass searches in 2010 (Table 8). No bird species listed as threatened or endangered under the state of Indiana (INHDC 2010) or federal endangered species acts (ESA 1973, USFWS 2011) were found.

Table 8. Total number of bird carcasses found at the Fowler Ridge Wind Farm from April 13 – May 15, 2010 and July 30 – October 15, 2010.

Species	Scientific Name	Total Bird Carcasses	% Composition
killdeer	*Charadrius vociferus*	9	15.0
European starling	*Sturnus vulgaris*	5	8.3
golden-crowned kinglet	*Regulus satrapa*	5	8.3
unidentified bird		5	8.3
cliff swallow	*Petrochelidon pyrrhonota*	3	5.0
mourning dove	*Zenaida macroura*	3	5.0
red-tailed hawk	*Buteo jamaicensis*	3	5.0
American redstart	*Setophaga ruticilla*	2	3.3
chimney swift	*Chaetura pelagica*	2	3.3
common yellowthroat	*Geothlypis trichas*	2	3.3
horned lark	*Eremophila alpestris*	2	3.3
Nashville warbler	*Vermivora ruficapilla*	2	3.3
ruby-crowned kinglet	*Regulus calendula*	2	3.3
Tennessee warbler	*Vermivora peregrina*	2	3.3
unidentified dove		2	3.3
unidentified passerine		2	3.3
house sparrow	*Passer domesticus*	1	1.7
red-eyed vireo	*Vireo olivaceus*	1	1.7
rough-legged hawk	*Buteo lagopus*	1	1.7
ring-necked pheasant	*Phasianus colchicus*	1	1.7
rock pigeon	*Columba livia*	1	1.7
ruby-throated hummingbird	*Archilochus colubris*	1	1.7
red-winged blackbird	*Agelaius phoeniceus*	1	1.7
unidentified kinglet		1	1.7
yellow-throated vireo	*Vireo flavifrons*	1	1.7
Overall		**60**	**100**

Estimated Time since Death

Most of the bat casualties (64.92%) found during daily casualty searches were estimated to have been killed the previous night, 22.65% were estimated to have been killed 2-3 days prior to discovery, and 8.01% were estimated to be 4-7 days old (Table 9). The remaining 4.4% of bat fatalities found during daily searches were estimated to be greater than seven days old.

Table 9. Estimated time since death for bat casualties found at the Fowler Ridge Wind Farm from April 13 – October 15, 2010.

Estimated Time Since Death	Percentage during Daily Searches	Percentage during Weekly Searches
previous night	64.92	30.52
2-3 days	22.65	32.86
4-7 days	8.01	30.52
7-14 days	3.04	1.88
>2 weeks	0.83	0.47
>month	0.28	0
unknown	0.28	3.76

Timing of Bat Fatalities

Bat casualties occurred throughout the study period (Figure 9) with the majority being found during the month of August. Similarly, most bat fatalities recorded at FRWF during 2009 were recorded between August 1 – September 15 (Johnson et al. 2010b).

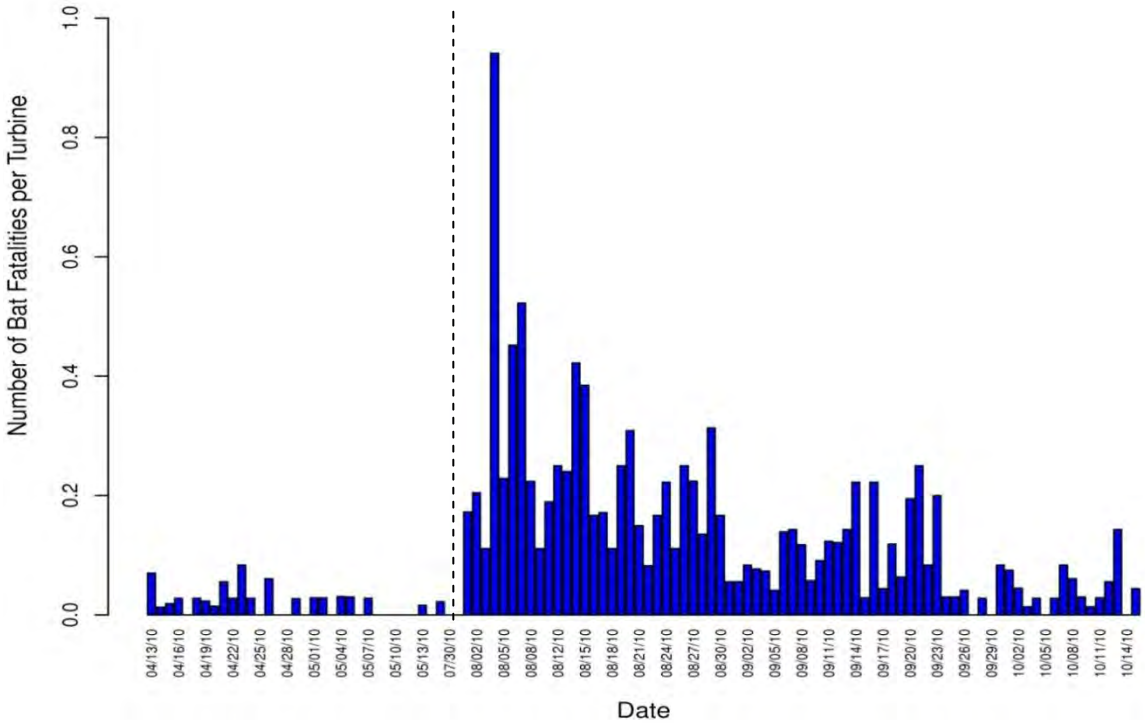

Figure 9. Timing of bat mortality at the Fowler Ridge Wind Farm from April 13 – May 15, 2010 and July 30 – October 15, 2010.

One Indiana bat casualty was recorded during the study on September 18, 2010. The only other Indiana bat found as a casualty at FRWF was recorded on September 11, 2009 (Johnson et al. 2010b). The Indiana bat casualty occurred later than the five other *Myotis or Perimyotis* casualties at the FRWF in 2010; the four other *Myotis* or *Perimyotis* were found on 7/31, 8/20, 8/22, and 8/26. Similarly, in 2009 the single Indiana bat casualty was found later than other *Myotis* casualties; the four other *Myotis or Perimyotis* casualties in 2009 were found on 5/5, 8/22, 8/25, and 8/27. The later date, and consistency between years, associated with the two Indiana bat casualties support the premise that the two Indiana bats found as casualties at the FRWF were fall migrants.

Locations of Bat Casualties

The 80 x 80 m plot size was chosen based on the distances bats were found from turbines during previous studies of the FRWF, when approximately 88% of all bat fatalities were found

within 40 m of turbine locations (Johnson et al. 2010b). The vast majority of fatalities at the daily search turbines (89.29%) were found ≤30 m from a turbine, while 94.67% of fatalities at roads and pads were found ≤30 m from a turbine (Table 10, Figure 10).

Table 10. Distribution of distances of bat casualties from turbines at the Fowler Ridge Wind Farm from August 1 – October 1, 2010.

Distance to Turbine (m)	% Bat Casualties On Roads and Pads	% Bat Casualties Search Turbines	% Bat Casualties Incidentals
0 – 10	46.67	11.39	71.01
11 – 20	20.67	20.73	8.70
21 – 30	15.67	33.03	11.59
31 – 40	11.67	24.15	5.80
>40	5.33	10.71	2.90

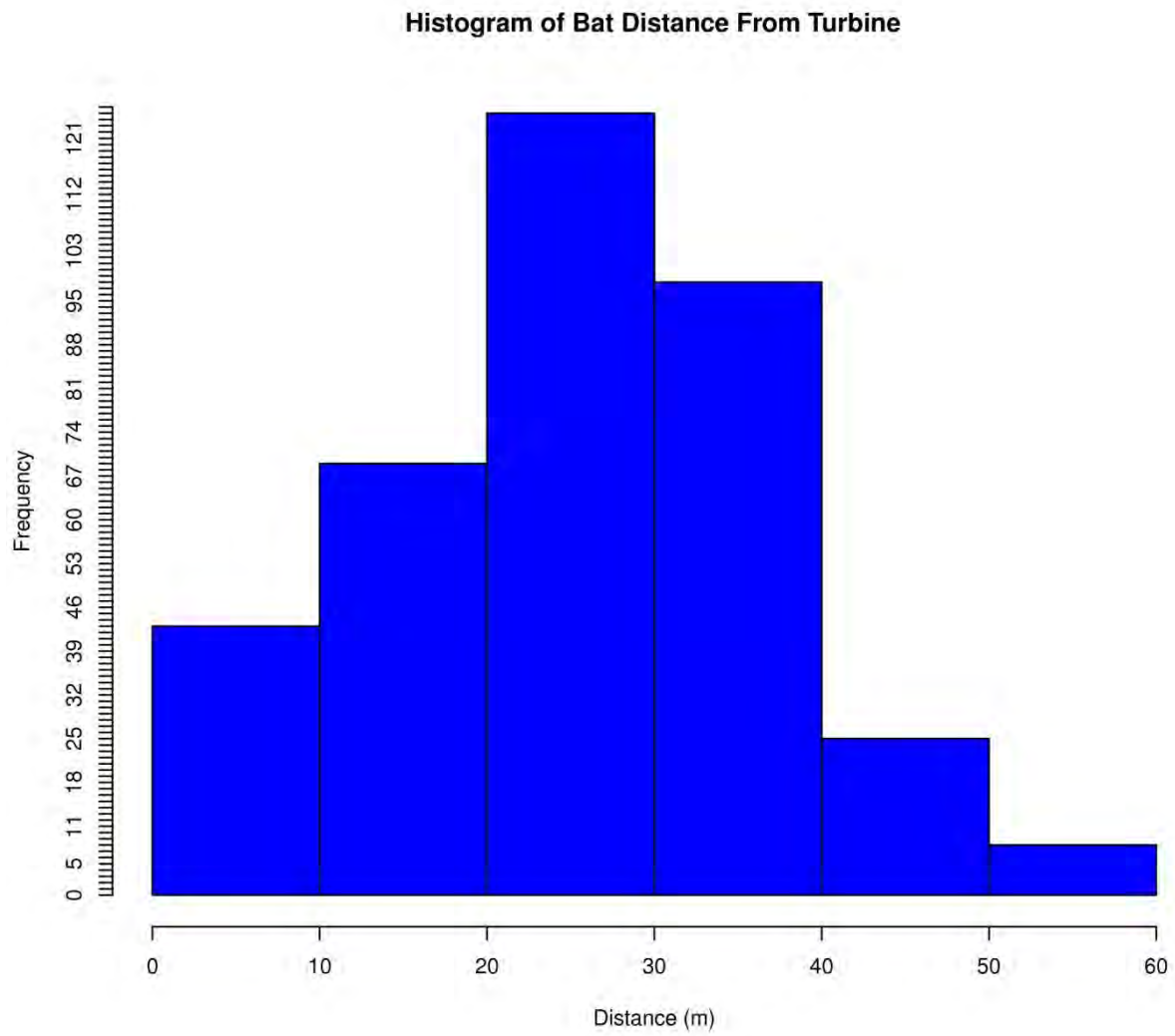

Figure 10. Distance from turbine for all bat casualties found at the Fowler Ridge Wind Farm.

The two turbines with the highest number of recorded bat fatalities were turbines 459 (33) and 628 (31). Both turbines were within the control group (i.e. no cut-in speed adjustments were made to either turbine throughout the study). The next highest total found at a turbine was 21, found at a turbine included in the curtailment experiment (turbine 640). The number of bat casualties found at other turbines and search plots ranged from zero to 18.

A visual examination of the number of bats found by turbine suggested that a relationship exists between geographic location and number of bat casualties, with a general trend of more bat casualties found in the central portion of the project (Figure 11). Trends in geographic location correspond to turbine models in those areas. In general, weekly observed casualty rates were higher for Clipper C96 turbines than for Vestas V82 turbines with both types of turbines having higher observed casualty rates than General Electric SLE turbines (Figure 12).

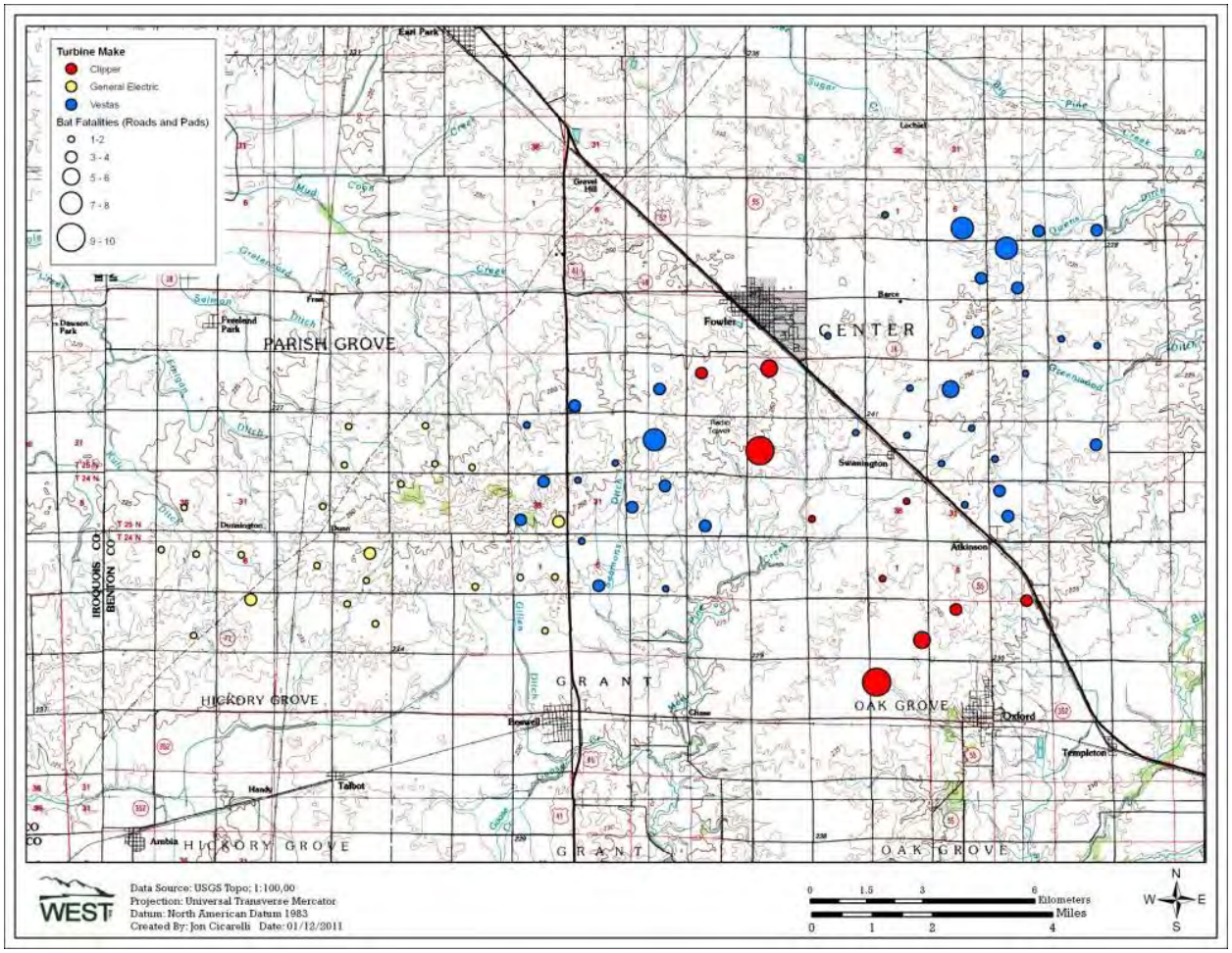

Figure 11. Number of bat casualties found at road and pad searches within the Fowler Ridge Wind Farm in 2010.

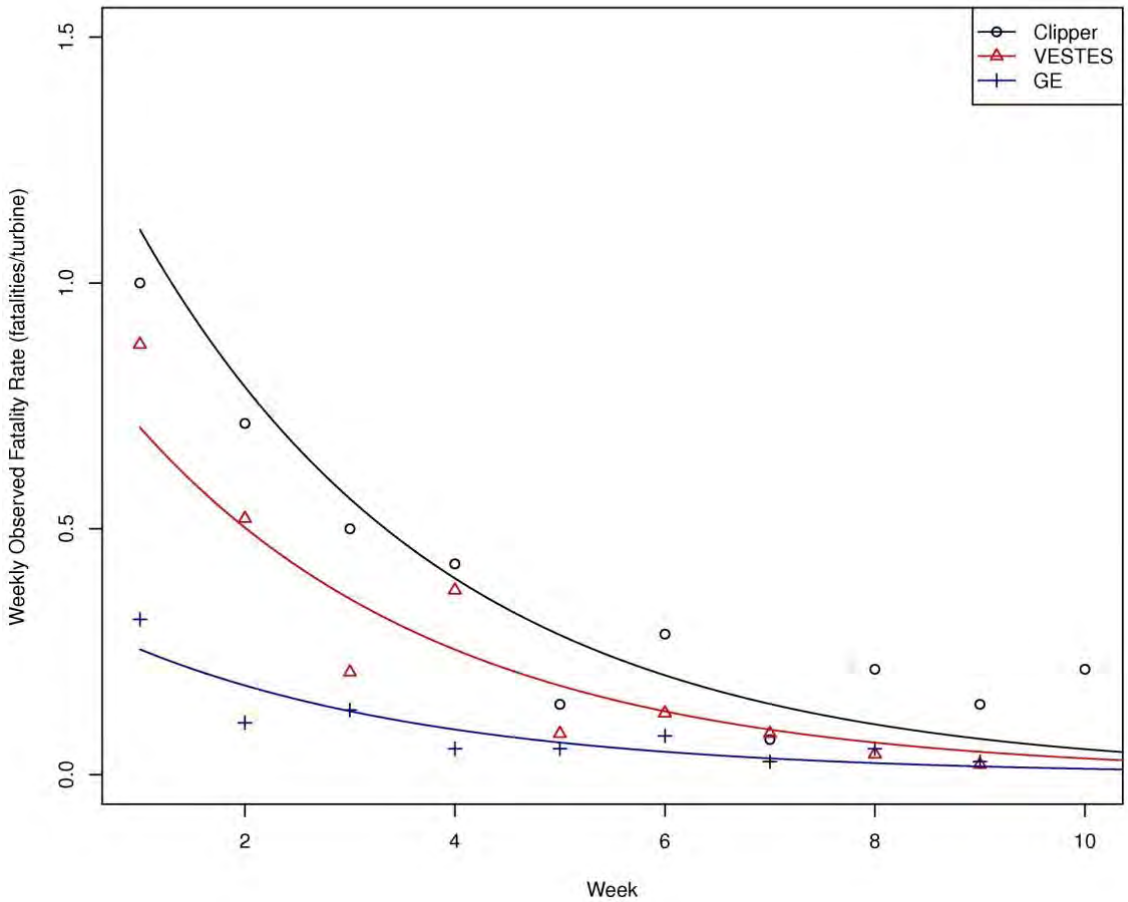

Figure 12. Fall weekly observed casualty rates at the Fowler Ridge Wind Farm by turbine model with Poisson regression lines based on model parameter estimates for the variable week.

The relationship between bat fatality rates at weekly road and pad only searches and proximity to potential bat habitat and other features was also investigated. Observed fatality counts by turbine were included in a Poisson model and analyzed against turbine type with covariates for the nearest water source (distWater), the nearest woodlot/shelterbelt (distance to forest), and the percent of area within 400 meters of turbines in a given crop type (pcCORN, pcSOY, pcOTHER). Week was also included in the model to account for temporal variation of observed fatality counts. An exhaustive variable selection process was conducted and all models contained significant variables for week and turbine type. All other covariates included in modeling were not significant after having adjusted for week and turbine type.

Model A

$$\log(\text{weekly fatality count per turbine}) = 0.52 - 0.46\,VESTAS - 1.48\,GE - 0.37\,week$$

Poisson regression coefficients suggest there were 1.59 times more fatalities at Clipper turbines than at VESTAS turbines and 4.41 times more than at GE turbines (Model A). Corresponding

90% confidence intervals for the multiplicative increase in fatality counts of Clipper turbines in relation to VESTAS (1.2, 2.1) and GE (3.1, 6.42) suggest that the effect of turbine type is significantly different from one even after adjusting for all other coefficients in the model. The observed fatality rates at different turbine types also follows differences in rotor diameter, with Clipper turbines having the largest rotor diameter, followed by Vestas and GE. The nacelle height of all three turbine types was 80 m.

Very few *Myotis* or *Perimyotis* were found as casualties at the FRWF, making it difficult to determine if any geographic patterns existed. While most *Myotis* and *Perimyotis* carcasses were found within Phase I, carcasses were found at all three turbine types, and Phase I covers a relatively large portion of the overall FRWF (Figure 13). Habitat characteristics were also similar when comparing between phases (Figure 14). *Myotis* and *Perimyotis* carcasses were found at varying distances from water and forested areas, and no clear patterns of carcass location in relation to land cover or habitat characteristics were apparent (Table 11).

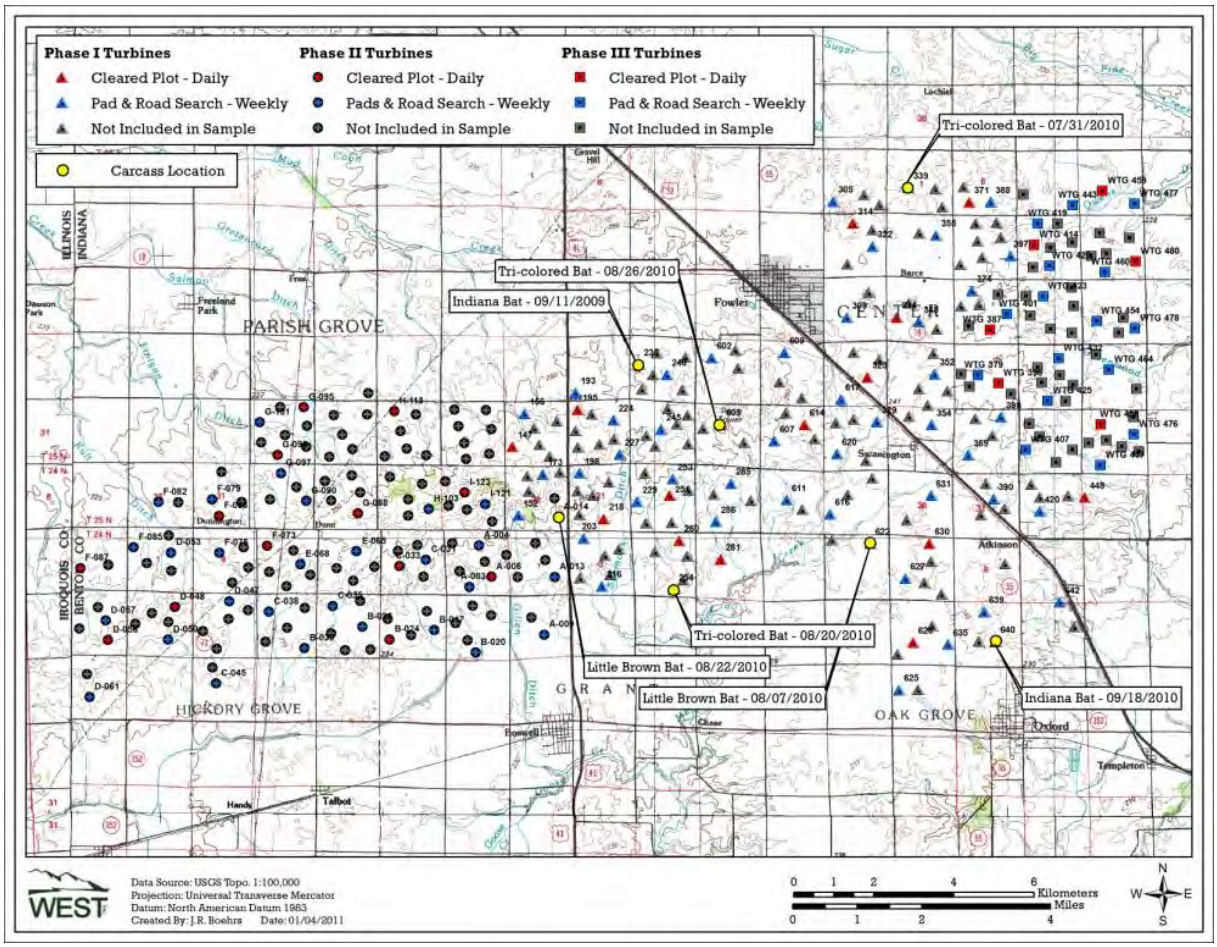

Figure 13. Locations of 2010 *Myotis/Perimyotis* carcasses and the 2009 Indiana bat carcass found at the Fowler Ridge Wind Farm.

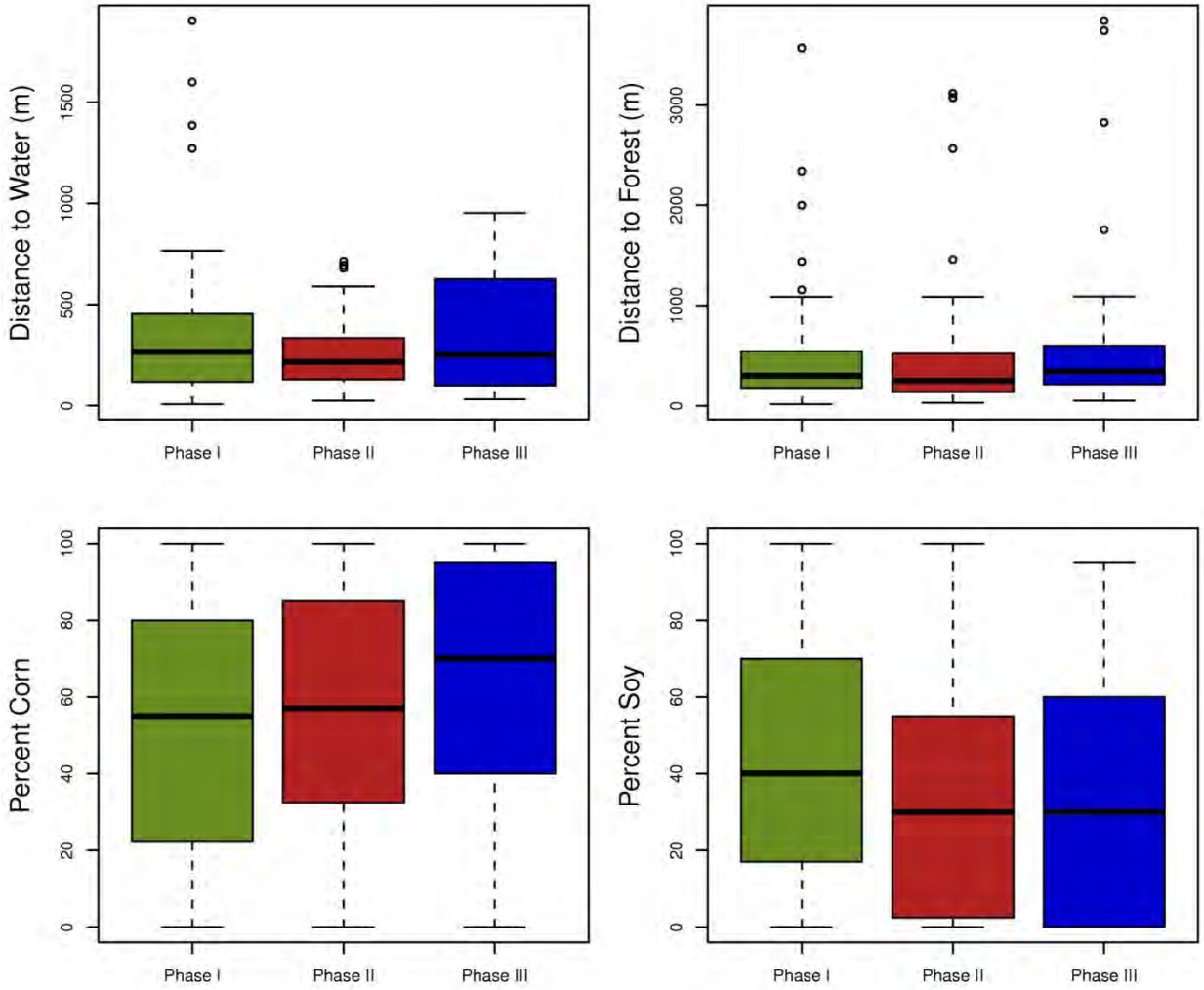

Figure 14. Box plots illustrating the similarity in habitat characteristics associated with turbines searched, by phase, at the Fowler Ridge Wind Farm during 2010.

Table 11. Turbine locations of 2010 *Myotis/Perimyotis* carcasses and the 2009 Indiana bat carcass found at the Fowler Ridge Wind Farm.

Date	Species	Age	Sex	Turbine	Model	Phase	Treatment	Estimated Time of Death	Distance to Water (m)	Distance to Forest (m)
9/11/2009	Indiana bat	A	F	230	Vestas	I	NA	2 to 3 days	180	598
8/7/2010	little brown bat	U	U	622	Clipper	I	Road & Pad	4 to 7 days	449	2000
7 /31/2010	tri-colored bat	U	U	339	Vestas	I	Road & Pad	2 to 3 days	150	2340
8 /20/2010	tri-colored bat	U	U	254	Vestas	I	Road & Pad	2 to 3 days	205	150
8 /22/2010	little brown bat	A	U	14	GE	II	Road & Pad	4 to 7 days	126	177
8 /26/2010	tri-colored bat	J	F	603	Clipper	I	5 m/s	Last Night	164	600
9 /18/2010	Indiana bat	A	F	640	Clipper	I	5 m/s	Last Night	45	45

Searcher Efficiency Trials

Searcher efficiency trials were conducted throughout the study period at both daily search turbines and the weekly turbine road and pad searches. A total of 192 carcasses were placed at daily search turbines, of which 55 were both available and found (31.79% efficiency) during the next search day. A total of 125 carcasses were placed at the weekly turbine road and pad plots, of which 77 were both available and found on the next search day (84.62% searcher efficiency; Table 12).

Table 12. Single day searcher efficiency results at the Fowler Ridge Wind Farm.

Plot Type	Placed	Available	Found	Percent Found
Plot	192	173	55	31.79
Road & Pad Only	125	91	77	84.62

Carcass Removal Trials

A total of 233 fresh bat carcasses and 53 mice were placed during carcass removal trials throughout the study period. Carcass removal trials for bats showed that by Day 3, approximately 50% of the bats remained, by Day 7, approximately 35% remained, and by Day 14, approximately 20% of the bats remained (Figure 15). The mean length of stay before removal or decomposition was 10.34 days.

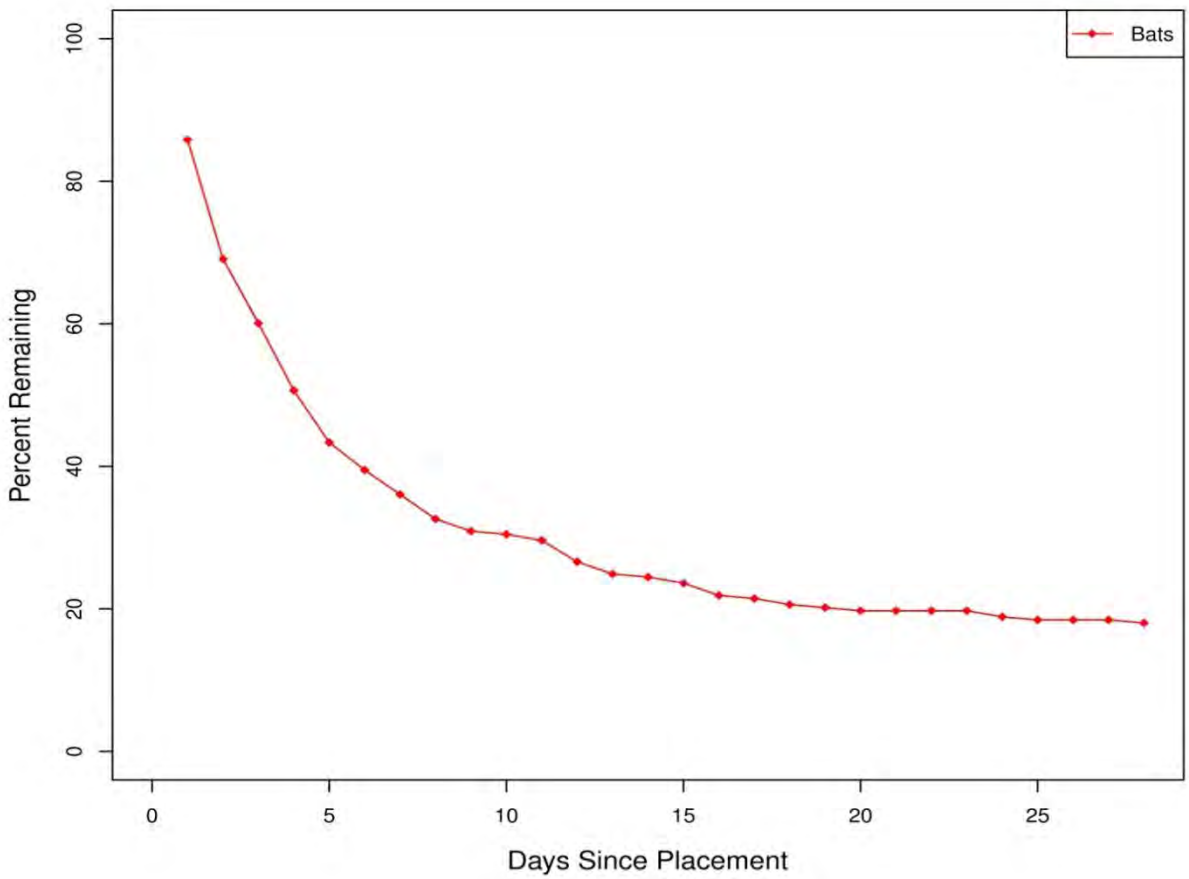

Figure 15. Removal rates for bats during carcass removal trials at the Fowler Ridge Wind Farm.

Empirical Estimate of the Probability of Carcass Availability and Detection

A total of 222 trial carcasses were used in calculating an empirical estimate of the probability of availability and detected. These carcasses were allowed to remain where placed for up to 28 days and the date when searchers found the carcasses was noted. Carcasses placed 10 days prior to survey completion were not included in these estimates due to insufficient time for predation to occur. This was based on the average carcass removal rate of 10.34 days.

Of the 222 carcasses placed 77 were placed on turbines where only the road and pad was searched and 145 were placed on turbines where cleared plots were searched. The empirical estimate for the probability of available and detected on weekly road/pad searches was 0.51 and 0.58 for cleared plot turbines respectively (Table 13).

Table 13. Empirical estimates for the probability of available and detected at the Fowler Ridge Wind Farm.

Plot Type	Placed	Found	Proportion Ever Found
Plot	145	84	0.58
Road & Pad Only	77	39	0.51

Adjusted Casualty Estimates

While searches at cleared plots encompassed an area where at least 88% of 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 total bats found at cleared plot turbines to the number of bats found on roads and pads of cleared plots (5.10; Table 14) as an adjustment factor for casualty estimates at road and pad only plots. Only bats found during the fall were used for this calculation, because roads and pads were not constructed and present at all search turbines during the spring.

We also examined the proportions of bats, by species, that fell within cleared plots versus roads and pads, to determine if bat species fell at similar distances from turbines. Differences were analyzed using a chi-square test for proportions which tests whether the ratios observed by species are significantly different from each other. Results did not indicate that the distance or location where bats fell varied between eastern red bats, hoary bats, and silver-haired bats. Sample sizes were too small to investigate if differences existed for other bat species. An overall area adjustment value of 5.10 was used based on no significant difference in bat casualty distribution by species (chisq=1.38, df=5, p-value=0.93; Table 14).

Table 14. Search area adjustment for road and pad only searches by species at the Fowler Ridge Wind Farm.

Species	On Road/Pad of Cleared Plot	Total Cleared Plot	Adjustment
big brown bat	1	8	8.00
eastern red bat	40	215	5.38
hoary bat	13	53	4.08
Indiana bat	0	1	--
little brown bat	0	0	--
silver haired bat	13	64	4.92
tri-colored bat	0	1	--
Overall	**67**	**342**	**5.10**

The 80 X 80 m cleared plots were established to ensure all areas within 40 m of a turbine were searched. 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). Johnson et al. (2010b) found approximately 88% of bat fatalities within 40 m of turbine locations, thus no search area adjustment factor was used for cleared plot searches. Average search intervals (1.02 days for daily searches and 7.45 days for weekly searches) were calculated for weekly road and pad searches (Table 15).

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 79% for daily searches (both spring and fall), 65% for spring weekly searches and 68% for fall weekly searches (Table 16). The estimated number of bat fatalities per turbine (based on Shoenfeld"s pi estimates) was 0.91 for daily search plots and 0.43 for weekly search plots during the spring season. These estimates increased during the fall season, with 17.69 bat fatalities per turbine per season at daily search turbines and 15.73 bats per turbine per season at weekly search turbines (Table 16).

Based on Shoenfeld estimates for the probability of carcass availability and detected the estimated number of bat fatalities per turbine per season was 0.586 during the spring and 16.830 during the fall with an overall adjusted casualty estimate for bat of 16.59 bats per turbine per study period (Table 16). The 2010 Shoenfeld overall bat casualty estimate for the FRWF was slightly higher than the 2009 estimate for Phase I (15.03 bats / turbine in 2009; see Johnson et al. 2010b).

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 0.74 bats per turbine in the spring and 21.45 bats per turbine in the fall with an overall adjusted casualty estimate of 22.20 bats per turbine per study period (Table 17).

Table 15. Bootstrap point estimates (mean) and lower (ll) and upper (ul) of 90% confidence intervals for bat observed casualty rates at the Fowler Ridge Wind Farm.

	Spring Estimates						Fall Estimates											
	Daily 80x80m Plot Searches			Weekly Road & Pad Searches			Daily Control 80x80m Plot Searches			Daily 5.0 m/s Cut-in 80x80m Plot Searches			Daily 6.5 m/s Cut-in 80x80m Plot Searches			Weekly Road & Pad Searches		
		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
Search Area Adjustment																		
Bats	1.00	--	--	5.10	--	--	1.00	--	--	1.00	--	--	1.00	--	--	5.10	--	--
Average Search Interval																		
Bats	1.02	--	--	7.45	--	--	1.03	--	--	1.03	--	--	1.03	--	--	6.76	--	--
Observer Detection																		
Bats	0.32	0.26	0.38	0.85	0.80	0.89	0.32	0.26	0.38	0.32	0.26	0.38	0.32	0.26	0.38	0.85	0.80	0.89
Average Removal Time																		
Bats	10.34	8.69	12.18	10.34	8.69	12.18	10.34	8.69	12.18	10.34	8.69	12.18	10.34	8.69	12.18	10.34	8.69	12.18
Observed Casualty Rates (fatalities/turbine/season)																		
Bats	0.72	0.47	1.00	0.05	0.02	0.10	14.00	11.56	16.50	7.00	5.11	9.11	3.00	1.78	4.22	2.08	1.75	2.42

Table 16. Bootstrap point estimates (mean) and lower (ll) and upper (ul) of 90% confidence intervals for bat casualty rate estimates using the Shoenfeld estimator for the probability a carcass is available and detected at the Fowler Ridge Wind Farm.

	Spring Estimates						Fall Estimates											
	Daily 80x80m Plot Searches			Weekly Road & Pad Searches			Daily Control 80x80m Plot Searches			Daily 5.0 m/s Cut-in 80x80m Plot Searches			Daily 6.5 m/s Cut-in 80x80m Plot Searches			Weekly Road & Pad Searches		
		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
Average Probability of Carcass Availability and Detected (Shoenfeld)																		
Bats	0.79	0.74	0.83	0.65	0.61	0.70	0.79	0.74	0.83	0.79	0.74	0.83	0.79	0.74	0.83	0.68	0.63	0.83
Adjusted Casualty Estimates (fatalities/turbine/search type/season)																		
Bats	0.91	0.60	1.27	0.43	0.16	0.77	17.69	14.62	21.30	8.84	6.32	11.51	3.79	2.27	5.50	15.73	13.34	18.43

Seasonal Adjusted Casualty Estimate (fatalities/turbine/season)

		90% Confidence Interval				90% Confidence Interval	
	mean	lower limit	upper limit	mean	lower limit	upper limit
Bats	0.56	0.32	0.82	16.03	13.95	18.33

Overall Adjusted Casualty Estimates

		90% Confidence Interval	
	mean	lower limit	upper limit
Bats	16.59	14.36	18.92

Table 17. Bootstrap point estimates (mean) and lower (ll) and upper (ul) of 90% confidence intervals for bat casualty rate estimates using an empirical estimate for the probability a carcass is available and detected at the Fowler Ridge Wind Farm.

	Spring Estimates						Fall Estimates											
	Daily 80x80m Plot Searches			Weekly Road & Pad Searches			Daily Control 80x80m Plot Searches			Daily 5.0 m/s ut-in 80x80m Plot Searches			Daily 6.5 m/s Cut-in 80x80m Plot Searches			Weekly Road & Pad Searches		
		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
Average Probability of Carcass Availability and Detected (multiple search p)																		
Bats	0.58	0.51	0.65	0.51	0.40	0.60	0.58	0.51	0.65	0.58	0.51	0.65	0.58	0.51	0.65	0.51	0.40	0.60
Adjusted Casualty Estimates (fatalities/turbine/search type/season)																		
Bats	1.25	0.82	1.74	0.55	0.21	1.07	24.17	19.50	30.02	12.08	8.63	16.11	5.18	3.12	7.53	20.96	17.52	28.78

Seasonal Adjusted Casualty Estimate (fatalities/turbine/season)						
		90% Confidence Interval			90% Confidence Interval	
	mean	lower limit	upper limit	mean	lower limit	upper limit
Bats	0.74	0.44	1.14	21.45	18.50	28.34

Overall Adjusted Casualty Estimates			
		90% Confidence Interval	
	mean	lower limit	upper limit
Bats	22.20	19.32	29.17

Effects of Raising Turbine Cut-In Speeds on Bat Casualty

Estimated time of death data were used to determine the curtailment condition that the casualty most likely occurred during. Two hundred fifty-two bat carcasses were determined to have occurred at turbines while under normal operational cut-in speeds of 3.5 m/s (control) throughout fall casualty searches. This compares to 63 dead bats found at turbines with cut-in speeds raised to 5.0 m/s and 27 dead bats found at turbines with cut-in speeds raised to 6.5 m/s (Table 18). This resulted in observed casualty rates and corresponding 90% bootstrap confidence intervals of 14.0 (11.6 - 16.5), 7.0 (7.0 - 9.1), and 3.0 (1.8 - 4.2) bats/turbine/season for control, 5.0 m/s, and 6.5 m/s treatment conditions respectively (Table 15). Non-overlapping confidence intervals for observed casualty rates under each cut-in speed condition indicate a significant difference between treatments. An approximate 50% reduction in overall bat mortality was realized by raising the cut-in speed by 1.5 m/s (from 3.5 m/s to 5.0 m/s). An approximate 78% reduction in overall bat mortality was realized by raising the cut-in speed by 3.0 m/s (from 3.5 m/s to 6.5 m/s).

Table 18. Distribution of bat casualties by turbine cut-in speed at the Fowler Ridge Wind Farm.

Species	Control Count	5.0 m/s Count	6.5 m/s Count	Total
big brown bat	7	1	0	8
eastern red bat	168	32	15	245
hoary bat	34	12	7	53
Indiana bat	0	1	0	1
silver-haired bat	43	16	5	64
tri-colored bat	0	1	0	1
Overall	**252**	**63**	**27**	**342**

Poisson modeling of observed casualty rates resulted in significant cut-in speed covariates and week effect covariate. Although blocking by week can potentially eliminate temporal effects, a definite trend was observed by week and therefore week was left as a fixed effect in the model to account for this variation. The parameter estimate for the 5.0 m/s cut-in speed was -0.69, which corresponds to a 0.5 = exp(-0.69) incident rate ratio (i.e. the ratio of the casualty rate occurring at turbines with cut in speeds of 5.0 m/s to the casualty rate occurring at turbines with cut in speeds of 3.5 m/s) confirming a 50.0% reduction in casualty rates when turbines have a cut-in speed of 5.0 m/s having adjusted for all other model variables. The corresponding 90% confidence interval for the 5.0 m/s incident rate ratio implies a reduction in casualty rates of between 37.3% and 60.6%.The parameter estimates for the 6.5 m/s cut in speed treatment were also significant with a value of -1.54 which corresponds to a 0.2 incident rate ratio. This implies a reduction of 78.6% in casualty rate for turbines curtailed below wind speeds of 6.5 m/s with a 90% confidence interval of 70.5% to 84.9%. Non-overlapping confidence intervals between cut-in speeds of 5.0 m/s and 6.5 m/s suggests a significant difference in casualty rates between these treatments. The incident rate ratio between treatment types Is 0.4 which corresponds to a 57.3% reduction in fatalities at 6.5 m/s cut-in speeds when compared to 5.0 m/s cut-in speeds. A visual of model fit and interpolation is shown in Figure 16.

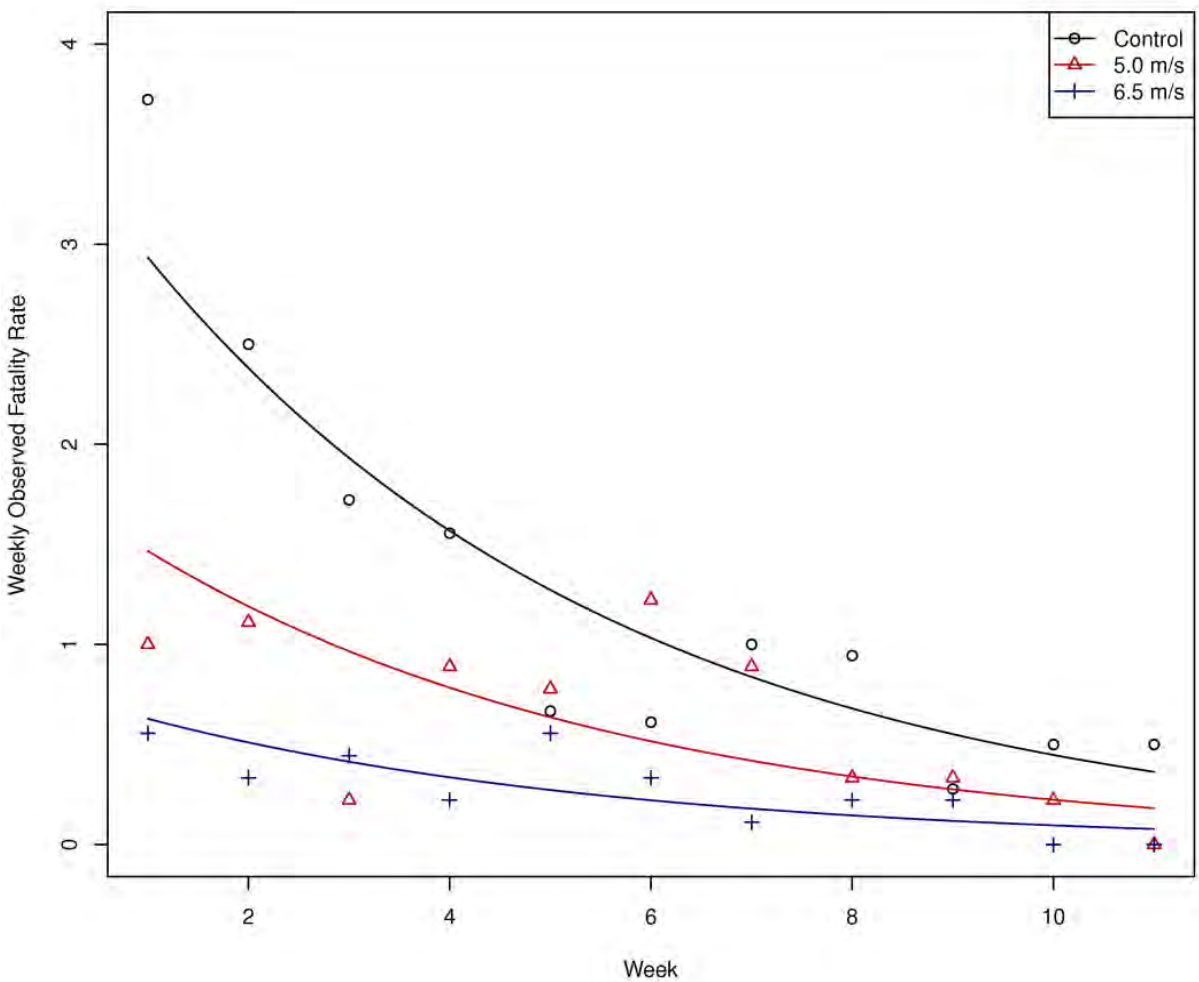

Figure 16. Weekly observed casualty rate at the Fowler Ridge Wind Farm by week with Poisson regression lines based on model parameter estimates for cut-in speed adjustments.

Based on weather data collected at casualty search turbines and an on-site meteorological tower during fall surveys at FRWF, the average nightly wind speed (between 7:00 pm and 7:00 am) at the FRWF was 5.70 m/s (18.69 ft/s) during the study period. Nightly wind speeds at the FRWF were below 5.0 m/s approximately 43.4% of the time, and were below 6.5 m/s approximately 63.7% of the time (Table 19). It is impossible to know exactly when each bat casualty occurred during a night, so it cannot be determined whether the cut-in speed restrictions were active at a particular turbine when the casualty occurred. However, the turbines were estimated to be operating approximately 21.6% less at the 5.0 m/s and 42.1% less at the 6.5 m/s treatments than turbines that were fully operational.

Table 19. Percentage of time the wind speed at the Fowler Ridge Wind Farm is below the given wind speed. Wind speed is based on the average of winds speeds collected at casualty search turbines and one on-site meteorological tower.

Wind Speed (m/s)	Percentage of Time Below
3.5	21.6
4.0	28.9
4.5	36.2
5.0	43.3
5.5	50.6
6.0	57.4
6.5	63.7

The Indiana bat carcass found in 2010 appeared to be fresh, and was likely killed the night before the date of discovery. The turbine had a cut-in speed adjustment of 5.0 m/s the night the bat was thought to be killed. Although the turbine was under a cut-in speed adjustment, wind speeds during the night of the casualty were over 5.0 m/s for much of the evening (Figure 17); thus the turbine was likely operating at wind speeds greater than 5.0 m/s when the Indiana bat casualty occurred.

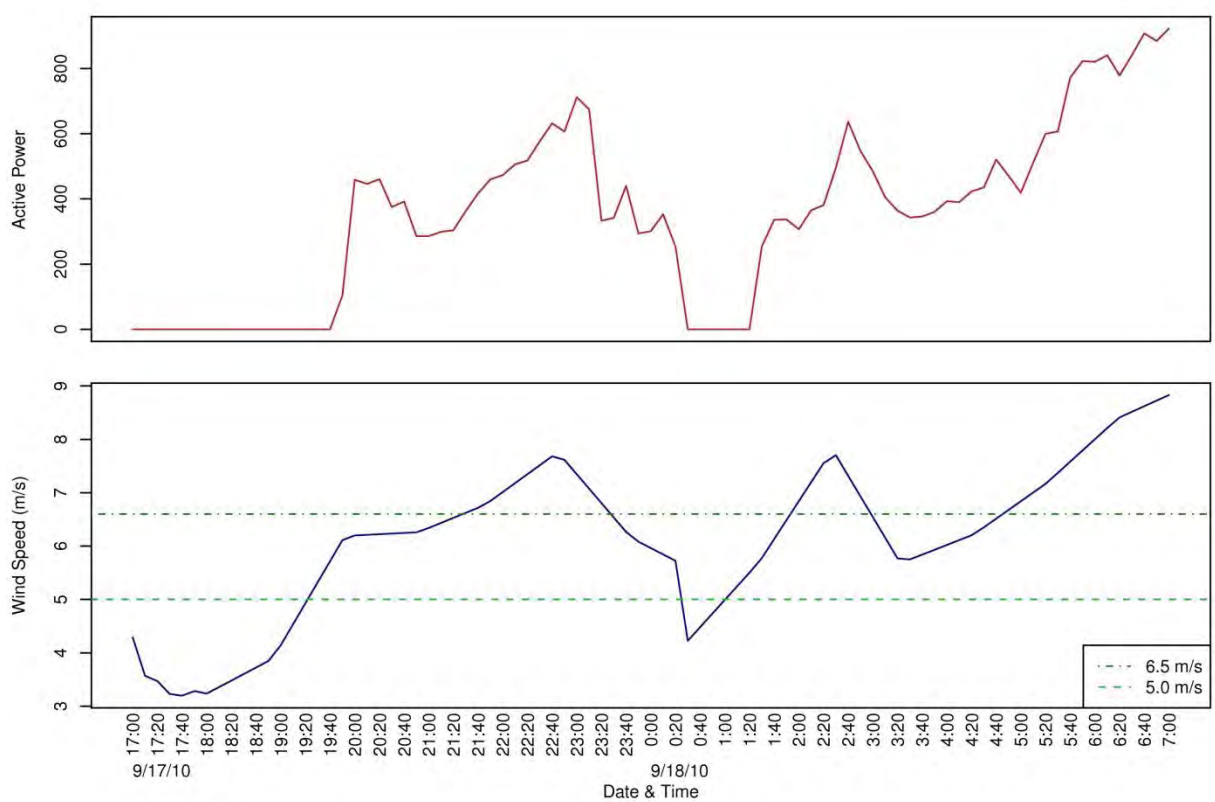

Figure 17. Wind speeds during the evening of September 17 and early morning of September 18 at the location of the Indiana bat casualty at the Fowler Ridge Wind Farm.

Correlation Analyses

Weather and Bat Casualty

All of the top ten Poisson models for explaining casualty rates by weather, chosen by AIC, contained the variables mean nightly wind speed (mean.ws) and mean nightly ambient temperature for the 24 hour period before corresponding searches (mean.nat; Table 20). The standard deviation of the ambient temperature (sd.at) and the mean humidity (mean.hu) for the 24 hour period before corresponding searches were also included in 9 of the 10 top models.

Table 20. Variables in the top Poisson regression models based on AIC for weather correlation analyses at the Fowler Ridge Wind Farm.

AIC	β_1	β_2	β_3	β_4	β_5…
270.0	mean.ws	mean.nat	sd.at	mean.hu	--
270.5	mean.ws	mean.nat	sd.at	mean.hu	mean.bp
271.1	mean.ws	mean.nat	sd.at	mean.hu	range.nbp
271.2	mean.ws	mean.nat	sd.at	mean.hu	mean.wd
271.3	mean.ws	mean.nat	sd.at	--	mean.nhu
271.4	mean.ws	mean.nat	sd.at	mean.hu	mean.nbp
271.9	mean.ws	mean.nat	--	mean.hu	mean.bp, range.nbp
271.9	mean.ws	mean.nat	sd.at	mean.hu	sd.nbp
272.0	mean.ws	mean.nat	sd.at	mean.hu	csd.ws
272.0	mean.ws	mean.nat	sd.at	mean.hu	sd.bp

The model with the lowest AIC contains all four of the previously discussed variables exclusively (Model B).

Model B

$$\log\big(mean(fresh\ bat\ fatalities\ per\ search)\big)$$
$$= -6.69 - 0.15\ mean.ws + 0.14\ mean.nat + 0.38\ sd.at + 0.02\ mean.hu$$

This model indicates a significant negative effect for mean wind speed. Specifically, as mean wind speed increases by one meter per second the incident rate ratio of a casualty decreases by a factor of 0.86. In other words a 14% decrease in fatalities was realized for every one meter per second increase in wind speed. The corresponding 90% confidence interval for decreases in casualty due to mean wind speed ranged from 7% to 21% decrease for every one meter per second increase in wind speed. Mean nightly ambient temperature, the standard deviation of the ambient temperature (sd.at) and the mean humidity (mean.hu) for the 24 hour period before corresponding searches show a significant positive effect on bat casualty rates. Figure 18 shows this relationship for each variable when all other variables are held constant at their respective means. Larger casualty rates for temperature and humidity most likely correspond with the higher bat activity during the early fall period when temperatures are warmer with decreasing activity and casualty towards the end of fall when temperatures begin to cool. The positive relation of casualty rates to the standard deviation of the ambient temperature for the 24 hour period before corresponding searches may be attributed to the larger variance in temperatures on warm days followed by cooler nights, or may be associated with the passage of storm fronts and changes in temperature. Coefficients for these variables suggest increases of 15%, 47%, and 2% in fatalities with a one unit increases in mean nightly ambient

temperature, standard deviation of the ambient temperature and mean humidity respectively. None of the corresponding 90% confidence intervals for the preceding variables included zero (mean.nat; 11% to 19%, sd.at; 22% to 75%, mean.hu; 1% to 3%). This implies these variables were significant in the Poisson model predicting casualty rates.

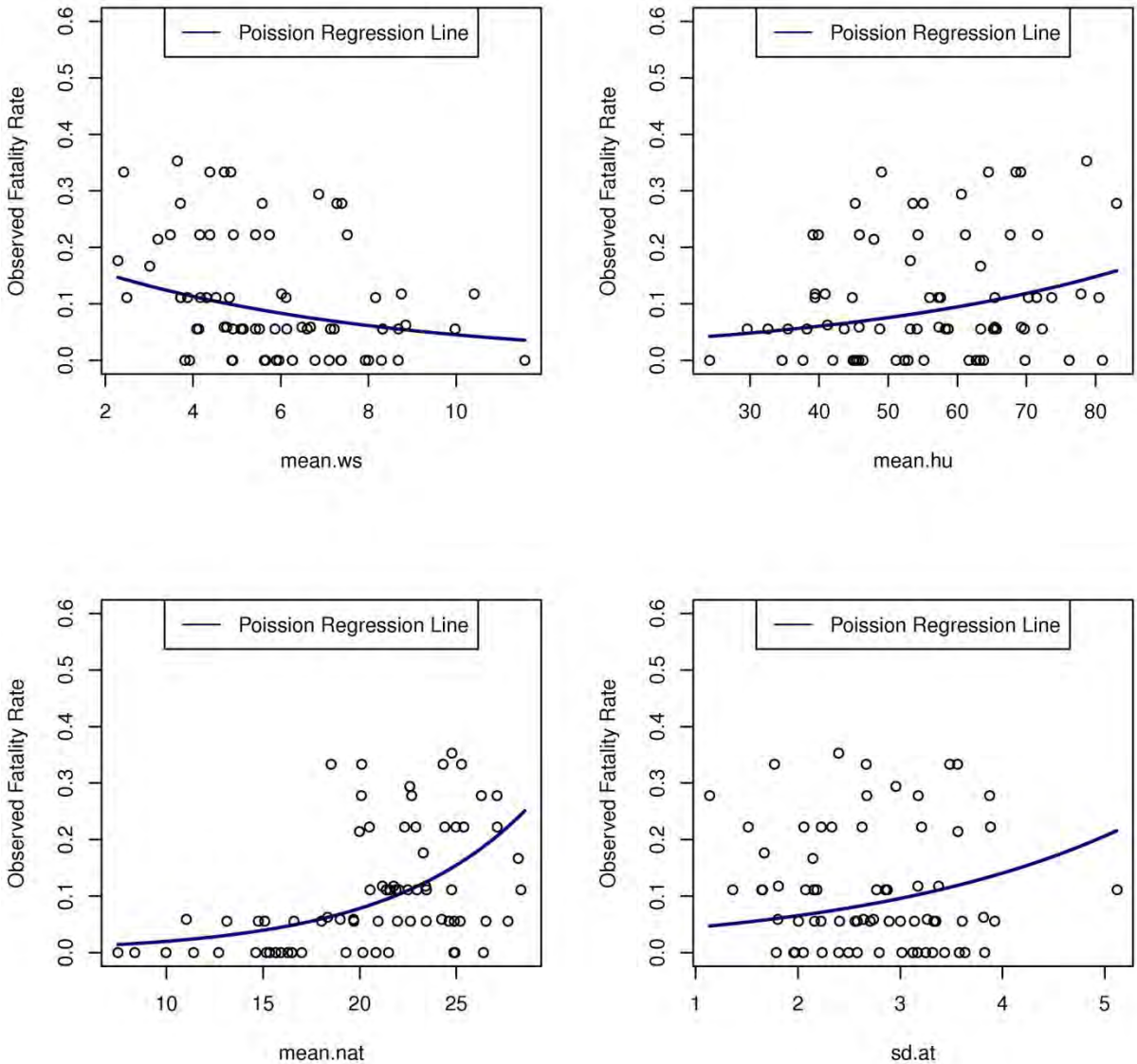

Figure 18. Daily casualty rates at the Fowler Ridge Wind Farm as explained by Poisson regression model covariates. Regression lines represent sequential values of the variable of interest while restraining all other covariates to their means.

Bat Acoustical Activity and Casualties

Correlation between bat activity (number of bat passes per detector night) taken from Anabat units located on the nacelles of selected turbines and observed casualty rates was stronger than the correlation of casualty rates to Anabat detectors located at the base of turbines

(Pearson"s correlation coefficients; 0.45 and 0.07 respectively; Figure 19). Correlations between activity and casualty comparing ground and nacelle Anabat units were restricted to dates past the night of August 18, 2010 when both nacelle and ground units were in place. On average, nights with higher Anabat activity rates also had higher observed casualty rates, although weather variables also affected bat casualty rates.

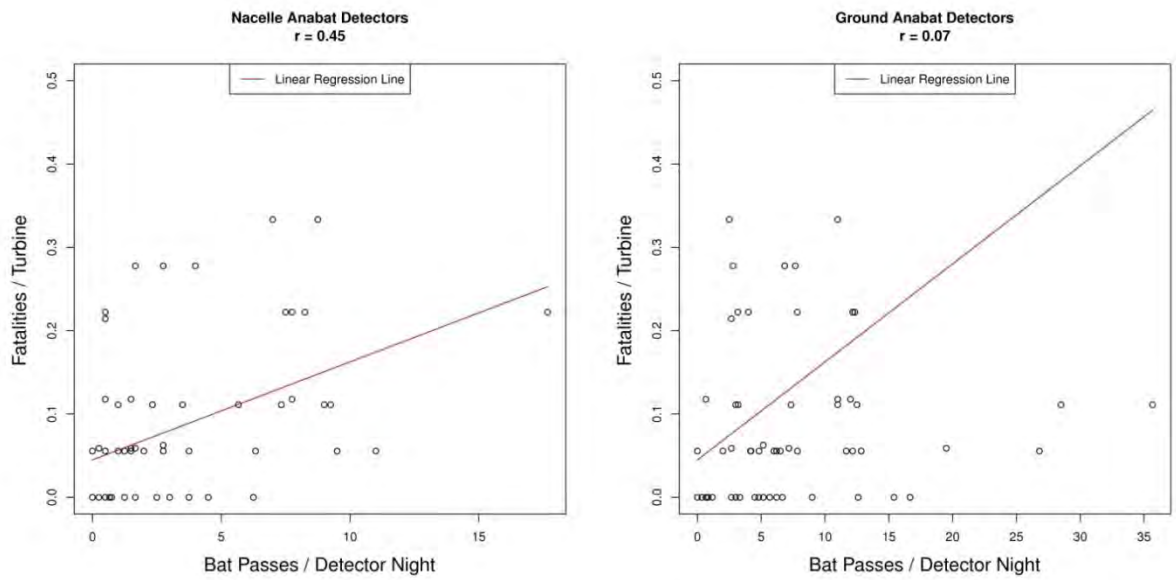

Figure 19. Correlation between activity rates by Anabat detector locations and observed casualty rates at the Fowler Ridge Wind Farm with Pearson's correlation coefficient (r).

To try to account for this variability, bat activity was included in the Poisson modeling process with weather variables and an exhaustive search for the model with lowest AIC resulted in the models shown in Table 21. The combined ground and nacelle activity rate (arate) appears in all of the top ten models. The lowest AIC value for any model including the activity rates from ground detectors only (grate) was 258.2 a difference of 3.4 in AIC from the best combined activity rate model. It is normally agreed that differences in AIC greater than 2 are significant. This implies that combining activity rates from the nacelle and ground Anabat units was a better predictor of bat casualty rates at the FRWF than ground units alone. Since nacelle units were not placed during the complete fall survey period a similar comparison of nacelle units was not included in Poisson modeling. Mean nightly wind speed, mean nightly ambient temperature, and the variance in the ambient temperature during the 24 hours previous to corresponding searches still appear as significant weather variables in each of the top 10 models. Mean humidity during the 24 hours previous to searches was selected in only four of the top 10 models and mean barometric pressure during the same 24-hour period was selected in eight out of the 10 top models (Table 21).

Table 21. Variables in the top Poisson regression models based on AIC for Anabat activity adjusting for weather at the Fowler Ridge Wind Farm.

AIC	β_1	β_2	β_3	β_4	β_5	β_6…
254.8	arate	mean.ws	mean.nat	sd.at	mean.bp	--
255.0	arate	mean.ws	mean.nat	sd.at	mean.bp	mean.hu
255.5	arate	mean.ws	mean.nat	sd.at	mean.bp	mean.nhu
255.9	arate	mean.ws	mean.nat	sd.at	mean.bp	sd.bp
256.0	arate	mean.ws	mean.nat	sd.at	mean.bp	mean.wd
256.1	arate	mean.ws	mean.nat	sd.at	--	mean.nbp
256.4	arate	mean.ws	mean.nat	sd.at	mean.bp	mean.hu, sd.bp
256.4	arate	mean.ws	mean.nat	sd.at	mean.bp	sd.nhu
256.5	arate	mean.ws	mean.nat	sd.at	--	mean.hu, mean.nbp
256.6	arate	mean.ws	mean.nat	sd.at	mean.bp	mean.hu, sd.nhu

The model with the lowest AIC contains the variables for combined ground and nacelle Anabat activity (arate), mean nightly wind speed (mean.ws), mean nightly ambient temperature (mean.nat), and the variance of the ambient temperature and mean barometric pressure for the 24 hour period previous to searches (Model C).

Model C

$$\log\big(mean(fresh\ bat\ fatalities\ per\ search)\big)$$
$$= -66.65 + 0.04\ arate - 0.15\ mean.ws + 0.12\ mean.nat + 0.54\ sd.at + 0.06\ mean.bp$$

Coefficients for combined activity rates have an incident rate ratio of 1.04 implying a 4% increase in fatalities for each one unit increase in bat passes per detector night. The 90% confidence interval for decreases in casualty due to combined activity rate is 3% to 5% for each one unit increase in bat passes per detector night. Figure 20 shows the graphical interpretation of model coefficients unique to this model.

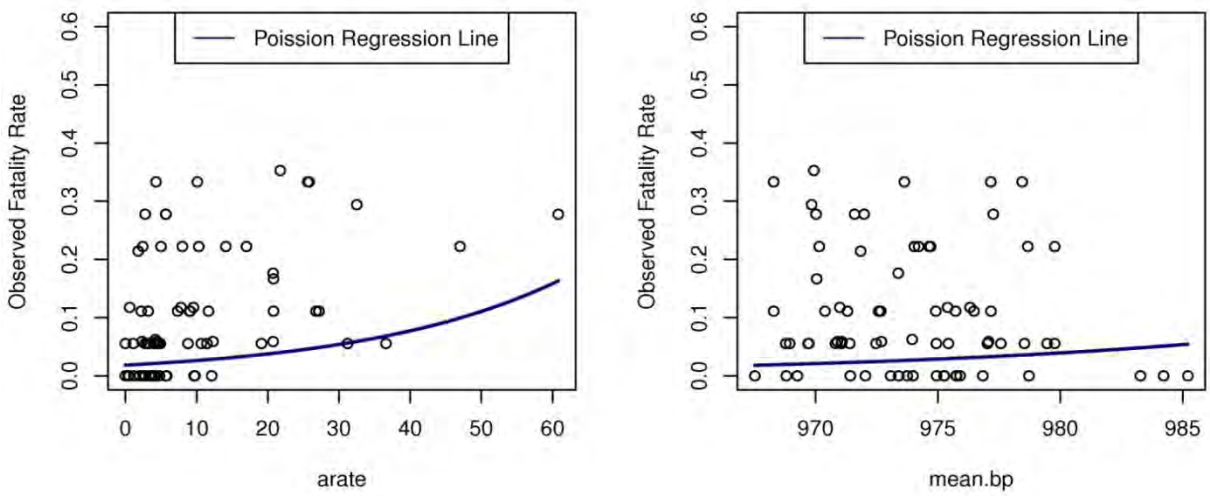

Figure 20. Daily casualty rates at the Fowler Ridge Wind Farm as explained by Poisson regression model covariates. Regression lines represent sequential values of the variable of interest while restraining all other covariates to their means.

Casualty rates varied throughout the study, with the highest rates occurring during the month of August. An especially large number of fresh bat carcasses were discovered on August 4, 2010, when observed casualty rates were twice as high as recorded on any other evening.

The months of August and September were warmer and drier than historical averages. La Nina weather patterns weakened or rerouted storm systems in August that were heading toward Indiana (Indiana Climate Center 2010), and relatively few, strong fronts associated with precipitation events crossed the FRWF. The evening of August 4 was unusual in that August 3 and 4 were one of the few days when stronger fronts associated with precipitation events occurred in the Fowler area.

On-site weather data collected on the evening of August 3, 2010 indicate that mean temperature and humidity were higher than normal, and wind speeds and barometric pressure were lower than normal, as compared to weather data collected during the fall migration period (Figure 21). Barometric pressure decreased from the morning of August 3 through the early morning of August 4, 2010, as a weather front passed through the area. Periods of rain and heavy wind associated with thunderstorms were present during periods of the day on August 3 and 4; however, wind speeds dropped during the evening, and temperatures were high, humidity was high, and wind speeds low throughout the evening of August 3-4, 2010. Bat activity rates were also very high during this night.

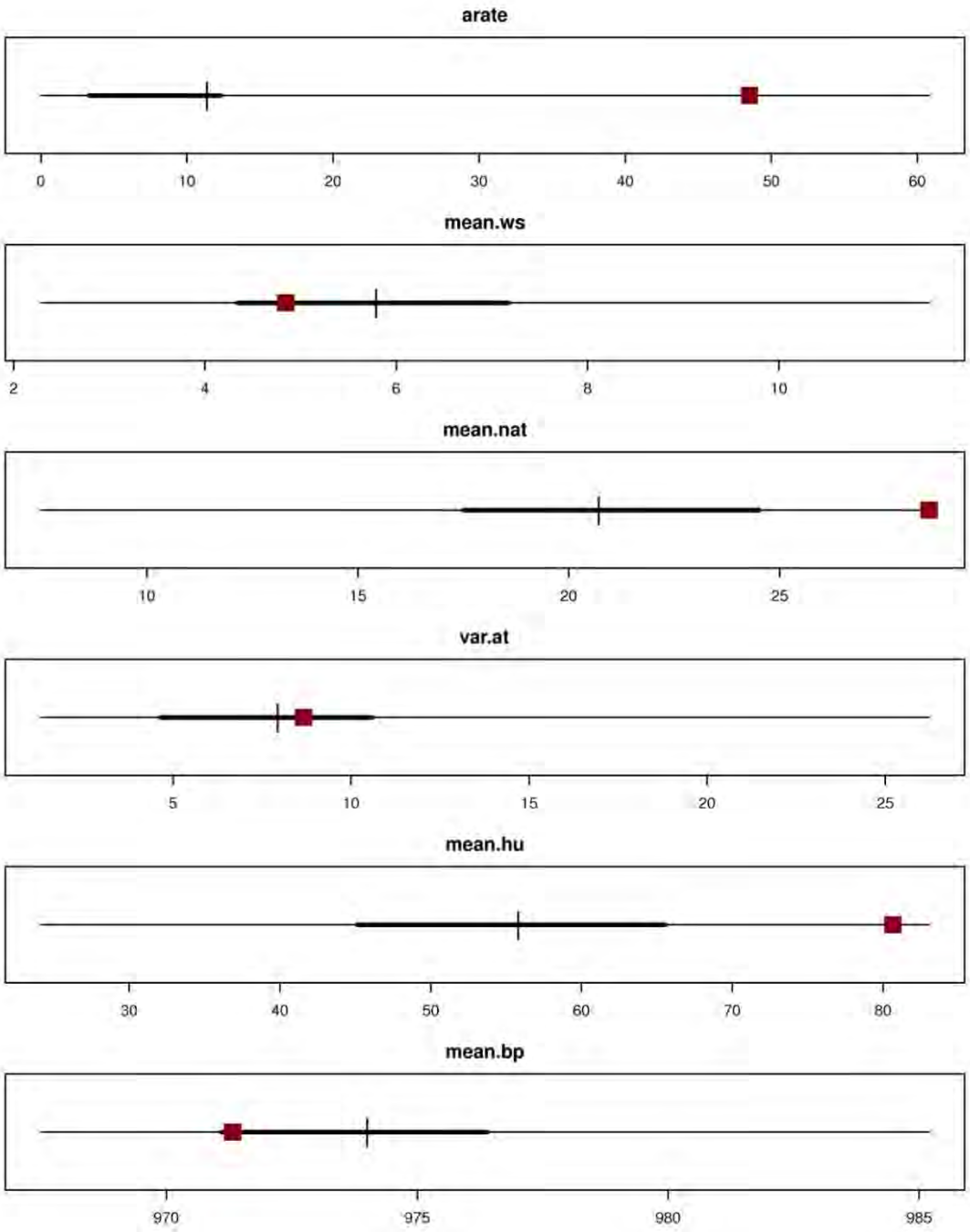

Figure 21. Average climate conditions on the night preceding August 4, 2010, the night prior to the date when the highest number of bat casualties were found.

Weather conditions during the night before the date the Indiana bat casualty was found were not typical of nights when most bat fatalities occurred. The Indiana bat was found on September 18, 2010. During the evening of September 17, bat activity rates were below the fall median values and mean barometric pressure was above median values. Mean temperature, and mean wind speed were at fall median values, and humidity and variation in air temperature were slightly

below median values, but within the 1st and 3rd quartiles (Figure 22). No precipitation was present the day and night of September 17, and no large fronts were moving through the area.

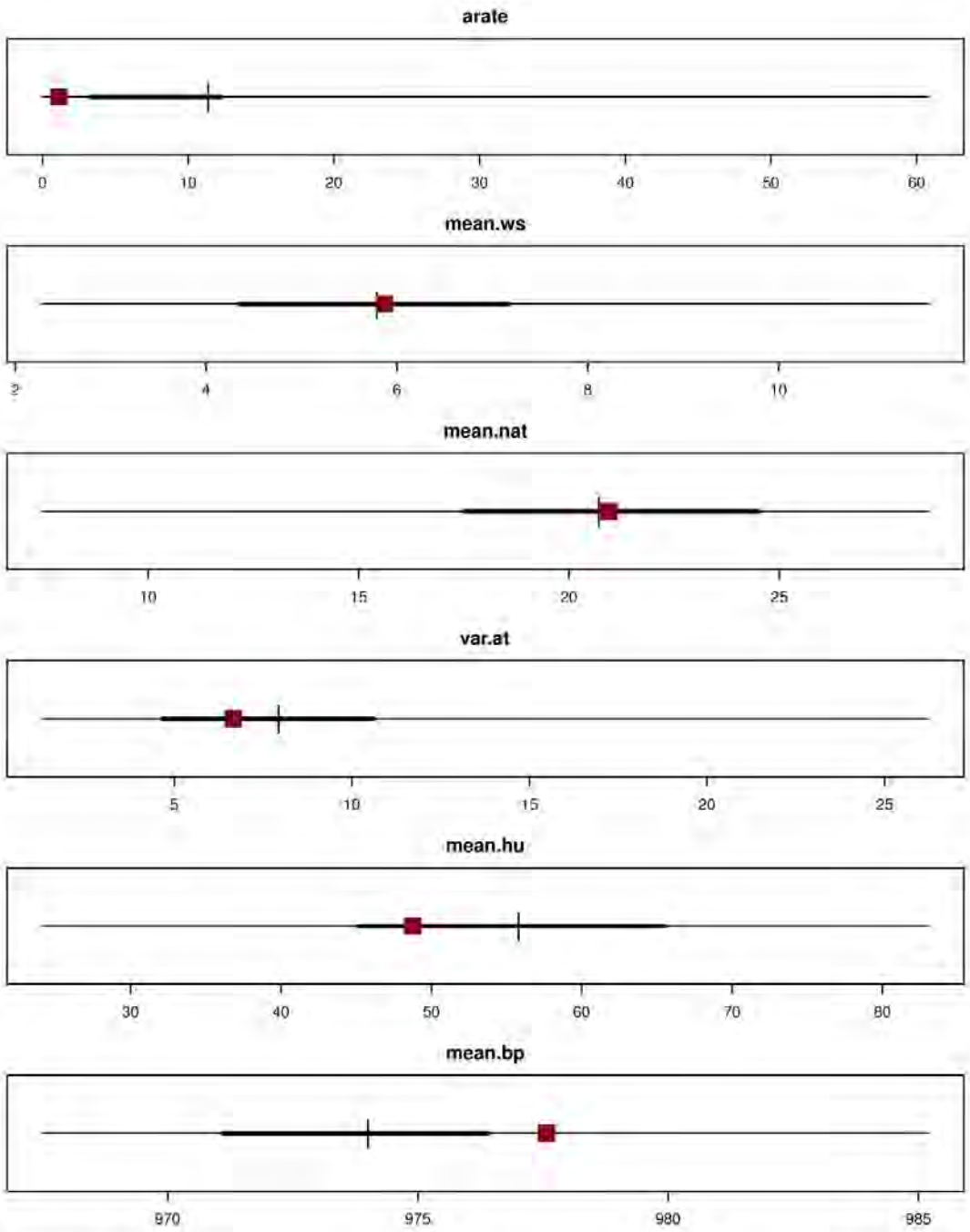

Figure 22. Average climate conditions on the night preceding September 18, 2010, the night prior to the date when the Indiana bat casualty was discovered.

Bat Acoustic Surveys

Bat activity was monitored at four fixed sampling locations on a total of 36 nights during the spring period of April 9 through May 14, and again at ten fixed sampling locations on a total of

95 nights during the fall period of July 15 through October 18, 2010. During the fall season, sampling began on July 15 for the two locations that were previously monitored in 2007, while monitoring at the base of turbines began August 1. Anabat units were operable for 93.5% of the spring sampling period, and 93.3% of the fall sampling period. Anabat units recorded 185 bat passes on 137 detector-nights during the spring (Table 22), and 5,721 bat passes on 685 detector-nights during the fall. The average bat activity for ground stations was 1.34 ± 0.29 bat passes per detector-night in the spring (Table 22), and 11.46 ± 1.29 at ground stations and 3.10 ± 0.42 at raised stations during the fall (Table 23).

Table 22. Results of spring acoustic bat surveys conducted at the Fowler Ridge Wind Farm, April 9 – May 14, 2010, 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*
FR056g	ground	13	16	23	52	36	1.44±0.46
FR098g	ground	14	9	23	46	36	1.28±0.28
FR251g	ground	9	9	13	31	29	1.07±0.34
FR414g	ground	11	18	27	56	36	1.56±0.34
Grand Total		**47**	**52**	**86**	**185**	**137**	**1.34±0.29**
Active		*5*	*1*	*9*	*15*	*5*	*3.00± NA*

Table 23. Results of fall acoustic bat surveys conducted at the Fowler Ridge Wind Farm, July 15 – October 18, 2010, separated by call frequency (HF = high frequency, MF = mid frequency, LF = low frequency). Stations FRr1g and FRr2g were previously monitored in 2007, 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*
FRr1g	ground	71	65	296	432	86	5.02±0.43
FRr2g	ground	173	59	93	325	93	3.49±0.85
FR083g	ground	220	205	436	861	68	12.66±1.62
FR083h	raised	11	26	75	112	61	1.84±0.32
FR251g	ground	193	189	495	877	68	12.90±1.59
FR251h	raised	24	50	133	207	61	3.39±0.63
FR458g	ground	476	505	1007	1988	76	26.16±4.12
FR458h	raised	22	27	154	203	48	4.23±0.97
FR614g	ground	88	118	331	537	63	8.52±1.19
FR614h	raised	6	33	140	179	61	2.93±0.60
Total Ground		**1,221**	**1,141**	**2,658**	**5,020**	**454**	**11.46±1.29**
Total Raised		**63**	**136**	**502**	**701**	**231**	**3.10±0.42**
Grand Total		**1,284**	**1,277**	**3,160**	**5,721**	**685**	**8.12±0.88**
Active		*32*	*59*	*43*	*134*	*21*	*6.38±2.08*

Species Composition

During the spring study season, passes by low-frequency bats (LF; 46.5% of all passes) outnumbered passes by mid-frequency bats (MF; 28.1%) and high-frequency bats (HF; 25.4%; Table 22), and this pattern was consistent among ground stations (Figure 23). Temporal patterns of use were similar among all three species groups during the study period (Figure 23).

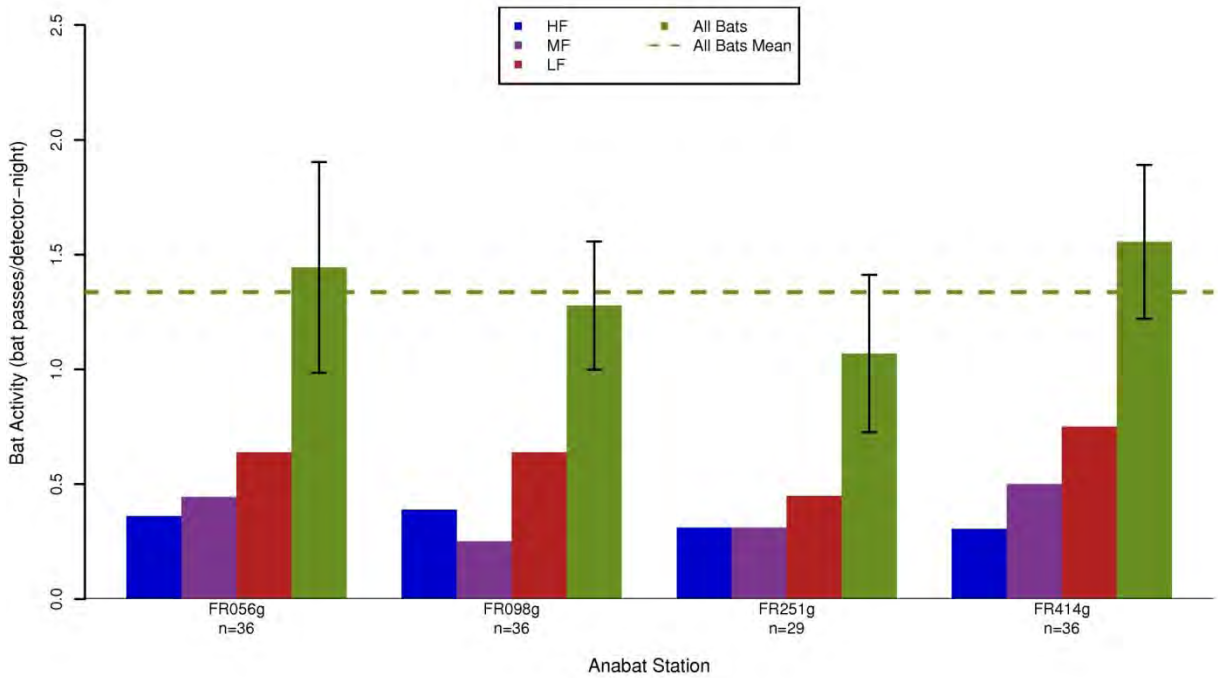

Figure 23. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the spring study period April 9 – May 14, 2010. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

During the fall study season, passes by LF bats (55.2% of all passes) again outnumbered passes by HF bats (22.4%), and MF bats (22.3%; Table 23), and this pattern was consistent among ground stations (Figure 24). Among raised stations, LF bats comprised 71.6% of passes (Table 23). 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 during the fall (Figures 25 and 26). Temporal patterns of use were similar among all three species groups during the study period (Figure 24).

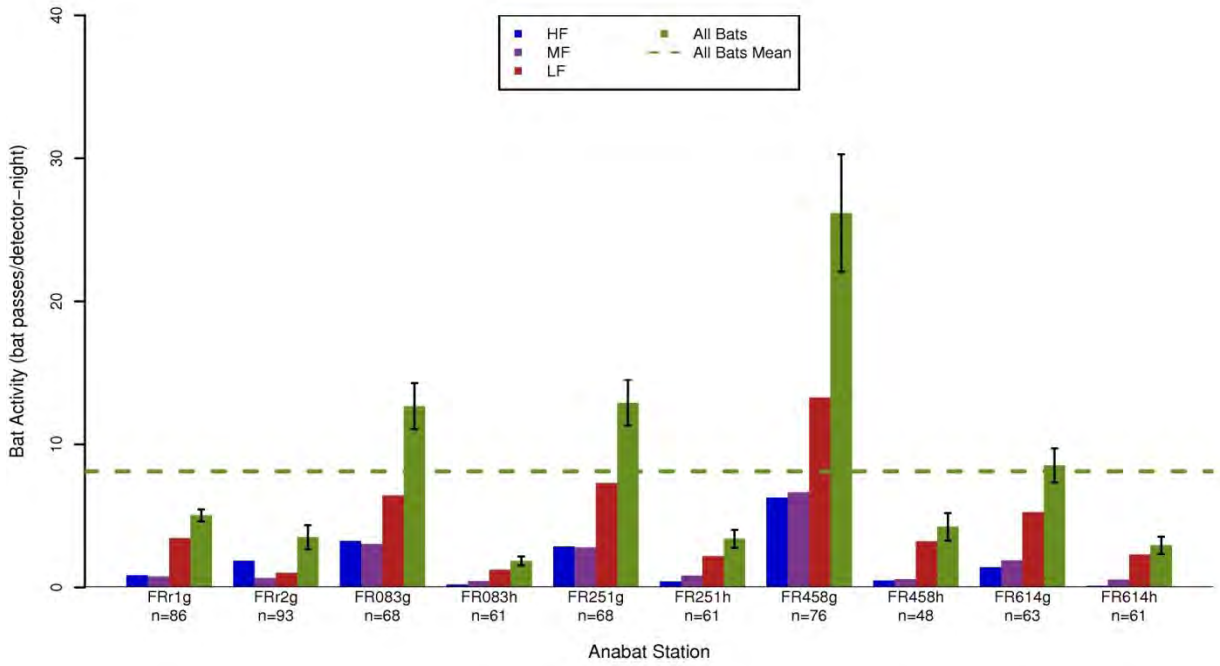

Figure 24. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the fall study period July 15 – October 18, 2010. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns. Stations FRr1g and FRr2g were previously monitored in 2007, and were located away from turbines.

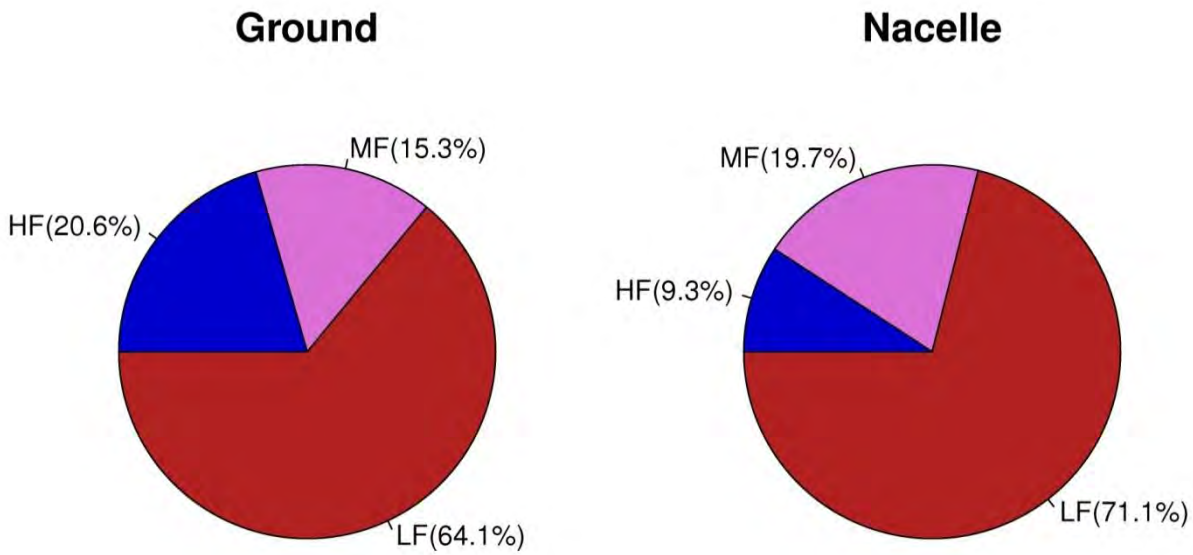

Figure 25. Percentage of bat calls, by frequency class, recorded at the Fowler Ridge Wind Farm at nacelles versus detectors at the base of turbines on nights when both units were operational during the fall migration period.

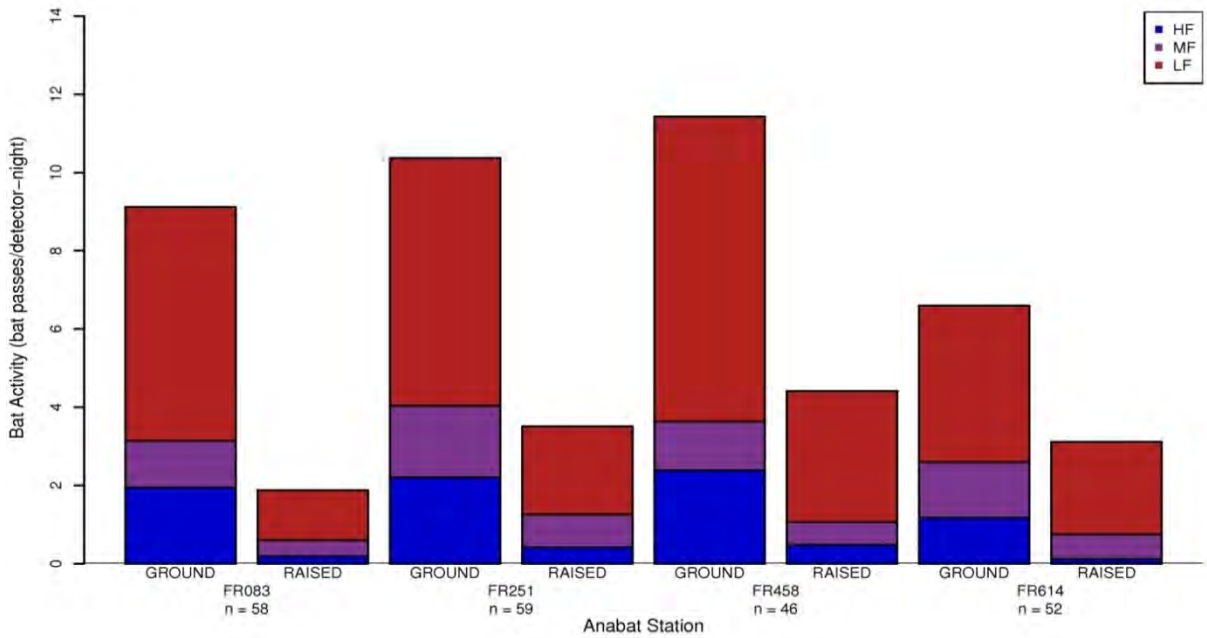

Figure 26. Bat activity at paired stations during the fall study period at the Fowler Ridge Wind Farm, August 18 – October 18, 2010 on nights when both ground and nacelle units were operational.

Data for HF bat passes were analyzed during both the spring and fall study period to look at temporal trends among species of interest (including Indiana bat). During the spring study season, HF bat activity was similar at each of the four sampling stations, as well as during active monitoring; the majority of HF bat passes occurred in late-April and early-May (Figure 27). During the fall study season, HF bat activity also showed similar temporal patterns across all stations, with most HF bat passes being recorded from early- to mid-August (Figure 28).

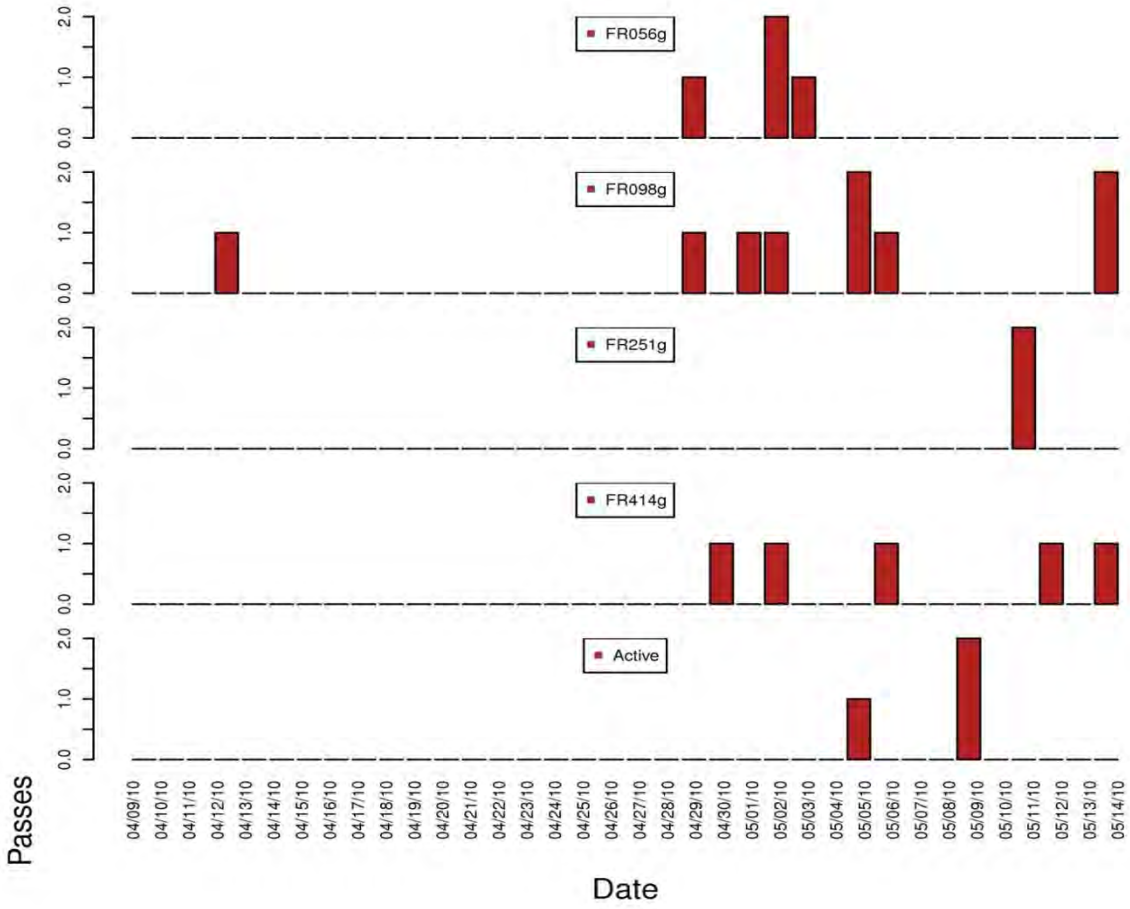

Figure 27. High-frequency bat passage rates during the Fowler Ridge Wind Farm spring study season, April 9 – May 14, 2010.

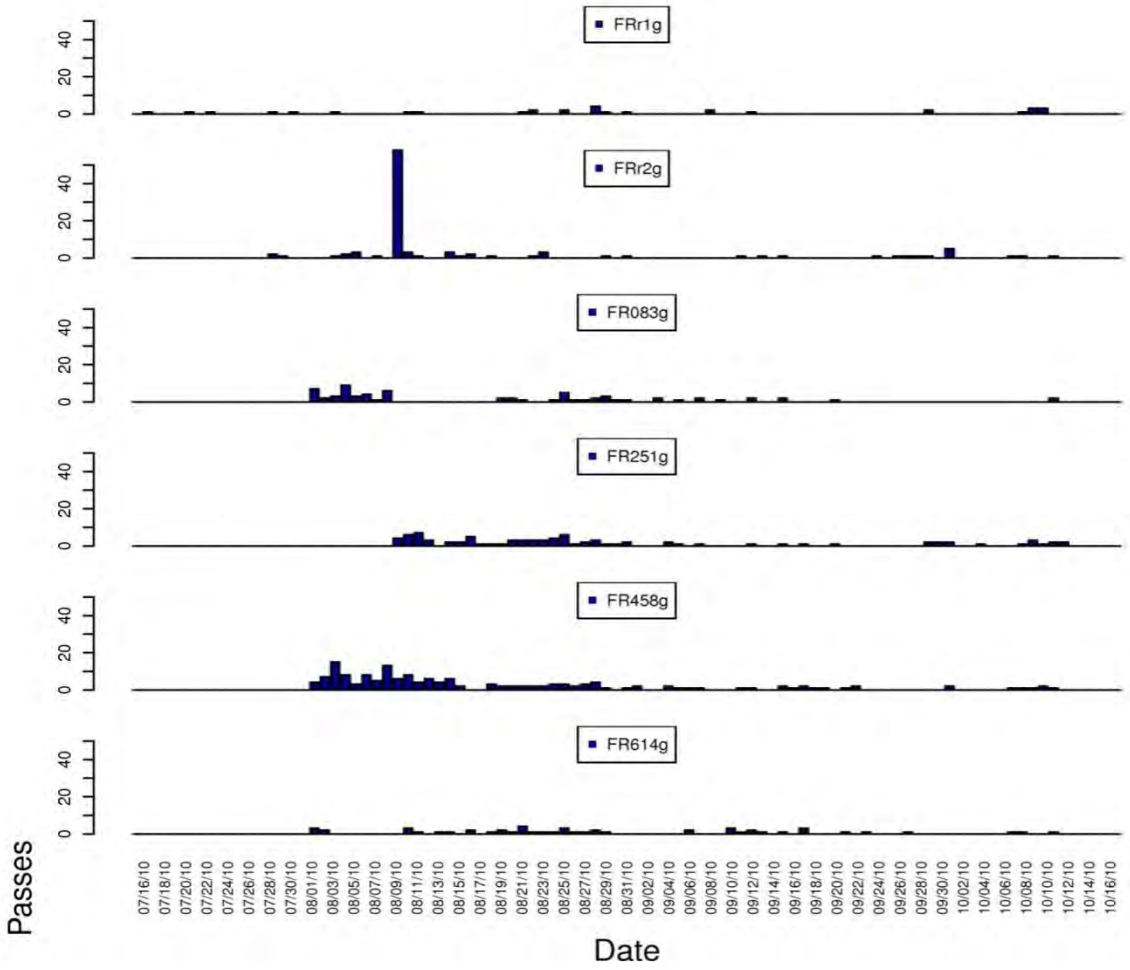

Figure 28. High-frequency bat passage rates during the Fowler Ridge Wind Farm fall study season, July 15 – October 18, 2010.

HF bat passes were further analyzed, to gain a better understanding of what species comprised calls in this category. Calls were analyzed by visually comparing call sonograms and characteristics to a set of known calls from a call library. *Myotis* comprised only 15% of calls that were good enough quality for identification in 2010 (Table 24). Based on this analysis, *Myotis* activity was low within the FRWF during the spring and fall of 2010, and the majority of calls identified within the HF category were comprised of non-myotis species, including red bats and tri-colored bats.

Table 24. Bat activity by bat species within the high-frequency (HF) category at the Fowler Ridge Wind Farm.

Species	Activity (bat passes/ detector night)	Percent Composition of identified bat activity
myotis	0.10	15.6%
eastern red bat	0.16	23.9%
tri-colored bat	0.05	7.3%
other non-myotis species	0.35	53.2%
unknown	0.84	55.9% of HF calls were unable to be identified

Myotis calls were 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 Discriminant Function Analysis, the "Britzke" filter, and a qualitative analysis by WEST biologists. No potential Indiana bat calls were identified by the Discriminant Function Analysis from the 2007 data set. In 2008, five call files were identified by the Discriminant Function Analysis as Indiana bat calls. However, neither the "Britzke" filter nor qualitative analysis classified these calls as Indiana bats. Thirty calls were identified by the Discriminant Function Analysis as resembling calls made by Indiana bats in 2010, two calls passed the Britzke filter, and WEST biologists identified all 30 calls as either made by Indiana bats or little brown bats (Table 25). Most potential Myotis calls were identified as occurring on the evening of August 9-10, 2010 at reference Station 2, located away from turbines (FRr2g). Based on the presence of multiple potential calls, *Myotis* were present on the evening of August 9-10 at Station 2, and the potential exists that these calls were made by Indiana bats. The recording of individual potential Indiana bat calls on other nights do not provide as strong of evidence of Indiana bat activity due to the potential for incorrect identifications.

Table 25. Bat calls identified by the Discriminant Function (DF) Analysis in 2010 as potentially made by Indiana bats. MYSO = Indiana bat (*Myotis sodalis*) and MYLU = Little brown bat (*Myotis lucifugus*).

Station	Month	Date	Filename	Discriminant Function ID	WEST Biologist ID	Briztke ID
FR458g	Aug	11	k8120107.52#	MYSO	MYSO or MYLU	
FR458g	Sep	1	k9012343.46#	MYSO	MYSO or MYLU	
FR251g	Aug	10	k8110423.53#	MYSO	MYSO or MYLU	
FR083g	Aug	3	k8040517.29#	MYSO	MYSO or MYLU	
FR083g	Sep	10	k9110508.41#	MYSO	MYSO or MYLU	
FRr2g	Aug	5	k8060303.30#	MYSO	MYSO or MYLU	
FRr2g	**Aug**	**9**	**k8100138.40#**	**MYSO**	MYSO or MYLU	**MYSO**
FRr2g	Aug	9	k8100143.27#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100147.26#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100148.32#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100149.17#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100149.37#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100151.06#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100152.01#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100154.48#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100155.44#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100156.20#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100156.32#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100156.49#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100158.03#	MYSO	MYSO or MYLU	

Table 25. Bat calls identified by the Discriminant Function (DF) Analysis in 2010 as potentially made by Indiana bats. MYSO = Indiana bat (*Myotis sodalis*) and MYLU = Little brown bat (*Myotis lucifugus*).

Station	Month	Date	Filename	Discriminant Function ID	WEST Biologist ID	Briztke ID
FRr2g	Aug	9	k8100158.14#	MYSO	MYSO or MYLU	
FRr2g	**Aug**	**9**	**k8100158.36#**	**MYSO**	MYSO or MYLU	**MYSO**
FRr2g	Aug	9	k8100159.10#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100201.33#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100203.02#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100204.59#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100205.39#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100206.17#	MYSO	MYSO or MYLU	
FRr2g	Aug	9	k8100207.40#	MYSO	MYSO or MYLU	
FRr2g	Aug	10	k8110052.38#	MYSO	MYSO or MYLU	

Spatial Variation

During the spring studies at the FRWF, bat activity was similar among the four fixed stations in (Figures 23), ranging between 1.07 and 1.56 bat passes per detector-night among ground stations (Table 22). Overall, use was lowest at station FR251g (1.07 bat passes/detector night), and higher at stations FR098g (1.28), FR056g (1.44), and FR414g (1.56; Table 22)

During the fall study season, bat activity varied among the ten stations in the FRWF (Figure 24), ranging between 3.49 and 26.16 bat passes per detector-night among ground stations, and between 1.84 and 4.23 bat passes per detector-night among raised stations (Table 23). Ground stations previously monitored in 2007 recorded lower bat activity rates (3.49 and 5.02) in 2010 compared to detectors located at the base of wind turbines (8.52, 12.66, 19.90, 26,16; Figure 24, Table 23).

Temporal Variation

During the spring study season, bat activity increased from early-April through mid-May (Figure 29). The highest number of bat passes per detector-night (of all frequencies) within a single week were recorded on the week of April 30 through May 6 (2.57 bat passes per detector-night); the highest number of bat passes per detector-night of HF bats were recorded during the week of April 30 through May 6 (0.71); the highest number of MF bat passes per detector-night were recorded during the week of April 30 through May 6 (0.90); the highest number of LF bat passes per detector-night were recorded during the week of April 19 through April 27 (1.07;Table 26). HF bat passes were most commonly recorded after May 1 (Figure 27).

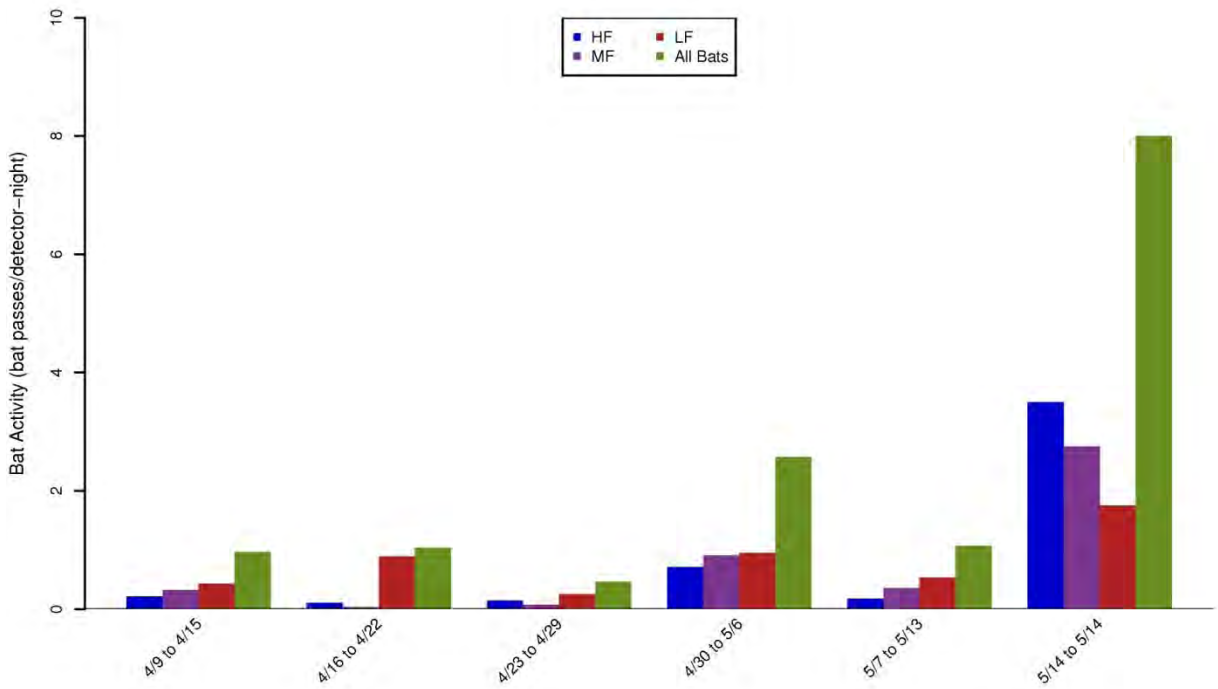

Figure 29. Bat activity, by week, during the spring migration period at the Fowler Ridge Wind Farm.

Table 26. 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.

Period of Interest	Week(s) of Highest Passage Rate	Bat activity Rate
	All Bats	
Spring Study Period	04/30/10 to 05/06/10	2.57
	HF Bats	
Spring Study Period	04/30/10 to 05/06/10	0.71
	MF Bats	
Spring Study Period	04/30/10 to 05/06/10	0.90
	LF Bats	
Spring Study Period	04/19/10 to 04/27/10	1.07

During the fall study season, bat activity was highest from late-July through late-August, and then decreased through mid-October (Figure 30). The highest number of bat passes per detector-night (all frequencies) within a single week were recorded on the week of July 26 through August 1 (61.45 bat passes per detector night); the highest number of HF bat passes per detector-night were recorded during the week of August 4 through August 10 (10.84); the highest number of MF bat passes per detector-night were recorded during the week of July 29 through August 4 (12.62); the highest number of LF bat passes per detector-night were recorded during the week of July 26 through August 1 (44.37; Table 27). Few HF bat basses were recorded outside of the week of August 4-10 (Figure 28).

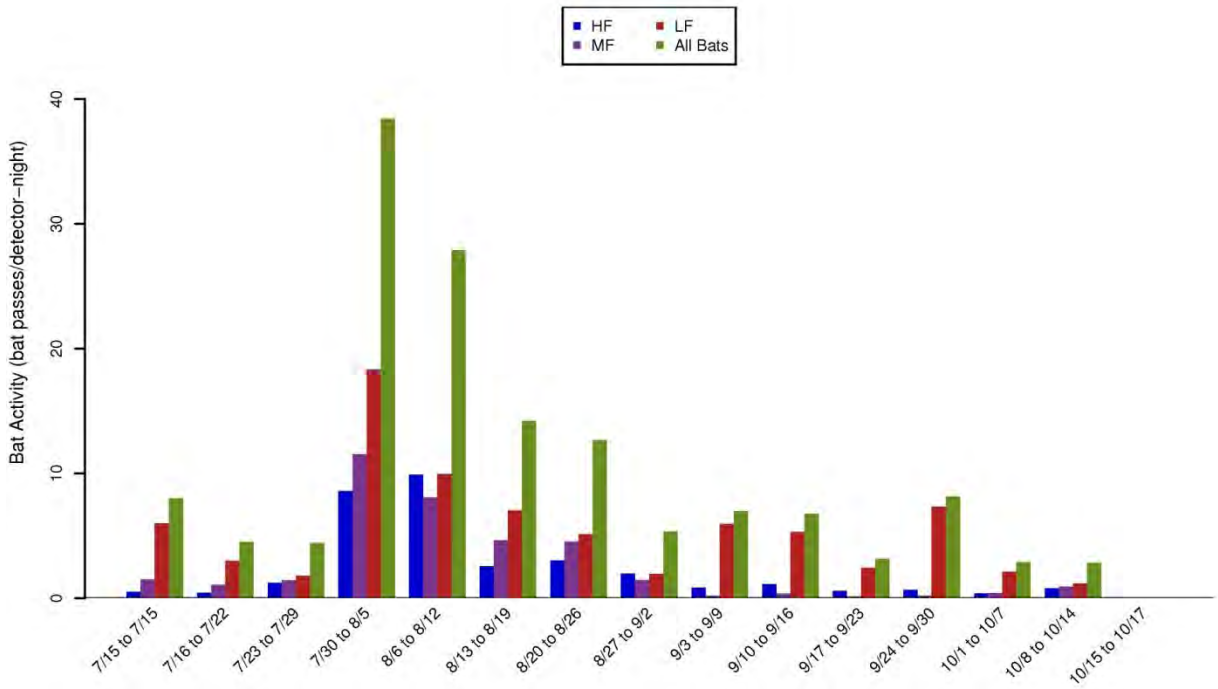

Figure 30. Bat activity, by week, during the fall migration period at the Fowler Ridge Wind Farm. Monitoring of bat activity began at two stations on July 15 that were previously monitored in 2007, while monitoring at the base of turbines began July 30.

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 fall study period.

Period of Interest	Week(s) of Highest Passage Rate	Bat activity Rate
	All Bats	
Overall	07/26/10 to 08/01/10	61.46
Fall Study Period	07/30/10 to 08/05/10	38.44
	HF Bats	
Overall	08/04/10 to 08/10/10	10.84
Fall Study Period	08/04/10 to 08/10/10	10.84
	MF Bats	
Overall	07/29/10 to 08/04/10	12.62
Fall Study Period	07/31/10 to 08/06/10	11.66
	LF Bats	
Overall	07/26/10 to 08/01/10	44.37
Fall Study Period	07/30/10 to 08/05/10	18.33

Most calls identified by the DF as resembling potential Indiana bat calls were recorded on the evening of August 9. This corresponds with the peaks in activity observed for LF, MF, and HF bats during the first two weeks in August.

Temporal patterns of bat activity between ground and raised stations were similar (Figure 31), and followed the overall trend. However, raised stations recorded more bat passes through late August, while ground stations recorded more activity through the remainder of the study period.

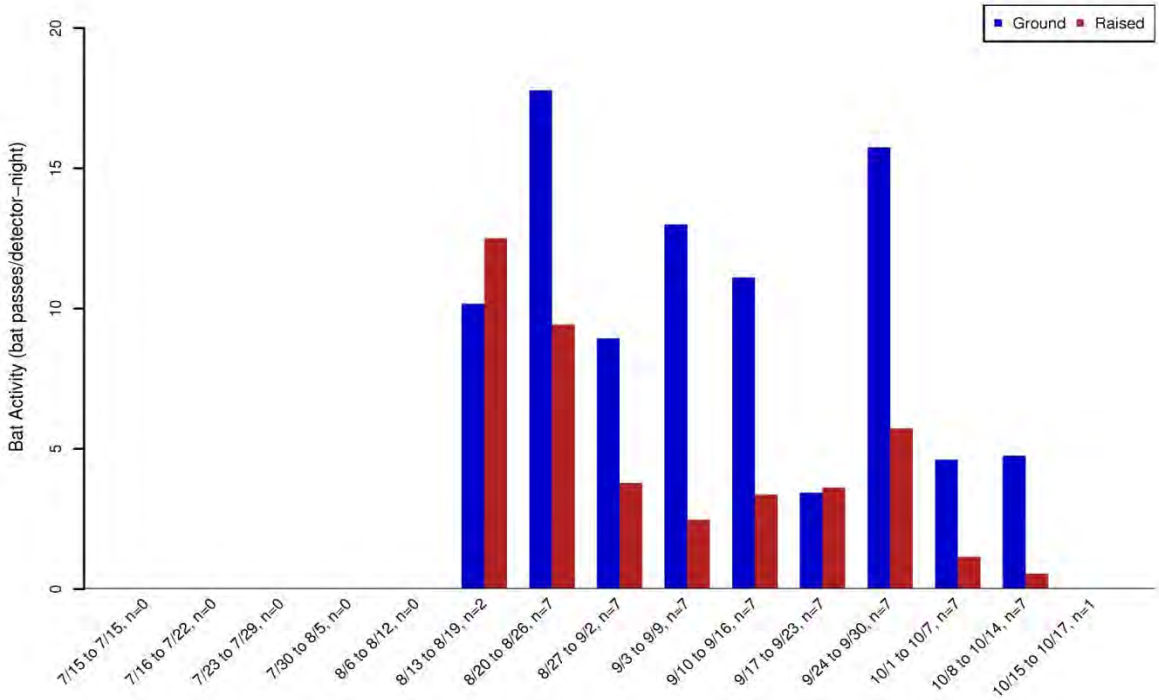

Figure 31. Number of bat passes per detector-night by ground and raised Anabat stations at the Fowler Ridge Wind Farm for the fall study period July 15 – October 18, 2010 when raised and ground units were operational on the same night.

Bat activity rates as a function of hour past sunset are shown in Figure 32. In general, bat activity was recorded throughout the night, with rates highest from 2 – 6 hours past sunset, Activity generally decreased in the latter part of the night.

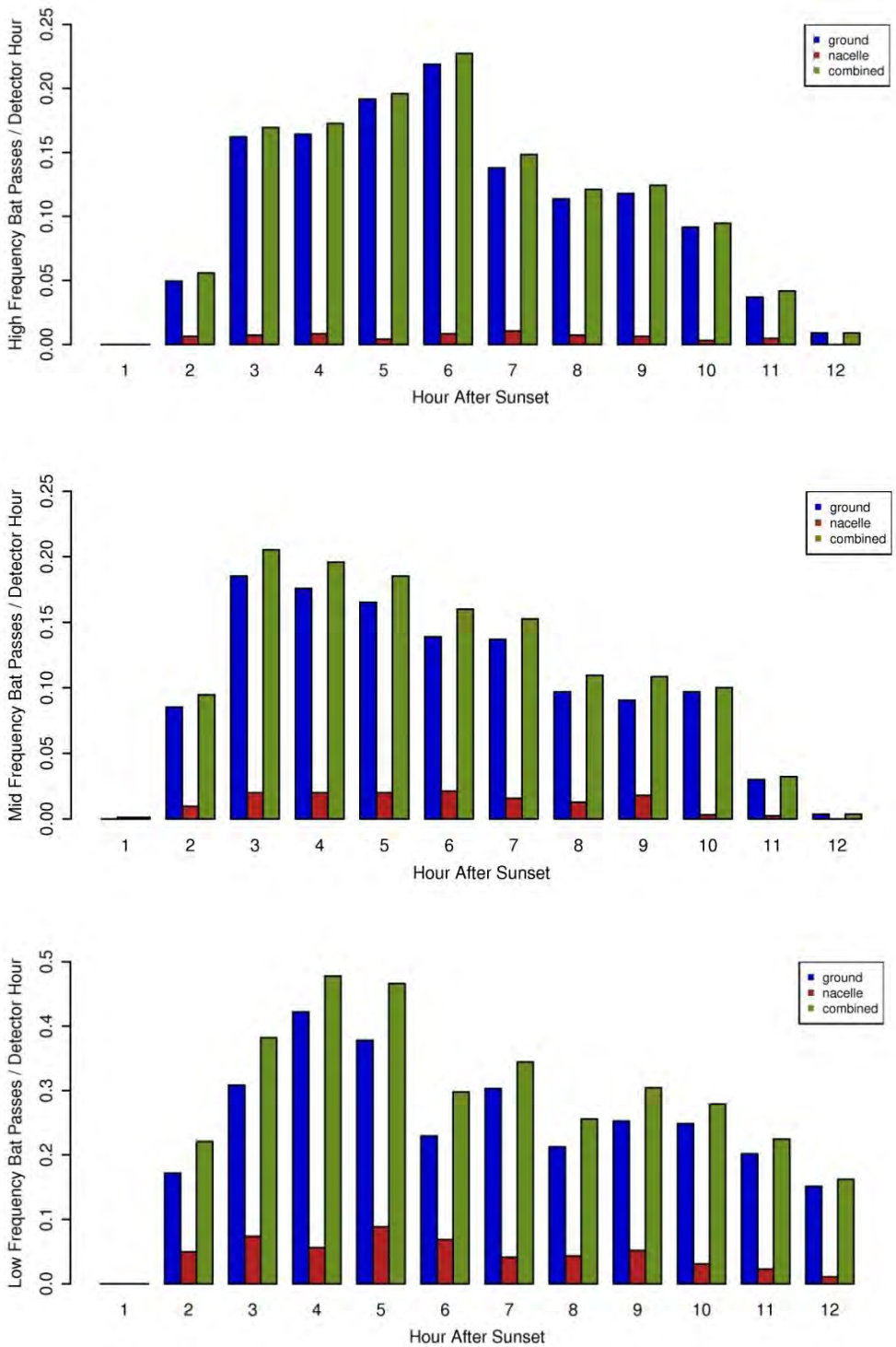

Figure 32. Bat activity rates as a function of hour past sunset at the Fowler Ridge Wind Farm.

Active Monitoring

Active monitoring was conducted during both the spring and fall study seasons. During the spring study period (five detector nights), active bat monitoring efforts recorded five HF bat

passes, one MF bat pass, and nine LF bat passes (Table 22). During the fall study season (21 detector-nights), active bat monitoring efforts recorded 32 HF bat passes, 59 MF bat passes, and 43 LF bat passes (Table 23). No calls were identified as potential Indiana bat calls during the active monitoring surveys.

Weather and Anabat Activity Rates

Modeling Anabat activity rates (bat passes per detector night) resulted in different variables of importance for ground and nacelle detectors. Ground activity rates were best predicted by the mean and variability of barometric pressure and the standard deviation in the ambient temperature during the previous 24-hour period along with the mean nightly ambient temperature and mean and variability of nightly humidity (Table 28). Each variable was significant in the model with p-values less than 0.01, suggesting that each covariate has a significant effect on predicting ground activity having adjusted for all other model covariates. Nacelle activity rates were more dependent on the wind speed variables, mean nightly wind speed and standard deviation of nightly wind speed. Other significant covariates included the standard deviation of nightly barometric pressure, mean nightly humidity, mean ambient temperature for the 24 hour period previous to searches and the standard deviation of humidity during that same period. Poisson models predicting combined ground and nacelle detector activity had significant covariates for mean nightly wind speed, mean and standard deviation of the barometric pressure during the 24 hour period previous to searches, mean and standard deviation of the humidity either nightly or during the 24 hour period previous to searches, and the standard deviation of the nightly ambient temperature (Table 28).

Table 28. Significant variables (p-value < 0.05) in the top Poisson regression models based on AIC for weather correlation analyses at the Fowler Ridge Wind Farm.

AIC	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Models for nacelle Anabat Activity (bat passes/detector night)								
834.7	mean.ws	sd.ws	--	sd.nbp	mean.nhu	sd.hu	mean.at	--
835.3	mean.ws	sd.ws	--	sd.nbp	mean.nhu	sd.hu	mean.nat	--
837.1	--	sd.ws	mean.nbp	sd.nbp	mean.nhu	sd.hu	mean.at	--
Models for ground Anabat Activity (bat passes/detector night)								
2467.6	--	--	mean.bp	sd.bp	mean.nhu	sd.nhu	mean.nat	sd.at
2474.2	--	sd.ws	mean.bp	sd.bp	mean.hu	sd.nhu	mean.nat	sd.at
2474.9	--	sd.ws	mean.bp	sd.bp	mean.hu	sd.hu	mean.nat	sd.nat
Models for combined nacelle & ground Anabat Activity (bat passes/detector night)								
3165.2	mean.ws	--	mean.bp	sd.bp	mean.nhu	sd.hu	mean.nat	sd.nat
3168.3	mean.ws	--	mean.bp	sd.bp	mean.hu	sd.hu	mean.nat	sd.nat
3170.0	mean.ws	--	mean.bp	sd.bp	mean.nhu	sd.hu	mean.nat	--

As with casualty rate predictions, nacelle and combined Anabat activity rates were negatively correlated with mean nightly wind speed. This implies that as wind speed increased activity decreased (Figure 33). Wind speed was not a significant variable for predicting ground Anabat activity. The standard deviation of nightly wind speed was also negatively correlated with nacelle activity but not significantly correlated with ground or combined activity rates. As the mean and standard deviation of barometric pressure decreased so did Anabat activity at ground and combined detectors. This relationship was not as strong for nacelle activity rates (Figure 33). Mean nightly humidity was a significant covariate for nacelle, ground, and combined

activity rates where a positive correlation suggested that as mean nightly humidity increased so did the number of bat passes per detector night (Figure 34). The variability of humidity during the 24 hour period previous to searches had a positive correlation with nacelle activity rates but a negative correlation with ground and combined activity rates. This difference may be due to the reduced sampling period of detectors on turbine nacelles. As seen with observed casualty rates, nights with higher ambient temperature had higher nacelle, ground, and combined activity rates while the standard deviation of the nightly ambient temperature had a negative effect on ground and combined activity rates, showing that nights with larger variability in ambient temperatures had higher ground and combined activity rates (Figure 34). Standard deviation in ambient temperature was not a significant covariate in predicting nacelle activity rates.

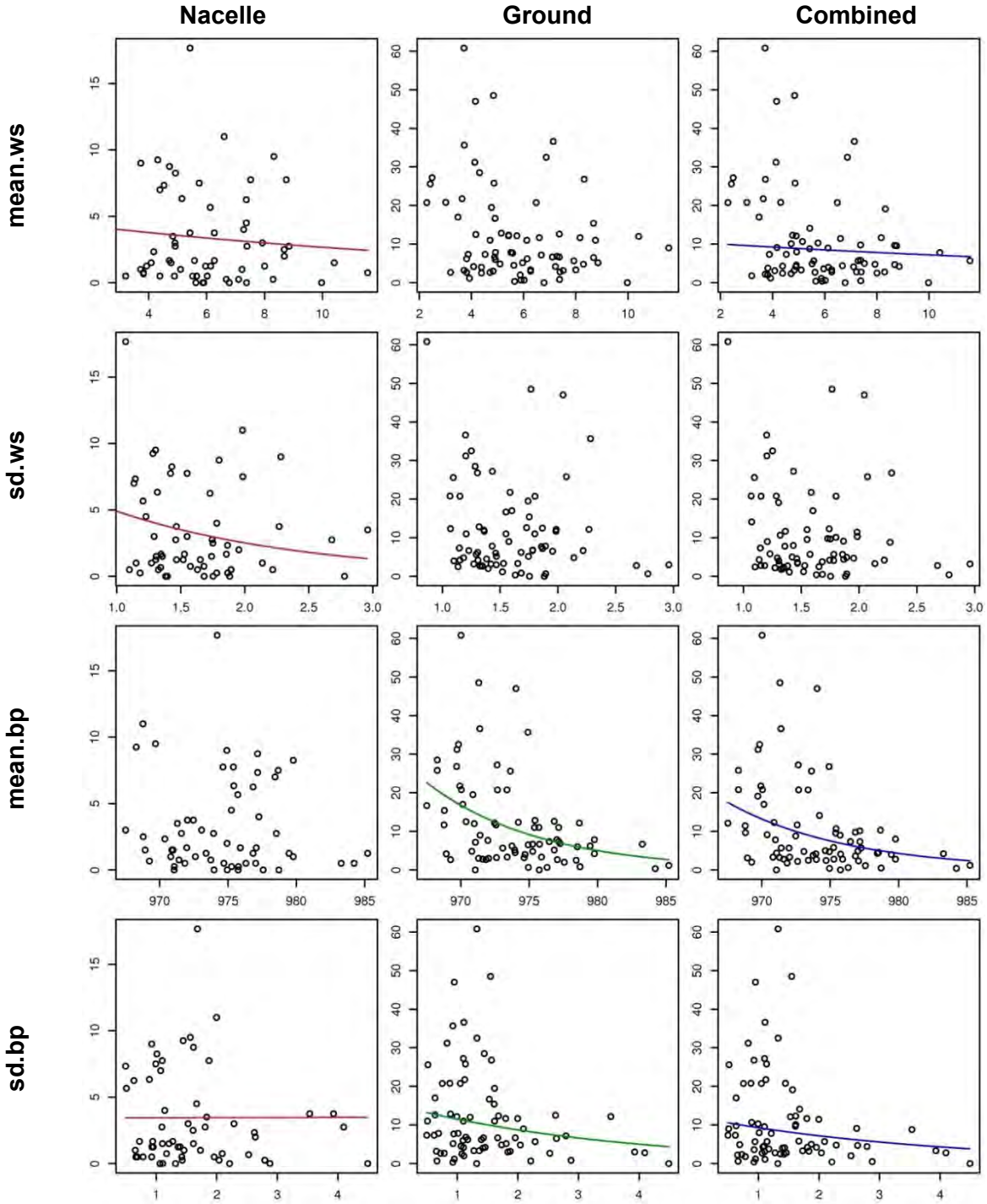

Figure 33. Nightly bat passes per detector at the Fowler Ridge Wind Farm as explained by Poisson regression model covariates. Regression lines represent sequential values of the variable of interest while restraining all other covariates to their means.

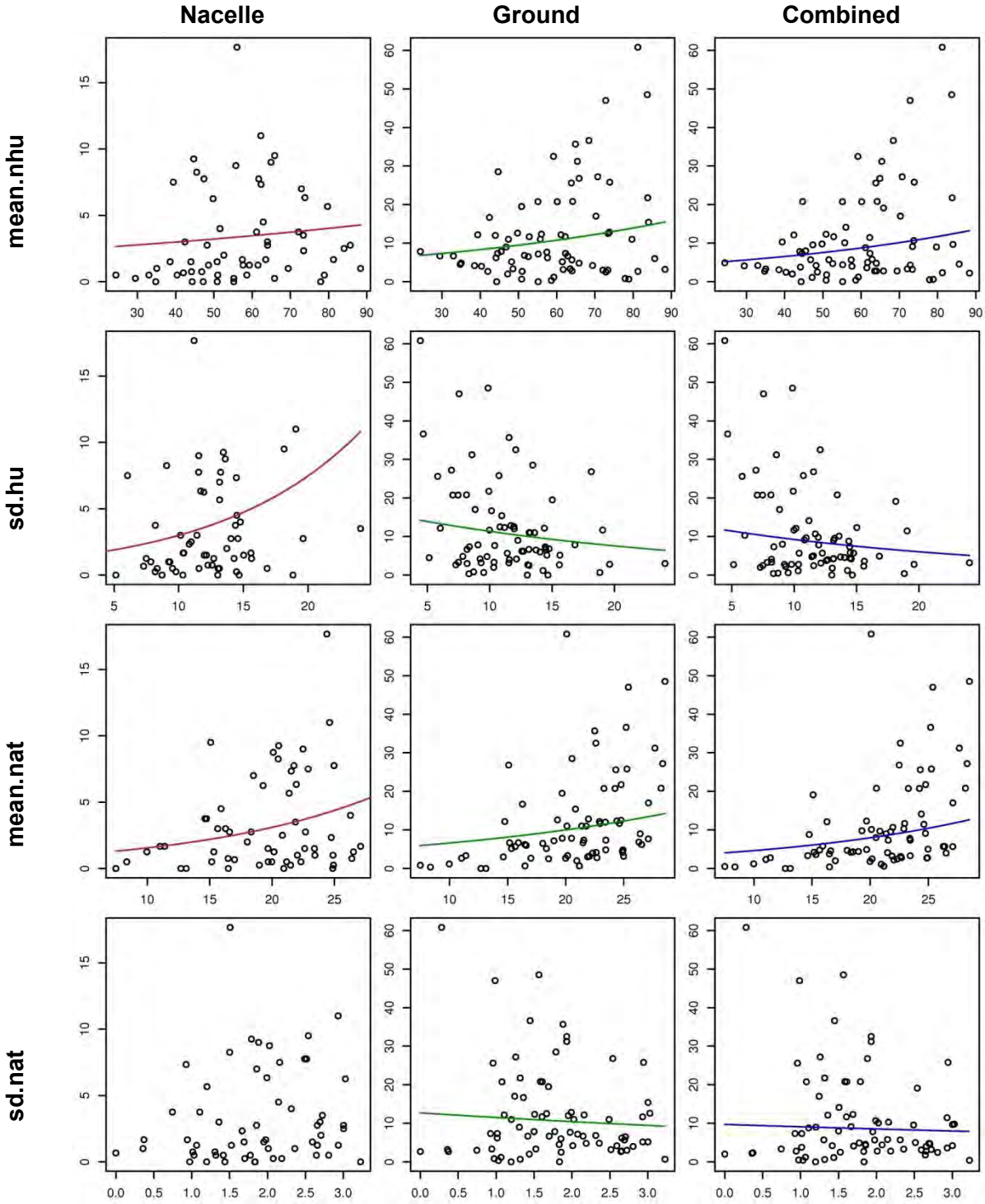

Figure 34. Nightly bat passes per detector at the Fowler Ridge Wind Farm as explained by Poisson regression model covariates. Regression lines represent sequential values of the variable of interest while restraining all other covariates to their means.

DISCUSSION

Were Indiana bat Casualties Widespread, and Did They Occur at High Levels?

The objective of the 2009 study was to determine if the number of bird and bat casualties within Phase I was low, moderate or high compared to other wind-energy projects; therefore methods differed from studies conducted to precisely quantify bat fatality rates or to detect rare fatality events. In 2010, the number of plots searched and the frequency at which plots were searched was greatly increased as compared to 2009. During 2009, the Phase I study protocol suggested that 32 turbines should be searched, of which 18 would have strips of crops mowed in order to sample the area under turbines where birds and bats could fall. However, due to lack of landowner participation, 25 turbines were searched, of which nine had crops cleared under turbines. Turbines were searched at varying intervals, from once every two weeks to twice per week, depending on season. Given the lack of landowner participation in 2009, and the discovery of an Indiana bat carcass outside of a scheduled carcass search, some uncertainty existed regarding the overall bat casualty estimate, as well as the number of Indiana bat casualties occurring at FRWF. One of the primary goals of the 2010 study was to determine if Indiana bat casualties were widespread, and if they occurred at levels that may impact Indiana bat populations; hence, the 2010 study was conducted with increased survey effort. During 2010, 36 plots were cleared of crops within three phases of study, and these turbines were searched on a daily basis during migration. Weekly searches were conducted at an additional 100 turbines in 2010.

In addition to daily searches, most fresh bat carcasses were placed in the field to estimate the probability of a carcass being found or missed due to removal by scavengers or missed by searchers. Estimates of probability of a carcass being available and detected by searchers was 0.51 and 0.58 for weekly road and pad searches and daily cleared plot searchers respectively. Thus, there was a reasonable probability of detecting bat carcasses during the study period.

Despite the increased survey effort over studies conducted in 2009, and despite reasonable probabilities of detecting bat carcasses during the study, very few *Myotis* carcasses were found, with only one Indiana bat carcass found during the study. Very few *Myotis* calls were recorded during the course of the study, and calls potentially resembling Indiana bat calls were only recorded at a single station on one evening during the fall migration period. The 2010 study was conducted during the Indiana bat spring and fall migration periods. It is clear that Indiana bat casualties were not widespread and did not occur at a high rate during the spring and fall migration period of Indiana bats. The data collected during this study can be used to calculate a defensible estimate of Indiana bat casualties that may occur at the FRWF in the future. More detailed estimates of Indiana bat casualties for future operations of the FRWF will be calculated within a Habitat Conservation Plan, currently being prepared for the FRWF.

Species Composition

Similar to other wind-energy projects in the Midwest and Northeast U.S., the vast majority of fatalities found at the FRWF were migratory tree bats, while *Myotis* and *Perimyotis* comprised less than 1% of bat carcasses recovered in 2010. Migratory tree bats comprised a similar proportion of fatalities in 2009 at Phase I when compared to the 2010 results; however; the relative proportion of species within the migratory tree bat group changed. Eastern red bats comprised a higher proportion of fatalities in 2010, and hoary bats and silver-haired bats comprised a lower proportion of fatalities in 2010. The reasons behind the changes in species composition are unclear, and may be a result of between-year variation. The fall of 2010 was abnormally warm and dry, and relatively few strong fronts associated with precipitation passed through the Benton County area (Indiana State Climate Center 2010). Little is known regarding migratory routes for bats, and the influence of weather on bat migration has not been well studied, complicating interpretation of between-year results.

Composition of bat species group activity recorded at FRWF generally mirrored the composition of bat casualties. LF and MF species groups, which include eastern red bat, hoary bat, and silver-haired bats, comprised the majority of bat activity recorded at ground stations. LF species groups comprised a higher proportion and HF a lower proportion of calls recorded at turbine nacelles, which indicate LF and MF bat species spend more time flying and echolocating at higher heights than HF species. This is further illustrated by the lack of *Myotis* calls recorded at nacelle detectors.

Cause of Indiana Bat Casualty

The Indiana bat casualty was found with a broken wing, and abrasions to the skin. A necropsy of the carcass was not performed, and it is not clear if the bat perished due to blunt force trauma associated with colliding with a blade, or if barotrauma played a role in the casualty (Baerwald et al. 2008).

Overall Bat Casualty Estimate

The 2010 Shoenfeld bat casualty estimate for Phases I,II and III of the FRWF was slightly higher than recorded at Phase I during 2009 (Johnson et al. 2010a). However; the 2010 study was designed to estimate bat fatalities during the Indiana bat migration periods, and hence casualty studies were only conducted during the spring and fall. Bat casualties also occur during the summer, and 102 bats were found while clearing plots of bats prior to the start of the study, or were estimated to have been killed prior to August 1, indicating that a substantial number of bat casualties may have occurred in late July. Thus the 2009 and 2010 estimates are not directly comparable, and the 2010 overall bat casualty estimate would have been higher if surveys were conducted during the summer. In 2009, Johnson et al. (2010a) found 7.5% of all casualties occurred during the months of June and July at Phase I of the FRWF.

While casualty rates of some bat species would have been higher during the summer, no Indiana bat casualties would be expected to occur in the summer. The FRWF generally lacks potential summer habitat and is comprised of only 249 acres of forested areas spread over

54,880 acres of project, or approximately 0.45% of the area within a half-mile of turbine locations. The timing of the two Indiana bat casualties discovered during 2009 and 2010 also strongly suggest that the Indiana bats discovered as casualties were migrating during the fall.

A growing number of bat casualty studies at wind farms are available from agricultural regions of the Midwest. When compared to other Midwest wind farms, the 2010 empirical rate for the FRWF was higher than reported at the Crescent Ridge, Illinois, Grand Ridge, Illinois, Top of Iowa, Iowa, and Buffalo Ridge, Minnesota, but lower than estimates from Blue Sky Green Field and Cedar Ridge in Wisconsin (Appendix G). It is important to note that the 2010 estimate for the FRWF only included the spring and fall migration seasons, while estimates from most other wind-energy facilities in the Midwest include spring, summer and fall seasons.

Patterns of Bat Activity

One of the objectives of the acoustic monitoring conducted at FRWF was to determine if the Anabat ultrasonic bat detector was an effective tool for predicting bat casualty rates. Bat activity was monitored at six stations over the course of two fall seasons from the ground, prior to construction of the FRWF. Two of the previously monitored stations were monitored again in 2010, to gain an understanding of how bat activity patterns may change over time. Bat activity at the two previously monitored stations averaged 5.02 and 3.49 bat passes per detector night during 2010, which was similar to the overall average bat pass rates recorded in 2007 (4.7 bat passes per detector night in 2007; Gruver et al. 2007) and 2008 (6.45 bat passes per detector night in 2008; Carder et al. 2009). While overall bat passes were similar between years for detectors placed at the same location, bat passes recorded at ground stations located below four wind turbines in 2010 recorded an average of 15.06 bat passes per detectors night in 2010, or approximately 3 – 5 times more activity than ground stations located away from turbines in 2007, 2008 and 2010 (Gruver et al. 2007, Carder et al. 2009). 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 FRWF 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 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.

Timing of Bat Fatalities

Similar to other studies of bat casualties and wind-energy projects, the vast majority of bat casualties at FRWF occurred during August and September (Johnson 2005, Arnettet al. 2008), which coincides with the fall migration period for migratory tree bats. Johnson et al. (2010a) also noted that most fatalities occurred within Phase I of the FRWF 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.

Peaks in bat fatalities also generally corresponded with peak bat activity recorded at FRWF in 2010, and bat activity rates were 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, higher mean temperature and increasing variance in temperature, and increase barometric pressure. In other words, higher bat fatalities were associated with warmer, calmer evenings prior to, or after, the passage of weather fronts and increasing bat activity.

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, Arnettet al. 2008, and 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 (Arnettet al. 2008). The results of our models of 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. This may indicate that bats continue to fly and echolocate in stronger winds, but do so at lower altitudes when winds are strong. We were not able to monitor bat use above the heights of turbines, and do not know 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.

The Indiana bat carcass discovered in 2010 was discovered on a daily search plot, and was estimated to have been killed the night before, which allowed a closer examination of weather conditions. The evening preceding the Indiana bat casualty was largely unremarkable, with air temperature, wind speeds, and humidity within or near median values for the fall migration period. Bat activity was lower than typically observed during the fall, and barometric pressure was higher than typically recorded. A high pressure system was apparently present over northern Indiana the evening the casualty occurred, and no strong fronts associated with precipitation were recorded. Other bats were recorded as casualties on the evening the Indiana bat was killed; however, unusually large numbers of casualties were not recorded. Unlike the Indiana bat found in 2010, the 2009 Indiana bat casualty at FRWF was found on a day when the most bat casualties were found.

Bat Fatalities and Turbine Type

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, we are 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. 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.

One potentially confounding factor was turbine type. While all three turbines were of the same nacelle height, the turbines were produced by different manufacturers. It is not known if one turbine type may have emitted more sounds or had other characteristics that may have potentially attracted bats. However; differences in bat fatalities between turbine types are most likely explained by differences in rotor swept areas.

We also included potential habitat variables in models predicting bat casualty rates, to determine if habitat factors may have played a larger role than turbine, or were correlated with turbine type. Similar to patterns observed at other wind-energy facilities, bat fatality rates were not related to distance to wooded areas, water, or percent cover type within 400 m of turbines (Arnettet al. 2008).

Myotis and *Perimyotis* casualties were recorded at all three types of turbines. It was not possible to test if *Myotis or Perimyotis* casualty rates varied between turbine types due to the low overall number of *Myotis* or *Perimyotis* casualties.

Bat Casualty Rates and Habitat

Arnett et al. (2008) suggested that understanding bat fatalities in relation to habitat or topographic characteristics could provide a basis for designing effective strategies for reducing bat fatalities. However, few researchers have found any spatial variation in bat fatalities within a wind-energy facility, potentially due to a general lack in variation of habitat characteristics within wind-energy facilities (Johnson et al. 2004, Jain 2005, and Arnett et al. 2008). The results of this study do not indicate that bat fatality rates varied due to proximity to habitat features; however, the FRWF is dominated by tilled agriculture and has relatively low amounts of forest cover.

Land cover and water sources surrounding all *Myotis* and *Perimyotis* carcasses can be characterized as open corn and soybean fields located at varying distances from water sources and forested shelterbelts. Only two Indiana bat carcasses have been found over the course of two years of studies at FRWF, which limit inferences that can be made regarding the effects of habitat and other features on Indiana bat casualty rates. Turbines at which the two carcasses were discovered had differing land cover and water sources surrounding the turbines. In 2009,

one Indiana bat carcass was discovered at a turbine on the northern edge of Phase I. The location of the 2009 carcass was within a large, open corn and soybean field, located relatively far (598 m) from any forested areas, and 180 m from the nearest water source. The 2010 carcass was located at a turbine on the southern edge of Phase I, and the turbine was located within a soybean field. The turbine was located closer to forest and water sources compared to the 2009 carcass location, approximately 45 m from a tree lined pond. Other linear shelterbelts were also present within 200 m of the turbine location.

Casualty and Curtailment Study

The study design utilized for the facility management study was similar to the study of cut-in speed adjustment conducted by Bat Conservation International (BCI) at the Casselman wind-energy facility in Pennsylvania (Arnett et al. 2009), and should allow comparison of study results. The largest difference between methods used by Arnett et al. (2009) and the 2010 FRWF study was the frequency at which cut-in speeds were changed. Arnett et al. (2009) switched the turbines selected for the cut-in speed adjustment on a nightly basis, whereas cut-in speeds were adjusted on a weekly basis during the 2010 FRWF study. By changing treatment turbines on a nightly basis, Arnett et al. (2009) assumed that the time of death was correctly classified for all bats found since the treatments were changed every day. Switching treatment turbines on a weekly basis reduced the potential for bats missed during prior carcass searches to be incorrectly assigned to the wrong cut-in speed treatment.

Baerwald (et al. 2009) and Arnett et al. (2010) demonstrated that raising cut-in speeds of turbines to between 5 – 6.5 m/s, or reducing rotor speeds on lower wind nights reduced bat fatalities between 57.5 – 82% over the course of single fall migration seasons in Alberta and Pennsylvania, respectively. However, both authors suggested that further tests of cut-in speed adjustment were needed in different geographic areas to determine if cut-in speed adjustments were effective in differing landscapes and for varying suites of bat species. The results of this study provide further evidence that raising wind turbine cut-in speeds is an effective measure to reduce bat casualty rates at operating wind energy facilities, and is effective for projects located in landscapes in the Midwest dominated by tilled agriculture. The results obtained during this study are comparable to results at the Casselman facility in Pennsylvania, a facility in Alberta, Canada, and a facility in Germany, where raising cut-in speeds to 5.0 – 6.5 m/s has resulted in reductions in bat mortality of 50% to 77.5% (Table 29).

Arnett et al. (2010) found no significant differences in bat casualty rates between turbines raised to 5.0 m/s and 6.5 m/s. The FRWF study is the first to demonstrate that bat casualty rates were not only significantly different between control and treatment turbines, but that bat casualty rates were significantly different between cut-in speeds raised to 5.0 m/s versus turbines with cut-in speeds raised to 6.5 m/s. The reasons for the significant differences at the FRWF versus the Casselman facility in Pennsylvania could be related to differences in wind regimes. Wind data collected at the FRWF suggest that wind speeds were between 5.0 m/s and 6.5 m/s for a significant amount of the fall survey period (19.4%). Wind speeds could have potentially been more common between 5.0 m/s and 6.5 m/s at the FRWF versus the Casselman facility;

however, data regarding the percentage of time wind speeds were within discreet ranges were not available within Arnett et al. (2010).

Table 29. Comparison of available data on effectiveness of changing turbine cut-in speeds on reducing bat mortality

Location	Turbine type	Cut-In Speed(s) Tested	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
Fowler Ridge, IN	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	This study
Germany	Unknown	5.5 m/s	~50	O. Behr, unpubl. data

The 2010 Indiana bat was discovered at a turbine with a cut-in speed raised to 5 m/s. We caution against assuming that raising cut-in speeds to 5 m/s is not an effective measure for reducing Indiana bat casualties, based on a sample size of one. Additional data are needed before conclusions regarding cut-in speed adjustment and Indiana bat fatality rates can be made.

The different casualty rates observed between the three turbine types had some potential to confound the results of the curtailment experiment; however, our study design accounted for this potential difference. Curtailment treatments were sufficiently randomized across daily search turbines to eliminate any potential confounding factor due to turbine type. The composition by turbine type of daily search turbines where no curtailment treatment was employed (control turbines) was representative of the composition of turbine types across the project. This was confirmed with a non-significant chi-squared test of proportions (chisq = 1.08, df = 2, p-value=0.58).

RECOMMENDATIONS

The data collected at the FRWF provides a baseline for identifying and refining measures to reduce bat casualty rates. While the low rate of Indiana bat fatalities likely indicates impacts of operation of the FRWF are also low, the low casualty rates also make it difficult to recommend measures specific to Indiana bats. Thus, the following recommendations are aimed at providing a basis for designing a strategy for reducing overall bat casualty rates, under the assumption that Indiana bat casualty rates will also be reduced.

Raising cut-in speeds showed a reduction in bat casualty rates at FRWF during the Fall of 2010, and similar reductions in bat casualty rates have also been documented by researchers at other wind-energy facilities (Arnett et al. 2010, Baerwald et al. 2009). However, correlations observed

between weather variables and bat fatalities suggest that focusing or adjusting cut-in speed adjustments during periods when bats may be at most risk, or at locations where bats may be more likely to be found, may optimize reductions in bat fatalities. Other measures such as bat deterrents could also potentially be used to reduce bat casualty rates in the future (Horn et al. 2008).

The following are recommendations for potentially reducing bat mortality at FRWF. These recommendations are based largely on a single year of study at FRWF, as well as the results of research from other wind-energy facilities, where applicable. Bat migration patterns can vary between years, and few research studies are available that examine patterns of bat fatalities in the Midwest. These recommendations could be utilized in an adaptive management framework to refine minimization strategies as additional data and results become available from FRWF and other wind-energy facilities. The following recommendations should be seen as a toolbox of potential measures for reducing bat casualty rates, but should not be seen as a directive to implement specific practices. Potential use of these recommendations will depend largely on the biological goals and objectives of a minimization and monitoring strategy, currently being developed for the FRWF:

- Develop an optimization model that attempts to maximize bat casualty reductions while balancing financial impacts to FRWF.

- Test additional cut-in speeds (e.g. 4.5 m/s) beyond those cited in this report (5.0 m/s and 6.5 m/s) that may potentially reduce fatalities to similar levels.

- To date, the vast majority of bat fatalities occur during the fall migration period for most bat species, and the only two Indiana bat fatalities discovered to date occurred during the first three weeks in September. However, potential *Myotis* activity was only recorded within the FRWF during the evening of August 9-10, 2010. The Indiana Bat Recovery Plan (USFWS 2007) defines that fall migration season for Indiana bats as August 1- October 15. Based on currently available information, we recommend focusing casualty minimization efforts during this critical time, under the assumption that Indiana bats are at most risk during this period.

- Within the fall migration period for Indiana bats, attention should be focused during specific weather conditions that were shown to have the greatest influence on bat casualty rates. For example:
    - Air Temperature: 91.13% of fatalities occurred on nights with mean nightly temperature above 20.08 degrees C (68.10 degrees Fahrenheit).
    - Passage of Fronts: The night with the most bat casualties appeared to be associated with the passage of one or more weather fronts, and bat casualty rates were associated with barometric pressure.
    - Humidity: Increasing humidity was shown to be a significant predictor of bat activity and bat casualty rates.

- Additional considerations when designing a plan should include:
    - Turbine type
    - Distance to water.
    - Areas with high concentrations of bat activity (Anabat supported)

The following are recommendations for future monitoring of bat casualty and activity at FRWF:

- Monitoring of spring fatalities may be considered for a limited period of time, to verify the assumption that Indiana bats are most at risk during the fall migration period.

- Cleared plots require relatively large crop loss payments to farmers, as well as vegetation maintenance costs. Searcher efficiency rates are also lower on cleared plots versus roads and pads. Future monitoring of bat casualty rates can be completed by searching roads and pads, which were shown to provide comparable overall casualty estimates as searches on cleared plots.

- The 2010 study was not designed to determine if bat casualty rates varied by turbine type or habitat features, although apparently significant patterns of bat fatalities by turbine type were recorded. Additional monitoring of FRWF could consider the influence of turbine type and habitat features.

- Comparable bat casualty estimates were obtained on weekly road and pad searches versus daily road and pad searches. Search intervals used for future monitoring should be based on study objectives. Studies designed to measure overall bat casualty rates may be completed utilizing less frequent search intervals, while studies designed to measure influence of weather on bat casualty rates may require daily searches.

- Patterns and estimates of bat fatality recorded at Phases I, II and III should be similar for Phases IV and V given their proximity, assuming that habitat and topographic characteristics are similar. We recommend verifying similarities in habitat and topography between future phases and Phases I, II, and III when assessing the risk of bat fatalities occurring at future phases of the FRWF.

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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. Wind-energy facilities in North America with casualty data for bats, grouped by geographic region.

WEST, Inc.
Western EcoSystems Technology
2003 Central Avenue Cheyenne, Wyoming 82001
Phone: (307) 634-1756 Fax: (307) 637-6981

Date: January 12, 2011

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 Lynn Robbins (University of Missouri). There were 644 bat calls from 11 bat species used to develop the function. The average number of pulses per call is shown in Table 1. The "bnoise" 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 median 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 11 variables in the candidate variable list: median duration (Dur), median maximum frequency (Fmax), median minimum frequency (Fmin), variance of the minimum frequency (varFmin), median frequency (Fmean), median time to inflection point of pulse (Tk), median frequency at inflection point of pulse (Fk), median characteristic time (Tc), median characteristic frequency (Fc), median initial slope (S1), and median 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 10 variables entering and staying in the model, all in the candidate variable list except variance of Fmin. The model had a correct classification rate of 89% 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 ($p=0.001$). When the model was rerun with equal sample sizes to determine the sensitivity of the model predictions to the homogeneity assumption, the model classified the bat calls to the same species 87% of the time.

The first eigenvalue accounted for 61% of the variance explained with the second accounting for 29% for a cumulative sum across the first two eigenvalues of 90%. 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, mean frequency and characteristic 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. The third canonical variate is negatively correlated with mean frequency, inflection frequency, and maximum frequency.

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	95% Confidence Interval Upper
EPFU	110	33.17	29.18	37.17
LABO	46	34.70	27.88	41.51
LACI	32	22.78	17.46	28.10
LANO	34	23.24	16.92	29.55
MYGR	62	57.94	44.09	71.78
MYLE	12	37.50	29.87	45.13
MYLU	68	38.31	33.23	43.39
MYSE	50	36.88	31.12	42.64
MYSO	93	37.60	32.93	42.28
NYHU	15	26.00	21.19	30.81
PESU	118	27.89	24.09	31.69

Table 2. Percent correct classification rate for each species and all species combined.

Species	Total number of Calls	Number of Correctly Classified Calls	Percentage of Calls Correctly Classified
EPFU	110	98	0.89
LABO	46	32	0.70
LACI	32	25	0.78
LANO	34	27	0.79
MYGR	62	60	0.97
MYLE	12	8	0.67
MYLU	68	66	0.97
MYSE	50	45	0.90
MYSO	93	83	0.89
NYHU	15	12	0.80
PESU	118	115	0.97
Total	640	571	0.89

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

Species	Constant	Fmin	Sc	Fmean	Dur	Tk	S1	Fk	Fc	Fmax	Tc
EPFU	-225.48	14.89	-0.02	0.52	9.61	6.77	-0.01	-0.56	-0.33	-0.04	-4.66
LABO	-396.93	21.14	-0.18	-1.90	10.74	2.80	0.00	-2.40	2.35	0.70	-3.63
LACI	-192.46	14.10	-0.01	-0.47	8.98	-2.97	0.01	-1.55	0.54	0.14	0.91
LANO	-197.82	15.11	-0.09	-1.04	7.94	-0.51	0.01	-1.76	1.27	0.30	-1.51
MYGR	-532.34	22.75	-0.24	-1.28	10.26	1.48	-0.01	-0.37	0.99	0.91	-3.18
MYLE	-530.11	22.37	0.15	-1.25	11.13	2.00	0.02	-3.42	3.62	0.45	-2.45
MYLU	-424.25	20.44	-0.10	0.57	11.29	3.57	-0.01	1.45	-2.79	0.35	-4.92
MYSE	-456.76	17.88	0.28	-0.46	10.02	1.71	-0.05	-3.81	4.62	1.28	-1.50
MYSO	-446.05	20.04	0.02	0.40	11.78	3.35	-0.02	-2.35	1.95	0.51	-4.97
NYHU	-362.23	20.28	-0.20	-2.21	8.16	0.96	0.01	-2.69	2.95	0.70	-1.19
PESU	-491.35	23.71	-0.27	-2.81	10.76	1.13	0.02	-4.08	4.74	0.75	-3.07

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

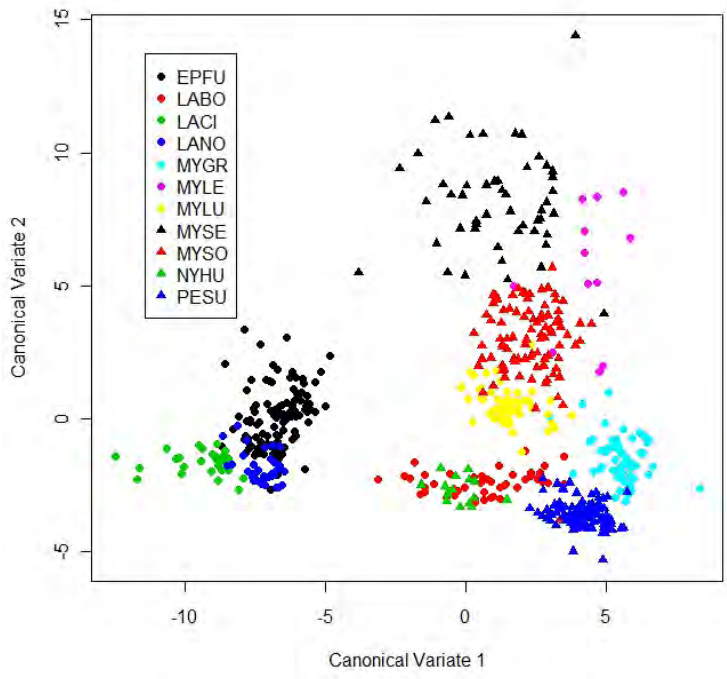
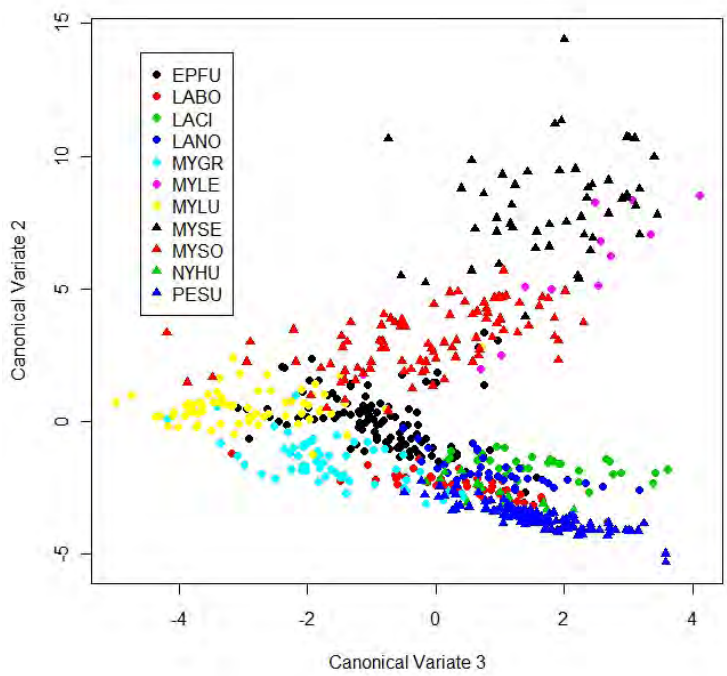


Figure 2. Bat calls in the space of the second and third canonical variates.



Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
041310-ERBA-459-1	4 /13/2010	08:22	eastern red bat	carcass search
041310-SHBA-113-1	4 /13/2010	11:10	silver-haired bat	carcass search
041310-ERBA-458-1	4 /13/2010	12:30	eastern red bat	carcass search
041410-SHBA-640-1	4 /14/2010	10:46	silver-haired bat	carcass search
041510-SHBA-628-1	4 /15/2010	15:19	silver-haired bat	carcass search
041610-ERBA-281-1	4 /16/2010	11:24	eastern red bat	carcass search
041810-ERBA-628-1	4 /18/2010	11:30	eastern red bat	carcass search
041910-ERBA-387-1	4 /19/2010	11:20	eastern red bat	carcass search
041910-ERBA-397-1	4 /19/2010	11:57	eastern red bat	carcass search
042010-SHBA-640-1	4 /20/2010	10:35	silver-haired bat	carcass search
042110-HOBA-230-1	4 /21/2010	08:57	hoary bat	carcass search
042110-ERBA-260-1	4 /21/2010	15:12	eastern red bat	carcass search
042210-ERBA-480-1	4 /22/2010	15:56	eastern red bat	carcass search
042310-ERBA-334-1	4 /23/2010	09:50	eastern red bat	carcass search
042310-SHBA-323-2	4 /23/2010	11:00	silver-haired bat	carcass search
042310-SHBA-614-3	4 /23/2010	14:25	silver-haired bat	carcass search
042410-ERBA-640-1	4 /24/2010	11:00	eastern red bat	carcass search
042610-SHBA-640-1	4 /26/2010	10:19	silver-haired bat	carcass search
042610-SHBA-24-1	4 /26/2010	11:55	silver-haired bat	carcass search
042610-SHBA-88-1	4 /26/2010	12:40	silver-haired bat	carcass search
042610-SHBA-26-1	4 /26/2010	12:55	silver-haired bat	carcass search
042910-ERBA-396-1	4 /29/2010	12:00	eastern red bat	carcass search
050110-ERBA-480-1	5 /1 /2010	16:15	eastern red bat	carcass search
050210-SHBA-628-1	5 /2 /2010	13:10	silver-haired bat	carcass search
050410-SHBA-216-1	5 /4 /2010	10:10	silver-haired bat	carcass search
050410-SHBA-24-1	5 /4 /2010	12:50	silver-haired bat	carcass search
050510-SHBA-314-1	5 /5 /2010	14:30	silver-haired bat	carcass search
050510-SHBA-625-1	5 /5 /2010	15:39	silver-haired bat	carcass search
050710-SHBA-614-1	5 /7 /2010	14:00	silver-haired bat	carcass search
051310-ERBA-622-1	5 /13/2010	11:56	eastern red bat	carcass search
051510-ERBA-251-2	5 /15/2010	12:55	eastern red bat	carcass search
080110-ERBA-314-1	8 /1 /2010	07:55	eastern red bat	carcass search
080110-ERBA-407-2	8 /1 /2010	08:35	eastern red bat	carcass search
080110-ERBA-230-1	8 /1 /2010	09:36	eastern red bat	carcass search
080110-ERBA-390-1	8 /1 /2010	09:56	eastern red bat	carcass search
080110-HOBA-642-1	8 /1 /2010	10:23	hoary bat	carcass search
080110-ERBA-459-2	8 /1 /2010	13:18	eastern red bat	carcass search
080110-ERBA-459-1	8 /1 /2010	13:22	eastern red bat	carcass search
080110-ERBA-628-1	8 /1 /2010	14:16	eastern red bat	carcass search
080110-ERBA-609-1	8 /1 /2010	15:33	eastern red bat	carcass search
080110-ERBA-286-1	8 /1 /2010	15:59	eastern red bat	carcass search
080210-BBBA-617-1	8 /2 /2010	07:41	big brown bat	carcass search
080210-HOBA-459-1	8 /2 /2010	08:01	hoary bat	carcass search
080210-ERBA-459-3	8 /2 /2010	08:06	eastern red bat	carcass search
080210-ERBA-459-2	8 /2 /2010	08:06	eastern red bat	carcass search
080210-ERBA-459-4	8 /2 /2010	08:08	eastern red bat	carcass search
080210-HOBA-602-2	8 /2 /2010	08:45	hoary bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
080210-ERBA-248-1	8 /2 /2010	09:03	eastern red bat	carcass search
080210-ERBA-480-1	8 /2 /2010	09:12	eastern red bat	carcass search
080210-HOBA-253-1	8 /2 /2010	09:42	hoary bat	carcass search
080210-ERBA-253-2	8 /2 /2010	09:53	eastern red bat	carcass search
080210-HOBA-245-3	8 /2 /2010	10:20	hoary bat	carcass search
080210-ERBA-229-1	8 /2 /2010	11:06	eastern red bat	carcass search
080210-HOBA-013-1	8 /2 /2010	11:59	hoary bat	carcass search
080210-ERBA-147-1	8 /2 /2010	13:45	eastern red bat	carcass search
080210-HOBA-314-1	8 /2 /2010	14:00	hoary bat	carcass search
080210-ERBA-047-1	8 /2 /2010	15:48	eastern red bat	carcass search
080210-ERBA-026-1	8 /2 /2010	15:50	eastern red bat	carcass search
080210-ERBA-065-1	8 /2 /2010	16:11	eastern red bat	carcass search
080310-ERBA-448-1	8 /3 /2010	12:51	eastern red bat	carcass search
080310-HOBA-281-1	8 /3 /2010	13:21	hoary bat	carcass search
080310-ERBA-281-2	8 /3 /2010	13:28	eastern red bat	carcass search
080310-ERBA-628-1	8 /3 /2010	15:45	eastern red bat	carcass search
080410-ERBA-459-2	8 /4 /2010	08:12	eastern red bat	carcass search
080410-ERBA-459-1	8 /4 /2010	08:12	eastern red bat	carcass search
080410-ERBA-087-1	8 /4 /2010	08:30	eastern red bat	carcass search
080410-ERBA-087-2	8 /4 /2010	08:36	eastern red bat	carcass search
080410-ERBA-087-3	8 /4 /2010	08:45	eastern red bat	carcass search
080410-ERBA-480-1	8 /4 /2010	09:20	eastern red bat	carcass search
080410-ERBA-056-1	8 /4 /2010	09:50	eastern red bat	carcass search
080410-ERBA-628-1	8 /4 /2010	09:51	eastern red bat	carcass search
080410-ERBA-628-2	8 /4 /2010	09:55	eastern red bat	carcass search
080410-ERBA-628-3	8 /4 /2010	10:00	eastern red bat	carcass search
080410-ERBA-628-4	8 /4 /2010	10:08	eastern red bat	carcass search
080410-ERBA-628-6	8 /4 /2010	10:20	eastern red bat	carcass search
080410-ERBA-048-1	8 /4 /2010	10:28	eastern red bat	carcass search
080410-ERBA-048-2	8 /4 /2010	10:30	eastern red bat	carcass search
080410-ERBA-480-1	8 /4 /2010	10:45	eastern red bat	carcass search
080410-BBBA-448-1	8 /4 /2010	10:55	big brown bat	carcass search
080410-ERBA-448-2	8 /4 /2010	10:55	eastern red bat	carcass search
080410-ERBA-448-3	8 /4 /2010	10:57	eastern red bat	carcass search
080410-ERBA-083-1	8 /4 /2010	11:13	eastern red bat	carcass search
080410-ERBA-073-1	8 /4 /2010	11:39	eastern red bat	carcass search
080410-ERBA-414-1	8 /4 /2010	12:00	eastern red bat	carcass search
080410-ERBA-281-1	8 /4 /2010	13:04	eastern red bat	carcass search
080410-ERBA-024-1	8 /4 /2010	14:07	eastern red bat	carcass search
080410-ERBA-387-1	8 /4 /2010	14:13	eastern red bat	carcass search
080410-ERBA-387-2	8 /4 /2010	14:17	eastern red bat	carcass search
080410-ERBA-371-1	8 /4 /2010	15:22	eastern red bat	carcass search
080410-ERBA-314-1	8 /4 /2010	15:44	eastern red bat	carcass search
080410-ERBA-314-2	8 /4 /2010	15:58	eastern red bat	carcass search
080410-ERBA-314-3	8 /4 /2010	16:01	eastern red bat	carcass search
080410-ERBA-314-4	8 /4 /2010	16:03	eastern red bat	carcass search
080410-HOBA-230-1	8 /4 /2010	16:06	hoary bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
080410-HOBA-230-2	8 /4 /2010	16:10	hoary bat	carcass search
080510-ERBA-480-1	8 /5 /2010	10:55	eastern red bat	carcass search
080510-ERBA-048-1	8 /5 /2010	12:15	eastern red bat	carcass search
080510-ERBA-230-1	8 /5 /2010	12:44	eastern red bat	carcass search
080510-ERBA-056-1	8 /5 /2010	13:11	eastern red bat	carcass search
080510-ERBA-087-1	8 /5 /2010	13:45	eastern red bat	carcass search
080510-ERBA-314-1	8 /5 /2010	14:30	eastern red bat	carcass search
080510-ERBA-314-2	8 /5 /2010	14:35	eastern red bat	carcass search
080510-ERBA-314-3	8 /5 /2010	14:40	eastern red bat	carcass search
080610-BBBA-339-1	8 /6 /2010	07:51	big brown bat	carcass search
080610-ERBA-314-1	8 /6 /2010	08:20	eastern red bat	carcass search
080610-HOBA-355-1	8 /6 /2010	08:21	hoary bat	carcass search
080610-ERBA-056-1	8 /6 /2010	08:35	eastern red bat	carcass search
080610-ERBA-388-1	8 /6 /2010	08:40	eastern red bat	carcass search
080610-ERBA-388-2	8 /6 /2010	08:42	eastern red bat	carcass search
080610-ERBA-419-1	8 /6 /2010	09:18	eastern red bat	carcass search
080610-ERBA-323-1	8 /6 /2010	09:30	eastern red bat	carcass search
080610-ERBA-443-1	8 /6 /2010	09:42	eastern red bat	carcass search
080610-ERBA-426-1	8 /6 /2010	10:37	eastern red bat	carcass search
080610-ERBA-426-2	8 /6 /2010	10:38	eastern red bat	carcass search
080610-ERBA-095-1	8 /6 /2010	10:56	eastern red bat	carcass search
080610-ERBA-397-1	8 /6 /2010	11:19	eastern red bat	carcass search
080610-ERBA-088-1	8 /6 /2010	11:54	eastern red bat	carcass search
080610-ERBA-309-1	8 /6 /2010	12:06	eastern red bat	carcass search
080610-ERBA-309-2	8 /6 /2010	12:07	eastern red bat	carcass search
080610-ERBA-454-1	8 /6 /2010	13:11	eastern red bat	carcass search
080610-ERBA-123-1	8 /6 /2010	13:17	eastern red bat	carcass search
080610-ERBA-414-1	8 /6 /2010	13:30	eastern red bat	carcass search
080610-ERBA-628-1	8 /6 /2010	13:48	eastern red bat	carcass search
080610-ERBA-459-1	8 /6 /2010	14:15	eastern red bat	carcass search
080610-HOBA-398-1	8 /6 /2010	14:39	hoary bat	carcass search
080610-ERBA-379-1	8 /6 /2010	15:03	eastern red bat	carcass search
080610-ERBA-379-2	8 /6 /2010	15:04	eastern red bat	carcass search
080610-ERBA-379-3	8 /6 /2010	15:06	eastern red bat	carcass search
080610-ERBA-379-4	8 /6 /2010	15:08	eastern red bat	carcass search
080610-ERBA-448-1	8 /6 /2010	15:45	eastern red bat	carcass search
080610-ERBA-369-1	8 /6 /2010	16:28	eastern red bat	carcass search
080710-ERBA-476-1	8 /7 /2010	07:02	eastern red bat	carcass search
080710-ERBA-476-2	8 /7 /2010	07:04	eastern red bat	carcass search
080710-ERBA-476-3	8 /7 /2010	07:05	eastern red bat	carcass search
080710-ERBA-420-1	8 /7 /2010	08:04	eastern red bat	carcass search
080710-ERBA-420-2	8 /7 /2010	08:05	eastern red bat	carcass search
080710-ERBA-390-1	8 /7 /2010	08:38	eastern red bat	carcass search
080710-ERBA-639-1	8 /7 /2010	09:22	eastern red bat	carcass search
080710-ERBA-635-1	8 /7 /2010	09:47	eastern red bat	carcass search
080710-ERBA-414-1	8 /7 /2010	09:50	eastern red bat	carcass search
080710-ERBA-625-1	8 /7 /2010	10:10	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
080710-ERBA-625-2	8 /7 /2010	10:11	eastern red bat	carcass search
080710-ERBA-098-1	8 /7 /2010	10:31	eastern red bat	carcass search
080710-LBBA-622-1	8 /7 /2010	10:52	little brown bat	carcass search
080710-BBBA-622-2	8 /7 /2010	10:53	big brown bat	carcass search
080710-ERBA-083-1	8 /7 /2010	11:30	eastern red bat	carcass search
080710-ERBA-329-1	8 /7 /2010	12:00	eastern red bat	carcass search
080710-ERBA-230-1	8 /7 /2010	12:30	eastern red bat	carcass search
080710-BBBA-609-1	8 /7 /2010	12:40	big brown bat	carcass search
080710-ERBA-607-1	8 /7 /2010	13:08	eastern red bat	carcass search
080710-ERBA-607-3	8 /7 /2010	13:09	eastern red bat	carcass search
080710-HOBA-607-2	8 /7 /2010	13:09	hoary bat	carcass search
080710-HOBA-607-4	8 /7 /2010	13:10	hoary bat	carcass search
080710-ERBA-620-1	8 /7 /2010	13:57	eastern red bat	carcass search
080710-HOBA-253-1	8 /7 /2010	14:45	hoary bat	carcass search
080710-BBBA-628-1	8 /7 /2010	15:25	big brown bat	carcass search
080710-ERBA-216-1	8 /7 /2010	15:27	eastern red bat	carcass search
080710-ERBA-229-1	8 /7 /2010	15:57	eastern red bat	carcass search
080710-HOBA-245-1	8 /7 /2010	16:16	hoary bat	carcass search
080710-ERBA-245-2	8 /7 /2010	16:20	eastern red bat	carcass search
080710-ERBA-227-1	8 /7 /2010	16:46	eastern red bat	carcass search
080710-ERBA-198-1	8 /7 /2010	17:11	eastern red bat	carcass search
080710-HOBA-198-2	8 /7 /2010	17:12	hoary bat	carcass search
080710-ERBA-193-1	8 /7 /2010	17:35	eastern red bat	carcass search
080710-ERBA-193-2	8 /7 /2010	17:36	eastern red bat	carcass search
080710-ERBA-602-1	8 /7 /2010	18:19	eastern red bat	carcass search
080810-ERBA-045-1	8 /8 /2010	07:28	eastern red bat	carcass search
080810-ERBA-448-1	8 /8 /2010	08:19	eastern red bat	carcass search
080810-ERBA-448-2	8 /8 /2010	08:28	eastern red bat	carcass search
080810-ERBA-047-1	8 /8 /2010	08:45	eastern red bat	carcass search
080810-HOBA-035-1	8 /8 /2010	10:23	hoary bat	carcass search
080810-HOBA-065-1	8 /8 /2010	10:52	hoary bat	carcass search
080810-ERBA-090-1	8 /8 /2010	11:23	eastern red bat	carcass search
080810-ERBA-218-1	8 /8 /2010	12:08	eastern red bat	carcass search
080810-ERBA-152-1	8 /8 /2010	12:46	eastern red bat	carcass search
080810-SHBA-371-1	8 /8 /2010	12:52	silver-haired bat	carcass search
080810-BBBA-014-1	8 /8 /2010	13:07	big brown bat	carcass search
080810-ERBA-092-2	8 /8 /2010	13:18	eastern red bat	carcass search
080810-ERBA-007-1	8 /8 /2010	13:29	eastern red bat	carcass search
080810-ERBA-003-1	8 /8 /2010	14:12	eastern red bat	carcass search
080810-ERBA-173-1	8 /8 /2010	14:41	eastern red bat	carcass search
080810-ERBA-173-2	8 /8 /2010	14:44	eastern red bat	carcass search
080810-HOBA-127-1	8 /8 /2010	15:11	hoary bat	carcass search
080910-ERBA-480-1	8 /9 /2010	08:30	eastern red bat	carcass search
080910-ERBA-048-1	8 /9 /2010	09:25	eastern red bat	carcass search
080910-ERBA-281-1	8 /9 /2010	09:50	eastern red bat	carcass search
080910-HOBA-458-1	8 /9 /2010	12:38	hoary bat	carcass search
081110-ERBA-414-1	8 /11/2010	13:28	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
081110-ERBA-459-2	8 /11/2010	13:55	eastern red bat	carcass search
081110-ERBA-113-1	8 /11/2010	14:25	eastern red bat	carcass search
081110-ERBA-480-3	8 /11/2010	14:30	eastern red bat	carcass search
081110-ERBA-480-1	8 /11/2010	14:30	eastern red bat	carcass search
081110-ERBA-480-2	8 /11/2010	14:30	eastern red bat	carcass search
081110-ERBA-630-1	8 /11/2010	16:20	eastern red bat	carcass search
081210-ERBA-123-1	8 /12/2010	08:00	eastern red bat	carcass search
081210-ERBA-088-1	8 /12/2010	09:30	eastern red bat	carcass search
081210-HOBA-414-1	8 /12/2010	10:20	hoary bat	carcass search
081210-ERBA-414-2	8 /12/2010	10:25	eastern red bat	carcass search
081210-ERBA-260-1	8 /12/2010	13:36	eastern red bat	carcass search
081210-ERBA-251-1	8 /12/2010	14:34	eastern red bat	carcass search
081210-ERBA-459-1	8 /12/2010	15:15	eastern red bat	incidental find
081210-ERBA-609-1	8 /12/2010	16:04	eastern red bat	incidental find
081210-ERBA-609-2	8 /12/2010	16:11	eastern red bat	incidental find
081310-BBBA-609-1	8 /13/2010	08:54	big brown bat	incidental find
081310-ERBA-609-2	8 /13/2010	08:57	eastern red bat	incidental find
081310-ERBA-480-1	8 /13/2010	09:20	eastern red bat	carcass search
081310-HOBA-480-1	8 /13/2010	09:22	hoary bat	carcass search
081310-ERBA-230-1	8 /13/2010	10:36	eastern red bat	carcass search
081310-ERBA-230-2	8 /13/2010	10:46	eastern red bat	carcass search
081310-HOBA-448-1	8 /13/2010	10:52	hoary bat	carcass search
081310-HOBA-230-3	8 /13/2010	10:53	hoary bat	carcass search
081310-ERBA-396-1	8 /13/2010	12:00	eastern red bat	carcass search
081310-ERBA-260-1	8 /13/2010	12:54	eastern red bat	carcass search
081310-ERBA-414-1	8 /13/2010	13:10	eastern red bat	carcass search
081310-ERBA-388-1	8 /13/2010	13:54	eastern red bat	incidental find
081310-ERBA-085-1	8 /13/2010	15:13	eastern red bat	carcass search
081310-BBBA-047-1	8 /13/2010	15:41	big brown bat	carcass search
081310-ERBA-627-1	8 /13/2010	15:41	eastern red bat	incidental find
081310-ERBA-075-1	8 /13/2010	16:11	eastern red bat	carcass search
081310-ERBA-068-1	8 /13/2010	16:37	eastern red bat	carcass search
081310-BBBA-639-1	8 /13/2010	17:29	big brown bat	incidental find
081410-ERBA-642-1	8 /14/2010	07:30	eastern red bat	carcass search
081410-ERBA-628-1	8 /14/2010	08:45	eastern red bat	carcass search
081410-ERBA-611-1	8 /14/2010	08:54	eastern red bat	carcass search
081410-ERBA-459-1	8 /14/2010	08:54	eastern red bat	incidental find
081410-BBBA-628-2	8 /14/2010	08:56	big brown bat	carcass search
081410-ERBA-254-1	8 /14/2010	09:51	eastern red bat	carcass search
081410-ERBA-203-2	8 /14/2010	10:23	eastern red bat	carcass search
081410-ERBA-230-2	8 /14/2010	10:25	eastern red bat	incidental find
081410-HOBA-230-1	8 /14/2010	10:25	hoary bat	incidental find
081410-ERBA-152-1	8 /14/2010	11:05	eastern red bat	carcass search
081410-ERBA-407-2	8 /14/2010	11:15	eastern red bat	carcass search
081410-ERBA-260-1	8 /14/2010	11:20	eastern red bat	carcass search
081410-HOBA-048-1	8 /14/2010	11:22	hoary bat	carcass search
081410-ERBA-173-1	8 /14/2010	11:52	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
081410-ERBA-113-2	8 /14/2010	13:25	eastern red bat	carcass search
081410-HOBA-224-1	8 /14/2010	13:29	hoary bat	carcass search
081410-ERBA-113-3	8 /14/2010	13:30	eastern red bat	carcass search
081410-ERBA-224-2	8 /14/2010	13:31	eastern red bat	carcass search
081410-ERBA-113-1	8 /14/2010	13:35	eastern red bat	carcass search
081410-ERBA-387-1	8 /14/2010	13:40	eastern red bat	carcass search
081410-ERBA-193-1	8 /14/2010	13:58	eastern red bat	carcass search
081410-ERBA-607-1	8 /14/2010	14:53	eastern red bat	carcass search
081410-HOBA-414-1	8 /14/2010	15:10	hoary bat	carcass search
081410-ERBA-329-1	8 /14/2010	15:24	eastern red bat	carcass search
081410-ERBA-459-1	8 /14/2010	15:44	eastern red bat	carcass search
081410-ERBA-459-2	8 /14/2010	15:50	eastern red bat	carcass search
081410-ERBA-480-1	8 /14/2010	16:40	eastern red bat	carcass search
081510-ERBA-420-1	8 /15/2010	07:47	eastern red bat	carcass search
081510-ERBA-476-2	8 /15/2010	08:37	eastern red bat	carcass search
081510-ERBA-476-4	8 /15/2010	08:41	eastern red bat	carcass search
081510-ERBA-476-3	8 /15/2010	08:41	eastern red bat	carcass search
081510-ERBA-414-1	8 /15/2010	10:20	eastern red bat	carcass search
081510-ERBA-414-2	8 /15/2010	10:24	eastern red bat	carcass search
081510-ERBA-352-1	8 /15/2010	10:42	eastern red bat	carcass search
081510-ERBA-352-2	8 /15/2010	10:44	eastern red bat	carcass search
081510-HOBA-095-1	8 /15/2010	11:01	hoary bat	carcass search
081510-ERBA-095-2	8 /15/2010	11:11	eastern red bat	carcass search
081510-ERBA-379-1	8 /15/2010	11:15	eastern red bat	carcass search
081510-ERBA-095-3	8 /15/2010	11:16	eastern red bat	carcass search
081510-HOBA-098-1	8 /15/2010	11:58	hoary bat	carcass search
081510-ERBA-098-2	8 /15/2010	12:05	eastern red bat	carcass search
081510-ERBA-401-1	8 /15/2010	12:13	eastern red bat	carcass search
081510-ERBA-073-2	8 /15/2010	12:40	eastern red bat	carcass search
081510-HOBA-630-1	8 /15/2010	12:48	hoary bat	carcass search
081510-ERBA-426-1	8 /15/2010	13:00	eastern red bat	carcass search
081510-ERBA-426-3	8 /15/2010	13:00	eastern red bat	carcass search
081510-HOBA-056-1	8 /15/2010	13:50	hoary bat	carcass search
081510-ERBA-477-1	8 /15/2010	14:16	eastern red bat	carcass search
081510-ERBA-443-1	8 /15/2010	14:36	eastern red bat	carcass search
081510-ERBA-419-1	8 /15/2010	14:53	eastern red bat	carcass search
081510-ERBA-419-2	8 /15/2010	14:55	eastern red bat	carcass search
081510-HOBA-339-1	8 /15/2010	15:36	hoary bat	carcass search
081610-ERBA-630-1	8 /16/2010	09:05	eastern red bat	carcass search
081610-HOBA-630-1	8 /16/2010	09:12	hoary bat	carcass search
081610-ERBA-603-1	8 /16/2010	10:17	eastern red bat	carcass search
081610-ERBA-396-1	8 /16/2010	10:34	eastern red bat	carcass search
081610-HOBA-006-1	8 /16/2010	14:02	hoary bat	carcass search
081610-ERBA-006-2	8 /16/2010	14:10	eastern red bat	carcass search
081710-ERBA-056-1	8 /17/2010	08:34	eastern red bat	carcass search
081710-ERBA-048-1	8 /17/2010	09:07	eastern red bat	carcass search
081710-ERBA-073-1	8 /17/2010	10:02	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
081710-ERBA-396-2	8 /17/2010	10:40	eastern red bat	carcass search
081710-ERBA-396-1	8 /17/2010	10:45	eastern red bat	carcass search
081710-ERBA-396-3	8 /17/2010	10:50	eastern red bat	carcass search
081810-ERBA-630-1	8 /18/2010	08:45	eastern red bat	carcass search
081810-ERBA-230-1	8 /18/2010	09:15	eastern red bat	incidental find
081810-ERBA-083-1	8 /18/2010	10:20	eastern red bat	carcass search
081810-ERBA-095-1	8 /18/2010	11:27	eastern red bat	carcass search
081910-ERBA-459-1	8 /19/2010	08:00	eastern red bat	carcass search
081910-ERBA-459-1	8 /19/2010	08:25	eastern red bat	carcass search
081910-ERBA-048-1	8 /19/2010	12:10	eastern red bat	carcass search
081910-HOBA-281-1	8 /19/2010	13:18	hoary bat	carcass search
081910-ERBA-281-2	8 /19/2010	13:26	eastern red bat	carcass search
081910-HOBA-625-1	8 /19/2010	13:38	hoary bat	incidental find
081910-HOBA-625-2	8 /19/2010	13:47	hoary bat	incidental find
081910-HOBA-628-1	8 /19/2010	14:09	hoary bat	carcass search
081910-ERBA-630-1	8 /19/2010	14:43	eastern red bat	carcass search
082010-HOBA-602-1	8 /20/2010	08:03	hoary bat	carcass search
082010-ERBA-248-1	8 /20/2010	08:22	eastern red bat	carcass search
082010-ERBA-630-1	8 /20/2010	08:40	eastern red bat	carcass search
082010-HOBA-203-1	8 /20/2010	09:27	hoary bat	incidental find
082010-HOBA-281-1	8 /20/2010	09:27	hoary bat	carcass search
082010-HOBA-414-1	8 /20/2010	10:02	hoary bat	carcass search
082010-ERBA-251-1	8 /20/2010	10:40	eastern red bat	carcass search
082010-ERBA-116-1	8 /20/2010	10:49	eastern red bat	carcass search
082010-ERBA-620-1	8 /20/2010	10:57	eastern red bat	carcass search
082010-BBBA-603-1	8 /20/2010	11:30	big brown bat	carcass search
082010-ERBA-603-2	8 /20/2010	11:35	eastern red bat	carcass search
082010-ERBA-639-1	8 /20/2010	11:44	eastern red bat	carcass search
082010-ERBA-614-1	8 /20/2010	12:05	eastern red bat	carcass search
082010-ERBA-635-1	8 /20/2010	12:06	eastern red bat	carcass search
082010-ERBA-635-2	8 /20/2010	12:10	eastern red bat	carcass search
082010-ERBA-286-1	8 /20/2010	13:35	eastern red bat	carcass search
082010-HOBA-611-1	8 /20/2010	13:37	hoary bat	carcass search
082010-ERBA-480-1	8 /20/2010	13:45	eastern red bat	carcass search
082010-HOBA-459-1	8 /20/2010	14:24	hoary bat	carcass search
082010-ERBA-459-2	8 /20/2010	14:33	eastern red bat	carcass search
082010-TRBA-254-1	8 /20/2010	15:04	tricolored bat	carcass search
082110-HOBA-448-1	8 /21/2010	08:50	hoary bat	carcass search
082110-ERBA-354-1	8 /21/2010	09:40	eastern red bat	carcass search
082110-HOBA-459-1	8 /21/2010	10:43	hoary bat	carcass search
082110-ERBA-414-1	8 /21/2010	11:24	eastern red bat	carcass search
082110-BBBA-401-1	8 /21/2010	12:09	big brown bat	carcass search
082110-ERBA-388-1	8 /21/2010	13:39	eastern red bat	carcass search
082110-HOBA-419-1	8 /21/2010	13:58	hoary bat	carcass search
082110-ERBA-419-2	8 /21/2010	13:59	eastern red bat	carcass search
082110-HOBA-419-3	8 /21/2010	14:00	hoary bat	carcass search
082110-ERBA-477-1	8 /21/2010	14:57	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
082210-LBBA-014-1	8 /22/2010	11:14	little brown bat	carcass search
082210-ERBA-007-1	8 /22/2010	11:36	eastern red bat	carcass search
082210-ERBA-090-1	8 /22/2010	12:50	eastern red bat	carcass search
082210-BBBA-640-1	8 /22/2010	12:56	big brown bat	carcass search
082210-ERBA-230-1	8 /22/2010	13:14	eastern red bat	carcass search
082210-ERBA-082-1	8 /22/2010	13:31	eastern red bat	carcass search
082310-ERBA-195-1	8 /23/2010	09:25	eastern red bat	carcass search
082310-ERBA-230-1	8 /23/2010	10:03	eastern red bat	carcass search
082310-ERBA-113-1	8 /23/2010	11:20	eastern red bat	carcass search
082310-ERBA-113-2	8 /23/2010	11:25	eastern red bat	carcass search
082310-BBBA-281-1	8 /23/2010	11:31	big brown bat	carcass search
082310-ERBA-251-1	8 /23/2010	12:17	eastern red bat	carcass search
082410-ERBA-314-1	8 /24/2010	07:50	eastern red bat	carcass search
082410-ERBA-314-2	8 /24/2010	08:00	eastern red bat	carcass search
082410-ERBA-414-1	8 /24/2010	09:57	eastern red bat	carcass search
082410-SHBA-095-1	8 /24/2010	11:13	silver-haired bat	carcass search
082410-BBBA-095-2	8 /24/2010	11:21	big brown bat	carcass search
082410-ERBA-095-3	8 /24/2010	11:30	eastern red bat	carcass search
082410-SHBA-088-1	8 /24/2010	12:29	silver-haired bat	carcass search
082410-ERBA-006-1	8 /24/2010	13:37	eastern red bat	carcass search
082510-ERBA-024-1	8 /25/2010	08:50	eastern red bat	carcass search
082510-HOBA-371-1	8 /25/2010	11:30	hoary bat	carcass search
082510-ERBA-628-1	8 /25/2010	13:00	eastern red bat	carcass search
082510-HOBA-620-1	8 /25/2010	14:54	hoary bat	incidental find
082610-ERBA-459-1	8 /26/2010	08:30	eastern red bat	carcass search
082610-ERBA-459-3	8 /26/2010	08:35	eastern red bat	carcass search
082610-ERBA-459-2	8 /26/2010	08:35	eastern red bat	carcass search
082610-ERBA-630-1	8 /26/2010	08:43	eastern red bat	carcass search
082610-ERBA-630-2	8 /26/2010	08:49	eastern red bat	carcass search
082610-ERBA-628-1	8 /26/2010	09:17	eastern red bat	carcass search
082610-ERBA-628-2	8 /26/2010	09:25	eastern red bat	carcass search
082610-ERBA-314-1	8 /26/2010	10:30	eastern red bat	carcass search
082610-TRBA-603-1	8 /26/2010	10:40	tricolored bat	carcass search
082710-ERBA-477-1	8 /27/2010	07:47	eastern red bat	carcass search
082710-SHBA-314-1	8 /27/2010	08:16	silver-haired bat	carcass search
082710-ERBA-419-1	8 /27/2010	08:17	eastern red bat	carcass search
082710-HOBA-388-1	8 /27/2010	08:37	hoary bat	carcass search
082710-SHBA-388-2	8 /27/2010	08:38	silver-haired bat	carcass search
082710-ERBA-388-3	8 /27/2010	08:40	eastern red bat	carcass search
082710-ERBA-387-1	8 /27/2010	09:54	eastern red bat	carcass search
082710-ERBA-397-1	8 /27/2010	10:32	eastern red bat	carcass search
082710-ERBA-635-1	8 /27/2010	10:40	eastern red bat	incidental find
082710-ERBA-048-1	8 /27/2010	11:05	eastern red bat	carcass search
082710-HOBA-454-1	8 /27/2010	11:06	hoary bat	carcass search
082710-ERBA-478-1	8 /27/2010	11:29	eastern red bat	carcass search
082710-ERBA-379-1	8 /27/2010	13:03	eastern red bat	carcass search
082710-ERBA-459-1	8 /27/2010	13:57	eastern red bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
082710-ERBA-628-2	8 /27/2010	15:28	eastern red bat	carcass search
082810-ERBA-448-1	8 /28/2010	08:19	eastern red bat	carcass search
082810-ERBA-628-1	8 /28/2010	08:50	eastern red bat	carcass search
082810-ERBA-640-1	8 /28/2010	09:00	eastern red bat	carcass search
082810-ERBA-458-1	8 /28/2010	09:40	eastern red bat	carcass search
082810-ERBA-224-1	8 /28/2010	11:10	eastern red bat	incidental find
082810-ERBA-414-1	8 /28/2010	11:37	eastern red bat	carcass search
082810-ERBA-033-1	8 /28/2010	11:55	eastern red bat	carcass search
082810-ERBA-050-1	8 /28/2010	12:51	eastern red bat	carcass search
082810-ERBA-478-1	8 /28/2010	13:42	eastern red bat	incidental find
082810-HOBA-009-1	8 /28/2010	15:03	hoary bat	carcass search
082910-ERBA-156-1	8 /29/2010	07:42	eastern red bat	carcass search
082910-ERBA-248-1	8 /29/2010	08:38	eastern red bat	incidental find
082910-HOBA-147-1	8 /29/2010	08:50	hoary bat	carcass search
082910-ERBA-602-1	8 /29/2010	09:02	eastern red bat	carcass search
082910-ERBA-448-1	8 /29/2010	09:40	eastern red bat	carcass search
082910-ERBA-033-1	8 /29/2010	09:47	eastern red bat	carcass search
082910-HOBA-607-1	8 /29/2010	10:15	hoary bat	carcass search
082910-ERBA-607-2	8 /29/2010	10:16	eastern red bat	carcass search
082910-ERBA-640-1	8 /29/2010	10:25	eastern red bat	carcass search
082910-ERBA-281-1	8 /29/2010	10:26	eastern red bat	carcass search
082910-BBBA-245-2	8 /29/2010	11:07	big brown bat	carcass search
082910-ERBA-245-1	8 /29/2010	11:07	eastern red bat	carcass search
082910-ERBA-245-3	8 /29/2010	11:08	eastern red bat	carcass search
082910-HOBA-414-1	8 /29/2010	11:28	hoary bat	carcass search
082910-HOBA-227-1	8 /29/2010	11:50	hoary bat	carcass search
082910-HOBA-371-1	8 /29/2010	12:04	hoary bat	carcass search
082910-ERBA-630-1	8 /29/2010	12:06	eastern red bat	carcass search
082910-ERBA-173-1	8 /29/2010	12:16	eastern red bat	carcass search
082910-ERBA-048-1	8 /29/2010	13:00	eastern red bat	carcass search
082910-ERBA-286-1	8 /29/2010	13:46	eastern red bat	carcass search
082910-ERBA-625-1	8 /29/2010	15:23	eastern red bat	carcass search
083010-ERBA-459-1	8 /30/2010	08:50	eastern red bat	carcass search
083010-ERBA-630-1	8 /30/2010	08:55	eastern red bat	carcass search
083010-ERBA-480-1	8 /30/2010	10:00	eastern red bat	carcass search
083010-HOBA-095-1	8 /30/2010	13:17	hoary bat	carcass search
083010-ERBA-147-1	8 /30/2010	13:18	eastern red bat	carcass search
083010-ERBA-024-1	8 /30/2010	13:42	eastern red bat	carcass search
083110-ERBA-628-1	8 /31/2010	08:15	eastern red bat	carcass search
083110-ERBA-218-1	8 /31/2010	11:58	eastern red bat	carcass search
090110-HOBA-024-1	9 /1 /2010	12:20	hoary bat	carcass search
090110-ERBA-334-1	9 /1 /2010	13:15	eastern red bat	carcass search
090210-ERBA-628-2	9 /2 /2010	08:45	eastern red bat	carcass search
090210-BBBA-628-1	9 /2 /2010	08:50	big brown bat	carcass search
090210-ERBA-112-1	9 /2 /2010	09:27	eastern red bat	incidental find
090310-ERBA-625-1	9 /3 /2010	08:17	eastern red bat	carcass search
090310-HOBA-216-1	9 /3 /2010	12:13	hoary bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
090310-ERBA-245-1	9 /3 /2010	13:03	eastern red bat	carcass search
090310-HOBA-387-1	9 /3 /2010	13:04	hoary bat	carcass search
090310-HOBA-156-1	9 /3 /2010	13:58	hoary bat	carcass search
090410-SHBA-614-1	9 /4 /2010	08:05	silver-haired bat	carcass search
090410-ERBA-628-1	9 /4 /2010	09:00	eastern red bat	carcass search
090410-SHBA-048-1	9 /4 /2010	09:00	silver-haired bat	carcass search
090410-HOBA-098-1	9 /4 /2010	10:17	hoary bat	carcass search
090410-ERBA-443-1	9 /4 /2010	13:23	eastern red bat	carcass search
090510-HOBA-113-1	9 /5 /2010	10:05	hoary bat	carcass search
090510-HOBA-048-1	9 /5 /2010	12:20	hoary bat	carcass search
090510-ERBA-014-1	9 /5 /2010	14:16	eastern red bat	carcass search
090610-HOBA-614-1	9 /6 /2010	08:15	hoary bat	carcass search
090610-HOBA-281-1	9 /6 /2010	09:45	hoary bat	carcass search
090610-SHBA-640-1	9 /6 /2010	11:05	silver-haired bat	carcass search
090610-ERBA-459-1	9 /6 /2010	13:32	eastern red bat	carcass search
090610-SHBA-459-2	9 /6 /2010	13:37	silver-haired bat	carcass search
090710-SHBA-640-1	9 /7 /2010	09:30	silver-haired bat	carcass search
090710-ERBA-640-1	9 /7 /2010	11:10	eastern red bat	carcass search
090710-SHBA-448-1	9 /7 /2010	12:12	silver-haired bat	carcass search
090710-SHBA-614-1	9 /7 /2010	12:17	silver-haired bat	carcass search
090710-HOBA-630-1	9 /7 /2010	12:55	hoary bat	carcass search
090810-HOBA-260-1	9 /8 /2010	10:43	hoary bat	carcass search
090810-SHBA-195-1	9 /8 /2010	12:15	silver-haired bat	carcass search
090810-ERBA-048-1	9 /8 /2010	12:25	eastern red bat	carcass search
090810-HOBA-006-1	9 /8 /2010	13:10	hoary bat	carcass search
090910-SHBA-371-1	9 /9 /2010	10:50	silver-haired bat	carcass search
090910-SHBA-088-1	9 /9 /2010	12:10	silver-haired bat	carcass search
091010-ERBA-371-1	9 /10/2010	08:40	eastern red bat	carcass search
091010-HOBA-443-1	9 /10/2010	08:50	hoary bat	carcass search
091010-HOBA-477-1	9 /10/2010	09:07	hoary bat	carcass search
091010-SHBA-401-1	9 /10/2010	10:22	silver-haired bat	carcass search
091010-SHBA-401-2	9 /10/2010	10:22	silver-haired bat	carcass search
091010-ERBA-432-1	9 /10/2010	11:44	eastern red bat	carcass search
091110-ERBA-045-1	9 /11/2010	07:55	eastern red bat	carcass search
091110-HOBA-603-1	9 /11/2010	10:26	hoary bat	carcass search
091110-ERBA-260-1	9 /11/2010	11:45	eastern red bat	carcass search
091110-HOBA-088-1	9 /11/2010	12:18	hoary bat	carcass search
091110-HOBA-625-1	9 /11/2010	12:25	hoary bat	incidental find
091110-SHBA-125-1	9 /11/2010	12:31	silver-haired bat	carcass search
091110-SHBA-628-1	9 /11/2010	13:05	silver-haired bat	carcass search
091110-ERBA-628-2	9 /11/2010	13:10	eastern red bat	carcass search
091110-HOBA-116-1	9 /11/2010	13:22	hoary bat	carcass search
091210-ERBA-635-1	9 /12/2010	07:49	eastern red bat	carcass search
091210-SHBA-628-1	9 /12/2010	08:23	silver-haired bat	carcass search
091210-ERBA-622-1	9 /12/2010	08:52	eastern red bat	carcass search
091210-ERBA-088-1	9 /12/2010	10:22	eastern red bat	carcass search
091210-SHBA-607-1	9 /12/2010	10:33	silver-haired bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
091210-ERBA-152-1	9 /12/2010	12:21	eastern red bat	carcass search
091210-ERBA-152-2	9 /12/2010	12:22	eastern red bat	carcass search
091210-SHBA-087-1	9 /12/2010	14:05	silver-haired bat	carcass search
091310-ERBA-625-1	9 /13/2010	09:05	eastern red bat	incidental find
091310-SHBA-458-1	9 /13/2010	09:15	silver-haired bat	carcass search
091310-ERBA-640-1	9 /13/2010	09:59	eastern red bat	carcass search
091310-SHBA-628-1	9 /13/2010	11:52	silver-haired bat	carcass search
091310-SHBA-371-1	9 /13/2010	12:00	silver-haired bat	carcass search
091410-SHBA-087-1	9 /14/2010	08:40	silver-haired bat	carcass search
091410-ERBA-630-1	9 /14/2010	08:44	eastern red bat	carcass search
091410-SHBA-056-1	9 /14/2010	09:02	silver-haired bat	carcass search
091410-SHBA-603-1	9 /14/2010	09:45	silver-haired bat	carcass search
091410-ERBA-048-1	9 /14/2010	10:22	eastern red bat	carcass search
091410-SHBA-281-1	9 /14/2010	10:40	silver-haired bat	carcass search
091410-SHBA-260-1	9 /14/2010	11:10	silver-haired bat	carcass search
091410-ERBA-448-1	9 /14/2010	13:10	eastern red bat	carcass search
091510-ERBA-387-1	9 /15/2010	12:23	eastern red bat	carcass search
091610-SHBA-056-2	9 /16/2010	08:25	silver-haired bat	carcass search
091610-SHBA-056-1	9 /16/2010	08:30	silver-haired bat	carcass search
091610-SHBA-614-1	9 /16/2010	08:39	silver-haired bat	carcass search
091610-HOBA-048-1	9 /16/2010	09:15	hoary bat	carcass search
091610-ERBA-640-1	9 /16/2010	09:40	eastern red bat	carcass search
091610-SHBA-640-2	9 /16/2010	09:50	silver-haired bat	carcass search
091610-SHBA-073-1	9 /16/2010	09:53	silver-haired bat	carcass search
091610-SHBA-033-1	9 /16/2010	12:50	silver-haired bat	carcass search
091710-SHBA-253-1	9 /17/2010	07:46	silver-haired bat	carcass search
091710-SHBA-229-1	9 /17/2010	09:15	silver-haired bat	carcass search
091710-ERBA-607-1	9 /17/2010	10:59	eastern red bat	carcass search
091810-ERBA-476-1	9 /18/2010	08:00	eastern red bat	carcass search
091810-ERBA-614-2	9 /18/2010	09:30	eastern red bat	carcass search
091810-SHBA-614-1	9 /18/2010	09:35	silver-haired bat	carcass search
091810-SHBA-281-1	9 /18/2010	11:12	silver-haired bat	carcass search
091810-SHBA-458-1	9 /18/2010	11:57	silver-haired bat	carcass search
091810-HOBA-218-1	9 /18/2010	12:20	hoary bat	carcass search
091810-SHBA-640-1	9 /18/2010	12:40	silver-haired bat	carcass search
091810-INBA-640-2	9 /18/2010	12:45	Indiana bat	carcass search
091810-SHBA-024-1	9 /18/2010	13:08	silver-haired bat	carcass search
091910-ERBA-419-1	9 /19/2010	09:31	eastern red bat	carcass search
091910-ERBA-087-1	9 /19/2010	13:10	eastern red bat	carcass search
091910-ERBA-087-2	9 /19/2010	13:22	eastern red bat	carcass search
091910-HOBA-628-1	9 /19/2010	13:42	hoary bat	carcass search
092010-HOBA-323-1	9 /20/2010	08:50	hoary bat	carcass search
092010-SHBA-414-2	9 /20/2010	10:19	silver-haired bat	carcass search
092010-SHBA-281-1	9 /20/2010	10:34	silver-haired bat	carcass search
092010-ERBA-218-1	9 /20/2010	11:38	eastern red bat	carcass search
092010-SHBA-218-2	9 /20/2010	11:43	silver-haired bat	carcass search
092010-SHBA-640-1	9 /20/2010	13:33	silver-haired bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
092010-BBBA-107-1	9 /20/2010	17:00	big brown bat	incidental find
092110-SHBA-056-1	9 /21/2010	08:52	silver-haired bat	carcass search
092110-HOBA-006-1	9 /21/2010	08:55	hoary bat	carcass search
092110-SHBA-048-1	9 /21/2010	09:36	silver-haired bat	carcass search
092110-ERBA-083-1	9 /21/2010	10:07	eastern red bat	carcass search
092110-SHBA-640-2	9 /21/2010	11:20	silver-haired bat	carcass search
092110-SHBA-640-1	9 /21/2010	11:22	silver-haired bat	carcass search
092110-ERBA-033-1	9 /21/2010	13:07	eastern red bat	carcass search
092110-SHBA-628-1	9 /21/2010	13:15	silver-haired bat	carcass search
092110-ERBA-480-1	9 /21/2010	13:20	eastern red bat	carcass search
092210-SHBA-480-1	9 /22/2010	08:00	silver-haired bat	carcass search
092210-HOBA-095-1	9 /22/2010	10:05	hoary bat	carcass search
092210-HOBA-640-1	9 /22/2010	10:20	hoary bat	carcass search
092310-HOBA-611-1	9 /23/2010	08:30	hoary bat	incidental find
092310-SHBA-334-1	9 /23/2010	08:32	silver-haired bat	carcass search
092310-ERBA-371-1	9 /23/2010	09:35	eastern red bat	carcass search
092310-ERBA-640-1	9 /23/2010	12:18	eastern red bat	carcass search
092310-HOBA-480-1	9 /23/2010	13:40	hoary bat	carcass search
092310-SHBA-459-1	9 /23/2010	14:09	silver-haired bat	carcass search
092310-SHBA-459-2	9 /23/2010	14:13	silver-haired bat	carcass search
092410-SHBA-354-1	9 /24/2010	11:07	silver-haired bat	carcass search
092410-SHBA-420-1	9 /24/2010	12:32	silver-haired bat	carcass search
092510-SHBA-627-1	9 /25/2010	09:00	silver-haired bat	carcass search
092510-SHBA-616-1	9 /25/2010	09:58	silver-haired bat	carcass search
092610-HOBA-281-1	9 /26/2010	10:45	hoary bat	carcass search
092610-SHBA-053-1	9 /26/2010	13:03	silver-haired bat	carcass search
092610-SHBA-065-1	9 /26/2010	14:06	silver-haired bat	carcass search
092810-ERBA-218-1	9 /28/2010	11:17	eastern red bat	carcass search
093010-SHBA-630-1	9 /30/2010	08:25	silver-haired bat	carcass search
093010-SHBA-323-1	9 /30/2010	08:50	silver-haired bat	carcass search
093010-SHBA-459-1	9 /30/2010	13:30	silver-haired bat	carcass search
100110-SHBA-425-1	10/1 /2010	09:18	silver-haired bat	carcass search
100110-ERBA-448-1	10/1 /2010	09:45	eastern red bat	carcass search
100110-SHBA-113-1	10/1 /2010	11:37	silver-haired bat	carcass search
100110-ERBA-088-1	10/1 /2010	12:17	eastern red bat	carcass search
100110-SHBA-630-1	10/1 /2010	13:20	silver-haired bat	carcass search
100210-SHBA-611-1	10/2 /2010	10:10	silver-haired bat	carcass search
100210-SHBA-640-1	10/2 /2010	11:50	silver-haired bat	carcass search
100210-ERBA-616-1	10/2 /2010	12:46	eastern red bat	carcass search
100310-SHBA-014-1	10/3 /2010	14:10	silver-haired bat	carcass search
100410-SHBA-630-1	10/4 /2010	08:11	silver-haired bat	carcass search
100610-SHBA-056-1	10/6 /2010	11:48	silver-haired bat	carcass search
100710-SHBA-147-1	10/7 /2010	08:21	silver-haired bat	carcass search
100710-SHBA-195-1	10/7 /2010	09:15	silver-haired bat	carcass search
100710-SHBA-251-1	10/7 /2010	11:49	silver-haired bat	carcass search
100810-ERBA-371-1	10/8 /2010	09:30	eastern red bat	carcass search
100810-SHBA-625-1	10/8 /2010	12:41	silver-haired bat	carcass search

Appendix C. Carcasses found on or scheduled search turbines during the spring and fall migration periods at Fowler Ridge Wind Resource Area.

CarcassID	Date	Time	Species	Found
100810-ERBA-087-1	10/8 /2010	13:08	eastern red bat	carcass search
100810-SHBA-448-1	10/8 /2010	16:22	silver-haired bat	carcass search
100910-SHBA-083-1	10/9 /2010	10:12	silver-haired bat	carcass search
100910-SHBA-033-1	10/9 /2010	13:20	silver-haired bat	carcass search
101010-ERBA-281-1	10/10/2010	11:26	eastern red bat	carcass search
101110-ERBA-448-1	10/11/2010	11:42	eastern red bat	carcass search
101210-HOBA-056-1	10/12/2010	09:08	hoary bat	carcass search
101210-ERBA-083-1	10/12/2010	10:14	eastern red bat	carcass search
101310-ERBA-628-1	10/13/2010	08:01	eastern red bat	carcass search
101310-ERBA-642-1	10/13/2010	08:05	eastern red bat	carcass search
101310-ERBA-459-1	10/13/2010	08:10	eastern red bat	carcass search
101310-SHBA-631-1	10/13/2010	09:24	silver-haired bat	carcass search
101310-ERBA-098-1	10/13/2010	10:20	eastern red bat	carcass search
101310-SHBA-414-1	10/13/2010	11:14	silver-haired bat	carcass search
101510-ERBA-098-1	10/15/2010	09:53	eastern red bat	carcass search
101510-ERBA-459-1	10/15/2010	11:08	eastern red bat	carcass search
101510-ERBA-459-2	10/15/2010	11:10	eastern red bat	carcass search
Overall			**581 carcasses**	

Appendix D. Carcasses found at Fowler Ridge Wind farm during spring and fall migration periods that are incidental and are not included in fatality estimates.

CarcassID	Date	Time	Species	Reason not Included in Fatality Estimates
041510-ERBA-61-1	4 /15/2010	11:58	eastern red bat	Outside Plot Area
042710-BBBA-610-1	4 /27/2010	15:20	big brown bat	Not on Scheduled Search Turbine
051410-SHBA-26-1	5 /14/2010	15:20	silver-haired bat	Outside Plot Area
051510-HOBA-314-1	5 /15/2010	10:22	hoary bat	Outside Plot Area
051510-SHBA-251-1	5 /15/2010	12:50	silver-haired bat	Outside Plot Area
073010-BBBA-314-3	7 /30/2010	13:10	big brown bat	Clearing Search
073010-ERBA-314-4	7 /30/2010	13:10	eastern red bat	Clearing Search
073010-ERBA-314-1	7 /30/2010	13:10	eastern red bat	Clearing Search
073010-HOBA-314-2	7 /30/2010	13:10	hoary bat	Clearing Search
073110-TRBA-339-1	7 /31/2010	07:43	tricolored bat	Clearing Search
073110-HOBA-339-2	7 /31/2010	07:59	hoary bat	Clearing Search
073110-ERBA-628-1	7 /31/2010	08:03	eastern red bat	Clearing Search
073110-HOBA-480-1	7 /31/2010	08:05	hoary bat	Clearing Search
073110-ERBA-628-2	7 /31/2010	08:21	eastern red bat	Clearing Search
073110-ERBA-628-3	7 /31/2010	09:26	eastern red bat	Clearing Search
073110-ERBA-087-1	7 /31/2010	09:30	eastern red bat	Clearing Search
073110-HOBA-459-1	7 /31/2010	09:30	hoary bat	Clearing Search
073110-ERBA-388-1	7 /31/2010	09:31	eastern red bat	Clearing Search
073110-ERBA-628-4	7 /31/2010	09:36	eastern red bat	Clearing Search
073110-ERBA-087-2	7 /31/2010	09:41	eastern red bat	Clearing Search
073110-BBBA-459-2	7 /31/2010	09:44	big brown bat	Clearing Search
073110-ERBA-087-3	7 /31/2010	09:47	eastern red bat	Clearing Search
073110-ERBA-628-5	7 /31/2010	09:47	eastern red bat	Clearing Search
073110-ERBA-048-1	7 /31/2010	10:29	eastern red bat	Clearing Search
073110-HOBA-460-1	7 /31/2010	10:29	hoary bat	Clearing Search
073110-ERBA-048-2	7 /31/2010	10:35	eastern red bat	Clearing Search
073110-ERBA-048-4	7 /31/2010	10:40	eastern red bat	Clearing Search
073110-ERBA-048-3	7 /31/2010	10:44	eastern red bat	Clearing Search
073110-HOBA-426-1	7 /31/2010	10:52	hoary bat	Clearing Search
073110-ERBA-371-3	7 /31/2010	11:20	eastern red bat	Clearing Search
073110-ERBA-371-1	7 /31/2010	11:25	eastern red bat	Clearing Search
073110-ERBA-371-2	7 /31/2010	11:27	eastern red bat	Clearing Search
073110-ERBA-355-1	7 /31/2010	11:37	eastern red bat	Clearing Search
073110-BBBA-230-1	7 /31/2010	12:15	big brown bat	Clearing Search
073110-HOBA-083-1	7 /31/2010	12:17	hoary bat	Clearing Search
073110-HOBA-309-1	7 /31/2010	12:20	hoary bat	Clearing Search
073110-ERBA-396-1	7 /31/2010	12:36	eastern red bat	Clearing Search
073110-ERBA-230-2	7 /31/2010	12:36	eastern red bat	Clearing Search
073110-ERBA-396-2	7 /31/2010	12:41	eastern red bat	Clearing Search
073110-BBBA-230-3	7 /31/2010	12:43	big brown bat	Clearing Search
073110-ERBA-396-4	7 /31/2010	12:46	eastern red bat	Clearing Search
073110-HOBA-396-5	7 /31/2010	12:46	hoary bat	Clearing Search
073110-ERBA-230-4	7 /31/2010	12:51	eastern red bat	Clearing Search
073110-HOBA-401-1	7 /31/2010	12:54	hoary bat	Clearing Search
073110-ERBA-396-3	7 /31/2010	13:00	eastern red bat	Clearing Search
073110-ERBA-423-1	7 /31/2010	13:15	eastern red bat	Clearing Search

Appendix D. Carcasses found at Fowler Ridge Wind farm during spring and fall migration periods that are incidental and are not included in fatality estimates.

CarcassID	Date	Time	Species	Reason not Included in Fatality Estimates
073110-ERBA-095-1	7 /31/2010	13:20	eastern red bat	Clearing Search
073110-ERBA-095-2	7 /31/2010	13:27	eastern red bat	Clearing Search
073110-ERBA-454-1	7 /31/2010	13:44	eastern red bat	Clearing Search
073110-ERBA-454-2	7 /31/2010	13:55	eastern red bat	Clearing Search
073110-HOBA-454-3	7 /31/2010	13:56	hoary bat	Clearing Search
073110-ERBA-260-1	7 /31/2010	14:06	eastern red bat	Clearing Search
073110-BBBA-448-1	7 /31/2010	14:20	big brown bat	Clearing Search
073110-HOBA-448-2	7 /31/2010	14:22	hoary bat	Clearing Search
073110-ERBA-478-1	7 /31/2010	14:34	eastern red bat	Clearing Search
073110-ERBA-123-1	7 /31/2010	14:45	eastern red bat	Clearing Search
073110-HOBA-640-2	7 /31/2010	15:00	hoary bat	Clearing Search
073110-HOBA-640-1	7 /31/2010	15:02	hoary bat	Clearing Search
073110-ERBA-425-1	7 /31/2010	15:09	eastern red bat	Clearing Search
073110-HOBA-640-3	7 /31/2010	15:13	hoary bat	Clearing Search
073110-ERBA-425-2	7 /31/2010	15:20	eastern red bat	Clearing Search
073110-ERBA-398-1	7 /31/2010	15:53	eastern red bat	Clearing Search
073110-ERBA-147-1	7 /31/2010	16:04	eastern red bat	Clearing Search
073110-ERBA-352-1	7 /31/2010	16:26	eastern red bat	Clearing Search
073110-ERBA-352-2	7 /31/2010	16:35	eastern red bat	Clearing Search
073110-BBBA-354-1	7 /31/2010	16:54	big brown bat	Clearing Search
080110-SHBA-369-1	8 /1 /2010	07:54	silver-haired bat	Summer Time of Death
080110-HOBA-369-2	8 /1 /2010	08:08	hoary bat	Summer Time of Death
080110-HOBA-407-1	8 /1 /2010	08:25	hoary bat	Summer Time of Death
080110-ERBA-476-5	8 /1 /2010	09:04	eastern red bat	Summer Time of Death
080110-ERBA-476-6	8 /1 /2010	09:17	eastern red bat	Summer Time of Death
080110-ERBA-608-1	8 /1 /2010	11:00	eastern red bat	Not on Scheduled Search Turbine
080110-ERBA-608-2	8 /1 /2010	11:08	eastern red bat	Not on Scheduled Search Turbine
080110-HOBA-625-1	8 /1 /2010	11:12	hoary bat	Summer Time of Death
080110-ERBA-625-1	8 /1 /2010	11:27	eastern red bat	Summer Time of Death
080110-ERBA-625-3	8 /1 /2010	11:39	eastern red bat	Summer Time of Death
080110-HOBA-640-1	8 /1 /2010	11:51	hoary bat	Summer Time of Death
080110-ERBA-631-1	8 /1 /2010	12:36	eastern red bat	Summer Time of Death
080110-HOBA-622-1	8 /1 /2010	12:58	hoary bat	Summer Time of Death
080110-ERBA-622-2	8 /1 /2010	13:06	eastern red bat	Summer Time of Death
080110-HOBA-622-3	8 /1 /2010	13:15	hoary bat	Summer Time of Death
080110-ERBA-622-4	8 /1 /2010	13:25	eastern red bat	Summer Time of Death
080110-ERBA-616-2	8 /1 /2010	13:46	eastern red bat	Summer Time of Death
080110-ERBA-616-1	8 /1 /2010	13:46	eastern red bat	Summer Time of Death
080110-ERBA-458-1	8 /1 /2010	14:45	eastern red bat	Unknown Time of Death
080110-HOBA-607-1	8 /1 /2010	14:45	hoary bat	Summer Time of Death
080110-HOBA-458-2	8 /1 /2010	14:53	hoary bat	Summer Time of Death
080110-ERBA-607-2	8 /1 /2010	14:55	eastern red bat	Summer Time of Death
080110-ERBA-448-1	8 /1 /2010	15:53	eastern red bat	Summer Time of Death
080110-HOBA-285-1	8 /1 /2010	16:54	hoary bat	Summer Time of Death
080210-ERBA-602-1	8 /2 /2010	08:35	eastern red bat	Summer Time of Death
080210-ERBA-248-2	8 /2 /2010	09:17	eastern red bat	Summer Time of Death

Appendix D. Carcasses found at Fowler Ridge Wind farm during spring and fall migration periods that are incidental and are not included in fatality estimates.

CarcassID	Date	Time	Species	Reason not Included in Fatality Estimates
080210-ERBA-245-1	8 /2 /2010	10:17	eastern red bat	Summer Time of Death
080210-ERBA-448-1	8 /2 /2010	10:18	eastern red bat	Summer Time of Death
080210-ERBA-245-2	8 /2 /2010	10:18	eastern red bat	Summer Time of Death
080210-ERBA-014-1	8 /2 /2010	10:46	eastern red bat	Summer Time of Death
080210-HOBA-007-1	8 /2 /2010	11:14	hoary bat	Summer Time of Death
080210-ERBA-227-1	8 /2 /2010	11:34	eastern red bat	Summer Time of Death
080210-HOBA-224-1	8 /2 /2010	12:05	hoary bat	Summer Time of Death
080210-HOBA-414-2	8 /2 /2010	12:35	hoary bat	Summer Time of Death
080210-HOBA-414-3	8 /2 /2010	12:36	hoary bat	Summer Time of Death
080210-ERBA-414-1	8 /2 /2010	12:42	eastern red bat	Summer Time of Death
080210-ERBA-020-1	8 /2 /2010	13:26	eastern red bat	Summer Time of Death
080210-ERBA-112-1	8 /2 /2010	14:21	eastern red bat	Summer Time of Death
080210-ERBA-118-1	8 /2 /2010	14:40	eastern red bat	Summer Time of Death
080210-ERBA-118-2	8 /2 /2010	14:43	eastern red bat	Summer Time of Death
080210-ERBA-116-1	8 /2 /2010	15:23	eastern red bat	Summer Time of Death
080210-ERBA-047-2	8 /2 /2010	15:48	eastern red bat	Summer Time of Death
080210-HOBA-193-1	8 /2 /2010	17:53	hoary bat	Summer Time of Death
080310-ERBA-087-1	8 /3 /2010	16:30	eastern red bat	Summer Time of Death
080310-BBBA-453-1	8 /3 /2010	16:52	big brown bat	Not on Scheduled Search Turbine
080310-ERBA-453-2	8 /3 /2010	16:52	eastern red bat	Not on Scheduled Search Turbine
080410-ERBA-628-5	8 /4 /2010	10:15	eastern red bat	Summer Time of Death
080410-ERBA-113-1	8 /4 /2010	12:52	eastern red bat	Summer Time of Death
080410-HOBA-387-3	8 /4 /2010	14:29	hoary bat	Summer Time of Death
080510-ERBA-624-1	8 /5 /2010	08:56	eastern red bat	Not on Scheduled Search Turbine
080510-ERBA-624-2	8 /5 /2010	08:57	eastern red bat	Not on Scheduled Search Turbine
080510-HOBA-624-3	8 /5 /2010	08:57	hoary bat	Summer Time of Death
080510-ERBA-480-2	8 /5 /2010	10:30	eastern red bat	Unknown Time of Death
080510-ERBA-098-1	8 /5 /2010	10:52	eastern red bat	Summer Time of Death
080510-ERBA-371-1	8 /5 /2010	13:05	eastern red bat	Outside Plot Area
080610-HOBA-323-2	8 /6 /2010	09:40	hoary bat	Summer Time of Death
080610-ERBA-425-1	8 /6 /2010	14:01	eastern red bat	Summer Time of Death
080610-ERBA-459-2	8 /6 /2010	14:25	eastern red bat	Summer Time of Death
080810-ERBA-260-1	8 /8 /2010	10:27	eastern red bat	Unknown Time of Death
080810-ERBA-065-2	8 /8 /2010	10:52	eastern red bat	Outside Plot Area
080810-ERBA-092-1	8 /8 /2010	13:15	eastern red bat	Outside Plot Area
080910-ERBA-431-1	8 /9 /2010	13:30	eastern red bat	Not on Scheduled Search Turbine
081110-ERBA-337-1	8 /11/2010	12:28	eastern red bat	Not on Scheduled Search Turbine
081110-ERBA-337-2	8 /11/2010	12:28	eastern red bat	Not on Scheduled Search Turbine
081210-ERBA-321-1	8 /12/2010	14:17	eastern red bat	Outside Plot Area
081210-BBBA-321-2	8 /12/2010	14:18	big brown bat	Outside Plot Area
081310-HOBA-353-1	8 /12/2010	14:30	hoary bat	Not on Scheduled Search Turbine
081210-ERBA-104-1	8 /12/2010	15:36	eastern red bat	Not on Scheduled Search Turbine
081210-HOBA-104-2	8 /12/2010	15:41	hoary bat	Not on Scheduled Search Turbine
081310-HOBA-459-1	8 /13/2010	08:05	hoary bat	Outside Plot Area
081310-ERBA-014-1	8 /13/2010	09:32	eastern red bat	Outside Plot Area
081310-BBBA-643-2	8 /13/2010	09:35	big brown bat	Not on Scheduled Search Turbine

Appendix D. Carcasses found at Fowler Ridge Wind farm during spring and fall migration periods that are incidental and are not included in fatality estimates.

CarcassID	Date	Time	Species	Reason not Included in Fatality Estimates
081310-ERBA-643-4	8 /13/2010	09:35	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-643-3	8 /13/2010	09:35	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-643-5	8 /13/2010	09:35	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-643-1	8 /13/2010	09:35	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-003-1	8 /13/2010	13:18	eastern red bat	Outside Plot Area
081310-HOBA-003-2	8 /13/2010	13:19	hoary bat	Outside Plot Area
081310-ERBA-019-1	8 /13/2010	13:37	eastern red bat	Not on Scheduled Search Turbine
081310-HOBA-392-1	8 /13/2010	14:05	hoary bat	Not on Scheduled Search Turbine
081310-ERBA-045-1	8 /13/2010	14:29	eastern red bat	Outside Plot Area
081310-ERBA-374-1	8 /13/2010	14:57	eastern red bat	Outside Plot Area
081310-ERBA-632-1	8 /13/2010	15:04	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-632-2	8 /13/2010	15:05	eastern red bat	Not on Scheduled Search Turbine
081310-HOBA-632-3	8 /13/2010	15:06	hoary bat	Not on Scheduled Search Turbine
081310-ERBA-624-1	8 /13/2010	16:02	eastern red bat	Not on Scheduled Search Turbine
081310-BBBA-624-2	8 /13/2010	16:07	big brown bat	Not on Scheduled Search Turbine
081310-ERBA-624-3	8 /13/2010	16:13	eastern red bat	Not on Scheduled Search Turbine
081310-HOBA-624-4	8 /13/2010	16:21	hoary bat	Not on Scheduled Search Turbine
081310-ERBA-624-5	8 /13/2010	16:28	eastern red bat	Not on Scheduled Search Turbine
081310-BBBA-629-1	8 /13/2010	16:49	big brown bat	Not on Scheduled Search Turbine
081310-ERBA-629-2	8 /13/2010	16:56	eastern red bat	Not on Scheduled Search Turbine
081310-HOBA-319-1	8 /13/2010	16:58	hoary bat	Not on Scheduled Search Turbine
081310-HOBA-629-3	8 /13/2010	17:05	hoary bat	Not on Scheduled Search Turbine
081310-ERBA-339-1	8 /13/2010	17:29	eastern red bat	Outside Plot Area
081310-ERBA-625-1	8 /13/2010	17:31	eastern red bat	Outside Plot Area
081310-HOBA-637-1	8 /13/2010	17:38	hoary bat	Not on Scheduled Search Turbine
081310-ERBA-637-2	8 /13/2010	17:46	eastern red bat	Not on Scheduled Search Turbine
081310-ERBA-629-4	8 /13/2010	17:50	eastern red bat	Not on Scheduled Search Turbine
081410-HOBA-203-1	8 /14/2010	10:21	hoary bat	Outside Plot Area
081410-ERBA-156-1	8 /14/2010	14:14	eastern red bat	Outside Plot Area
081510-HOBA-417-1	8 /15/2010	08:05	hoary bat	Not on Scheduled Search Turbine
081510-ERBA-476-1	8 /15/2010	08:34	eastern red bat	Outside Plot Area
081310-ERBA-021-1	8 /15/2010	09:25	eastern red bat	Not on Scheduled Search Turbine
081510-ERBA-426-2	8 /15/2010	13:00	eastern red bat	Outside Plot Area
081610-ERBA-458-1	8 /16/2010	09:18	eastern red bat	Unknown Time of Death
081910-ERBA-281-3	8 /19/2010	13:31	eastern red bat	Unknown Time of Death
082010-ERBA-604-1	8 /20/2010	08:20	eastern red bat	Outside Plot Area
082010-ERBA-604-2	8 /20/2010	08:20	eastern red bat	Outside Plot Area
082010-ERBA-241-1	8 /20/2010	11:02	eastern red bat	Not on Scheduled Search Turbine
082010-HOBA-115-1	8 /20/2010	11:38	hoary bat	Outside Plot Area
082010-HOBA-102-1	8 /20/2010	11:48	hoary bat	Outside Plot Area
082110-ERBA-476-1	8 /21/2010	08:29	eastern red bat	Outside Plot Area
082110-ERBA-630-1	8 /21/2010	13:33	eastern red bat	Outside Plot Area
082210-ERBA-017-1	8 /22/2010	08:01	eastern red bat	Outside Plot Area
082210-ERBA-103-1	8 /22/2010	12:16	eastern red bat	Outside Plot Area
082310-ERBA-613-1	8 /23/2010	14:30	eastern red bat	Not on Scheduled Search Turbine
082410-SHBA-458-1	8 /24/2010	11:23	silver-haired bat	Unknown Time of Death

Appendix D. Carcasses found at Fowler Ridge Wind farm during spring and fall migration periods that are incidental and are not included in fatality estimates.

CarcassID	Date	Time	Species	Reason not Included in Fatality Estimates
082410-ERBA-349-1	8 /24/2010	16:05	eastern red bat	Not on Scheduled Search Turbine
082510-ERBA-311-1	8 /25/2010	13:33	eastern red bat	Not on Scheduled Search Turbine
082510-ERBA-438-1	8 /25/2010	13:50	eastern red bat	Not on Scheduled Search Turbine
082510-ERBA-438-2	8 /25/2010	13:50	eastern red bat	Not on Scheduled Search Turbine
082510-ERBA-438-3	8 /25/2010	13:55	eastern red bat	Not on Scheduled Search Turbine
082610-SHBA-469-1	8 /26/2010	14:54	silver-haired bat	Not on Scheduled Search Turbine
082610-ERBA-482-1	8 /26/2010	15:44	eastern red bat	Not on Scheduled Search Turbine
082610-HOBA-482-2	8 /26/2010	15:50	hoary bat	Not on Scheduled Search Turbine
082610-ERBA-477-1	8 /26/2010	16:00	eastern red bat	Outside Plot Area
082710-ERBA-387-2	8 /27/2010	10:11	eastern red bat	Outside Plot Area
082710-ERBA-464-1	8 /27/2010	13:59	eastern red bat	Outside Plot Area
082810-ERBA-107-1	8 /28/2010	08:35	eastern red bat	Outside Plot Area
082810-ERBA-014-1	8 /28/2010	09:32	eastern red bat	Outside Plot Area
082810-HOBA-081-1	8 /28/2010	11:08	hoary bat	Not on Scheduled Search Turbine
082810-ERBA-061-1	8 /28/2010	11:56	eastern red bat	Outside Plot Area
082810-ERBA-061-2	8 /28/2010	11:57	eastern red bat	Outside Plot Area
082810-ERBA-061-3	8 /28/2010	11:58	eastern red bat	Outside Plot Area
082910-ERBA-224-1	8 /29/2010	08:15	eastern red bat	Outside Plot Area
082910-SHBA-229-1	8 /29/2010	12:59	silver-haired bat	Outside Plot Area
082910-ERBA-622-2	8 /29/2010	14:25	eastern red bat	Outside Plot Area
082910-ERBA-622-1	8 /29/2010	14:27	eastern red bat	Outside Plot Area
082910-ERBA-629-1	8 /29/2010	15:39	eastern red bat	Not on Scheduled Search Turbine
083010-ERBA-459-2	8 /30/2010	08:40	eastern red bat	Outside Plot Area
083110-ERBA-624-1	8 /31/2010	07:39	eastern red bat	Not on Scheduled Search Turbine
083110-ERBA-403-1	8 /31/2010	16:42	eastern red bat	Not on Scheduled Search Turbine
090310-ERBA-625-2	9 /3 /2010	08:14	eastern red bat	Outside Plot Area
090310-HOBA-634-1	9 /3 /2010	08:37	hoary bat	Not on Scheduled Search Turbine
090510-ERBA-323-1	9 /5 /2010	09:50	eastern red bat	Outside Plot Area
090710-HOBA-389-1	9 /7 /2010	09:55	hoary bat	Not on Scheduled Search Turbine
091010-HOBA-637-1	9 /10/2010	12:05	hoary bat	Not on Scheduled Search Turbine
091410-SHBA-417-1	9 /14/2010	12:46	silver-haired bat	Not on Scheduled Search Turbine
091710-HOBA-249-1	9 /17/2010	14:02	hoary bat	Not on Scheduled Search Turbine
091810-SHBA-121-1	9 /18/2010	10:06	silver-haired bat	Outside Plot Area
091810-HOBA-026-1	9 /18/2010	13:39	hoary bat	Outside Plot Area
092010-HOBA-459-1	9 /20/2010	11:40	hoary bat	Outside Plot Area
092010-SHBA-117-1	9 /20/2010	17:10	silver-haired bat	Not on Scheduled Search Turbine
092410-ERBA-417-1	9 /24/2010	12:18	eastern red bat	Not on Scheduled Search Turbine
092410-SHBA-626-1	9 /24/2010	13:30	silver-haired bat	Not on Scheduled Search Turbine
092410-SHBA-626-2	9 /24/2010	13:32	silver-haired bat	Not on Scheduled Search Turbine
092410-ERBA-626-3	9 /24/2010	13:33	eastern red bat	Not on Scheduled Search Turbine
092410-ERBA-626-4	9 /24/2010	13:35	eastern red bat	Not on Scheduled Search Turbine
092610-ERBA-003-1	9 /26/2010	09:55	eastern red bat	Outside Plot Area
100310-SHBA-230-1	10/3 /2010	09:55	silver-haired bat	Outside Plot Area
101510-SHBA-352-1	10/15/2010	11:17	silver-haired bat	Outside Plot Area
Overall			**228 Carcasses**	

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
3	control	8 /8 /2010	080810-ERBA-003-1	eastern red bat
3	control	9 /26/2010	092610-ERBA-003-1	eastern red bat
3	control	8 /13/2010	081310-HOBA-003-2	hoary bat
3	control	8 /13/2010	081310-ERBA-003-1	eastern red bat
4	control	No carcasses found		
6	5 m/s	8 /16/2010	081610-ERBA-006-2	eastern red bat
6	control	8 /16/2010	081610-HOBA-006-1	hoary bat
6	control	8 /24/2010	082410-ERBA-006-1	eastern red bat
6	6.5 m/s	9 /21/2010	092110-HOBA-006-1	hoary bat
6	5 m/s	9 /8 /2010	090810-HOBA-006-1	hoary bat
7	control	8 /22/2010	082210-ERBA-007-1	eastern red bat
7	control	8 /2 /2010	080210-HOBA-007-1	hoary bat
7	control	8 /8 /2010	080810-ERBA-007-1	eastern red bat
9	control	8 /28/2010	082810-HOBA-009-1	hoary bat
13	control	8 /2 /2010	080210-HOBA-013-1	hoary bat
14	control	8 /22/2010	082210-LBBA-014-1	little brown bat
14	control	9 /5 /2010	090510-ERBA-014-1	eastern red bat
14	control	8 /13/2010	081310-ERBA-014-1	eastern red bat
14	control	8 /8 /2010	080810-BBBA-014-1	big brown bat
14	control	8 /2 /2010	080210-ERBA-014-1	eastern red bat
14	control	10/3 /2010	100310-SHBA-014-1	silver-haired bat
14	control	8 /28/2010	082810-ERBA-014-1	eastern red bat
17	control	8 /22/2010	082210-ERBA-017-1	eastern red bat
19	control	8 /13/2010	081310-ERBA-019-1	eastern red bat
20	control	8 /2 /2010	080210-ERBA-020-1	eastern red bat
21	control	8 /15/2010	081310-ERBA-021-1	eastern red bat
24	control	8 /25/2010	082510-ERBA-024-1	eastern red bat
24	control	5 /4 /2010	050410-SHBA-24-1	silver-haired bat
24	5 m/s	9 /1 /2010	090110-HOBA-024-1	hoary bat
24	control	4 /26/2010	042610-SHBA-24-1	silver-haired bat
24	5 m/s	9 /18/2010	091810-SHBA-024-1	silver-haired bat
24	6.5 m/s	8 /4 /2010	080410-ERBA-024-1	eastern red bat
24	5 m/s	8 /30/2010	083010-ERBA-024-1	eastern red bat
26	control	8 /2 /2010	080210-ERBA-026-1	eastern red bat
26	control	9 /18/2010	091810-HOBA-026-1	hoary bat
26	control	4 /26/2010	042610-SHBA-26-1	silver-haired bat
26	control	5 /14/2010	051410-SHBA-26-1	silver-haired bat
30	control	No carcasses found		
31	control	No carcasses found		
33	control	10/9 /2010	100910-SHBA-033-1	silver-haired bat
33	control	8 /29/2010	082910-ERBA-033-1	eastern red bat
33	control	9 /16/2010	091610-SHBA-033-1	silver-haired bat
33	control	8 /28/2010	082810-ERBA-033-1	eastern red bat
33	control	9 /21/2010	092110-ERBA-033-1	eastern red bat
35	control	8 /8 /2010	080810-HOBA-035-1	hoary bat
38	control	No carcasses found		

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
45	control	8 /8 /2010	080810-ERBA-045-1	eastern red bat
45	control	9 /11/2010	091110-ERBA-045-1	eastern red bat
45	control	8 /13/2010	081310-ERBA-045-1	eastern red bat
47	control	8 /8 /2010	080810-ERBA-047-1	eastern red bat
47	control	8 /13/2010	081310-BBBA-047-1	big brown bat
47	control	8 /2 /2010	080210-ERBA-047-1	eastern red bat
47	control	8 /2 /2010	080210-ERBA-047-2	eastern red bat
48	6.5 m/s	9 /16/2010	091610-HOBA-048-1	hoary bat
48	control	8 /5 /2010	080510-ERBA-048-1	eastern red bat
48	control	9 /14/2010	091410-ERBA-048-1	eastern red bat
48	control	8 /4 /2010	080410-ERBA-048-2	eastern red bat
48	control	8 /4 /2010	080410-ERBA-048-1	eastern red bat
48	6.5 m/s	9 /4 /2010	090410-SHBA-048-1	silver-haired bat
48	control	9 /8 /2010	090810-ERBA-048-1	eastern red bat
48	5 m/s	8 /27/2010	082710-ERBA-048-1	eastern red bat
48	5 m/s	8 /29/2010	082910-ERBA-048-1	eastern red bat
48	control	7 /31/2010	073110-ERBA-048-4	eastern red bat
48	control	7 /31/2010	073110-ERBA-048-1	eastern red bat
48	control	7 /31/2010	073110-ERBA-048-2	eastern red bat
48	control	8 /17/2010	081710-ERBA-048-1	eastern red bat
48	6.5 m/s	9 /5 /2010	090510-HOBA-048-1	hoary bat
48	5 m/s	9 /21/2010	092110-SHBA-048-1	silver-haired bat
48	control	7 /31/2010	073110-ERBA-048-3	eastern red bat
48	control	8 /19/2010	081910-ERBA-048-1	eastern red bat
48	control	8 /14/2010	081410-HOBA-048-1	hoary bat
48	control	8 /9 /2010	080910-ERBA-048-1	eastern red bat
50	control	8 /28/2010	082810-ERBA-050-1	eastern red bat
53	control	9 /26/2010	092610-SHBA-053-1	silver-haired bat
56	control	8 /17/2010	081710-ERBA-056-1	eastern red bat
56	control	8 /4 /2010	080410-ERBA-056-1	eastern red bat
56	control	8 /15/2010	081510-HOBA-056-1	hoary bat
56	control	9 /16/2010	091610-SHBA-056-1	silver-haired bat
56	control	9 /14/2010	091410-SHBA-056-1	silver-haired bat
56	control	8 /5 /2010	080510-ERBA-056-1	eastern red bat
56	control	9 /16/2010	091610-SHBA-056-2	silver-haired bat
56	control	10/6 /2010	100610-SHBA-056-1	silver-haired bat
56	control	8 /6 /2010	080610-ERBA-056-1	eastern red bat
56	control	9 /21/2010	092110-SHBA-056-1	silver-haired bat
56	control	10/12/2010	101210-HOBA-056-1	hoary bat
57	control	No carcasses found		
61	control	8 /28/2010	082810-ERBA-061-1	eastern red bat
61	control	8 /28/2010	082810-ERBA-061-2	eastern red bat
61	control	8 /28/2010	082810-ERBA-061-3	eastern red bat
61	control	4 /15/2010	041510-ERBA-61-1	eastern red bat
65	control	9 /26/2010	092610-SHBA-065-1	silver-haired bat
65	control	8 /8 /2010	080810-ERBA-065-2	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
65	control	8 /8 /2010	080810-HOBA-065-1	hoary bat
65	control	8 /2 /2010	080210-ERBA-065-1	eastern red bat
68	control	8 /13/2010	081310-ERBA-068-1	eastern red bat
73	5 m/s	8 /17/2010	081710-ERBA-073-1	eastern red bat
73	control	9 /16/2010	091610-SHBA-073-1	silver-haired bat
73	5 m/s	8 /15/2010	081510-ERBA-073-2	eastern red bat
73	6.5 m/s	8 /4 /2010	080410-ERBA-073-1	eastern red bat
75	control	8 /13/2010	081310-ERBA-075-1	eastern red bat
79	control	No carcasses found		
81	control	8 /28/2010	082810-HOBA-081-1	hoary bat
82	control	8 /22/2010	082210-ERBA-082-1	eastern red bat
83	control	10/9 /2010	100910-SHBA-083-1	silver-haired bat
83	5 m/s	8 /4 /2010	080410-ERBA-083-1	eastern red bat
83	control	10/12/2010	101210-ERBA-083-1	eastern red bat
83	5 m/s	8 /18/2010	081810-ERBA-083-1	eastern red bat
83	control	7 /31/2010	073110-HOBA-083-1	hoary bat
83	5 m/s	8 /7 /2010	080710-ERBA-083-1	eastern red bat
83	5 m/s	9 /21/2010	092110-ERBA-083-1	eastern red bat
85	control	8 /13/2010	081310-ERBA-085-1	eastern red bat
87	control	10/8 /2010	100810-ERBA-087-1	eastern red bat
87	control	9 /19/2010	091910-ERBA-087-2	eastern red bat
87	control	7 /31/2010	073110-ERBA-087-3	eastern red bat
87	control	9 /19/2010	091910-ERBA-087-1	eastern red bat
87	5 m/s	9 /12/2010	091210-SHBA-087-1	silver-haired bat
87	5 m/s	8 /5 /2010	080510-ERBA-087-1	eastern red bat
87	control	9 /14/2010	091410-SHBA-087-1	silver-haired bat
87	5 m/s	8 /4 /2010	080410-ERBA-087-2	eastern red bat
87	5 m/s	8 /4 /2010	080410-ERBA-087-3	eastern red bat
87	5 m/s	8 /4 /2010	080410-ERBA-087-1	eastern red bat
87	control	8 /3 /2010	080310-ERBA-087-1	eastern red bat
87	control	7 /31/2010	073110-ERBA-087-2	eastern red bat
87	control	7 /31/2010	073110-ERBA-087-1	eastern red bat
88	5 m/s	9 /12/2010	091210-ERBA-088-1	eastern red bat
88	5 m/s	9 /11/2010	091110-HOBA-088-1	hoary bat
88	6.5 m/s	10/1 /2010	100110-ERBA-088-1	eastern red bat
88	control	8 /12/2010	081210-ERBA-088-1	eastern red bat
88	control	8 /6 /2010	080610-ERBA-088-1	eastern red bat
88	5 m/s	9 /9 /2010	090910-SHBA-088-1	silver-haired bat
88	control	4 /26/2010	042610-SHBA-88-1	silver-haired bat
88	6.5 m/s	8 /24/2010	082410-SHBA-088-1	silver-haired bat
90	control	8 /8 /2010	080810-ERBA-090-1	eastern red bat
90	control	8 /22/2010	082210-ERBA-090-1	eastern red bat
92	control	8 /8 /2010	080810-ERBA-092-1	eastern red bat
92	control	8 /8 /2010	080810-ERBA-092-2	eastern red bat
95	6.5 m/s	8 /15/2010	081510-ERBA-095-2	eastern red bat
95	control	7 /31/2010	073110-ERBA-095-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
95	control	7 /31/2010	073110-ERBA-095-2	eastern red bat
95	6.5 m/s	8 /15/2010	081510-HOBA-095-1	hoary bat
95	6.5 m/s	8 /15/2010	081510-ERBA-095-3	eastern red bat
95	6.5 m/s	8 /6 /2010	080610-ERBA-095-1	eastern red bat
95	control	8 /24/2010	082410-SHBA-095-1	silver-haired bat
95	control	9 /22/2010	092210-HOBA-095-1	hoary bat
95	5 m/s	8 /24/2010	082410-BBBA-095-2	big brown bat
95	control	8 /18/2010	081810-ERBA-095-1	eastern red bat
95	6.5 m/s	8 /30/2010	083010-HOBA-095-1	hoary bat
95	5 m/s	8 /24/2010	082410-ERBA-095-3	eastern red bat
97	control	No carcasses found		
98	control	8 /15/2010	081510-ERBA-098-2	eastern red bat
98	control	10/13/2010	101310-ERBA-098-1	eastern red bat
98	control	8 /5 /2010	080510-ERBA-098-1	eastern red bat
98	control	10/15/2010	101510-ERBA-098-1	eastern red bat
98	control	8 /15/2010	081510-HOBA-098-1	hoary bat
98	control	9 /4 /2010	090410-HOBA-098-1	hoary bat
98	control	8 /7 /2010	080710-ERBA-098-1	eastern red bat
101	control	No carcasses found		
102	control	8 /20/2010	082010-HOBA-102-1	hoary bat
103	control	8 /22/2010	082210-ERBA-103-1	eastern red bat
104	control	8 /12/2010	081210-HOBA-104-2	hoary bat
104	control	8 /12/2010	081210-ERBA-104-1	eastern red bat
107	control	8 /28/2010	082810-ERBA-107-1	eastern red bat
107	control	9 /20/2010	092010-BBBA-107-1	big brown bat
112	control	9 /2 /2010	090210-ERBA-112-1	eastern red bat
112	control	8 /2 /2010	080210-ERBA-112-1	eastern red bat
113	5 m/s	8 /23/2010	082310-ERBA-113-2	eastern red bat
113	control	8 /14/2010	081410-ERBA-113-2	eastern red bat
113	5 m/s	10/1 /2010	100110-SHBA-113-1	silver-haired bat
113	5 m/s	9 /5 /2010	090510-HOBA-113-1	hoary bat
113	5 m/s	8 /23/2010	082310-ERBA-113-1	eastern red bat
113	control	8 /14/2010	081410-ERBA-113-1	eastern red bat
113	control	8 /4 /2010	080410-ERBA-113-1	eastern red bat
113	control	8 /11/2010	081110-ERBA-113-1	eastern red bat
113	control	4 /13/2010	041310-SHBA-113-1	silver-haired bat
113	control	8 /14/2010	081410-ERBA-113-3	eastern red bat
115	control	8 /20/2010	082010-HOBA-115-1	hoary bat
116	control	8 /2 /2010	080210-ERBA-116-1	eastern red bat
116	control	9 /11/2010	091110-HOBA-116-1	hoary bat
116	control	8 /20/2010	082010-ERBA-116-1	eastern red bat
117	control	9 /20/2010	092010-SHBA-117-1	silver-haired bat
118	control	8 /2 /2010	080210-ERBA-118-1	eastern red bat
118	control	8 /2 /2010	080210-ERBA-118-2	eastern red bat
121	control	9 /18/2010	091810-SHBA-121-1	silver-haired bat
123	control	7 /31/2010	073110-ERBA-123-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
123	5 m/s	8 /6 /2010	080610-ERBA-123-1	eastern red bat
123	control	8 /12/2010	081210-ERBA-123-1	eastern red bat
125	control	9 /11/2010	091110-SHBA-125-1	silver-haired bat
127	control	8 /8 /2010	080810-HOBA-127-1	hoary bat
129	control	No carcasses found		
147	control	8 /2 /2010	080210-ERBA-147-1	eastern red bat
147	5 m/s	10/7 /2010	100710-SHBA-147-1	silver-haired bat
147	5 m/s	8 /30/2010	083010-ERBA-147-1	eastern red bat
147	control	7 /31/2010	073110-ERBA-147-1	eastern red bat
147	control	8 /29/2010	082910-HOBA-147-1	hoary bat
152	control	9 /12/2010	091210-ERBA-152-2	eastern red bat
152	control	8 /14/2010	081410-ERBA-152-1	eastern red bat
152	control	9 /12/2010	091210-ERBA-152-1	eastern red bat
152	control	8 /8 /2010	080810-ERBA-152-1	eastern red bat
156	control	8 /14/2010	081410-ERBA-156-1	eastern red bat
156	control	8 /29/2010	082910-ERBA-156-1	eastern red bat
156	control	9 /3 /2010	090310-HOBA-156-1	hoary bat
173	control	8 /14/2010	081410-ERBA-173-1	eastern red bat
173	control	8 /8 /2010	080810-ERBA-173-1	eastern red bat
173	control	8 /29/2010	082910-ERBA-173-1	eastern red bat
173	control	8 /8 /2010	080810-ERBA-173-2	eastern red bat
193	control	8 /14/2010	081410-ERBA-193-1	eastern red bat
193	control	8 /7 /2010	080710-ERBA-193-1	eastern red bat
193	control	8 /7 /2010	080710-ERBA-193-2	eastern red bat
193	control	8 /2 /2010	080210-HOBA-193-1	hoary bat
195	5 m/s	9 /8 /2010	090810-SHBA-195-1	silver-haired bat
195	5 m/s	8 /23/2010	082310-ERBA-195-1	eastern red bat
195	control	10/7 /2010	100710-SHBA-195-1	silver-haired bat
198	control	8 /7 /2010	080710-HOBA-198-2	hoary bat
198	control	8 /7 /2010	080710-ERBA-198-1	eastern red bat
203	control	8 /14/2010	081410-ERBA-203-2	eastern red bat
203	control	8 /14/2010	081410-HOBA-203-1	hoary bat
203	control	8 /20/2010	082010-HOBA-203-1	hoary bat
216	control	8 /7 /2010	080710-ERBA-216-1	eastern red bat
216	control	9 /3 /2010	090310-HOBA-216-1	hoary bat
216	control	5 /4 /2010	050410-SHBA-216-1	silver-haired bat
218	control	9 /20/2010	092010-ERBA-218-1	eastern red bat
218	control	8 /31/2010	083110-ERBA-218-1	eastern red bat
218	5 m/s	9 /18/2010	091810-HOBA-218-1	hoary bat
218	5 m/s	9 /28/2010	092810-ERBA-218-1	eastern red bat
218	6.5 m/s	8 /8 /2010	080810-ERBA-218-1	eastern red bat
218	control	9 /20/2010	092010-SHBA-218-2	silver-haired bat
224	control	8 /29/2010	082910-ERBA-224-1	eastern red bat
224	control	8 /28/2010	082810-ERBA-224-1	eastern red bat
224	control	8 /14/2010	081410-ERBA-224-2	eastern red bat
224	control	8 /2 /2010	080210-HOBA-224-1	hoary bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
224	control	8 /14/2010	081410-HOBA-224-1	hoary bat
227	control	8 /7 /2010	080710-ERBA-227-1	eastern red bat
227	control	8 /2 /2010	080210-ERBA-227-1	eastern red bat
227	control	8 /29/2010	082910-HOBA-227-1	hoary bat
229	control	8 /29/2010	082910-SHBA-229-1	silver-haired bat
229	control	8 /7 /2010	080710-ERBA-229-1	eastern red bat
229	control	8 /2 /2010	080210-ERBA-229-1	eastern red bat
229	control	9 /17/2010	091710-SHBA-229-1	silver-haired bat
230	control	8 /18/2010	081810-ERBA-230-1	eastern red bat
230	control	8 /22/2010	082210-ERBA-230-1	eastern red bat
230	control	8 /23/2010	082310-ERBA-230-1	eastern red bat
230	control	4 /21/2010	042110-HOBA-230-1	hoary bat
230	5 m/s	8 /14/2010	081410-HOBA-230-1	hoary bat
230	5 m/s	8 /13/2010	081310-HOBA-230-3	hoary bat
230	control	8 /4 /2010	080410-HOBA-230-1	hoary bat
230	5 m/s	8 /14/2010	081410-ERBA-230-2	eastern red bat
230	control	8 /4 /2010	080410-HOBA-230-2	hoary bat
230	control	8 /5 /2010	080510-ERBA-230-1	eastern red bat
230	control	7 /31/2010	073110-ERBA-230-2	eastern red bat
230	control	7 /31/2010	073110-ERBA-230-4	eastern red bat
230	control	7 /31/2010	073110-BBBA-230-1	big brown bat
230	control	10/3 /2010	100310-SHBA-230-1	silver-haired bat
230	control	8 /1 /2010	080110-ERBA-230-1	eastern red bat
230	control	7 /31/2010	073110-BBBA-230-3	big brown bat
230	control	8 /7 /2010	080710-ERBA-230-1	eastern red bat
230	5 m/s	8 /13/2010	081310-ERBA-230-1	eastern red bat
230	5 m/s	8 /13/2010	081310-ERBA-230-2	eastern red bat
232	control	9 /5 /2010	090510-ERBA-323-1	eastern red bat
241	control	8 /20/2010	082010-ERBA-241-1	eastern red bat
245	control	8 /29/2010	082910-BBBA-245-2	big brown bat
245	control	8 /2 /2010	080210-HOBA-245-3	hoary bat
245	control	9 /3 /2010	090310-ERBA-245-1	eastern red bat
245	control	8 /29/2010	082910-ERBA-245-1	eastern red bat
245	control	8 /7 /2010	080710-ERBA-245-2	eastern red bat
245	control	8 /2 /2010	080210-ERBA-245-1	eastern red bat
245	control	8 /2 /2010	080210-ERBA-245-2	eastern red bat
245	control	8 /7 /2010	080710-HOBA-245-1	hoary bat
245	control	8 /29/2010	082910-ERBA-245-3	eastern red bat
248	control	8 /29/2010	082910-ERBA-248-1	eastern red bat
248	control	8 /2 /2010	080210-ERBA-248-1	eastern red bat
248	control	8 /20/2010	082010-ERBA-248-1	eastern red bat
248	control	8 /2 /2010	080210-ERBA-248-2	eastern red bat
249	control	9 /17/2010	091710-HOBA-249-1	hoary bat
251	control	8 /23/2010	082310-ERBA-251-1	eastern red bat
251	control	5 /15/2010	051510-ERBA-251-2	eastern red bat
251	6.5 m/s	8 /20/2010	082010-ERBA-251-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
251	control	8 /12/2010	081210-ERBA-251-1	eastern red bat
251	control	5 /15/2010	051510-SHBA-251-1	silver-haired bat
251	5 m/s	10/7 /2010	100710-SHBA-251-1	silver-haired bat
253	control	8 /2 /2010	080210-ERBA-253-2	eastern red bat
253	control	8 /2 /2010	080210-HOBA-253-1	hoary bat
253	control	8 /7 /2010	080710-HOBA-253-1	hoary bat
253	control	9 /17/2010	091710-SHBA-253-1	silver-haired bat
254	control	8 /20/2010	082010-TRBA-254-1	tricolored bat
254	control	8 /14/2010	081410-ERBA-254-1	eastern red bat
260	control	8 /14/2010	081410-ERBA-260-1	eastern red bat
260	control	7 /31/2010	073110-ERBA-260-1	eastern red bat
260	5 m/s	9 /11/2010	091110-ERBA-260-1	eastern red bat
260	5 m/s	9 /8 /2010	090810-HOBA-260-1	hoary bat
260	control	4 /21/2010	042110-ERBA-260-1	eastern red bat
260	unknown	8 /8 /2010	080810-ERBA-260-1	eastern red bat
260	control	8 /12/2010	081210-ERBA-260-1	eastern red bat
260	control	8 /13/2010	081310-ERBA-260-1	eastern red bat
260	5 m/s	9 /14/2010	091410-SHBA-260-1	silver-haired bat
281	control	8 /19/2010	081910-HOBA-281-1	hoary bat
281	control	10/10/2010	101010-ERBA-281-1	eastern red bat
281	control	8 /20/2010	082010-HOBA-281-1	hoary bat
281	control	4 /16/2010	041610-ERBA-281-1	eastern red bat
281	control	9 /20/2010	092010-SHBA-281-1	silver-haired bat
281	control	8 /3 /2010	080310-HOBA-281-1	hoary bat
281	control	8 /23/2010	082310-BBBA-281-1	big brown bat
281	control	8 /19/2010	081910-ERBA-281-2	eastern red bat
281	control	8 /3 /2010	080310-ERBA-281-2	eastern red bat
281	control	9 /6 /2010	090610-HOBA-281-1	hoary bat
281	control	8 /4 /2010	080410-ERBA-281-1	eastern red bat
281	unknown	8 /19/2010	081910-ERBA-281-3	eastern red bat
281	control	9 /14/2010	091410-SHBA-281-1	silver-haired bat
281	control	9 /26/2010	092610-HOBA-281-1	hoary bat
281	control	8 /9 /2010	080910-ERBA-281-1	eastern red bat
281	control	9 /18/2010	091810-SHBA-281-1	silver-haired bat
281	control	8 /29/2010	082910-ERBA-281-1	eastern red bat
285	control	8 /1 /2010	080110-HOBA-285-1	hoary bat
286	control	8 /29/2010	082910-ERBA-286-1	eastern red bat
286	control	8 /1 /2010	080110-ERBA-286-1	eastern red bat
286	control	8 /20/2010	082010-ERBA-286-1	eastern red bat
305	control	No carcasses found		
309	control	7 /31/2010	073110-HOBA-309-1	hoary bat
309	control	8 /6 /2010	080610-ERBA-309-1	eastern red bat
309	control	8 /6 /2010	080610-ERBA-309-2	eastern red bat
311	control	8 /25/2010	082510-ERBA-311-1	eastern red bat
314	control	8 /5 /2010	080510-ERBA-314-2	eastern red bat
314	control	7 /30/2010	073010-BBBA-314-3	big brown bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
314	control	8 /26/2010	082610-ERBA-314-1	eastern red bat
314	control	8 /4 /2010	080410-ERBA-314-4	eastern red bat
314	control	8 /6 /2010	080610-ERBA-314-1	eastern red bat
314	control	8 /4 /2010	080410-ERBA-314-3	eastern red bat
314	control	7 /30/2010	073010-ERBA-314-4	eastern red bat
314	control	8 /5 /2010	080510-ERBA-314-3	eastern red bat
314	control	8 /1 /2010	080110-ERBA-314-1	eastern red bat
314	control	8 /5 /2010	080510-ERBA-314-1	eastern red bat
314	control	8 /4 /2010	080410-ERBA-314-2	eastern red bat
314	control	8 /2 /2010	080210-HOBA-314-1	hoary bat
314	control	8 /4 /2010	080410-ERBA-314-1	eastern red bat
314	6.5 m/s	8 /24/2010	082410-ERBA-314-1	eastern red bat
314	control	7 /30/2010	073010-HOBA-314-2	hoary bat
314	control	7 /30/2010	073010-ERBA-314-1	eastern red bat
314	control	5 /15/2010	051510-HOBA-314-1	hoary bat
314	control	8 /24/2010	082410-ERBA-314-2	eastern red bat
314	control	8 /27/2010	082710-SHBA-314-1	silver-haired bat
314	control	5 /5 /2010	050510-SHBA-314-1	silver-haired bat
319	control	8 /13/2010	081310-HOBA-319-1	hoary bat
321	control	8 /12/2010	081210-ERBA-321-1	eastern red bat
321	control	8 /12/2010	081210-BBBA-321-2	big brown bat
322	control	No carcasses found		
323	control	4 /23/2010	042310-SHBA-323-2	silver-haired bat
323	control	8 /6 /2010	080610-ERBA-323-1	eastern red bat
323	6.5 m/s	9 /30/2010	093010-SHBA-323-1	silver-haired bat
323	control	8 /6 /2010	080610-HOBA-323-2	hoary bat
323	control	9 /20/2010	092010-HOBA-323-1	hoary bat
329	control	8 /14/2010	081410-ERBA-329-1	eastern red bat
329	control	8 /7 /2010	080710-ERBA-329-1	eastern red bat
334	control	4 /23/2010	042310-ERBA-334-1	eastern red bat
334	6.5 m/s	9 /1 /2010	090110-ERBA-334-1	eastern red bat
334	control	9 /23/2010	092310-SHBA-334-1	silver-haired bat
337	control	8 /11/2010	081110-ERBA-337-2	eastern red bat
337	control	8 /11/2010	081110-ERBA-337-1	eastern red bat
339	control	8 /13/2010	081310-ERBA-339-1	eastern red bat
339	control	7 /31/2010	073110-TRBA-339-1	tricolored bat
339	control	8 /15/2010	081510-HOBA-339-1	hoary bat
339	control	8 /6 /2010	080610-BBBA-339-1	big brown bat
339	control	7 /31/2010	073110-HOBA-339-2	hoary bat
348	control	No carcasses found		
349	control	8 /24/2010	082410-ERBA-349-1	eastern red bat
352	control	7 /31/2010	073110-ERBA-352-1	eastern red bat
352	control	7 /31/2010	073110-ERBA-352-2	eastern red bat
352	control	8 /15/2010	081510-ERBA-352-1	eastern red bat
352	control	10/15/2010	101510-SHBA-352-1	silver-haired bat
352	control	8 /15/2010	081510-ERBA-352-2	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
353	control	8 /12/2010	081310-HOBA-353-1	hoary bat
354	control	7 /31/2010	073110-BBBA-354-1	big brown bat
354	control	8 /21/2010	082110-ERBA-354-1	eastern red bat
354	control	9 /24/2010	092410-SHBA-354-1	silver-haired bat
355	control	7 /31/2010	073110-ERBA-355-1	eastern red bat
355	control	8 /6 /2010	080610-HOBA-355-1	hoary bat
369	control	8 /6 /2010	080610-ERBA-369-1	eastern red bat
369	control	8 /1 /2010	080110-SHBA-369-1	silver-haired bat
369	control	8 /1 /2010	080110-HOBA-369-2	hoary bat
371	5 m/s	8 /4 /2010	080410-ERBA-371-1	eastern red bat
371	5 m/s	9 /10/2010	091010-ERBA-371-1	eastern red bat
371	6.5 m/s	8 /29/2010	082910-HOBA-371-1	hoary bat
371	control	8 /5 /2010	080510-ERBA-371-1	eastern red bat
371	6.5 m/s	8 /25/2010	082510-HOBA-371-1	hoary bat
371	control	9 /13/2010	091310-SHBA-371-1	silver-haired bat
371	6.5 m/s	9 /23/2010	092310-ERBA-371-1	eastern red bat
371	5 m/s	8 /8 /2010	080810-SHBA-371-1	silver-haired bat
371	5 m/s	9 /9 /2010	090910-SHBA-371-1	silver-haired bat
371	control	7 /31/2010	073110-ERBA-371-2	eastern red bat
371	control	7 /31/2010	073110-ERBA-371-1	eastern red bat
371	control	10/8 /2010	100810-ERBA-371-1	eastern red bat
371	control	7 /31/2010	073110-ERBA-371-3	eastern red bat
374	control	8 /13/2010	081310-ERBA-374-1	eastern red bat
379	control	8 /6 /2010	080610-ERBA-379-1	eastern red bat
379	control	8 /27/2010	082710-ERBA-379-1	eastern red bat
379	control	8 /6 /2010	080610-ERBA-379-3	eastern red bat
379	control	8 /15/2010	081510-ERBA-379-1	eastern red bat
379	control	8 /6 /2010	080610-ERBA-379-2	eastern red bat
379	control	8 /6 /2010	080610-ERBA-379-4	eastern red bat
387	control	8 /4 /2010	080410-ERBA-387-1	eastern red bat
387	5 m/s	9 /15/2010	091510-ERBA-387-1	eastern red bat
387	control	8 /14/2010	081410-ERBA-387-1	eastern red bat
387	control	8 /27/2010	082710-ERBA-387-1	eastern red bat
387	control	8 /4 /2010	080410-ERBA-387-2	eastern red bat
387	control	8 /27/2010	082710-ERBA-387-2	eastern red bat
387	5 m/s	9 /3 /2010	090310-HOBA-387-1	hoary bat
387	control	4 /19/2010	041910-ERBA-387-1	eastern red bat
387	control	8 /4 /2010	080410-HOBA-387-3	hoary bat
388	control	8 /27/2010	082710-SHBA-388-2	silver-haired bat
388	control	7 /31/2010	073110-ERBA-388-1	eastern red bat
388	control	8 /21/2010	082110-ERBA-388-1	eastern red bat
388	control	8 /6 /2010	080610-ERBA-388-2	eastern red bat
388	control	8 /6 /2010	080610-ERBA-388-1	eastern red bat
388	control	8 /13/2010	081310-ERBA-388-1	eastern red bat
388	control	8 /27/2010	082710-HOBA-388-1	hoary bat
388	control	8 /27/2010	082710-ERBA-388-3	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
389	control	9 /7 /2010	090710-HOBA-389-1	hoary bat
390	control	8 /7 /2010	080710-ERBA-390-1	eastern red bat
390	control	8 /1 /2010	080110-ERBA-390-1	eastern red bat
392	control	8 /13/2010	081310-HOBA-392-1	hoary bat
396	control	7 /31/2010	073110-ERBA-396-4	eastern red bat
396	control	7 /31/2010	073110-ERBA-396-2	eastern red bat
396	control	7 /31/2010	073110-ERBA-396-3	eastern red bat
396	control	8 /13/2010	081310-ERBA-396-1	eastern red bat
396	control	8 /17/2010	081710-ERBA-396-3	eastern red bat
396	control	8 /17/2010	081710-ERBA-396-2	eastern red bat
396	control	8 /17/2010	081710-ERBA-396-1	eastern red bat
396	control	4 /29/2010	042910-ERBA-396-1	eastern red bat
396	control	8 /16/2010	081610-ERBA-396-1	eastern red bat
396	control	7 /31/2010	073110-ERBA-396-1	eastern red bat
396	control	7 /31/2010	073110-HOBA-396-5	hoary bat
397	control	8 /6 /2010	080610-ERBA-397-1	eastern red bat
397	control	8 /27/2010	082710-ERBA-397-1	eastern red bat
397	control	4 /19/2010	041910-ERBA-397-1	eastern red bat
398	control	8 /6 /2010	080610-HOBA-398-1	hoary bat
398	control	7 /31/2010	073110-ERBA-398-1	eastern red bat
401	control	9 /10/2010	091010-SHBA-401-2	silver-haired bat
401	control	8 /21/2010	082110-BBBA-401-1	big brown bat
401	control	8 /15/2010	081510-ERBA-401-1	eastern red bat
401	control	7 /31/2010	073110-HOBA-401-1	hoary bat
401	control	9 /10/2010	091010-SHBA-401-1	silver-haired bat
403	control	8 /31/2010	083110-ERBA-403-1	eastern red bat
407	control	8 /1 /2010	080110-ERBA-407-2	eastern red bat
407	control	8 /14/2010	081410-ERBA-407-2	eastern red bat
407	control	8 /1 /2010	080110-HOBA-407-1	hoary bat
414	control	8 /15/2010	081510-ERBA-414-2	eastern red bat
414	control	8 /15/2010	081510-ERBA-414-1	eastern red bat
414	control	8 /2 /2010	080210-HOBA-414-2	hoary bat
414	control	8 /7 /2010	080710-ERBA-414-1	eastern red bat
414	control	8 /29/2010	082910-HOBA-414-1	hoary bat
414	control	8 /6 /2010	080610-ERBA-414-1	eastern red bat
414	control	8 /2 /2010	080210-HOBA-414-3	hoary bat
414	control	8 /12/2010	081210-HOBA-414-1	hoary bat
414	control	8 /28/2010	082810-ERBA-414-1	eastern red bat
414	control	8 /24/2010	082410-ERBA-414-1	eastern red bat
414	control	8 /13/2010	081310-ERBA-414-1	eastern red bat
414	control	8 /21/2010	082110-ERBA-414-1	eastern red bat
414	control	8 /2 /2010	080210-ERBA-414-1	eastern red bat
414	control	10/13/2010	101310-SHBA-414-1	silver-haired bat
414	control	8 /12/2010	081210-ERBA-414-2	eastern red bat
414	control	8 /20/2010	082010-HOBA-414-1	hoary bat
414	control	9 /20/2010	092010-SHBA-414-2	silver-haired bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
414	control	8 /11/2010	081110-ERBA-414-1	eastern red bat
414	control	8 /4 /2010	080410-ERBA-414-1	eastern red bat
414	control	8 /14/2010	081410-HOBA-414-1	hoary bat
417	control	8 /15/2010	081510-HOBA-417-1	hoary bat
417	control	9 /24/2010	092410-ERBA-417-1	eastern red bat
417	control	9 /14/2010	091410-SHBA-417-1	silver-haired bat
419	control	8 /6 /2010	080610-ERBA-419-1	eastern red bat
419	control	8 /21/2010	082110-ERBA-419-2	eastern red bat
419	control	8 /21/2010	082110-HOBA-419-3	hoary bat
419	control	9 /19/2010	091910-ERBA-419-1	eastern red bat
419	control	8 /21/2010	082110-HOBA-419-1	hoary bat
419	control	8 /15/2010	081510-ERBA-419-2	eastern red bat
419	control	8 /27/2010	082710-ERBA-419-1	eastern red bat
419	control	8 /15/2010	081510-ERBA-419-1	eastern red bat
420	control	8 /7 /2010	080710-ERBA-420-1	eastern red bat
420	control	8 /7 /2010	080710-ERBA-420-2	eastern red bat
420	control	9 /24/2010	092410-SHBA-420-1	silver-haired bat
420	control	8 /15/2010	081510-ERBA-420-1	eastern red bat
423	control	7 /31/2010	073110-ERBA-423-1	eastern red bat
425	control	7 /31/2010	073110-ERBA-425-1	eastern red bat
425	control	10/1 /2010	100110-SHBA-425-1	silver-haired bat
425	control	8 /6 /2010	080610-ERBA-425-1	eastern red bat
425	control	7 /31/2010	073110-ERBA-425-2	eastern red bat
426	control	8 /15/2010	081510-ERBA-426-2	eastern red bat
426	control	8 /15/2010	081510-ERBA-426-3	eastern red bat
426	control	8 /6 /2010	080610-ERBA-426-1	eastern red bat
426	control	7 /31/2010	073110-HOBA-426-1	hoary bat
426	control	8 /15/2010	081510-ERBA-426-1	eastern red bat
426	control	8 /6 /2010	080610-ERBA-426-2	eastern red bat
431	control	8 /9 /2010	080910-ERBA-431-1	eastern red bat
432	control	9 /10/2010	091010-ERBA-432-1	eastern red bat
438	control	8 /25/2010	082510-ERBA-438-3	eastern red bat
438	control	8 /25/2010	082510-ERBA-438-2	eastern red bat
438	control	8 /25/2010	082510-ERBA-438-1	eastern red bat
443	control	9 /4 /2010	090410-ERBA-443-1	eastern red bat
443	control	9 /10/2010	091010-HOBA-443-1	hoary bat
443	control	8 /6 /2010	080610-ERBA-443-1	eastern red bat
443	control	8 /15/2010	081510-ERBA-443-1	eastern red bat
448	control	8 /4 /2010	080410-ERBA-448-3	eastern red bat
448	control	7 /31/2010	073110-BBBA-448-1	big brown bat
448	control	8 /1 /2010	080110-ERBA-448-1	eastern red bat
448	control	8 /2 /2010	080210-ERBA-448-1	eastern red bat
448	control	8 /4 /2010	080410-ERBA-448-2	eastern red bat
448	control	8 /3 /2010	080310-ERBA-448-1	eastern red bat
448	control	9 /14/2010	091410-ERBA-448-1	eastern red bat
448	control	8 /8 /2010	080810-ERBA-448-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
448	control	8 /29/2010	082910-ERBA-448-1	eastern red bat
448	control	9 /7 /2010	090710-SHBA-448-1	silver-haired bat
448	control	8 /4 /2010	080410-BBBA-448-1	big brown bat
448	control	8 /8 /2010	080810-ERBA-448-2	eastern red bat
448	control	10/11/2010	101110-ERBA-448-1	eastern red bat
448	control	10/8 /2010	100810-SHBA-448-1	silver-haired bat
448	control	8 /21/2010	082110-HOBA-448-1	hoary bat
448	control	8 /13/2010	081310-HOBA-448-1	hoary bat
448	control	8 /28/2010	082810-ERBA-448-1	eastern red bat
448	control	10/1 /2010	100110-ERBA-448-1	eastern red bat
448	control	7 /31/2010	073110-HOBA-448-2	hoary bat
448	control	8 /6 /2010	080610-ERBA-448-1	eastern red bat
453	control	8 /3 /2010	080310-BBBA-453-1	big brown bat
453	control	8 /3 /2010	080310-ERBA-453-2	eastern red bat
454	control	7 /31/2010	073110-ERBA-454-2	eastern red bat
454	control	7 /31/2010	073110-HOBA-454-3	hoary bat
454	control	8 /6 /2010	080610-ERBA-454-1	eastern red bat
454	control	8 /27/2010	082710-HOBA-454-1	hoary bat
454	control	7 /31/2010	073110-ERBA-454-1	eastern red bat
458	control	9 /18/2010	091810-SHBA-458-1	silver-haired bat
458	unknown	8 /24/2010	082410-SHBA-458-1	silver-haired bat
458	control	4 /13/2010	041310-ERBA-458-1	eastern red bat
458	control	8 /1 /2010	080110-HOBA-458-2	hoary bat
458	unknown	8 /1 /2010	080110-ERBA-458-1	eastern red bat
458	unknown	8 /16/2010	081610-ERBA-458-1	eastern red bat
458	5 m/s	8 /28/2010	082810-ERBA-458-1	eastern red bat
458	control	9 /13/2010	091310-SHBA-458-1	silver-haired bat
458	5 m/s	8 /9 /2010	080910-HOBA-458-1	hoary bat
459	control	8 /13/2010	081310-HOBA-459-1	hoary bat
459	control	9 /30/2010	093010-SHBA-459-1	silver-haired bat
459	control	8 /20/2010	082010-ERBA-459-2	eastern red bat
459	control	9 /20/2010	092010-HOBA-459-1	hoary bat
459	control	8 /19/2010	081910-ERBA-459-1	eastern red bat
459	control	8 /14/2010	081410-ERBA-459-2	eastern red bat
459	control	8 /14/2010	081410-ERBA-459-1	eastern red bat
459	control	8 /19/2010	081910-ERBA-459-1	eastern red bat
459	control	8 /2 /2010	080210-HOBA-459-1	hoary bat
459	control	8 /14/2010	081410-ERBA-459-1	eastern red bat
459	control	8 /6 /2010	080610-ERBA-459-1	eastern red bat
459	control	9 /23/2010	092310-SHBA-459-1	silver-haired bat
459	control	10/15/2010	101510-ERBA-459-1	eastern red bat
459	control	10/13/2010	101310-ERBA-459-1	eastern red bat
459	control	8 /2 /2010	080210-ERBA-459-2	eastern red bat
459	control	8 /2 /2010	080210-ERBA-459-3	eastern red bat
459	control	4 /13/2010	041310-ERBA-459-1	eastern red bat
459	control	9 /23/2010	092310-SHBA-459-2	silver-haired bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
459	control	8 /6 /2010	080610-ERBA-459-2	eastern red bat
459	control	10/15/2010	101510-ERBA-459-2	eastern red bat
459	control	8 /30/2010	083010-ERBA-459-2	eastern red bat
459	control	8 /21/2010	082110-HOBA-459-1	hoary bat
459	control	8 /20/2010	082010-HOBA-459-1	hoary bat
459	control	9 /6 /2010	090610-ERBA-459-1	eastern red bat
459	control	8 /4 /2010	080410-ERBA-459-2	eastern red bat
459	control	8 /4 /2010	080410-ERBA-459-1	eastern red bat
459	control	8 /2 /2010	080210-ERBA-459-4	eastern red bat
459	control	8 /1 /2010	080110-ERBA-459-2	eastern red bat
459	control	8 /1 /2010	080110-ERBA-459-1	eastern red bat
459	control	8 /26/2010	082610-ERBA-459-1	eastern red bat
459	control	8 /26/2010	082610-ERBA-459-3	eastern red bat
459	control	9 /6 /2010	090610-SHBA-459-2	silver-haired bat
459	control	8 /27/2010	082710-ERBA-459-1	eastern red bat
459	control	8 /11/2010	081110-ERBA-459-2	eastern red bat
459	control	8 /30/2010	083010-ERBA-459-1	eastern red bat
459	control	7 /31/2010	073110-BBBA-459-2	big brown bat
459	control	7 /31/2010	073110-HOBA-459-1	hoary bat
459	control	8 /26/2010	082610-ERBA-459-2	eastern red bat
459	control	8 /12/2010	081210-ERBA-459-1	eastern red bat
460	control	7 /31/2010	073110-HOBA-460-1	hoary bat
464	control	8 /27/2010	082710-ERBA-464-1	eastern red bat
469	control	8 /26/2010	082610-SHBA-469-1	silver-haired bat
476	control	8 /15/2010	081510-ERBA-476-2	eastern red bat
476	control	8 /7 /2010	080710-ERBA-476-2	eastern red bat
476	control	8 /7 /2010	080710-ERBA-476-3	eastern red bat
476	control	8 /15/2010	081510-ERBA-476-4	eastern red bat
476	control	8 /15/2010	081510-ERBA-476-3	eastern red bat
476	control	8 /1 /2010	080110-ERBA-476-5	eastern red bat
476	control	8 /1 /2010	080110-ERBA-476-6	eastern red bat
476	control	8 /7 /2010	080710-ERBA-476-1	eastern red bat
476	control	8 /15/2010	081510-ERBA-476-1	eastern red bat
476	control	8 /21/2010	082110-ERBA-476-1	eastern red bat
476	control	9 /18/2010	091810-ERBA-476-1	eastern red bat
477	control	8 /27/2010	082710-ERBA-477-1	eastern red bat
477	control	8 /21/2010	082110-ERBA-477-1	eastern red bat
477	control	8 /26/2010	082610-ERBA-477-1	eastern red bat
477	control	9 /10/2010	091010-HOBA-477-1	hoary bat
477	control	8 /15/2010	081510-ERBA-477-1	eastern red bat
478	control	8 /28/2010	082810-ERBA-478-1	eastern red bat
478	control	7 /31/2010	073110-ERBA-478-1	eastern red bat
478	control	8 /27/2010	082710-ERBA-478-1	eastern red bat
480	control	8 /11/2010	081110-ERBA-480-2	eastern red bat
480	control	8 /20/2010	082010-ERBA-480-1	eastern red bat
480	control	8 /11/2010	081110-ERBA-480-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
480	control	8 /11/2010	081110-ERBA-480-3	eastern red bat
480	control	4 /22/2010	042210-ERBA-480-1	eastern red bat
480	control	8 /9 /2010	080910-ERBA-480-1	eastern red bat
480	control	8 /13/2010	081310-ERBA-480-1	eastern red bat
480	control	8 /5 /2010	080510-ERBA-480-1	eastern red bat
480	control	8 /14/2010	081410-ERBA-480-1	eastern red bat
480	control	8 /30/2010	083010-ERBA-480-1	eastern red bat
480	control	7 /31/2010	073110-HOBA-480-1	hoary bat
480	6.5 m/s	9 /21/2010	092110-ERBA-480-1	eastern red bat
480	5 m/s	9 /22/2010	092210-SHBA-480-1	silver-haired bat
480	control	8 /2 /2010	080210-ERBA-480-1	eastern red bat
480	control	8 /4 /2010	080410-ERBA-480-1	eastern red bat
480	unknown	8 /5 /2010	080510-ERBA-480-2	eastern red bat
480	5 m/s	9 /23/2010	092310-HOBA-480-1	hoary bat
480	control	8 /13/2010	081310-HOBA-480-1	hoary bat
480	control	5 /1 /2010	050110-ERBA-480-1	eastern red bat
480	control	8 /4 /2010	080410-ERBA-480-1	eastern red bat
482	control	8 /26/2010	082610-HOBA-482-2	hoary bat
482	control	8 /26/2010	082610-ERBA-482-1	eastern red bat
602	control	8 /2 /2010	080210-ERBA-602-1	eastern red bat
602	control	8 /29/2010	082910-ERBA-602-1	eastern red bat
602	control	8 /7 /2010	080710-ERBA-602-1	eastern red bat
602	control	8 /20/2010	082010-HOBA-602-1	hoary bat
602	control	8 /2 /2010	080210-HOBA-602-2	hoary bat
603	control	8 /20/2010	082010-ERBA-603-2	eastern red bat
603	control	9 /11/2010	091110-HOBA-603-1	hoary bat
603	control	9 /14/2010	091410-SHBA-603-1	silver-haired bat
603	5 m/s	8 /16/2010	081610-ERBA-603-1	eastern red bat
603	control	8 /20/2010	082010-BBBA-603-1	big brown bat
603	5 m/s	8 /26/2010	082610-TRBA-603-1	tricolored bat
604	control	8 /20/2010	082010-ERBA-604-1	eastern red bat
604	control	8 /20/2010	082010-ERBA-604-2	eastern red bat
607	control	8 /14/2010	081410-ERBA-607-1	eastern red bat
607	control	8 /1 /2010	080110-ERBA-607-2	eastern red bat
607	control	8 /29/2010	082910-ERBA-607-2	eastern red bat
607	control	8 /7 /2010	080710-ERBA-607-3	eastern red bat
607	control	9 /12/2010	091210-SHBA-607-1	silver-haired bat
607	control	9 /17/2010	091710-ERBA-607-1	eastern red bat
607	control	8 /1 /2010	080110-HOBA-607-1	hoary bat
607	control	8 /7 /2010	080710-HOBA-607-2	hoary bat
607	control	8 /7 /2010	080710-HOBA-607-4	hoary bat
607	control	8 /29/2010	082910-HOBA-607-1	hoary bat
607	control	8 /7 /2010	080710-ERBA-607-1	eastern red bat
608	control	8 /1 /2010	080110-ERBA-608-1	eastern red bat
608	control	8 /1 /2010	080110-ERBA-608-2	eastern red bat
609	control	8 /7 /2010	080710-BBBA-609-1	big brown bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
609	control	8 /13/2010	081310-BBBA-609-1	big brown bat
609	control	8 /12/2010	081210-ERBA-609-2	eastern red bat
609	control	8 /12/2010	081210-ERBA-609-1	eastern red bat
609	control	8 /1 /2010	080110-ERBA-609-1	eastern red bat
609	control	8 /13/2010	081310-ERBA-609-2	eastern red bat
610	control	4 /27/2010	042710-BBBA-610-1	big brown bat
611	control	10/2 /2010	100210-SHBA-611-1	silver-haired bat
611	control	9 /23/2010	092310-HOBA-611-1	hoary bat
611	control	8 /14/2010	081410-ERBA-611-1	eastern red bat
611	control	8 /20/2010	082010-HOBA-611-1	hoary bat
613	control	8 /23/2010	082310-ERBA-613-1	eastern red bat
614	control	9 /18/2010	091810-SHBA-614-1	silver-haired bat
614	6.5 m/s	8 /20/2010	082010-ERBA-614-1	eastern red bat
614	control	9 /18/2010	091810-ERBA-614-2	eastern red bat
614	control	4 /23/2010	042310-SHBA-614-3	silver-haired bat
614	control	9 /16/2010	091610-SHBA-614-1	silver-haired bat
614	control	9 /7 /2010	090710-SHBA-614-1	silver-haired bat
614	5 m/s	9 /6 /2010	090610-HOBA-614-1	hoary bat
614	5 m/s	9 /4 /2010	090410-SHBA-614-1	silver-haired bat
614	control	5 /7 /2010	050710-SHBA-614-1	silver-haired bat
616	control	9 /25/2010	092510-SHBA-616-1	silver-haired bat
616	control	10/2 /2010	100210-ERBA-616-1	eastern red bat
616	control	8 /1 /2010	080110-ERBA-616-1	eastern red bat
616	control	8 /1 /2010	080110-ERBA-616-2	eastern red bat
617	control	8 /2 /2010	080210-BBBA-617-1	big brown bat
620	control	8 /25/2010	082510-HOBA-620-1	hoary bat
620	control	8 /7 /2010	080710-ERBA-620-1	eastern red bat
620	control	8 /20/2010	082010-ERBA-620-1	eastern red bat
622	control	8 /1 /2010	080110-HOBA-622-1	hoary bat
622	control	8 /29/2010	082910-ERBA-622-2	eastern red bat
622	control	8 /1 /2010	080110-ERBA-622-4	eastern red bat
622	control	8 /1 /2010	080110-ERBA-622-2	eastern red bat
622	control	9 /12/2010	091210-ERBA-622-1	eastern red bat
622	control	8 /29/2010	082910-ERBA-622-1	eastern red bat
622	control	5 /13/2010	051310-ERBA-622-1	eastern red bat
622	control	8 /7 /2010	080710-BBBA-622-2	big brown bat
622	control	8 /7 /2010	080710-LBBA-622-1	little brown bat
622	control	8 /1 /2010	080110-HOBA-622-3	hoary bat
624	control	8 /13/2010	081310-HOBA-624-4	hoary bat
624	control	8 /31/2010	083110-ERBA-624-1	eastern red bat
624	control	8 /5 /2010	080510-HOBA-624-3	hoary bat
624	control	8 /5 /2010	080510-ERBA-624-2	eastern red bat
624	control	8 /13/2010	081310-ERBA-624-3	eastern red bat
624	control	8 /13/2010	081310-ERBA-624-1	eastern red bat
624	control	8 /5 /2010	080510-ERBA-624-1	eastern red bat
624	control	8 /13/2010	081310-ERBA-624-5	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
624	control	8 /13/2010	081310-BBBA-624-2	big brown bat
625	control	8 /13/2010	081310-ERBA-625-1	eastern red bat
625	control	9 /3 /2010	090310-ERBA-625-1	eastern red bat
625	control	8 /1 /2010	080110-HOBA-625-1	hoary bat
625	control	8 /19/2010	081910-HOBA-625-1	hoary bat
625	control	8 /1 /2010	080110-ERBA-625-1	eastern red bat
625	control	8 /1 /2010	080110-ERBA-625-3	eastern red bat
625	control	10/8 /2010	100810-SHBA-625-1	silver-haired bat
625	control	8 /19/2010	081910-HOBA-625-2	hoary bat
625	control	9 /13/2010	091310-ERBA-625-1	eastern red bat
625	control	9 /3 /2010	090310-ERBA-625-2	eastern red bat
625	control	9 /11/2010	091110-HOBA-625-1	hoary bat
625	control	8 /29/2010	082910-ERBA-625-1	eastern red bat
625	control	5 /5 /2010	050510-SHBA-625-1	silver-haired bat
625	control	8 /7 /2010	080710-ERBA-625-1	eastern red bat
625	control	8 /7 /2010	080710-ERBA-625-2	eastern red bat
626	control	9 /24/2010	092410-SHBA-626-2	silver-haired bat
626	control	9 /24/2010	092410-ERBA-626-4	eastern red bat
626	control	9 /24/2010	092410-SHBA-626-1	silver-haired bat
626	control	9 /24/2010	092410-ERBA-626-3	eastern red bat
627	control	8 /13/2010	081310-ERBA-627-1	eastern red bat
627	control	9 /25/2010	092510-SHBA-627-1	silver-haired bat
628	control	8 /27/2010	082710-ERBA-628-2	eastern red bat
628	control	8 /4 /2010	080410-ERBA-628-5	eastern red bat
628	control	8 /7 /2010	080710-BBBA-628-1	big brown bat
628	control	4 /18/2010	041810-ERBA-628-1	eastern red bat
628	control	4 /15/2010	041510-SHBA-628-1	silver-haired bat
628	control	7 /31/2010	073110-ERBA-628-5	eastern red bat
628	control	8 /6 /2010	080610-ERBA-628-1	eastern red bat
628	control	9 /21/2010	092110-SHBA-628-1	silver-haired bat
628	control	10/13/2010	101310-ERBA-628-1	eastern red bat
628	control	9 /2 /2010	090210-BBBA-628-1	big brown bat
628	control	8 /26/2010	082610-ERBA-628-2	eastern red bat
628	control	8 /25/2010	082510-ERBA-628-1	eastern red bat
628	control	8 /4 /2010	080410-ERBA-628-6	eastern red bat
628	control	9 /12/2010	091210-SHBA-628-1	silver-haired bat
628	control	9 /11/2010	091110-SHBA-628-1	silver-haired bat
628	control	8 /4 /2010	080410-ERBA-628-2	eastern red bat
628	control	8 /28/2010	082810-ERBA-628-1	eastern red bat
628	control	8 /1 /2010	080110-ERBA-628-1	eastern red bat
628	control	7 /31/2010	073110-ERBA-628-1	eastern red bat
628	control	9 /19/2010	091910-HOBA-628-1	hoary bat
628	control	8 /4 /2010	080410-ERBA-628-1	eastern red bat
628	control	7 /31/2010	073110-ERBA-628-2	eastern red bat
628	control	9 /2 /2010	090210-ERBA-628-2	eastern red bat
628	control	8 /26/2010	082610-ERBA-628-1	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
628	control	7 /31/2010	073110-ERBA-628-3	eastern red bat
628	control	5 /2 /2010	050210-SHBA-628-1	silver-haired bat
628	control	8 /4 /2010	080410-ERBA-628-3	eastern red bat
628	control	8 /4 /2010	080410-ERBA-628-4	eastern red bat
628	control	9 /4 /2010	090410-ERBA-628-1	eastern red bat
628	control	8 /14/2010	081410-ERBA-628-1	eastern red bat
628	control	9 /11/2010	091110-ERBA-628-2	eastern red bat
628	control	8 /31/2010	083110-ERBA-628-1	eastern red bat
628	control	8 /14/2010	081410-BBBA-628-2	big brown bat
628	control	7 /31/2010	073110-ERBA-628-4	eastern red bat
628	control	9 /13/2010	091310-SHBA-628-1	silver-haired bat
628	control	8 /3 /2010	080310-ERBA-628-1	eastern red bat
628	control	8 /19/2010	081910-HOBA-628-1	hoary bat
629	control	8 /13/2010	081310-BBBA-629-1	big brown bat
629	control	8 /29/2010	082910-ERBA-629-1	eastern red bat
629	control	8 /13/2010	081310-HOBA-629-3	hoary bat
629	control	8 /13/2010	081310-ERBA-629-2	eastern red bat
629	control	8 /13/2010	081310-ERBA-629-4	eastern red bat
630	control	8 /15/2010	081510-HOBA-630-1	hoary bat
630	control	9 /14/2010	091410-ERBA-630-1	eastern red bat
630	control	10/4 /2010	100410-SHBA-630-1	silver-haired bat
630	control	9 /7 /2010	090710-HOBA-630-1	hoary bat
630	control	8 /11/2010	081110-ERBA-630-1	eastern red bat
630	control	8 /19/2010	081910-ERBA-630-1	eastern red bat
630	control	8 /18/2010	081810-ERBA-630-1	eastern red bat
630	control	8 /29/2010	082910-ERBA-630-1	eastern red bat
630	control	10/1 /2010	100110-SHBA-630-1	silver-haired bat
630	control	8 /20/2010	082010-ERBA-630-1	eastern red bat
630	control	8 /21/2010	082110-ERBA-630-1	eastern red bat
630	control	8 /16/2010	081610-HOBA-630-1	hoary bat
630	control	8 /30/2010	083010-ERBA-630-1	eastern red bat
630	control	8 /26/2010	082610-ERBA-630-1	eastern red bat
630	control	8 /16/2010	081610-ERBA-630-1	eastern red bat
630	control	9 /30/2010	093010-SHBA-630-1	silver-haired bat
630	control	8 /26/2010	082610-ERBA-630-2	eastern red bat
631	control	10/13/2010	101310-SHBA-631-1	silver-haired bat
631	control	8 /1 /2010	080110-ERBA-631-1	eastern red bat
632	control	8 /13/2010	081310-HOBA-632-3	hoary bat
632	control	8 /13/2010	081310-ERBA-632-2	eastern red bat
632	control	8 /13/2010	081310-ERBA-632-1	eastern red bat
634	control	9 /3 /2010	090310-HOBA-634-1	hoary bat
635	control	8 /20/2010	082010-ERBA-635-1	eastern red bat
635	control	8 /7 /2010	080710-ERBA-635-1	eastern red bat
635	control	9 /12/2010	091210-ERBA-635-1	eastern red bat
635	control	8 /27/2010	082710-ERBA-635-1	eastern red bat
635	control	8 /20/2010	082010-ERBA-635-2	eastern red bat

Appendix E. Turbine and cut-in speed treatment for carcasses found at Fowler Ridge Wind Energy Facility during 2010 surveys.

Turbine	Cut-in Treatment	Date	CarcassID	Species
637	control	8 /13/2010	081310-ERBA-637-2	eastern red bat
637	control	8 /13/2010	081310-HOBA-637-1	hoary bat
637	control	9 /10/2010	091010-HOBA-637-1	hoary bat
639	control	8 /20/2010	082010-ERBA-639-1	eastern red bat
639	control	8 /13/2010	081310-BBBA-639-1	big brown bat
639	control	8 /7 /2010	080710-ERBA-639-1	eastern red bat
640	5 m/s	9 /18/2010	091810-INBA-640-2	Indiana bat
640	5 m/s	9 /16/2010	091610-ERBA-640-1	eastern red bat
640	control	4 /14/2010	041410-SHBA-640-1	silver-haired bat
640	control	4 /24/2010	042410-ERBA-640-1	eastern red bat
640	control	8 /28/2010	082810-ERBA-640-1	eastern red bat
640	6.5 m/s	9 /7 /2010	090710-SHBA-640-1	silver-haired bat
640	6.5 m/s	9 /6 /2010	090610-SHBA-640-1	silver-haired bat
640	control	8 /29/2010	082910-ERBA-640-1	eastern red bat
640	5 m/s	10/2 /2010	100210-SHBA-640-1	silver-haired bat
640	6.5 m/s	9 /7 /2010	090710-ERBA-640-1	eastern red bat
640	control	4 /26/2010	042610-SHBA-640-1	silver-haired bat
640	6.5 m/s	9 /13/2010	091310-ERBA-640-1	eastern red bat
640	5 m/s	9 /16/2010	091610-SHBA-640-2	silver-haired bat
640	5 m/s	9 /18/2010	091810-SHBA-640-1	silver-haired bat
640	control	9 /20/2010	092010-SHBA-640-1	silver-haired bat
640	control	8 /1 /2010	080110-HOBA-640-1	hoary bat
640	control	4 /20/2010	042010-SHBA-640-1	silver-haired bat
640	control	9 /22/2010	092210-HOBA-640-1	hoary bat
640	control	9 /23/2010	092310-ERBA-640-1	eastern red bat
640	control	9 /21/2010	092110-SHBA-640-1	silver-haired bat
640	control	9 /21/2010	092110-SHBA-640-2	silver-haired bat
640	control	7 /31/2010	073110-HOBA-640-2	hoary bat
640	control	7 /31/2010	073110-HOBA-640-1	hoary bat
640	control	8 /22/2010	082210-BBBA-640-1	big brown bat
642	control	10/13/2010	101310-ERBA-642-1	eastern red bat
642	control	8 /14/2010	081410-ERBA-642-1	eastern red bat
642	control	8 /1 /2010	080110-HOBA-642-1	hoary bat
643	control	8 /13/2010	081310-ERBA-643-1	eastern red bat
643	control	8 /13/2010	081310-ERBA-643-3	eastern red bat
643	control	8 /13/2010	081310-ERBA-643-5	eastern red bat
643	control	8 /13/2010	081310-ERBA-643-4	eastern red bat
643	control	8 /13/2010	081310-BBBA-643-2	big brown bat
650	control	7 /31/2010	073110-HOBA-640-3	hoary bat

Appendix F. Nightly weather variables recorded at casualty search turbines and one meteorological tower at the Fowler Ridge Wind Energy Facility

Date	mean.ws	var.ws	mean.at	var.at	mean.nat	var.nat	mean.hu	var.hu	mean.nhu	var.nhu	mean.wd	mean.bp	var.bp	range.bp	mean.nbp	var.nbp	range.nbp
08/01/10	3.7	0.8	20.3	1.3	20.1	0.1	83.1	19.7	81.2	14.4	52.3	970.0	1.8	5.7	971.1	0.7	5.7
08/02/10	2.4	1.2	24.2	3.1	24.3	0.9	64.5	33.9	63.9	4.7	96.4	973.6	0.3	2.9	973.9	0.2	2.9
08/03/10	4.2	4.2	25.9	2.3	25.4	1.0	67.6	56.9	72.8	32.0	194.9	974.0	0.9	4.1	973.6	0.5	3.7
08/04/10	4.8	3.1	27.8	8.7	28.5	2.5	80.7	97.3	83.7	47.7	235.1	971.3	2.4	6.1	970.2	0.3	2.2
08/05/10	3.6	2.5	25.9	5.8	24.8	1.7	78.7	98.6	83.8	49.6	315.8	969.9	1.3	5.3	969.6	0.2	3.2
08/06/10	6.9	1.6	24.7	8.8	22.6	3.7	60.6	146.0	59.2	26.6	329.5	969.8	1.8	5.3	970.3	1.3	5.3
08/07/10	2.3	1.3	23.8	2.8	23.3	1.2	53.2	55.7	55.1	19.1	319.4	973.4	0.6	4.3	973.7	0.3	4.3
08/08/10	6.5	3.2	24.7	3.3	24.2	2.6	57.3	49.5	60.2	33.5	203.9	972.7	1.1	4.2	972.1	0.2	2.3
08/09/10	7.1	1.4	25.7	5.0	25.2	2.1	65.7	21.8	68.4	4.9	183.9	971.4	1.2	5.4	971.4	0.5	3.9
08/11/10	2.5	2.1	28.1	4.3	28.3	1.6	71.5	48.1	70.8	15.7	176.8	972.7	1.2	5.9	972.0	0.8	3.9
08/12/10	3.0	1.1	28.5	4.6	28.2	2.5	63.4	66.2	64.2	45.9	342.7	970.0	0.8	4.2	969.8	0.2	2.3
08/13/10	4.1	1.4	28.7	4.0	27.7	3.7	63.4	73.5	65.4	81.4	107.7	969.7	0.7	3.0	969.3	0.3	2.0
08/14/10	4.9	4.3	27.4	12.1	25.3	8.7	68.5	115.2	73.9	81.0	197.8	968.3	1.3	4.9	967.9	0.8	3.9
08/15/10	3.5	2.6	26.7	4.2	27.1	1.6	71.6	78.0	70.3	40.9	202.3	970.2	0.4	3.0	970.4	0.3	3.0
08/16/10	8.2	1.9	25.5	8.3	23.0	2.6	57.3	99.5	52.8	14.5	312.7	972.6	3.2	6.9	974.1	1.1	6.9
08/17/10	3.9	1.3	23.8	2.7	23.5	1.0	44.8	70.0	44.5	9.1	282.6	976.5	0.4	-3.3	976.5	0.2	2.3
08/18/10	4.5	1.3	22.9	2.7	21.6	0.9	57.6	208.8	62.3	340.8	37.7	977.2	0.3	2.6	977.1	0.2	2.3
08/19/10	5.4	1.1	24.7	5.4	24.4	2.3	54.3	125.1	56.0	42.5	123.7	974.2	2.8	5.6	972.9	0.4	2.6
08/20/10	5.6	3.5	27.3	7.1	27.1	3.9	55.1	108.0	57.4	64.1	183.7	972.0	0.9	4.5	971.4	0.2	2.6
08/21/10	6.6	3.9	26.5	11.1	24.6	8.6	58.7	363.0	62.3	588.7	195.2	968.8	4.0	7.2	967.2	0.5	3.0
08/22/10	4.2	3.5	25.0	4.8	24.8	2.8	73.7	116.9	73.5	71.8	23.5	970.4	6.9	8.8	972.7	1.7	8.8
08/23/10	6.1	1.5	23.5	7.7	21.4	1.4	70.3	173.1	79.7	37.7	28.8	975.7	0.3	3.0	975.9	0.2	3.0
08/24/10	5.1	1.7	23.1	5.8	22.0	4.0	69.7	136.8	73.8	73.9	89.0	975.4	0.8	3.9	975.0	0.2	2.6
08/25/10	3.7	5.2	22.9	4.7	22.5	3.5	65.4	133.3	64.9	101.3	28.0	974.9	0.9	4.3	974.7	0.3	3.3
08/26/10	4.7	3.2	21.7	7.1	20.1	4.1	49.0	184.8	55.7	105.6	41.2	977.2	2.6	7.2	978.4	1.7	7.2
08/27/10	4.9	2.1	20.8	5.0	20.5	2.3	45.8	82.0	45.5	19.5	134.4	979.8	1.0	3.6	979.1	0.1	1.6
08/28/10	5.7	3.9	23.4	6.9	22.9	4.7	39.9	36.4	39.4	18.7	141.7	978.7	1.0	3.9	978.1	0.2	1.9
08/29/10	7.3	3.2	26.2	10.1	26.3	5.4	45.2	217.9	51.6	188.3	169.4	977.3	1.3	5.6	977.1	0.6	4.6
08/30/10	6.1	1.7	27.9	9.9	26.5	7.1	54.2	161.4	57.6	128.8	202.6	979.5	2.0	6.5	980.3	1.4	6.5
08/31/10	7.2	1.3	25.8	4.7	24.9	4.0	65.2	85.0	69.4	91.3	192.5	979.8	2.1	4.9	978.8	0.1	2.0
09/01/10	8.3	1.4	26.2	7.8	24.9	4.8	62.7	95.7	65.9	46.5	191.7	975.3	4.2	7.2	973.7	0.4	2.3
09/02/10	3.7	1.6	23.1	1.9	22.0	0.1	80.5	86.7	88.4	10.8	213.6	972.6	0.4	3.3	972.6	0.4	3.3
09/03/10	8.7	3.1	22.5	10.6	20.8	9.0	81.0	120.2	84.0	40.0	264.0	968.8	2.6	6.5	967.8	0.5	3.6
09/04/10	8.3	1.7	17.4	11.1	15.1	6.4	58.3	329.2	65.9	164.8	301.3	969.7	2.5	6.2	970.9	1.0	6.2
09/05/10	3.8	2.8	16.6	3.9	16.5	1.0	45.1	158.3	44.1	10.6	300.9	973.7	1.4	5.3	974.7	0.4	5.3
09/06/10	8.0	2.7	20.3	5.8	20.2	2.3	44.9	56.1	48.6	27.5	192.3	973.4	1.9	5.2	972.9	0.5	3.6
09/07/10	10.4	1.8	24.3	10.1	23.4	3.8	39.4	143.2	44.0	111.3	206.0	971.0	1.5	6.5	970.7	0.3	3.6
09/08/10	8.9	3.1	21.1	14.6	18.3	9.0	41.2	212.5	48.2	118.9	311.6	973.9	3.3	7.2	975.5	1.3	7.2

Appendix F. Nightly weather variables recorded at casualty search turbines and one meteorological tower at the Fowler Ridge Wind Energy Facility

Date	mean.ws	var.ws	mean.at	var.at	mean.nat	var.nat	mean.hu	var.hu	mean.nhu	var.nhu	mean.wd	mean.bp	var.bp	range.bp	mean.nbp	var.nbp	range.nbp
09/09/10	6.0	2.2	17.5	14.6	15.3	8.6	52.4	244.2	61.5	125.6	76.4	976.8	0.9	4.6	977.0	0.3	3.6
09/10/10	7.4	1.5	17.4	11.8	15.9	4.6	55.2	210.0	62.9	74.6	76.0	975.3	2.8	6.8	974.0	0.2	2.9
09/11/10	4.8	3.0	20.7	10.7	19.7	2.9	45.8	225.6	50.8	189.1	127.1	970.9	2.6	6.2	969.9	0.9	4.0
09/12/10	6.7	3.5	19.3	7.0	19.0	4.3	65.4	209.3	55.2	18.5	310.0	971.1	7.8	10.1	973.4	3.8	10.1
09/13/10	8.8	2.4	22.9	11.4	21.8	6.2	40.9	175.3	47.4	122.6	261.7	975.4	1.2	4.6	974.9	0.2	2.7
09/14/10	4.4	1.2	24.1	15.1	22.3	7.9	39.1	133.7	40.4	57.3	62.4	974.7	2.0	5.9	975.5	1.1	5.9
09/15/10	7.4	3.0	21.3	12.8	19.3	9.2	42.0	142.3	49.8	96.1	86.4	976.8	0.4	3.3	976.9	0.3	2.6
09/16/10	7.4	7.2	23.1	15.0	22.7	7.1	53.6	384.5	64.0	412.6	216.0	971.6	16.8	13.7	968.1	3.6	6.8
09/17/10	6.3	2.2	17.5	9.1	14.6	0.6	69.8	67.0	72.1	6.3	5.2	972.0	15.4	12.4	975.5	1.4	12.4
09/18/10	5.9	2.0	20.4	6.7	21.0	2.1	48.8	106.4	47.2	46.1	208.4	977.6	1.2	4.9	977.3	0.4	3.3
09/19/10	4.9	2.1	19.8	15.4	16.6	3.4	72.3	197.0	85.7	12.7	45.0	978.5	1.2	5.5	979.3	0.4	5.5
09/20/10	4.4	1.3	20.0	12.7	18.5	3.5	69.2	173.1	72.9	44.4	60.8	978.4	1.2	4.9	977.8	0.2	2.2
09/21/10	7.5	2.0	24.8	10.3	25.0	6.3	61.2	133.1	61.7	93.1	178.7	974.6	3.5	6.2	973.2	0.1	2.0
09/22/10	4.8	8.8	25.6	26.2	21.9	7.4	56.0	578.6	73.4	206.6	291.8	971.3	3.4	7.5	972.1	2.4	7.5
09/23/10	6.0	3.6	21.4	3.3	21.2	1.7	77.9	90.6	78.9	55.1	176.1	976.3	0.4	-3.6	976.4	0.4	3.3
09/24/10	11.6	2.5	27.5	9.8	26.4	1.7	45.8	150.2	46.8	16.7	208.9	971.4	4.4	8.5	970.0	1.3	3.6
09/25/10	7.9	1.7	18.6	13.2	15.7	7.3	63.3	130.1	64.0	62.8	301.6	973.1	5.2	9.5	975.1	0.6	9.5
09/26/10	4.7	1.8	13.1	7.5	11.0	0.1	69.3	242.7	81.3	27.8	33.5	977.1	0.5	3.6	977.2	0.4	3.6
09/27/10	6.3	2.3	12.5	3.2	11.4	0.9	61.7	107.0	63.5	11.2	47.9	975.9	1.6	4.9	975.1	0.5	2.6
09/28/10	3.8	1.8	16.0	4.2	17.0	0.0	45.4	53.0	42.0	0.0	340.0	969.3	6.4	9.1	967.4	1.6	3.9
09/29/10	4.9	2.4	17.7	5.0	16.3	1.9	37.7	102.9	42.4	80.9	93.1	967.5	2.3	6.1	968.8	0.5	6.1
09/30/10	4.3	1.7	20.7	8.1	20.5	3.2	39.4	180.8	44.7	108.3	281.4	968.3	2.1	5.6	967.7	0.2	2.7
10/01/10	5.4	5.2	17.6	11.2	14.8	1.2	53.2	206.8	61.1	13.9	28.9	972.5	12.5	11.4	975.7	2.8	11.4
10/02/10	5.9	7.7	17.5	11.0	16.5	10.4	46.4	354.5	50.9	414.6	292.6	974.9	4.9	8.8	973.4	1.2	4.9
10/03/10	7.4	2.8	9.5	5.0	7.5	1.0	76.2	75.8	77.9	48.2	10.3	978.7	8.3	9.8	981.3	1.2	9.8
10/04/10	5.7	2.7	9.5	3.8	8.4	1.1	52.9	69.4	58.6	11.6	37.9	984.2	0.9	4.5	984.9	0.3	4.5
10/05/10	3.9	2.3	10.8	6.2	10.0	1.1	51.1	203.7	59.3	44.5	16.0	985.2	0.9	4.9	985.2	0.3	4.2
10/06/10	4.9	4.9	15.2	7.8	15.2	2.0	34.6	172.7	33.0	27.3	326.5	983.3	3.8	7.1	981.9	0.9	3.2
10/07/10	8.7	3.8	18.7	13.0	18.0	7.3	43.6	188.0	52.6	111.3	309.3	974.9	7.0	9.5	973.2	1.0	4.9
10/08/10	5.5	3.6	20.0	9.0	19.7	3.1	29.6	283.3	24.3	22.5	321.5	977.0	0.5	3.9	977.1	0.1	3.3
10/09/10	7.1	3.2	22.3	6.7	21.5	2.9	24.2	66.9	29.4	30.4	264.4	975.8	2.1	5.2	974.9	0.2	2.3
10/10/10	5.6	1.9	25.3	10.1	24.9	3.4	34.7	26.4	34.8	7.6	282.7	974.0	1.1	4.6	973.7	0.1	2.6
10/11/10	5.1	4.6	24.9	7.3	23.4	5.6	32.6	61.5	35.0	79.0	267.8	970.8	3.0	6.1	969.8	0.1	2.2
10/12/10	4.1	1.7	23.7	8.4	22.6	6.7	35.5	147.4	38.5	164.1	333.2	968.9	1.2	4.6	969.3	0.4	4.2
10/13/10	3.2	1.8	21.5	12.7	20.0	7.0	47.9	170.4	51.0	102.5	129.5	971.8	0.6	4.2	972.4	0.2	4.2
10/14/10	6.8	3.1	14.2	3.8	12.7	1.4	63.8	215.1	55.2	178.0	342.2	975.7	1.7	5.2	976.9	0.2	5.2
10/15/10	10.0	3.5	14.0	6.5	13.1	3.4	38.2	169.4	44.3	147.0	290.2	971.1	20.2	14.7	967.4	3.6	6.5

Appendix G. Wind energy facilities in North America with activity and fatality data for bat species, grouped by geographic region. Bat activity estimates are included where available. To date, no studies or bat fatality estimates from southeastern facilities have been made public.

Wind Energy Facility	Bat Activity Estimate[A]	Fatality Estimate[B]	No. of Turbines	Total MW
Fowler, IN (2009)		8.09	162	301
Fowler, IN (2010)	***15.06***	***13.10***	***355***	***599***
	Midwest			
Blue Sky Green Field, WI	7.7[D]	24.57	88	145
Top of Iowa, IA (2004)	34.9[C]	10.27	89	80
Top of Iowa, IA (2003)	34.9[C]	7.16	89	80
Kewaunee County, WI		6.55	31	20
Ripley, Ont.		4.67	38	76
Buffalo Ridge, MN (Phases II&III; 2001)	2.2	4.03	281	210.75
Crescent Ridge, IL		3.27	33	49.5
Buffalo Ridge, MN (Phase III; 1999)		2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)		2.59	143	107.25
Buffalo Ridge, MN (Phase II; 1998)		2.16	143	107.25
Grand Ridge, IL		2.10	66	99
Buffalo Ridge, MN (Phases II&III; 2002)	1.9	1.73	281	210.75
NPPD Ainsworth, NE		1.16	36	59.4
Buffalo Ridge, MN (Phase I; 1999)		0.76	73	25
	Rocky Mountains			
Summerview, Alb. (2006)	5.3	14.62	39	70.2
Summerview, Alb. (2005/2006)		10.27	39	70.2
Judith Gap, MT		8.93	90	135
Summerview, Alb. (2007)		8.23	39	70.2
Foote Creek Rim, WY (Phase I; 1999)		3.97	69	41.4
Foote Creek Rim, WY (Phase I; 2001/2002)		1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2	1.05	69	41.4
	Western			
Stateline, OR/WA (2003)		2.52	454	300
High Winds, CA (2004)		2.51	90	162
Nine Canyon, WA		2.47	37	48
Dillon, CA		2.17	45	45
Biglow Canyon I, OR (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
High Winds, CA (2005)		1.52	90	162
Stateline, OR/WA (2002)		1.20	454	300
Vansycle, OR		1.12	38	24.9
Klondike, OR		0.77	16	24
Hopkins Ridge, WA		0.63	83	150
Biglow Canyon I, OR (2009)		0.58	76	125.4
Klondike II, OR		0.41	50	75
Wild Horse, WA		0.39	127	229
Marengo II, WA		0.27	39	70.2
Marengo I, WA		0.17	78	140.4
SMUD, CA		0.07		15
Alta-Oak Creek Mojave, CA	2.5			

Appendix G. Wind energy facilities in North America with activity and fatality data for bat species, grouped by geographic region. Bat activity estimates are included where available. To date, no studies or bat fatality estimates from southeastern facilities have been made public.

Wind Energy Facility	Bat Activity Estimate[A]	Fatality Estimate[B]	No. of Turbines	Total MW
	Southern Plains			
Oklahoma Wind Energy Center, OK		0.53	68	102
Buffalo Gap, TX		0.10	67	134
	Northeastern			
Buffalo Mountain, TN (2006)		39.70	18	29
Mountaineer, WV	38.3	31.69	44	66
Buffalo Mountain, TN (2000-2003)	23.7	31.54	3	2
Cassleman, PA		18.91	23	34.5
Meyersdale, PA		18.00	20	30
Cohocton/Dutch Hill, NY		16.02	50	125
Casselman, PA (Curtailment)		15.66	23	34.5
Maple Ridge, NY (2006)		15.00	120	198
Noble Bliss, NY (2008)		14.66	67	100
Mount Storm, WV (2008)	35.2	12.11	82	164
Maple Ridge, NY (2007)		9.42	195	321.75
Noble Clinton, NY (2009)		6.48	67	100
Wolfe Island, Ont.		6.42	86	197.8
Noble Bliss, NY (2009)		5.50	67	100
Noble Ellenburg, NY (2008)		5.45	54	80
Noble Ellenburg, NY (2009)		5.34	54	80
Noble Clinton, NY (2008)		3.63	67	100.5
Mars Hill, ME (2007)		2.91	28	42
Stetson Mountain, ME	0.30	1.40	38	57
Munnsville, NY		0.46	23	34.5
Mars Hill, ME (2008)		0.45	28	42

A=bat passes per detector-night
B=number of bats fatalities per megawatt per study period
C=averaged across phases and/or study years, and may not be directly related to fatality estimates
D=bat activity not measured concurrently with bat fatality studies

Appendix G. Wind energy facilities in North America with activity and fatality data for bat species, grouped by geographic region. Bat activity estimates are included where available. To date, no studies or bat fatality estimates from southeastern facilities have been made public.

Data from the following sources:

Facility	Activity Estimate	Fatality Estimate	Facility	Activity Estimate	Fatality Estimate
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	Klondike, OR		Johnson et al. 2003
Top of Iowa, IA (2004)	Jain 2005	Jain 2005	Hopkins Ridge, WA		Young et al. 2007
Top of Iowa, IA (2003)	Jain 2005	Jain 2005	Biglow Canyon I, (09)		Enk et al. 2010
Kewaunee County, WI		Howe et al. 2002	Klondike II, OR		NWC and WEST 2007
Ripley, Ont.		Jacques Whitford 2009	Wild Horse, WA		Erickson et al. 2008
Buffalo Ridge, MN (Phase II& III; 01)	Johnson et al. 2004	Johnsonet al. 2004	Marengo II, WA		URS Corporation 2010b
Crescent Ridge, IL		Kerlinger et al. 2007	Marengo I, WA		URS Corporation 2010a
Buffalo Ridge, MN (Phase III; 99)		Johnsonet al. 2004	SMUD, CA		URS et al. 2005
Buffalo Ridge, MN (Phase II; 99)		Johnsonet al. 2004	Alta-Oak Creek Mojave, CA	Erickson et al. 2009	
Buffalo Ridge, MN (Phase II; 98)		Johnsonet al. 2004	Oklahoma Wind Energy Center, OK		Piorkowski 2006
Grand Ridge, IL		Derby et al. 2010	Buffalo Gap, TX		Tierney 2007
Buffalo Ridge, MN (Phase II& III; 02)	Johnsonet al. 2004	Johnsonet al. 2004	Buffalo Mountain, TN (06)		Fiedler et al. 2007
NPPD Ainsworth, NE		Derby et al. 2007	Mountaineer, WV	Arnett (pers comm. 2005)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase I; 99)		Johnson et al. 2000	Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005
Summerview, Alb. (06)	Baerwald 2008	Baerwald 2008	Casselman, PA		Arnett et al. 2009b
Summerview, Alb. (05/06)		Brown and Hamilton 2006	Meyersdale, PA		Arnett et al. 2005
Judith Gap, MT		TRC 2008	Cohocton/Dutch Hill, NY		Stantec 2010
Summerview, Alb. (07)		Baerwald 2008	Casselman, PA (Curtailment)		Arnett et al. 2009a
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003	Maple Ridge, NY (06)		Jain et al. 2007
Foote Creek Rim, WY (Phase I; 01/02)		Younget al. 2003	Noble Bliss, NY (08)		Jain et al. 2009c
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Younget al. 2003	Mount Storm, WV (08)	Young et al. 2009	Younget al. 2009
Stateline, OR/WA (03)		Erickson et al. 2004	Maple Ridge, NY (07)		Jain et al. 2008
High Winds, CA (04)		Kerlinger et al. 2006	Noble Clinton, NY (09)		Jain et al. 2010b
Nine Canyon, WA		Erickson et al. 2003	Wolfe Island, Ont.		Stantec, Ltd. 2010
Dillon, CA		Chatfield et al. 2009	Noble Bliss, NY (09)		Jain et al. 2010a
Biglow Canyon I, OR (08)		Jeffrey et al. 2009	Noble Ellenburg, NY (08)		Jain et al. 2009a
Leaning Juniper, OR		Gritski et al. 2008	Noble Ellenburg, NY (09)		Jain et al. 2010c
Big Horn, WA		Kronner et al. 2008	Noble Clinton, NY (08)		Jain et al. 2009b
Combine Hills, OR		Young et al. 2006	Mars Hill, ME (07)		Stantec 2008a
High Winds, CA (05)		Kerlingeret al. 2006	Stetson Mountain, ME	Stantec 2009b	Stantec 2009b
Stateline, OR/WA (02)		Ericksonet al. 2004	Munnsville, NY		Stantec 2008b
Vansycle, OR		Erickson et al. 2000	Mars Hill, ME (08)		Stantec 2009a

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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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NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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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.

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

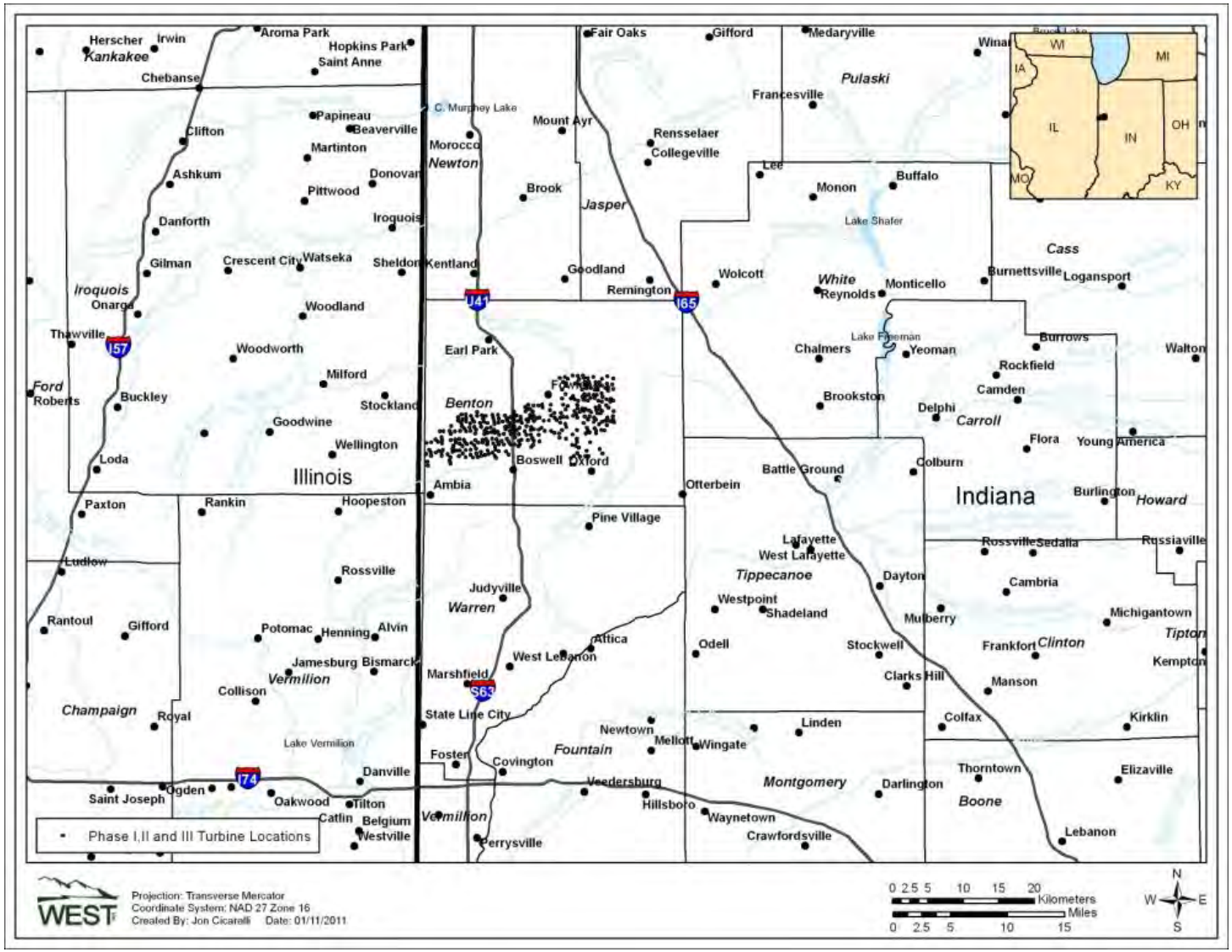

Figure 1. Location of the Fowler Ridge Wind Farm, Phases I, II and III.

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.

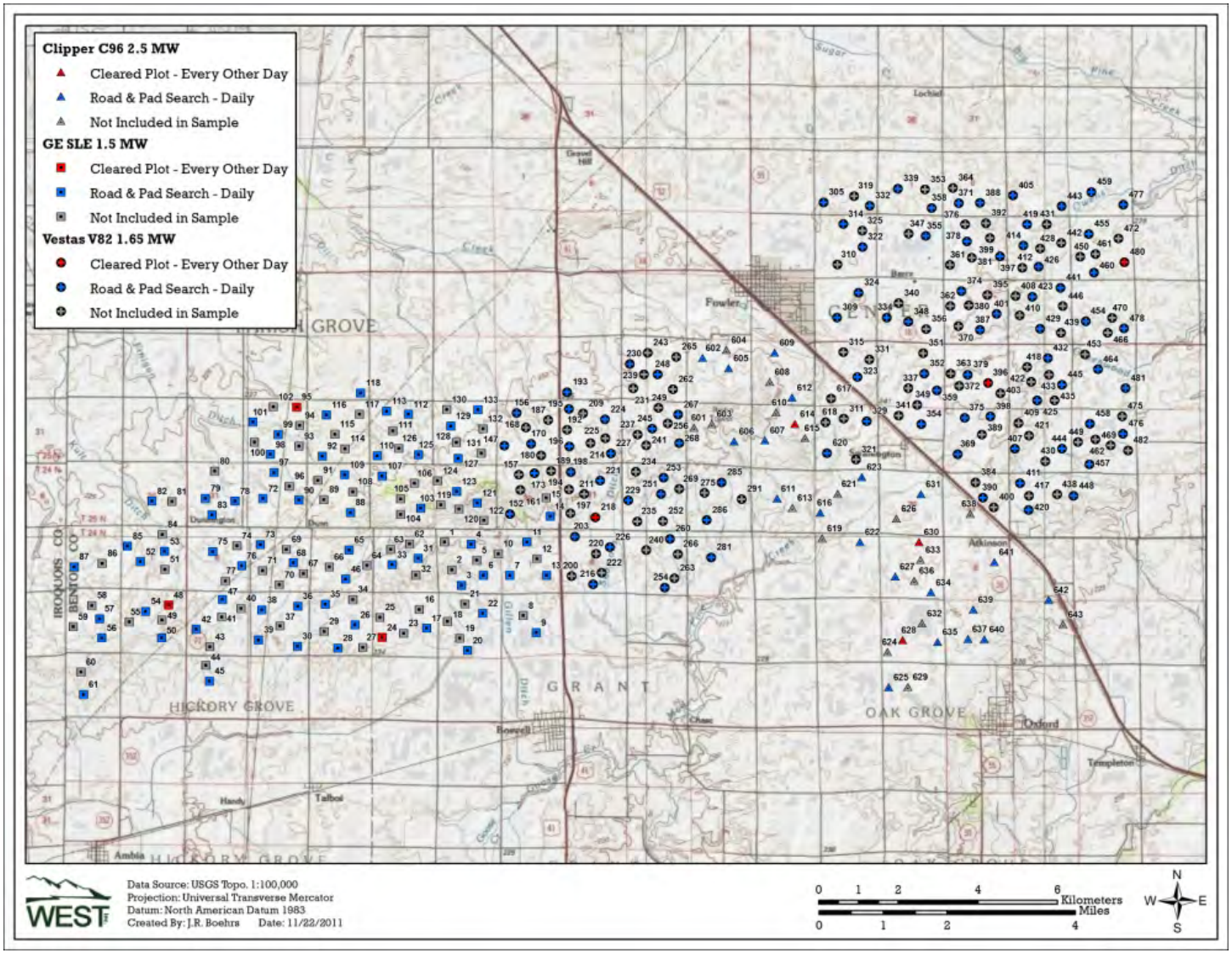

Figure 2. Elevation and topography of the Fowler Ridge Wind Farm.

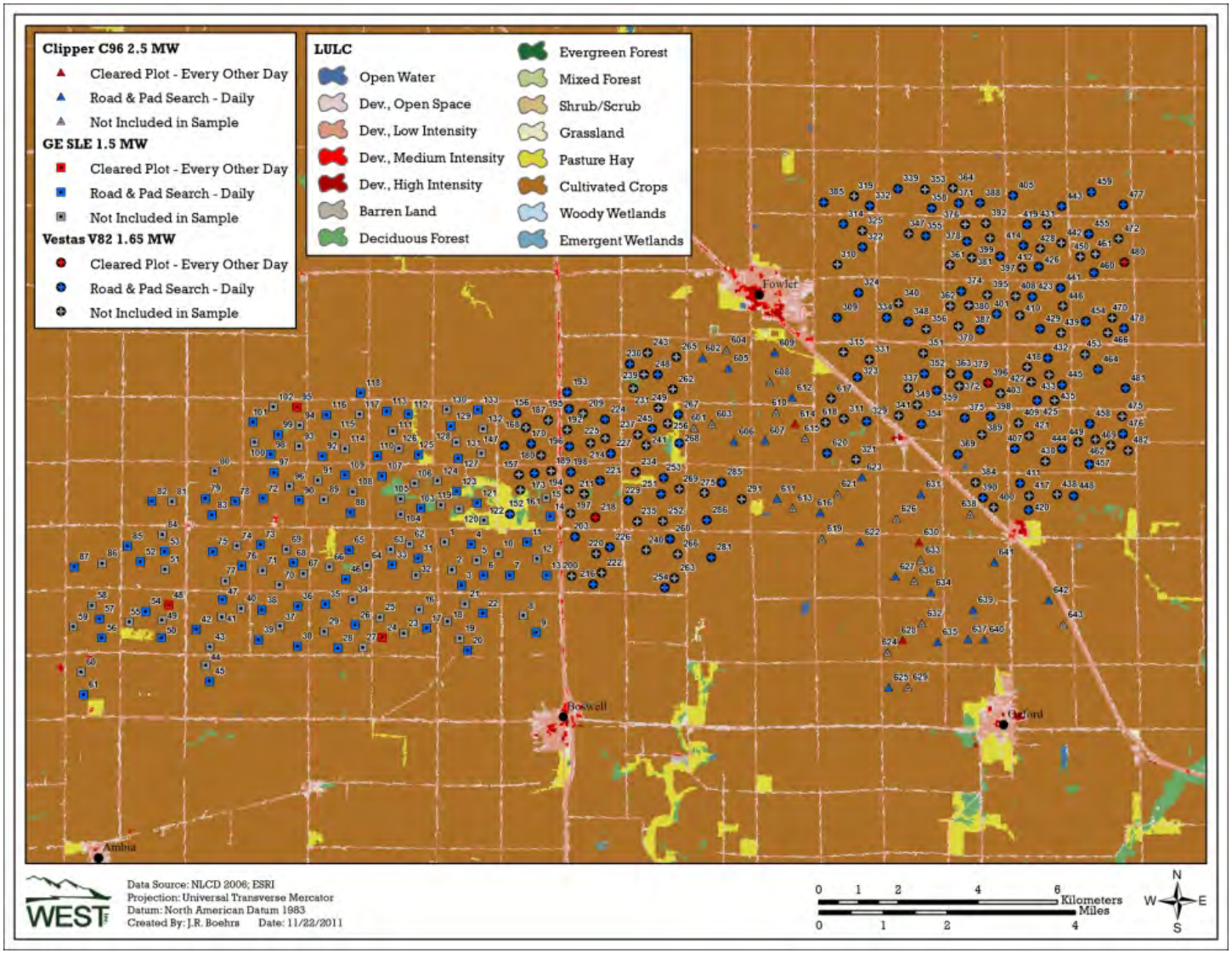

Figure 3. Turbine locations and land cover data at the Fowler Ridge Wind Farm (USGS NLCD 2001).

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.

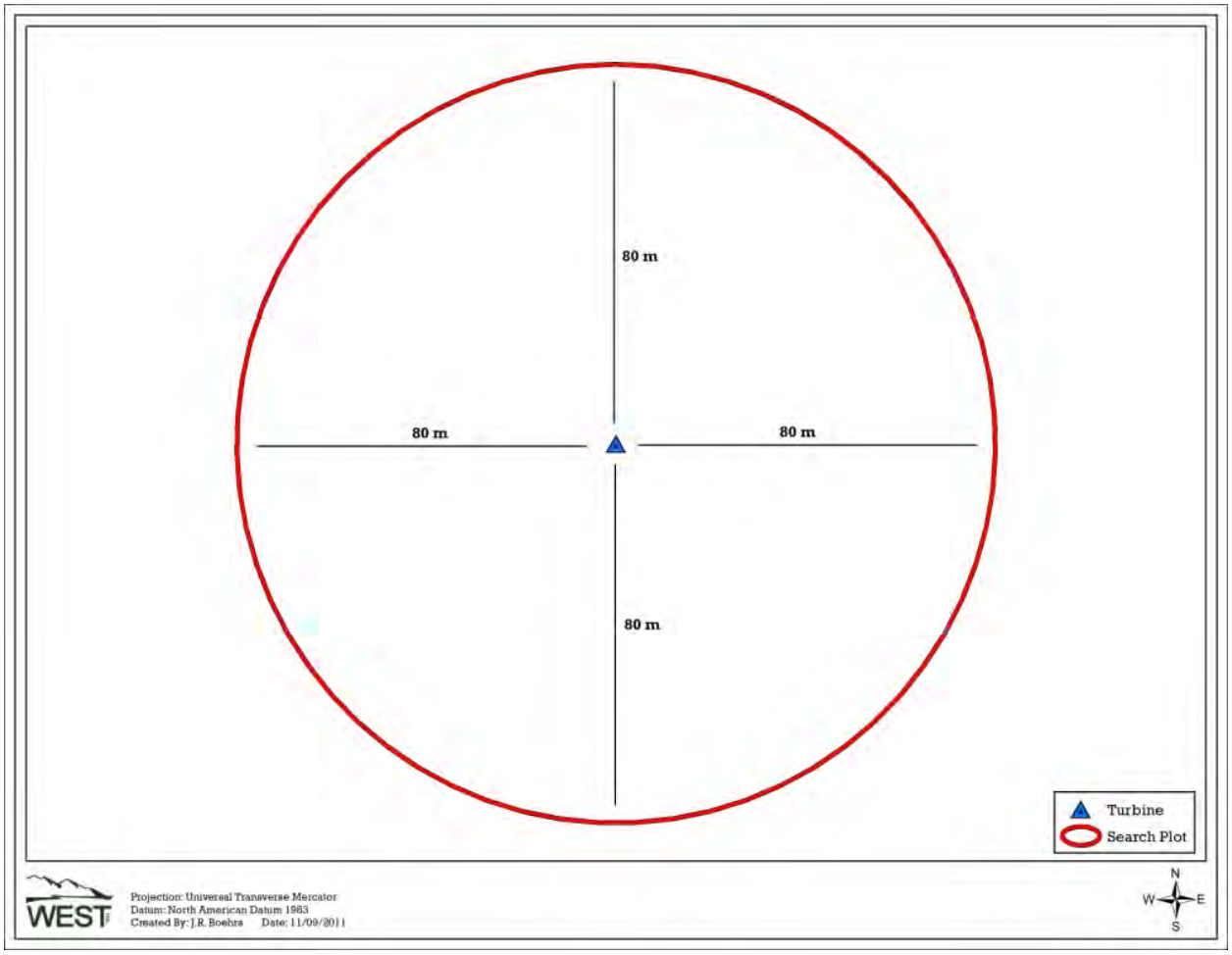

Figure 4. Example diagram of a cleared plot at the Fowler Ridge Wind Farm.

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:

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

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:

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

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:

$$m = \frac{\bar{c}}{\hat{\pi}} \tag{3}$$

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.

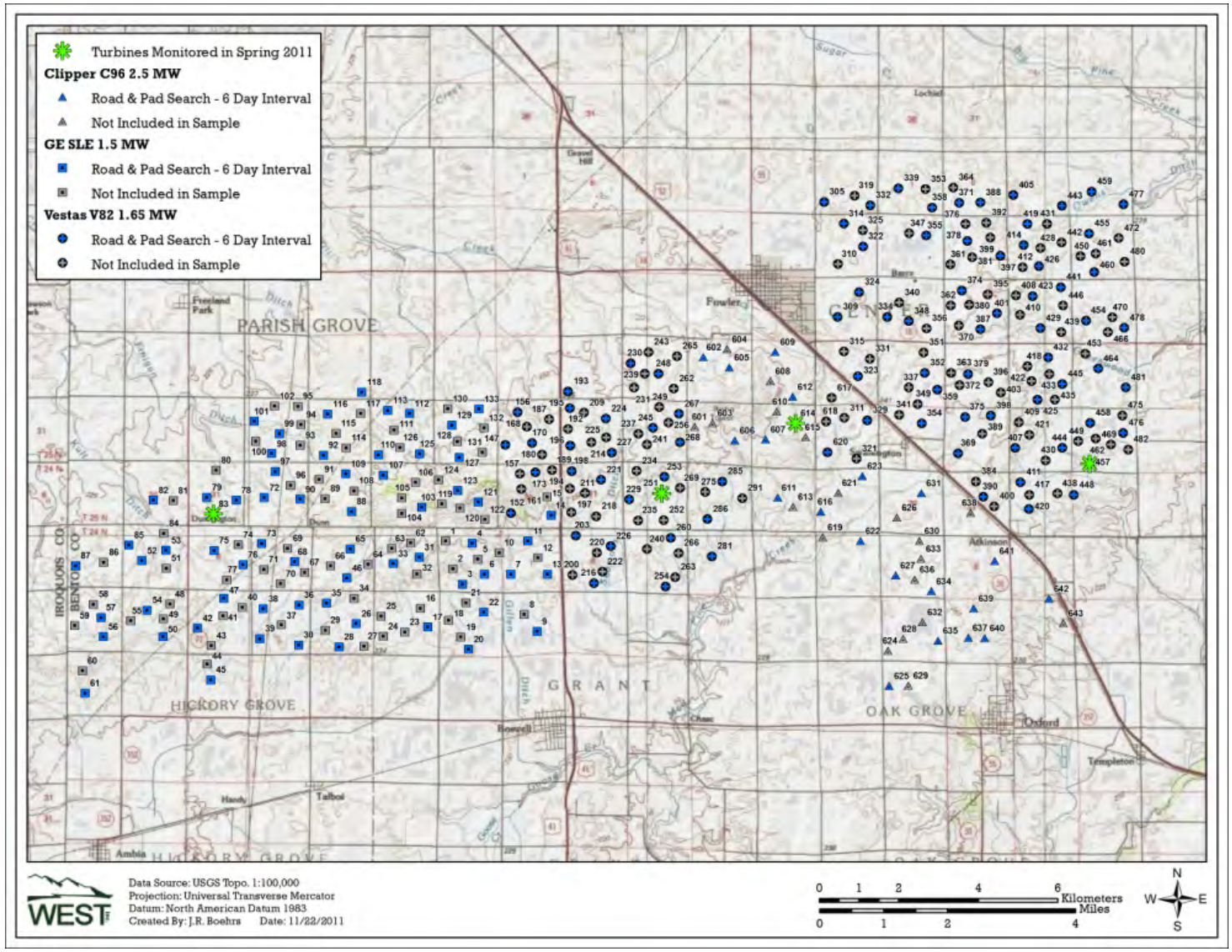

Figure 5. Study area map and spring fixed Anabat sampling stations at the Fowler Ridge Wind Farm.

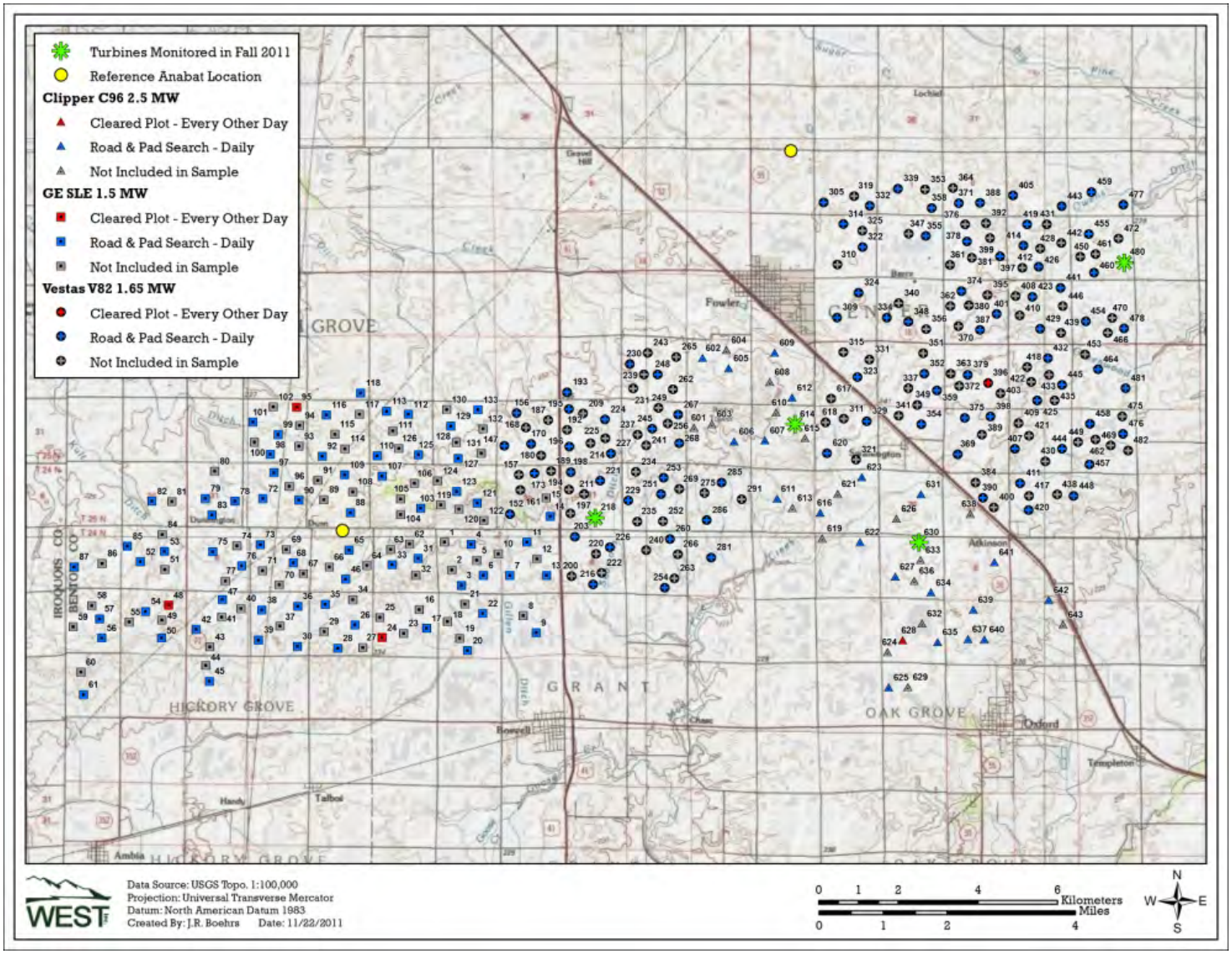

Figure 6. Study area map and fall fixed Anabat sampling stations at the Fowler Ridge Wind Farm.

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).

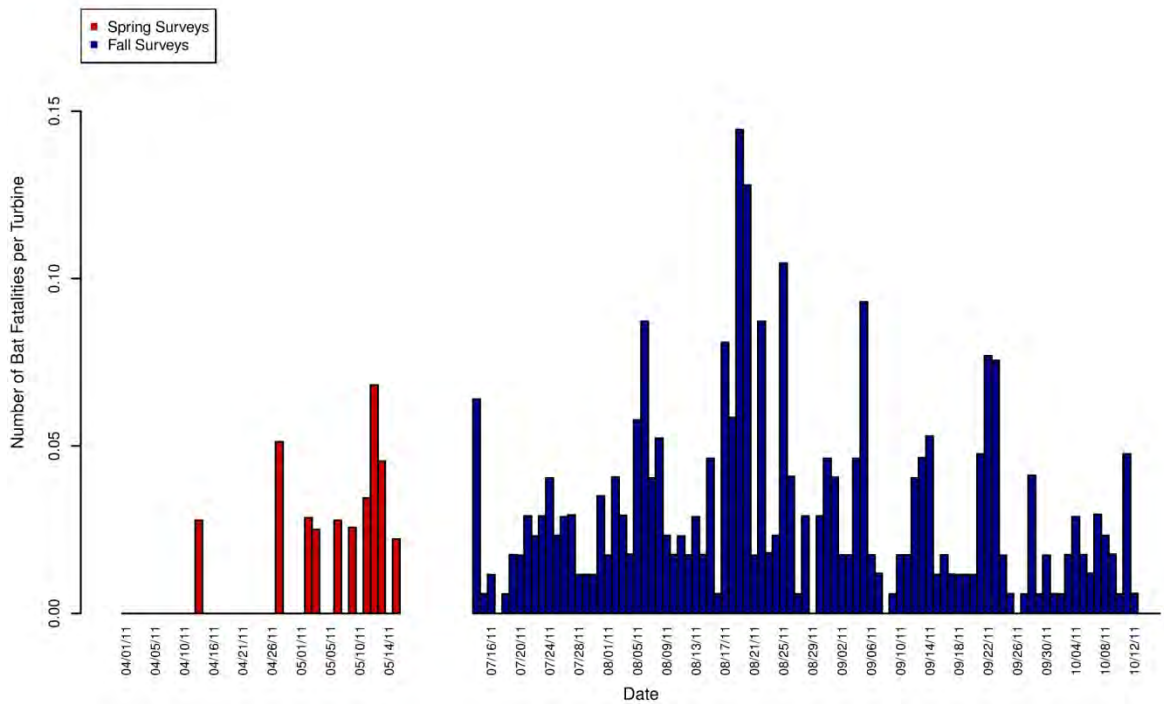

Figure 9. Timing of bat mortality at the Fowler Ridge Wind Farm from April 1 to May 15 and July 14 to October 15, 2011.

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

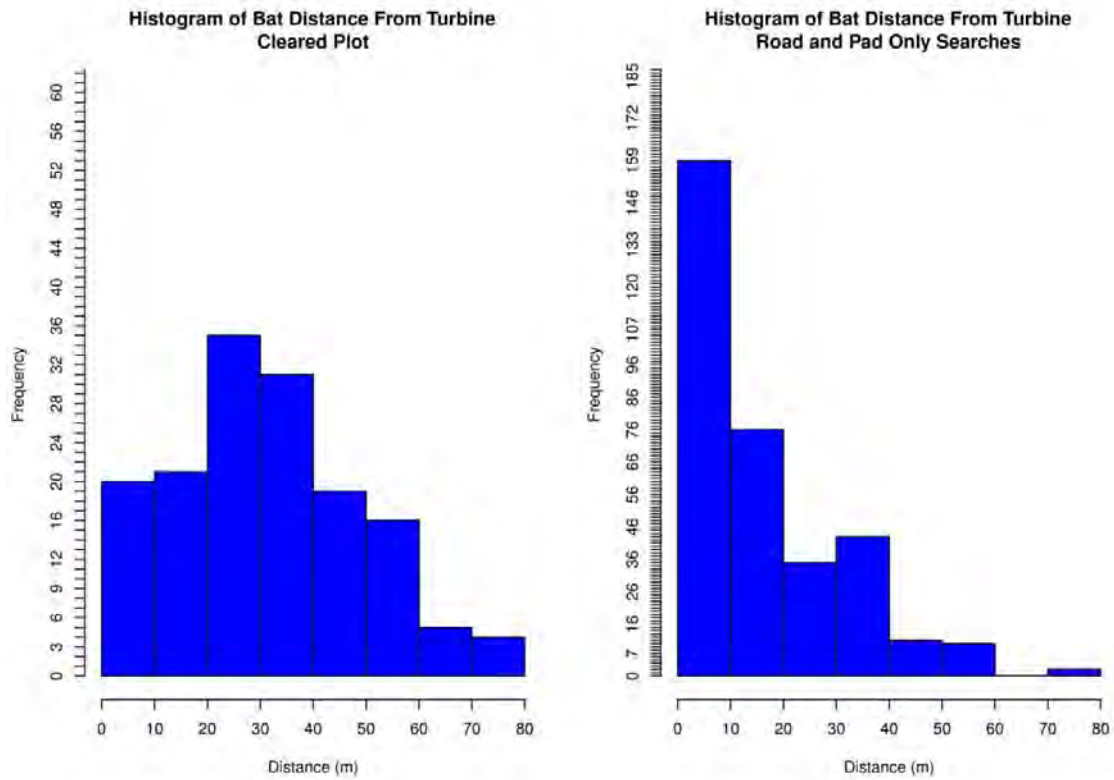

Figure 10. Distance from turbine for all bat casualties found at cleared plots and road and pads at the Fowler Ridge Wind Farm.

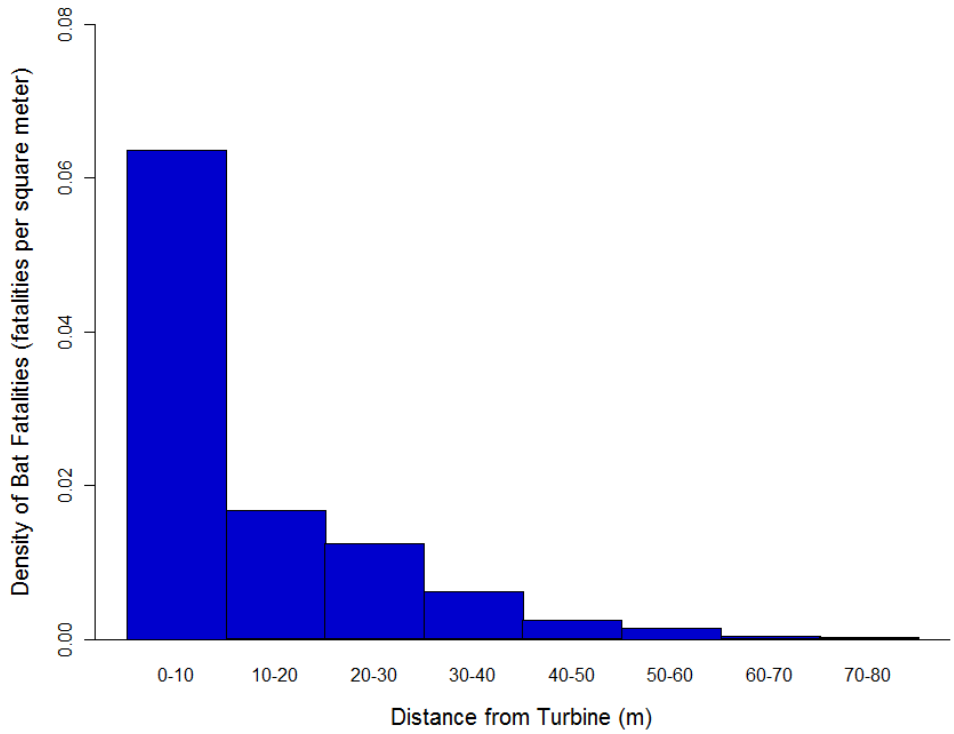

Figure 11. Density (fatalities per square meter searched) of bat fatalities at cleared plots by distance from turbine at the Fowler Ridge Wind Farm.

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		
Rate	**12.22**	**mean**	**ll**	**ul**	**mean**	**ll**	**ul**
		15.10	**12.23**	**18.51**	**13.02**	**9.20**	**18.00**

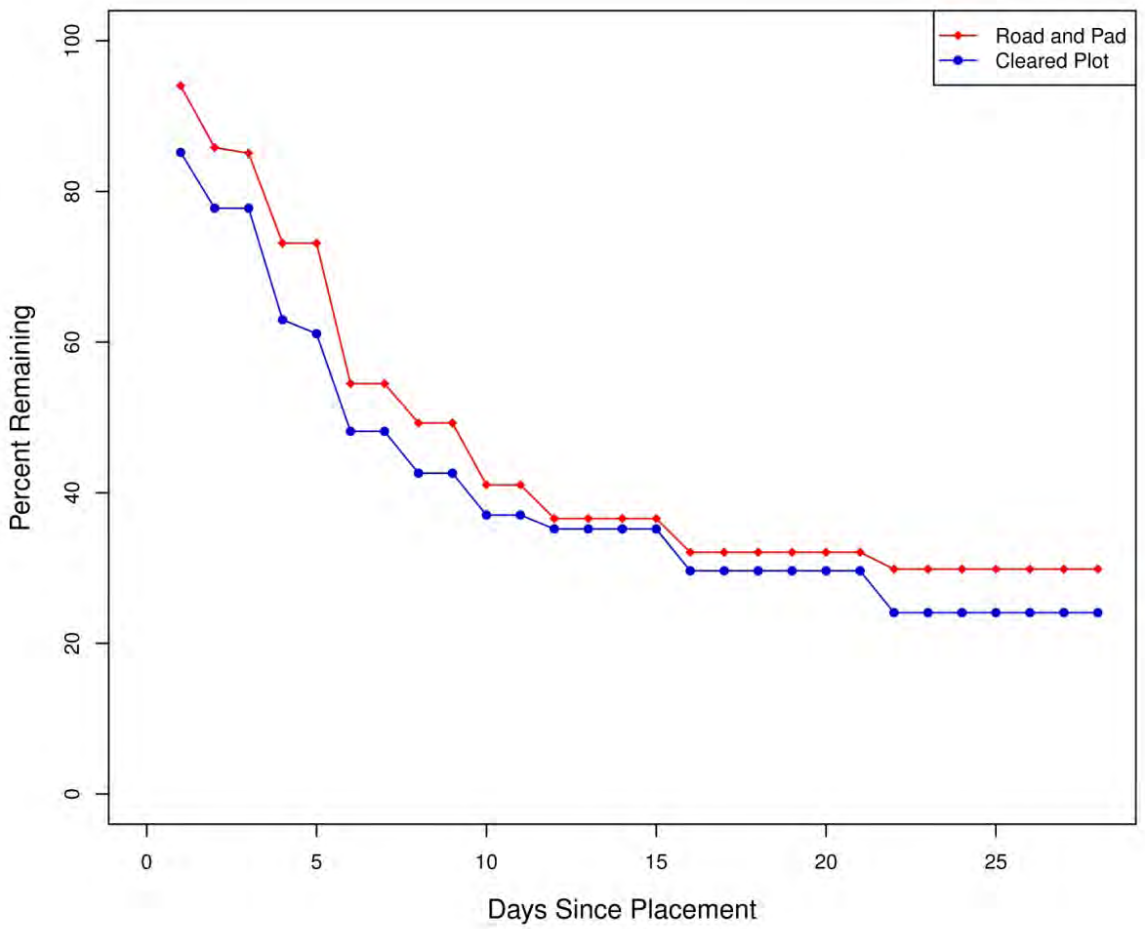

Figure 12. Removal rates for bats during carcass removal trials.

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**	
Road & Pad Correction Factor	**Ratio**	**ll**	**ul**	**Ratio**	**ll**	**Ul**
	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	90% Confidence Interval 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).

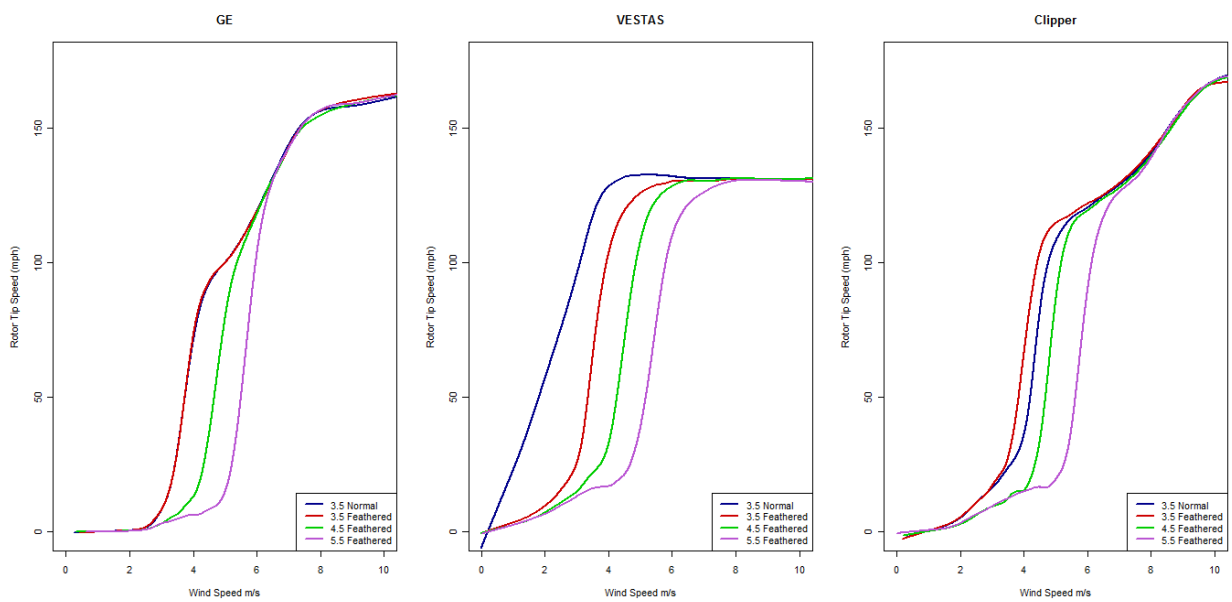

Figure 13. Estimated tip speed by wind speed for cut-in speed adjustments at GE, Clipper, and Vestas wind turbines during the 2011 carcass monitoring at the Fowler Ridge Wind Farm. Estimates were made based on Friedman's SuperSmoother (Friedman 1984).

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).

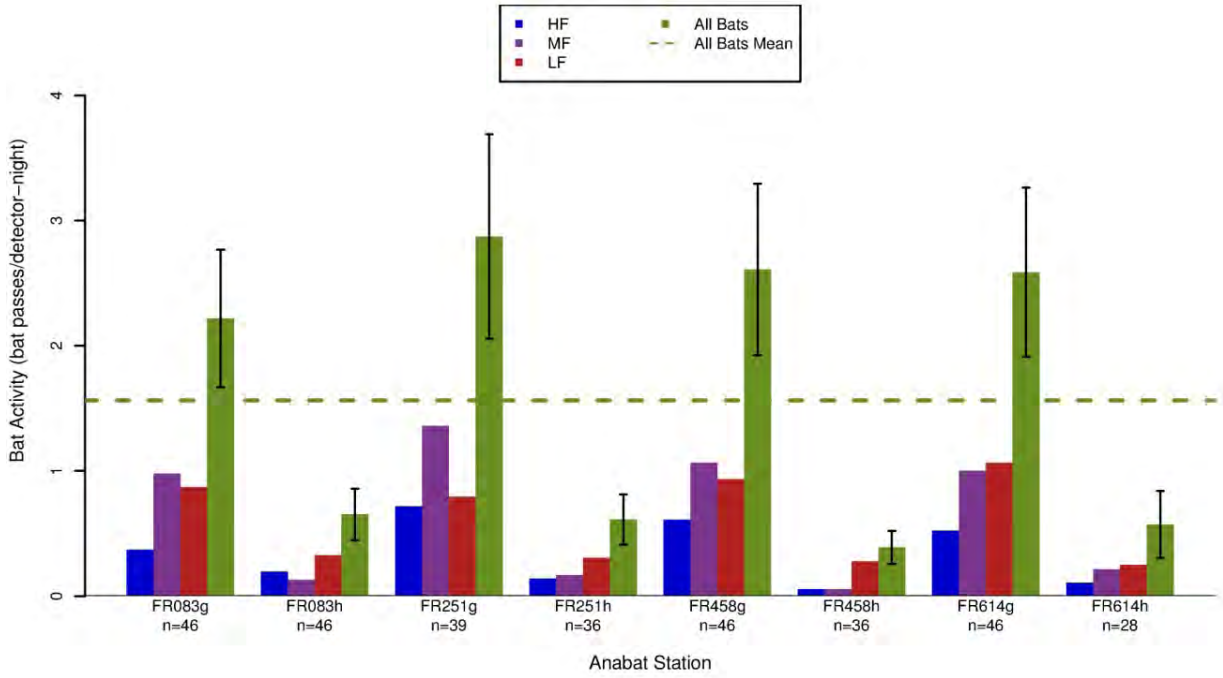

Figure 14. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the spring study period March 31 – May 15, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

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).

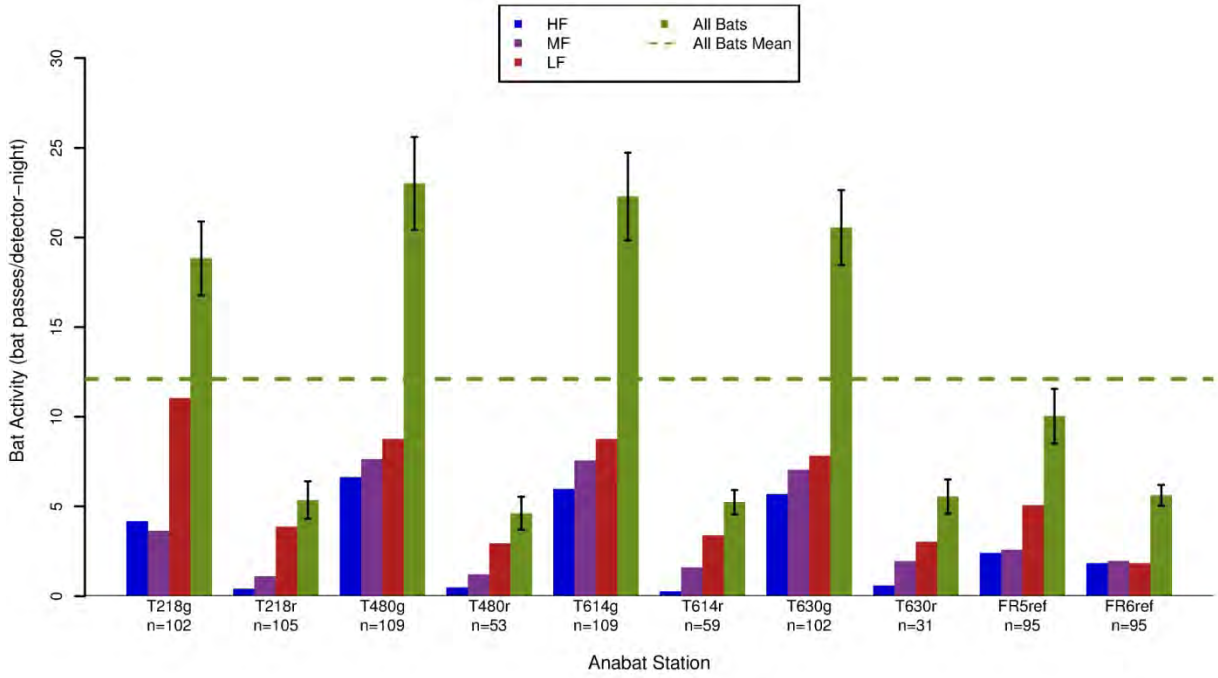

Figure 15. Number of bat passes per detector-night by Anabat station at the Fowler Ridge Wind Farm for the fall study period July 14 – October 31, 2011. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns. Stations FR5ref and FR6ref were previously monitored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

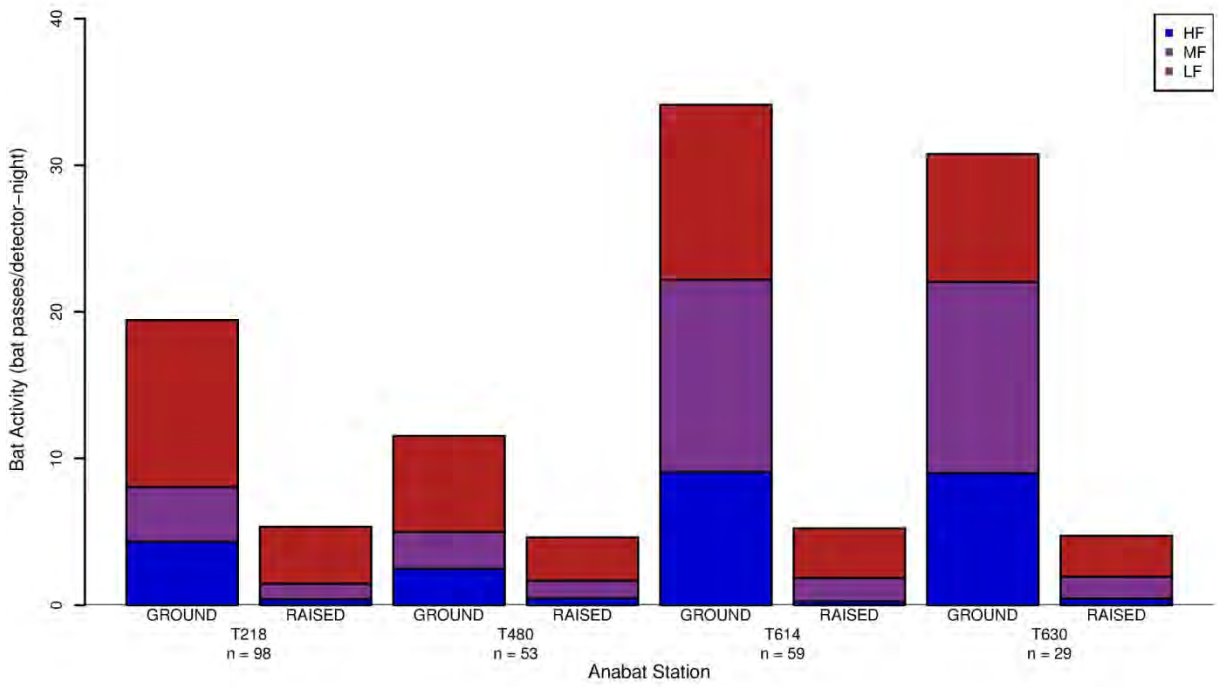

Figure 16. Bat activity at paired stations during the fall study period at the Fowler Ridge Wind Farm, July 22 – October 31, 2011 on nights when both ground and nacelle units were operational.

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**

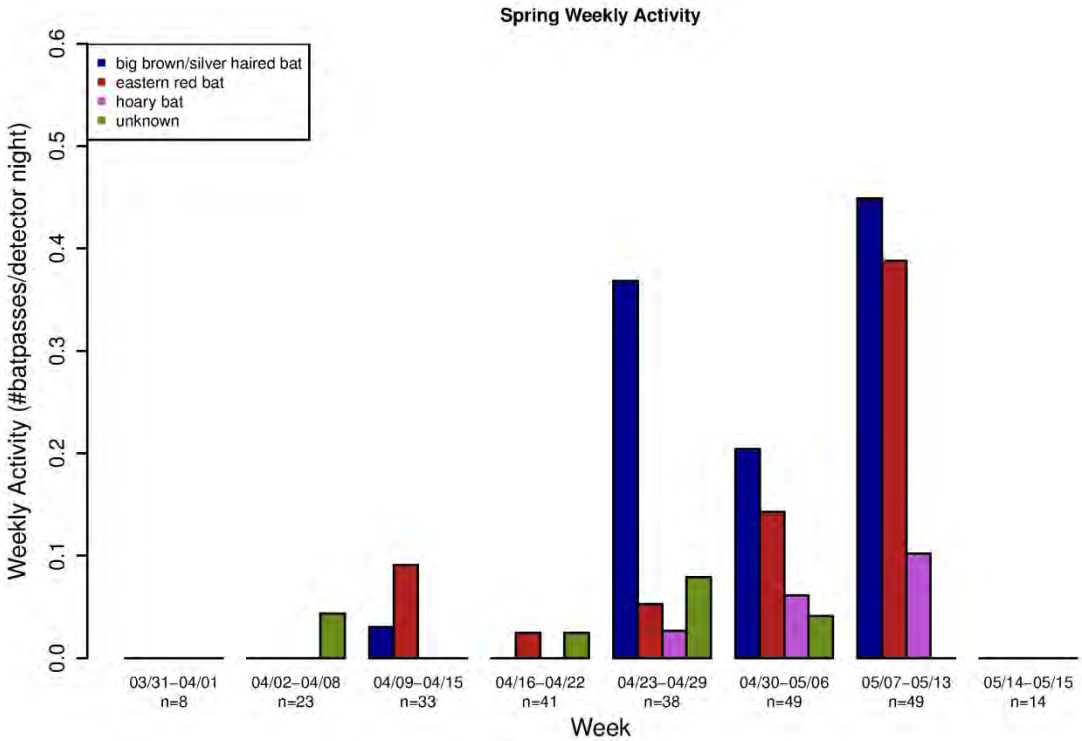

Figure 17. Composition of weekly activity for LF and MF bat species groups during spring monitoring at the Fowler Ridge Wind Farm.

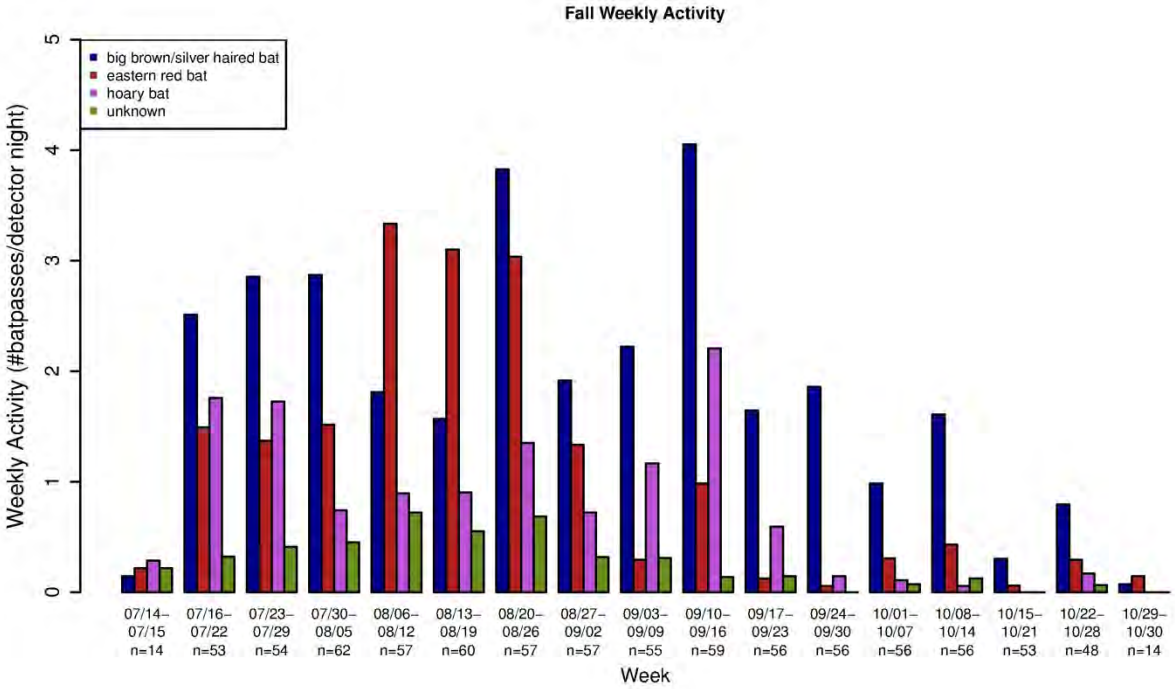

Figure 18. Composition of weekly activity for LF and MF bat species groups during fall monitoring at the Fowler Ridge Wind Farm.

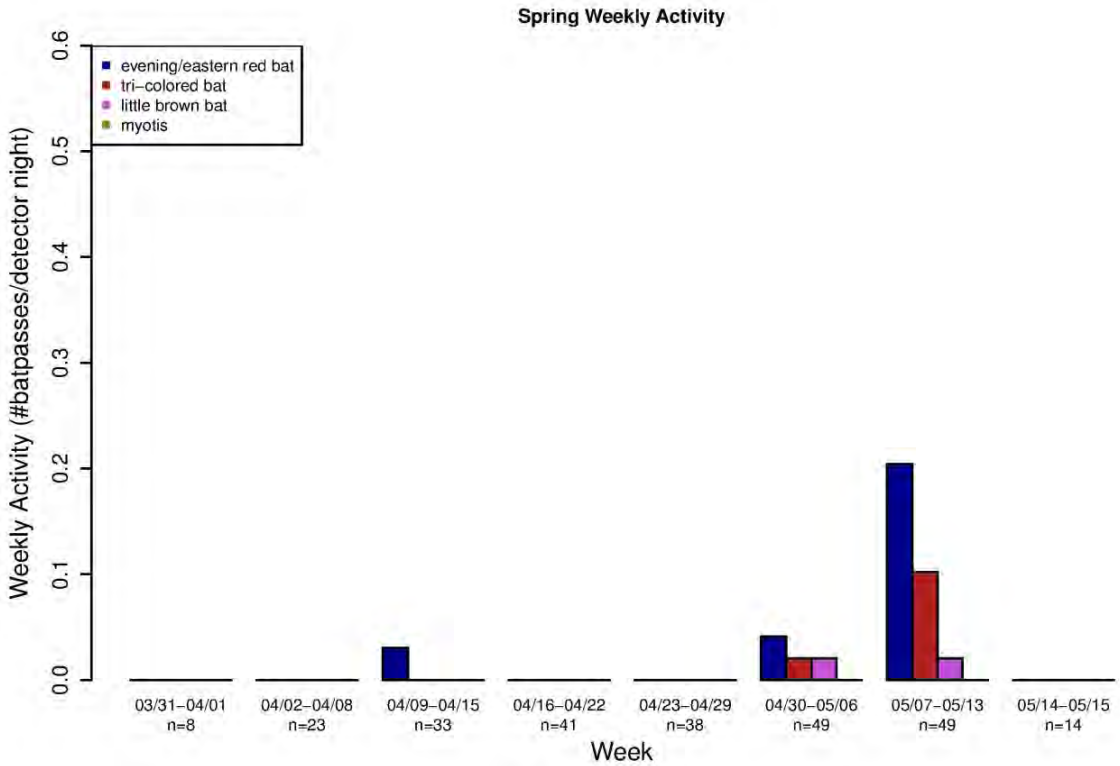

Figure 19. Composition of weekly activity for MF and HF bat species groups during spring monitoring at the Fowler Ridge Wind Farm.

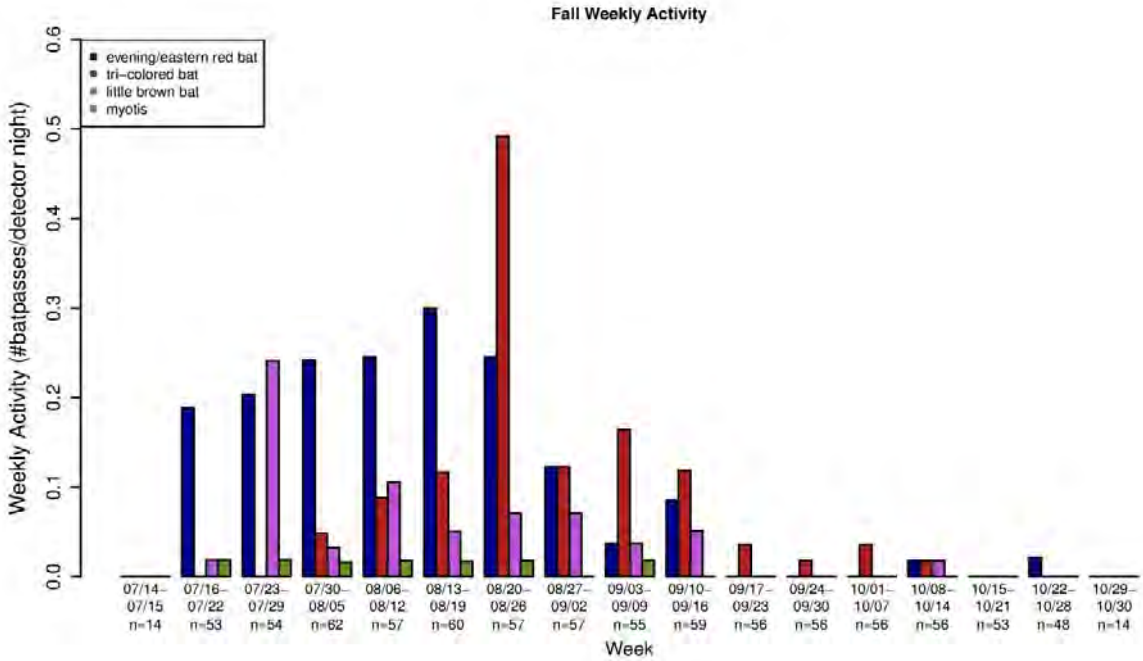

Figure 20. Composition of weekly activity for MF and HF bats during fall monitoring at the Fowler Ridge Wind Farm.

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 (l7300351.19#). 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	l8192137.02#	MYLU	NA	*Myotis* spp
T480g	Aug	6	l8070047.51#	MYSE	NA	LABO
T480g	Apr	26	l4270018.04#	MYSO	No	Unknown
T480g	Aug	14	l8150037.43#	MYSO	No	LABO
T614g	Aug	22	l8222307.52#	MYLU	NA	MYLU
T218g	Aug	31	l8312154.41#	MYLU	NA	Unknown
T218g	Sep	4	l9042217.12#	MYLU	NA	MYLU
T218g	Aug	18	l8182238.28#	MYSE	NA	LABO
T218g	Aug	21	l8220039.16#	MYSE	NA	LABO
T218g	Aug	15	l8160327.49#	MYSO	No	LABO
T218g	Aug	25	l8252218.06#	MYSO	No	*Myotis* spp
T630g	Aug	1	l8012337.49#	MYSE	NA	Unknown
T630g	Aug	5	l8060600.44#	MYSE	NA	Unknown
T630g	Jul	29	l7300351.19#	MYSO	Yes	Unknown
T218g	Aug	3	l8040056.01#	MYLU	NA	MYLU
T630g	Jul	25	l7260132.38#	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).

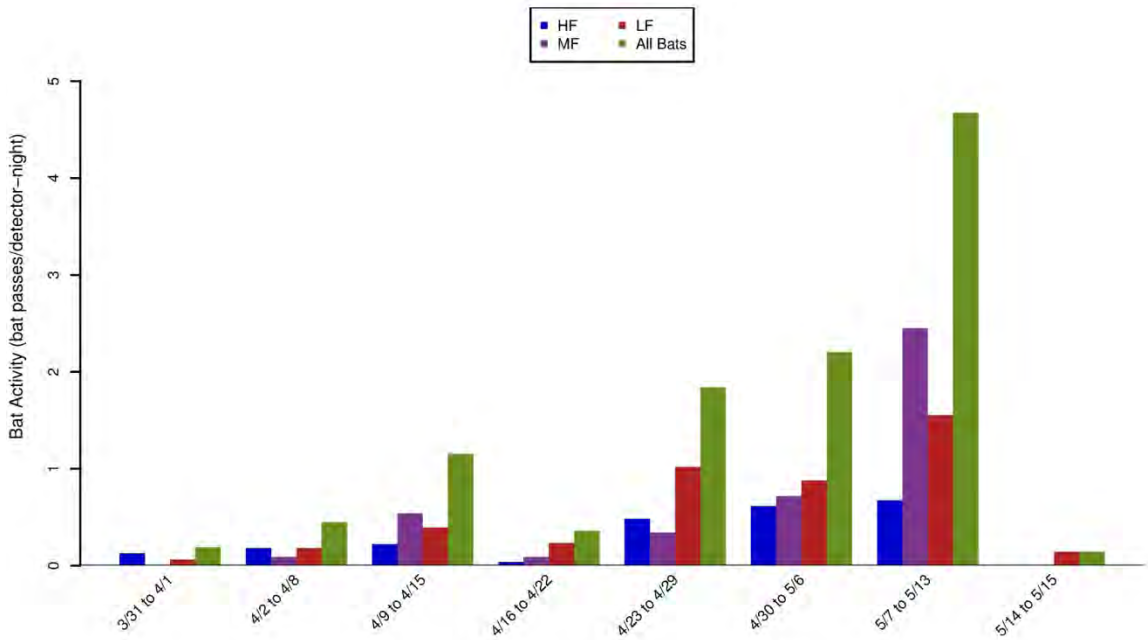

Figure 21. Bat activity, by week, during the spring migration period at the Fowler Ridge Wind Farm.

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).

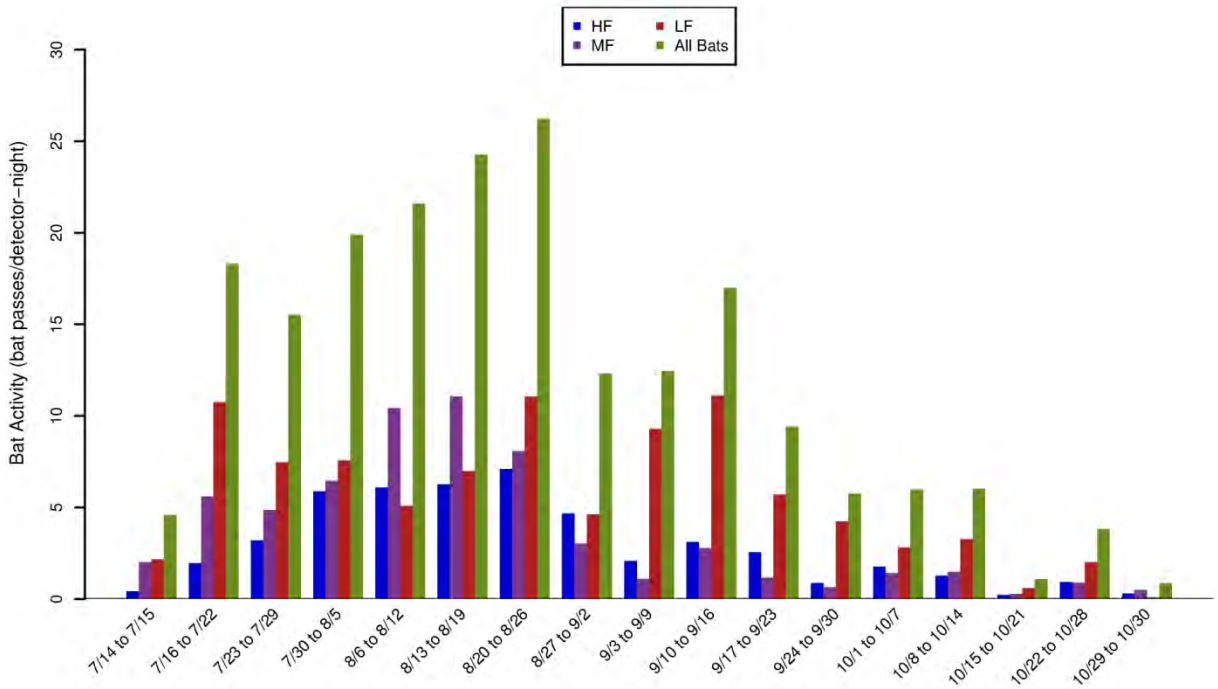

Figure 22. Bat activity, by week, during the fall migration period at the Fowler Ridge Wind Farm. Monitoring of bat activity began at two stations on July 28 that were previously monitored in 2007 and 2010, while monitoring at the base of turbines began July 14.

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).

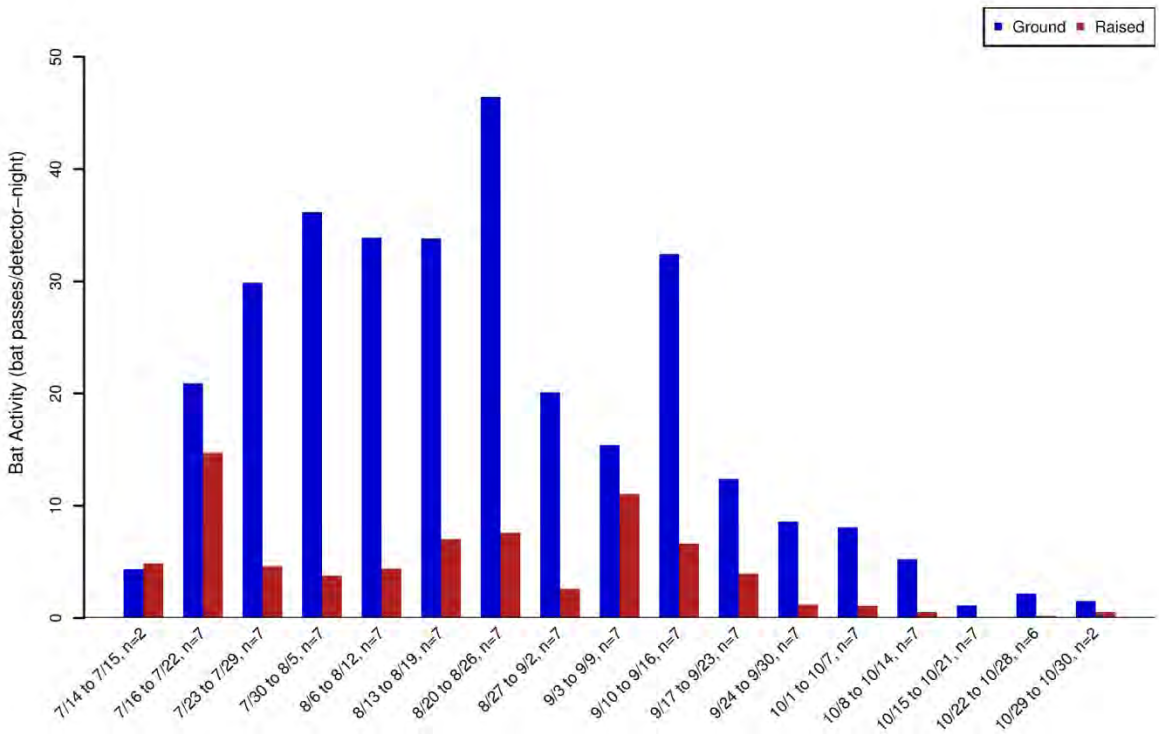

Figure 23. Number of bat passes per detector-night by ground and raised Anabat stations at the Fowler Ridge Wind Farm for the fall study period July 14 – October 31, 2011 when raised and ground units were operational on the same night.

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).

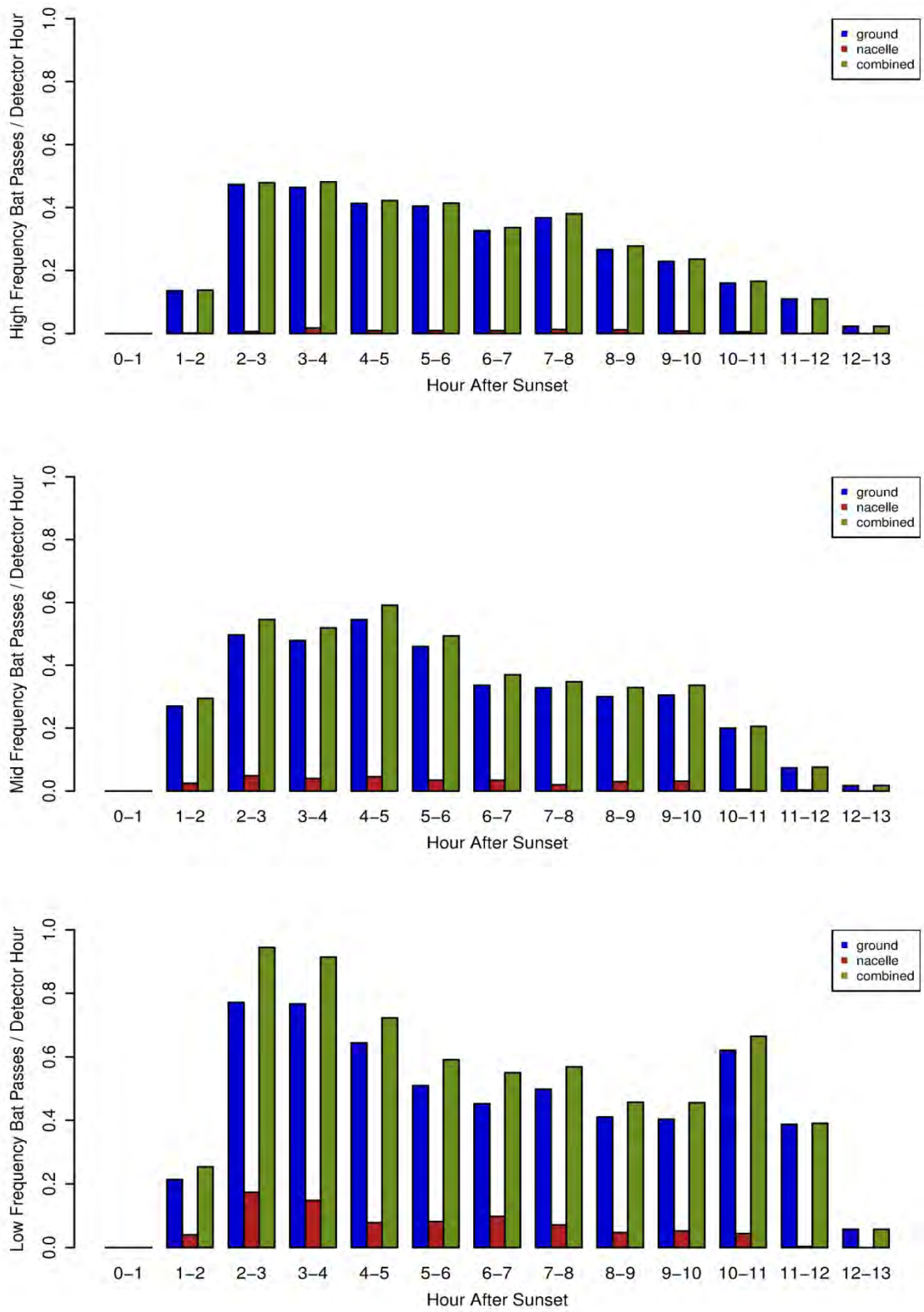

Figure 24. Bat activity rates as a function of hour past sunset at the Fowler Ridge Wind Farm.

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).

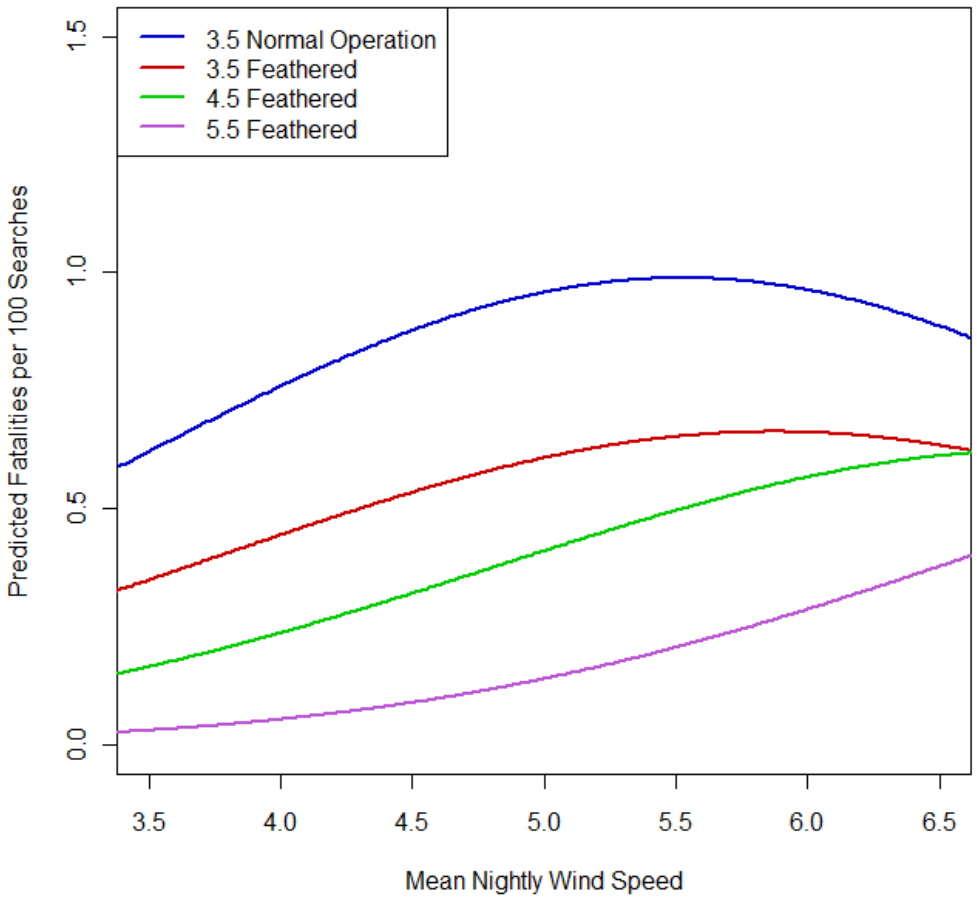

Figure 25. Predicted fatalities per 100 searches by mean nightly wind speed. Predictions from generalized linear regression Model A.

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.

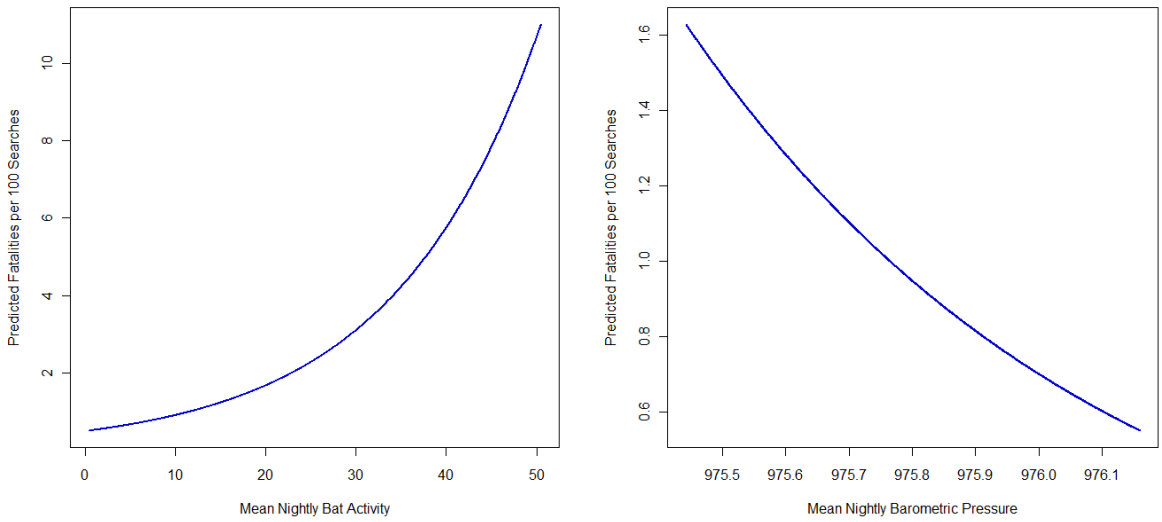

Figure 26. Predicted fatalities per 100 searches by mean nightly acoustic bat activity and barometric pressure. Predictions from generalized linear regression Model A.

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.

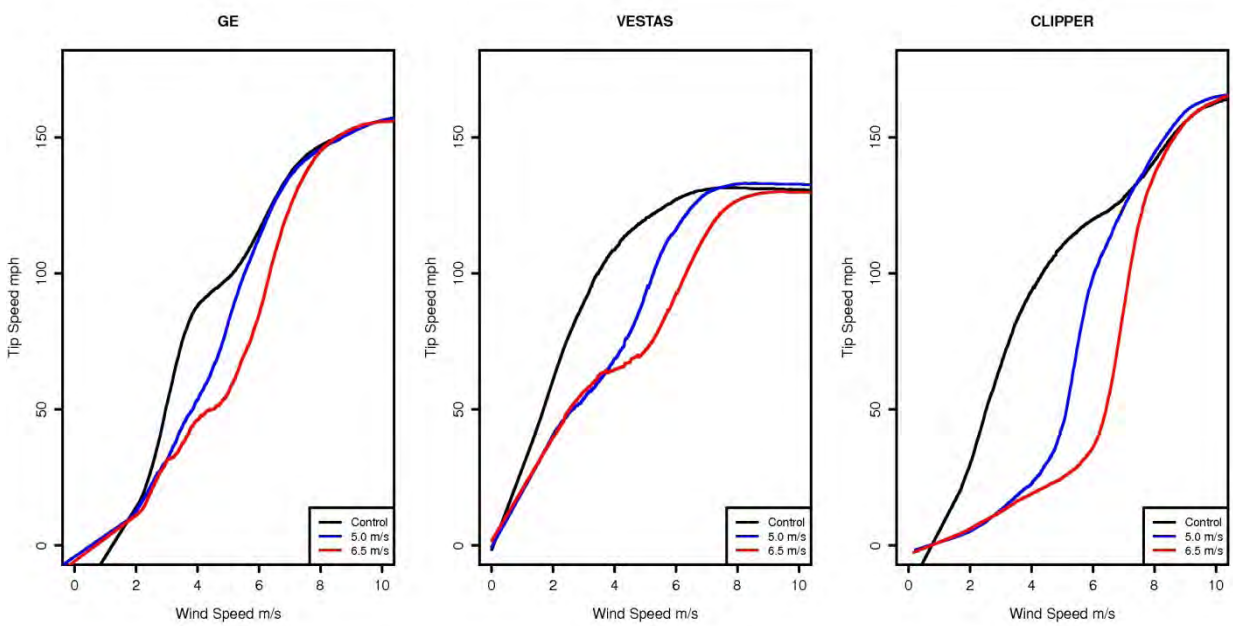

Figure 27. Estimated tip speed by wind speed for 3.5 m/s, 5.0 m/s, and 6.5 m/s cut-in speed adjustments for GE, Clipper, and Vestas wind turbines during the 2010 carcass monitoring at the Fowler Ridge Wind Farm. Estimates were made based on Friedman's SuperSmoother (Friedman 1984).

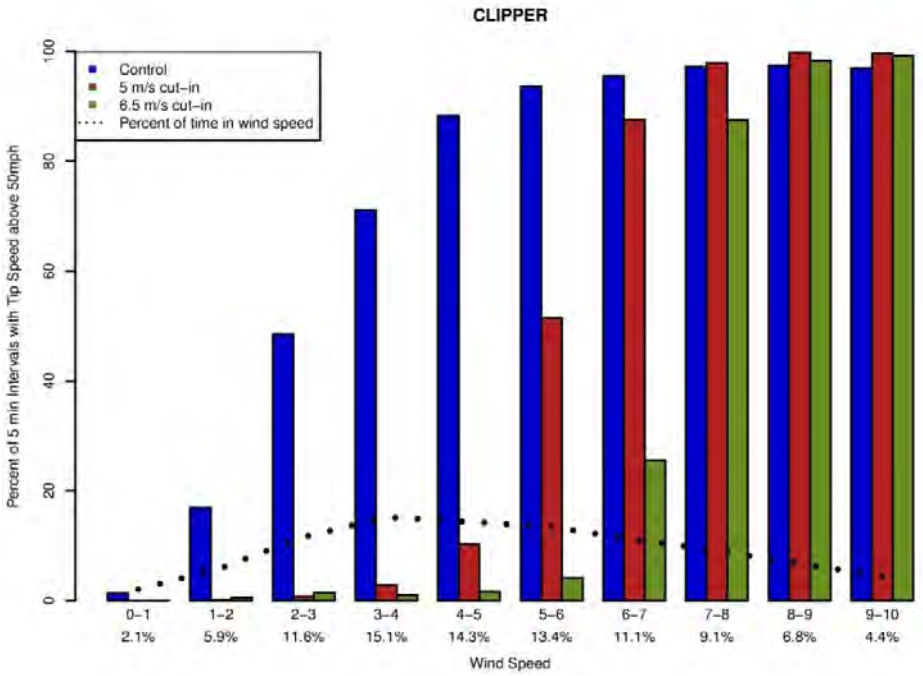

Figure 28. Percent of 5-minute intervals with tip speed above 50 mph for 1-meter intervals of wind speed for Clipper turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. The percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages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

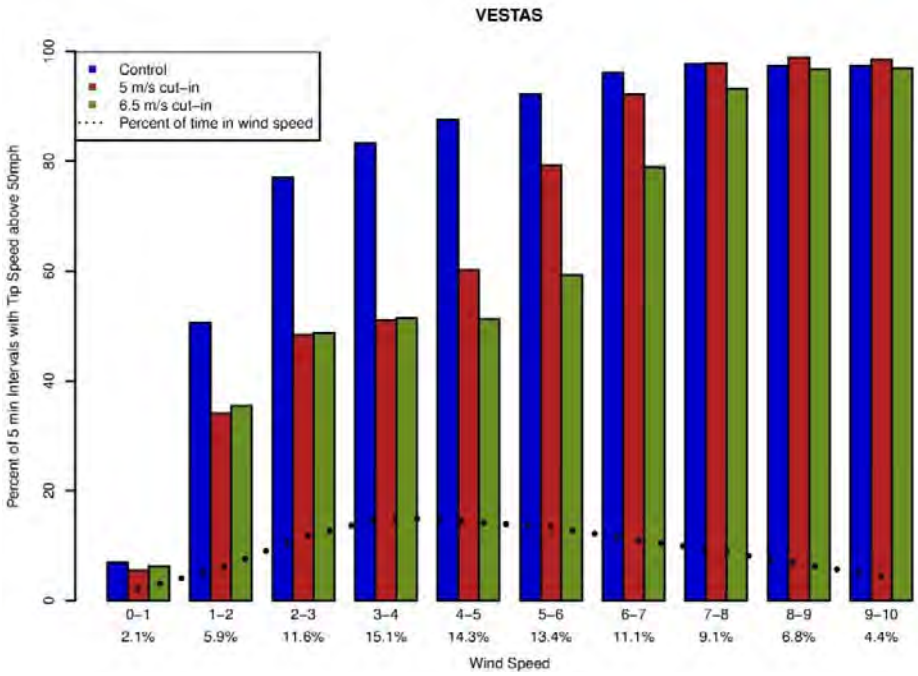

Figure 29. Percent of 5-minute intervals within 1-meter wind speed intervals with tip speed above 50 mph for VESTAS turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. The percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages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

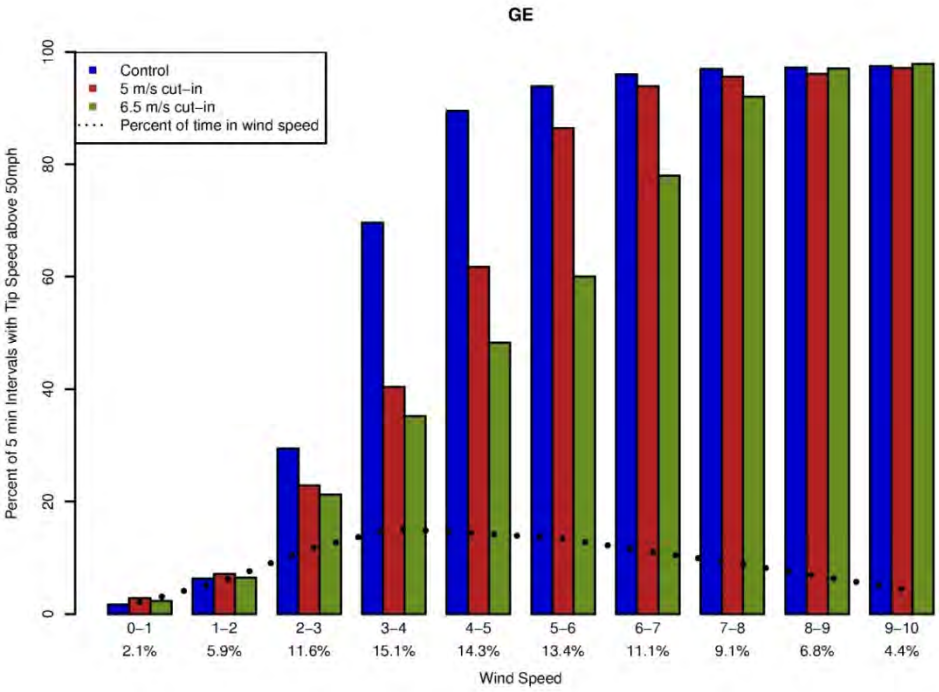

Figure 30. Percent of 5-minute intervals within 1-meter wind speed intervals with tip speed above 50 mph for GE turbines during fall carcass monitoring at the Fowler Ridge Wind Farm in 2010. Percent of overall 5-minute measures within each wind speed bin is shown as a dotted line. Percentages along the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

References

Afifi, A.A., V. Clark. 1996. Computer-aided Multivariate Analyses, 3rd edition. Chapman and Hall, London.

Manly, B.F.J. 1997. Randomization, Bootstrap and Monte Carlo Methods in Biology. Chapman and Hall, London.

Manly, B.F.J. 2005. Multivariate Statistical Methods: A Primer, 3rd edition. Chapman and Hall, London.

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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.

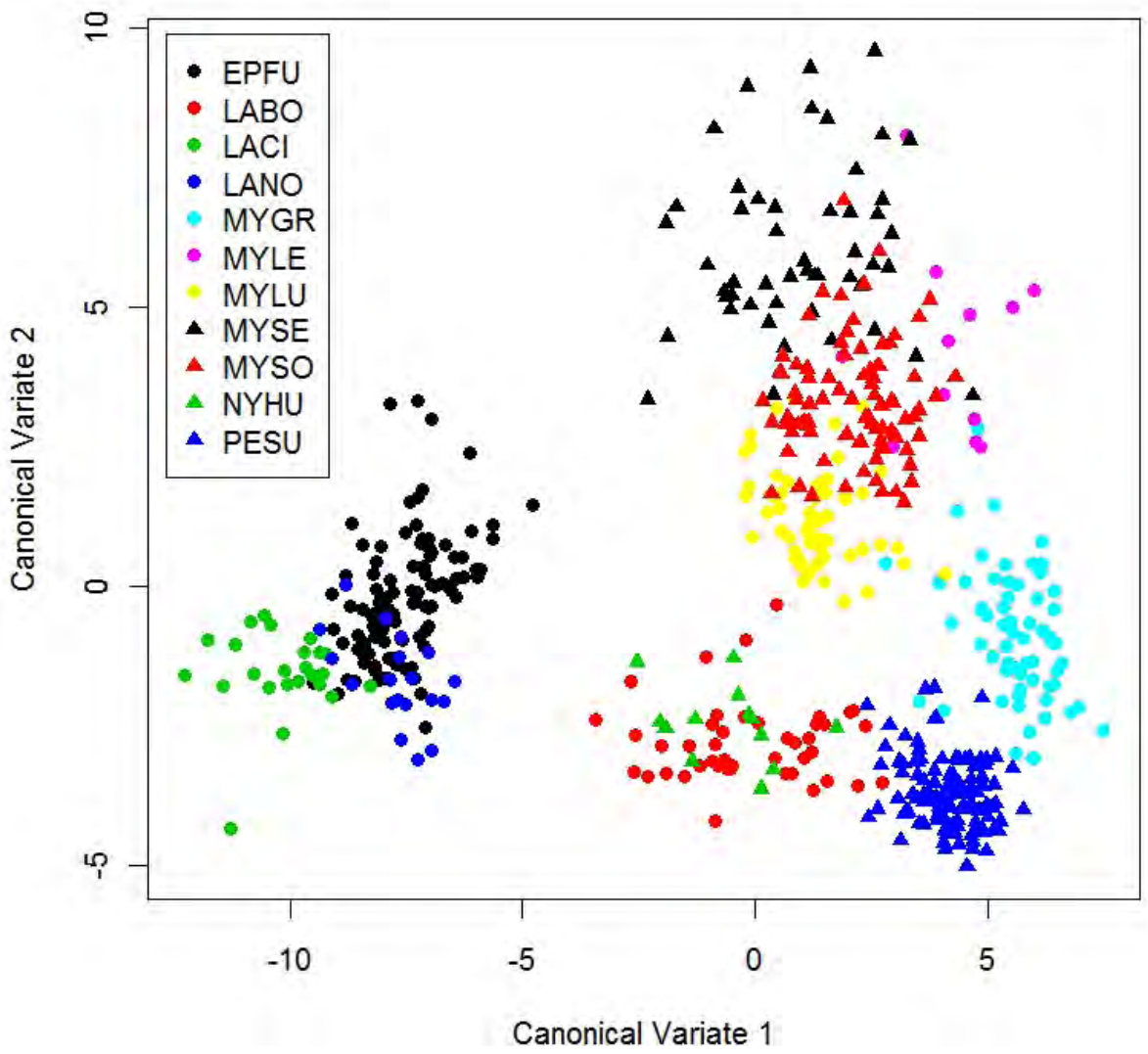
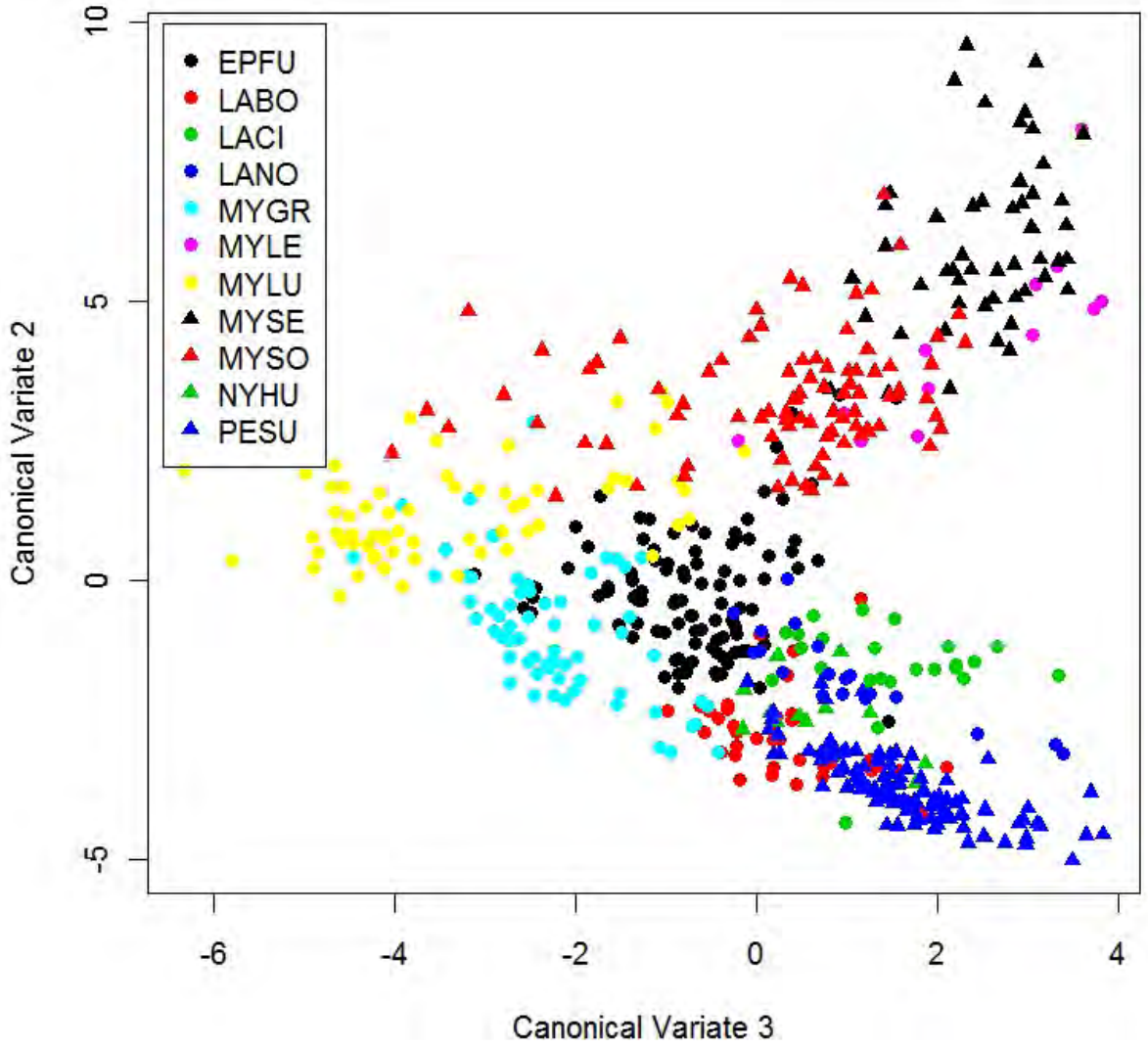


Figure 2. Bat calls in the space of the second and third canonical variates.



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

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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

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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

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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									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	--	--
Average Search Interval																											
Bats	5.84	--	--	5.78	--	--	5.88	--	--	2.00	--	--	2.00	--	--	2.00	--	--	2.00	--	--	2.00	--	--	2.02	--	--
Observer Detection																											
Bats	0.74	0.52	0.98	0.74	0.52	0.98	0.74	0.52	0.98	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44	0.29	0.17	0.44
Average Removal Time																											
Bats	15.10	12.23	18.51	15.10	12.23	18.51	15.10	12.23	18.51	13.02	9.20	18.00	13.02	9.20	18.00	13.02	9.20	18.00	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	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	0.74	0.63	0.83	0.75	0.63	0.83	0.74	0.63	0.83	0.69	0.50	0.80	0.69	0.50	0.80	0.69	0.50	0.80	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	2.30	0.67	4.93	0.68	0.24	1.37	0.00	--	--	1.94	1.33	3.00	2.42	0.89	4.32	1.94	1.31	3.01	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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Appendix B

Methodology for Calculating Adjustment Factor for Carcasses Falling Outside 80m X 80m Plots In 2010