we energies

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January 29, 2010

Ms. Sandra J. Paske
Secretary to the Commission
Public Service Commission of Wisconsin
Post Office Box 7854
Madison, WI 53707-7854

Dear Ms. Paske:

Application of Wisconsin Electric Power Company for a Certificate Of Public Convenience and Necessity to Construct a Wind Electric Generation Facility and Associated Electric Facilities, to be Located In Fond du Lac County, Wisconsin **6630-CE-294**

On June 9, 2009, the Company filed the Interim Report on the Post-Construction Bat and Bird Fatality Study at Blue Sky Green Field. The Company noted at that time that additional field work was occurring and a final report would be filed at a later date.

Attached please find the final Post-Construction Bat and Bird Fatality Study at the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin. This report was shared with the Commission and Wisconsin Department of Natural Resources staff late last year, and their comments have been incorporated in the report.

We have also attached the Post-Construction Avian Point-Count Study Report for this project.

If you have any questions regarding this project, please contact Paul Farron at (414) 221-3958.

Very truly yours,

Roman A. Draba
Vice President, Regulatory Affairs and Policy

cc: Mr. Scot Cullen - PSCW
Mr. James Lepinski - PSCW
Mr. Robert Norcross - PSCW
Mr. Dan Sage - PSCW
Ms. Marilyn Weiss – PSCW

WESTERN ECOSYSTEMS TECHNOLOGY, INC.

Post-Construction Bat and Bird Fatality Study at the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin

July 21, 2008 – October 31, 2008 and March 15, 2009 – June 4, 2009

Jeff Gruver, Michelle Sonnenburg, Kimberly Bay and Wallace Erickson
Western **E**co**S**ystems **T**echnology**,** Inc.
2003 Central Avenue
Cheyenne, Wyoming

12/17/2009

WEST, Inc.

EXECUTIVE SUMMARY

The Blue Sky Green Field Wind Energy Center began commercial operation in May of 2008. The wind farm is located in the townships of Calumet and Marshfield in Fond du Lac County, Wisconsin. The wind farm consists of 88 Vestas V-80 wind turbines that rise to approximately 121 meters (397 feet) at the highest point at the top of a turbine blade. Each wind turbine is capable of generating 1.65 MW of electricity, and the wind farm as a whole is capable of generating 145 MW of electricity, or enough to provide power to 36,000 average residences. Here, we report results of fatality studies at Blue Sky Green Field that were conducted during the summer and fall of 2008 and spring of 2009.

From July 21 to October 31, 2008, and again from March 17 to June 4, 2009, we conducted studies designed to estimate the number of bird and bat fatalities attributable to wind turbine operation. These dates correspond with the fall and spring migration periods for birds and bats. These studies included systematic searches at a random sample of 30 turbines at daily and weekly intervals. We also conducted trials designed to estimate potential sources of bias, including searcher efficiency and scavenger removal rates. We used a statistical estimator designed to accurately estimate total fatalities. The estimator started with the total number of fatalities found during searches and added amounts associated with the bias rates, search interval and proportion of area searched. We generated estimates of fatalities for all birds and all bats, as well as separate estimates for migratory and non-migratory bat species.

For the entire study, we estimated 11.83 bird fatalities/turbine/year (9.08, 16.43; 90% C.I.) and 7.17 bird fatalities/MW/year (5.50, 9.94; 90% C.I.). We estimated 40.54 bat fatalities/turbine (30.98, 51.16; 90% C.I.) and 24.57 bat fatalities/MW (18.78, 31.03; 90% C.I.). This estimate includes 27 fatalities (12.2% of the total number used to generate fatality estimates) found on search plots outside of the scheduled searches and increased the overall estimate by at least 12% relative to excluding them. If the incidental finds are removed, the estimates would be 35.6 bat fatalities/turbine/year and 21.6 bat fatalities/MW/year. Fatality studies may not consistently include incidental finds of carcasses, or may not have any incidental fatalities to include, as the number of incidental finds likely depends heavily on total number of people active on site, number of inspections and/or visits to the turbine by other (non-study related) site personnel, number of visits to search plots for other activities, etc.

Daily and weekly searches yielded estimates of 12.9 (8.81, 17.57; 90% C.I.) and 11.32 (7.72, 17.21; 90% C.I.) bird fatalities per turbine, respectively. We estimated 39.97 (30.76, 50.70; 90% C.I.) and 40.82 (28.16, 54.29; 90% C.I.) bats per turbine during daily and weekly, respectively. Non-migratory bat fatalities were estimated to be 23.37 (13.51, 27.78; 90% C.I.) and 20.23 (12.17, 26.14; 90% C.I.) per turbine for daily and weekly searches, respectively. Migratory bat fatalities were estimated to be 16.60 (12.99, 21.12; 90% C.I.) and 20.59 (16.33, 32.71; 90% C.I.) per turbine based on daily and weekly searches. The estimates for birds and bats are within the range of others from the United States and Canada but are higher than others reported from the Midwest to date. It may also be noted that estimates based on daily and weekly search intervals did not differ, which may be useful to consider with other goals when designing future studies.

We investigated the relationship between the number of fresh (< 1 day old) bat fatalities found during searches and local meteorological conditions measured on-site and at a local airport. The AIC-ranked best models indicated significant positive relationships between number of fresh fatalities and average temperature and low visibility conditions, and negative effects of wind speed at 50 meters and low cloud ceiling. The models also indicated a significant positive correlation between bat pass rates measured with ground-based detectors and number of fresh fatalities.

This study represents one of the few currently available that we are aware of to estimate bird and bat fatalities from wind turbine operation in the Midwest and contributes to our understanding of wind energy impacts to birds and bats. As more wind power projects are built in the region, and additional studies become available, a clearer picture of the impacts to birds and bats will emerge.

STUDY PARTICIPANTS

Jeff Gruver	Project Manager
Kimberly Bay	Data Analyst / Report Manager
Wally Erickson	Senior Statistician
Michelle Sonnenberg	Statistician
JR Boehrs	GIS Technician
Matt Kesterke	Report Compiler
Andrea Palochak	Technical Editor
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Nathan Kilger	Field Technician
Kelly Ryan	Field Technician
Brad Smith	Field Technician
Sam Theis	Field Technician

REPORT REFERENCE

Gruver, J.C., M. Sonnenberg, K. Bay, and W.P. Erickson. 2009. Results of a Post-Construction Bat and Bird Fatality Study at Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin, July 2008-May 2009. Final report prepared for We Energies, Milwaukee, WI. Prepared by Western EcoSystems Technology, Inc., Cheyenne, Wyoming.

ACKNOWLEDGEMENTS

A number of individuals from different organizations were instrumental in the completion of this monitoring study at the Blue Sky Green Field Energy Center (BSGF). We Energies provided funding for the field studies, access to the BSGF facility, and use of facility infrastructure. WDNR and PSCW personnel provided comments and input during development of the study protocol, and we thank M. Weiss, S. Kozlowski, and D. Redell. All the landowners involved in the BSGF project deserve recognition for their support and cooperation in allowing safe, secure, and trouble-free property access.

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INTRODUCTION

We Energies has developed a wind-energy facility of up to 145 megawatt (MW) capacity in Fond du Lac County, Wisconsin. The Blue Sky Green Field Energy Center (BSGF) is located approximately 15 miles (24 km) northeast of the city of Fond du Lac, Wisconsin in an area dominated largely by corn, soybean, and alfalfa fields. The wind energy project consists of 88 Vestas V82 wind turbines (Figure 1). This 1.65-MW turbine has a 80m (262 ft) hub height and a 82m (269 ft) rotor diameter. Total height at the tip of the blade is 121 m (397 ft). The BSGF project became fully operational in May 2008.

The following report presents results of the post-construction fatality monitoring at the BSGF project that was conducted between July 21 and October 31, 2008, and again from March 17 to June 6, 2009. This report summarizes the fatalities that were collected during the fall 2008 and spring 2009 study and estimates the total number of fatalities for bats and birds for the entire wind project for the fall and spring seasons. Preliminary estimates for the fall season were provided in a previous report (Gruver et al. 2009). This report uses additional data gathered during the spring sampling season to produce an estimated annual fatality rate, as well as comparisons of weather and bat activity data to patterns of bird and bat fatalities.

The mortality study plan for the BSGF site (Gruver et al. 2008) was designed primarily to estimate mortality caused by turbine impact to bats and birds in the project area. The study consisted of the following components: 1) standardized carcass searches in a square plot centered on select turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; and 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection.

The objective of the standardized carcass searches was to systematically search plots at the 30 selected turbines for bat and bird casualties that are attributable to collision with the turbines. All bird and bat fatalities during both transect surveys and incidental fatality observations (i.e. a fatality observed outside the 30 study locations) were recorded and are presented in this report.

The objective of the searcher efficiency trials was to estimate the percentage of casualties that are found by the observers. Searcher efficiency trials were conducted by placing "detection" carcasses in the same areas where carcass searches occur, and the efficiency trials were conducted periodically throughout both the fall 2008 and spring 2009 study season. Estimates of searcher efficiency were used to correct for detection bias by adjusting the total number of carcasses found for those missed by observers. Searcher efficiency trials occurred concurrently with carcass studies.

The objective of carcass removal trials is to estimate the likelihood a carcass is removed by scavengers as a function of time. Carcass removal includes removal by predation or scavenging, or removal by other means (e.g., cultivation, harvesting). Estimates of carcass removal were used to correct for removal bias by adjusting the total number of carcasses found by the relative rate at which carcasses are removed from the study area.

METHODS

This document reports results based on a protocol designed to estimate bat and bird fatality at BSGF and determine if environmental factors influence mortality rates. This report summarizes the monitoring that was conducted during the both the fall 2008 (July 21 – October 31) and spring 2009 (March 15 – June 6) migration seasons, the periods assumed to include the vast majority of fatalities (Johnson 2005). Searchers walked roads, crane pads, and bare areas around the sample turbines and crane pads from July 21 through July 25, 2008 while search plots were being prepared. Carcasses found while conducting these constrained searches were included in the summary tables and totals, but were not included in estimation of total fatalities.

Assumptions

Levels of mortality for the wind energy facility as a whole were estimated by searching in a predefined area around a sample of wind turbine generators on a periodic basis and recording all carcasses found. Decisions regarding the number of turbines to search and how to select them were based on the desire to extrapolate results from the sample to the wind farm as a whole. Decisions regarding the area to be searched around turbines and the interval across which turbines were searched were based on the statistical properties of the estimator used and on published guidelines (Kunz et al. 2007*a*). Some of the same factors were considered in the context of the statistical properties of our estimator. For instance, the estimator takes into account the proportion of area searched as a function of distance from the turbine, as well as the distance from a turbine a carcass was found. Standard statistical procedures allow us to understand and account for the variance associated with these choices. Another sampling decision that can influence mortality estimates is the size of the search plot. We selected search plot size based on recommendations in Kunz et al. (2007*a*), strengthened by evidence from other studies that suggested that the search distance was sufficient to capture most of the fatalities (e.g., Johnson et al. 2003, Jain 2005).

Factors independent of sampling choices also contribute to uncertainty and can introduce substantial bias into estimates of wind turbine-associated mortality. Therefore, these factors must be measured and accounted for to the extent possible. Chief among these are removal of carcasses (e.g., by scavengers) before searchers have opportunity to find them, and carcasses that are present during searches but missed by searchers. Rates of carcass removal by scavengers are likely to vary with time of year, scavenger density, conspicuousness of carcasses, and other factors. If carcass removal rates are high, then fewer carcasses are available to be found during searches, and mortality estimates would be biased low. We used trials designed to estimate the rate at which carcasses are removed by scavengers to account for this source of bias. Variation in searcher efficiency comes primarily from differences in vegetative condition in search plots, color and disposition of carcasses, and individual searcher skill. Searchers are never 100% efficient, so not accounting for this variability will result in mortality estimates that are biased low. We used trials designed to estimate searcher efficiency to account for this source of bias.

When establishing the survey dates, we assumed that most fatalities occur during the migration periods for birds and bats as has been the case at other wind energy facilities (Howe et al. 2002, Arnett et al. 2008), and therefore report estimated fatality rates per year. When calculating fatality estimates, we assumed that crippling bias (mortality of animals injured by turbines but that die from those injuries at a later time) and levels of background mortality (i.e., “natural”

mortality not attributable to turbines) were small. Most fatality monitoring studies at wind-energy facilities used this approach because of the relatively high costs or improbability of obtaining accurate estimates (Smallwood 2007; also see Johnson et al. 2000). Accurate estimates of crippling bias, in particular, are very difficult to obtain because crippling bias represents negative data (i.e., it represents a population of fatalities that is not seen). If a large number of animals are injured from turbine collisions but die later away from the plot, then the estimated mortality will be biased low. If levels of background mortality are high, then some of the fatalities discovered during searches may erroneously be attributed to turbine collision, resulting in an estimate that is biased high.

Sample Size

Thirty wind turbine generators (WTG) were selected for study (Kunz et al. 2007*a*) using a systematic random sample to ensure that sampled plots were spread throughout the BSGF site and to allow inference to the project as a whole. Seven of the 88 turbines were considered unavailable for study *a priori,* due to landowner considerations. The remaining 81 turbines were selected by systematic randomization by ordering the turbines from northwest to southeast and randomizing the list. From that list, every 3rd turbine (81/30 ≈ 3) was selected without replacement. The first 30 turbines selected in this manner were chosen for study, while the 31st through 81st turbines on the list were available in the event that one or more of the original became unavailable.

Search Plots

Two different types of search plots were used (see Plot Condition below), but all search plots were defined by a square with sides 160 m long (25,600 m^2; 6.3 acres; 2.56 ha) centered on the turbine (Figure 3). Studies at wind farms with other large turbines (e.g., Johnson et al. 2003, Young et al. 2005) indicate that most fatalities are found within the area that is roughly equivalent to the height of the turbine hub. Most bat fatalities are generally found within an even smaller area around the turbine (Kunz et al. 2007*a*).

Plot Condition

All search turbines were located in cultivated cropland (corn, soybeans, and alfalfa), however, conditions on the ground differed between the 2 seasons. During the fall 2008 portion of the study, search plots, as defined, included the graveled access road and crane pad abutting the base of the turbine, but also extended well into standing crops (Figure 4). During the spring 2009 season, which occurred mostly prior to planting, search plots consisted primarily of bare tilled soil (Figure 4.1).

Because searcher efficiency in plots that extend into crops was expected to be quite low during the growing season (i.e., during the fall 2008 season), we mowed six strips in each of 27 turbine search plots (e.g., Jain 2005), and for the remaining three turbines, we kept the entire 6.3 acre plot in a low-vegetative state. In corn and soybeans, the mowing clipped vegetation to stems approximately six inches tall. Planting row spacing (approximately three feet) in the corn and soybean fields resulted in mowed strips of primarily bare soil in between the mowed stubble (Figure 4). Plant spacing and growth-form were denser in the alfalfa fields, and while mowing increased visibility for the searchers, it was not able to produce strips of primarily bare ground as

in the other crops. Therefore, strips in alfalfa fields were re-mowed approximately every two weeks during the study.

Each mowed strip was 160m long and 5m wide. Two strips were centered vertically on the turbine, orthogonal to each other, 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 from the turbine, the other half had strips placed at 20, 40, 60, and 80 m from the turbine (see example in Figure 4). This scheme ensured that all distances from 0 to 80 m away from the turbine were sampled during searches. In addition, three randomly selected turbines had the entire 160 m by 160 m search plot maintained in a low-growth vegetative condition. This allowed us to estimate the percentage of carcasses missed by comparing the carcasses from the turbines with managed strips to the turbines whose turbine search plots are completely mowed. In addition to searching the managed strips, that portion of the turbine access road within 80 m of the turbine and the turbine pad were searched. This portion varied by turbine and was measured for each sample plot.

During the spring 2009 season, the strips that had been mowed the previous fall were re-established by demarcating strip edges with stakes and flagging tape so that search methods were consistent between seasons (Figure 4.1). At times, bare-ground, snowmelt, and rain combined to create waterlogged conditions in portions of plots. When transects passed through these areas, searching was very difficult. We initially attempted to complete transects through the muddy areas (Figure 4.2). However, by the beginning of April we made the decision to avoid these areas when they were encountered. If the area was too large to be visually searched (i.e., larger than about the width of a transect), technicians demarcated the area on plot maps, and we accounted for these small reductions in the search area estimates.

Carcass Searches

The objective of the standardized carcass searches was to systematically search plots at the 30 selected turbines for bat and bird casualties that are attributable to collision with the turbines. Personnel trained in proper search techniques conducted the carcass searches. The access road within 80m of the turbine, the turbine pad, and the managed transects were searched. 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 found at one location indicating predation or scavenging.

In addition to carcasses, any injured bats and birds observed in search plots were recorded and treated as a fatality. All carcasses found were labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A copy of the original data sheet for each carcass was placed in the bag with the frozen carcass. For all casualties found, data recorded included species, sex and age when possible, date and time collected, GPS location, condition (intact,

scavenged, feather spot), distance and bearing to turbine, and any comments that may indicate cause of death. All casualties located were photographed as found.

Bat and bird casualties found in non-search areas (e.g., near a BSGF turbine not included in the study) were coded as incidental discoveries and documented as much as possible in a similar fashion as those found during standard searches. While we include those finds in summary totals, they were not included in fatality estimates. Casualties discovered on search plots but outside the scheduled search period were included in fatality estimates under the assumption that they would have been discovered during the next scheduled search.

Appropriate wildlife salvage/collection permits were obtained from the Wisconsin Department of Natural Resources and the US Fish and Wildlife Service to facilitate legal transport of injured animals and/or carcasses. Deposition of carcasses is discussed in Disposition of Data section below.

Ancillary data that may be useful during analyses were also collected. Meteorological and climate data, including precipitation, cloud cover and ceiling level, temperature, wind speed and direction, and barometric pressure were also obtained from meteorological stations. Bat use data within the project area were collected using Anabat™ detectors (Titley Scientific™, Australia).

Search Schedule

Searches were conducted daily during the work week, with all 30 turbines searched at least once during the week. Ten of the 30 turbines were searched daily, and 20 turbines (five per day) were searched on a four to six day interval (Figure 5). In this report, we refer to these turbines as "weekly turbines". The order that searches were done was randomized so that each plot was searched at various periods during the day. For plots that consist of managed strips, searchers walked at a rate of approximately 45-60 meters/min along each transect. Searchers scanned the area on both sides out to approximately 2.5m for casualties as they walked each transect. Everything within the search plot transects, including the turbine access road and turbine pad, was searched. For cleared plots, searchers walked parallel transects spaced 5m apart while searching 2.5 m on either side of the transect line.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of casualties that are found by the observers. Searcher efficiency trials were conducted by placing "detection" carcasses in the same areas where carcass searches occur. Estimates of searcher efficiency were used to correct for detection bias by adjusting the total number of carcasses found for those missed by observers. Searcher efficiency trials were conducted throughout the survey seasons.

Observers conducting carcass searches did not know when the trials were being conducted, at which turbines "detection" carcasses were being placed, or the locations where the "detection" carcasses were placed in a search plot. An attempt was also made to place carcasses in each of the various habitats being searched and in some approximation of the habitat's aerial extent. Although many fatality studies must rely on non-native bird species such as House Sparrows, European Starlings, and Rock Pigeons, or farm-raised game bird species, Dr. Noel Cutright was able to procure sufficient numbers of a wide variety of native bird species that we were able to minimize or eliminate the need to rely on these other sources. Bird carcasses collected during the

study were also used. During this study, bat carcasses collected during the study were mostly used in searcher efficiency trials. Preliminary searcher efficiency trials were conducted using bat carcasses generously provided by WDNR (D. Redell). All searcher efficiency trial carcasses were placed within the search plots being searched prior to the carcass search on the same day. Each trial carcass was discreetly marked so that it could be identified as a "detection" carcass after it was found. The number and location of the "detection" carcasses found during the carcass search were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by Dr. Cutright.

Carcass Removal Trials

Carcass removal trials were conducted during the period that carcass searches were conducted. Beginning August 18 and continuing through the end of the fall 2008 portion of the study, an average of 20 carcasses of either birds (two different size classes) or bats was placed in a search plot and monitored for up to 30 days. By spreading trials throughout the study period, the effects of varying weather, climatic conditions, and scavenger densities were taken into account. Two carcass removal trials were conducted in 2009; one on April 6 and one on April 27. Twenty carcasses of either birds (two different size classes) or bats were placed in a search plot and monitored for up to 30 days. Similar to the searcher efficiency trials, local native bird and bat species were used in the removal trials.

All removal trial carcasses were marked with small piece of colored tape on the bill or leg to avoid confusing a trial bird with a true casualty. Turbines not included in standardized searches were selected for inclusion in the removal trials, and trial carcasses were randomly located in a similar-sized plot as used to search turbines. Major habitats represented around the site's turbines were included in these trials. Trial carcasses were placed in a variety of postures to simulate a range of conditions. For example, carcasses were: 1) placed in an exposed posture (tossed randomly to one side); 2) hidden to simulate a crippled bird (e.g., placed beneath a tuft of grass), and; 3) partially hidden. Field crews monitored the trial birds over a period of up to 30 days. Carcasses were checked every day for the first four days, and then on days seven, ten, fourteen, twenty, and thirty. Carcasses that remained at the end of the trial were removed from the field.

Fatality Estimation

The estimates presented below were calculated using the search periods July 21 to October 31, 2008, and March 17 to June 4, 2009, and most accurately represent number of fatalities per turbine for that period. Because fatalities outside that period are assumed to be very low, we refer to fatalities recorded during this period as yearly rates. In addition, we calculated four different fatality estimates for birds and bats. Each fatality estimate is based on the same equations (Shoenfeld 2004, Erickson et al. 2005) and used number of animals, searcher efficiency rates, carcass removal rates, search interval, and search area to generate estimates (see below for more detail). These estimates did not include carcasses found on non-search plots. Estimate One included all carcasses (and feather-spots for birds) that were found on the 30 scheduled search plots from the initiation of searches in July 2008 until the end the study in June 2009. Estimate Two included only those carcasses (and feather-spots for birds) found on the 30 scheduled search plots after the entire plot had been mowed and was searchable in 2008. That is, fatalities discovered before the entire search plot was mowed were not included. Estimate Three was similar to Estimate One, except feather spots (which may have resulted from predation rather

than turbine collision) and three bird fatalities that may not have been turbine-related were excluded. Estimate Four was identical to estimate One, but in addition, we separated migratory and non-migratory bats.

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 was either unknown or was 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 number of bat and bird fatalities attributable to operation of BSGF, based on the number of bat and bird fatalities found at BSGF whose death appears related to facility operation, is 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 number of bat and bird carcasses was estimated by adjusting for removal and searcher efficiency bias.

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 (e.g., one monitoring year), 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 (including the turbines centered within each search plot)
- $\bar{c}$ the average number of carcasses observed per turbine per monitoring year
- 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 annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias

Observed Number of Carcasses

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

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

Estimation of Carcass Non-Removal Rates

Estimates of carcass non-removal rates are 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:

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

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 and season.

Estimation of Facility-Related Fatality Rates

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

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

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 was 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 was 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.

This formula has been used widely. Other approaches have been proposed and generally differ in assumptions. Recent estimators proposed have the assumption that a carcass that is missed cannot be found (Huso 2008), which is extremely conservative (overestimate), especially when search intervals are short relative to the carcass removal rates. The Huso (2008) estimator is currently in review and has not been provided with enough detail to implement.

Comparison of Weather and Bat Activity to Fatalities

Weather data from an on-site Met tower and an off-site local airport were used to assess mortality in relation to weather variables at Blue Sky Green Field (Table 1). Wind speed, temperature, and barometric pressure data were obtained from the anemometers on the met tower, while ceiling height, visibility, and cloud cover were recorded at the Fond du Lac County Airport, located approximately 19 km (12 mi) south-east of the wind project.

Definition of Variables

Predictor Variable	Description
Temperature	
[avg.temp]	Mean nightly (1930 to 0630 hrs) temperature
Barometric Pressure	
[avg.press]	Mean nightly barometric pressure
Wind Speed	
[mean.ws50m]	Average nightly wind speed at 50 m AGL
[ws50m.0to4p]	Proportion of night (10 min intervals) with wind speed of 0–4 m/s
[ws50m.4to6p]	Proportion of night (10 min intervals) with wind speed of 4–6 m/s
[ws50m.gt6p]	Proportion of night (10 min intervals) with wind speed of >6 m/s
Ceiling Height	
[clow]	Proportion of night (10 min intervals) with cloud ceiling height less than 1000 m
Visibility	
[vlow]	Proportion of night (10 min intervals) with visibility less than 5000 m
Cloud Cover	
[cclow]	Proportion of night (10 min intervals) with cloud cover less than or equal to 0.5

Associations between weather characteristics and fresh bat casualties were investigated using graphical methods (least squares regression lines, interaction plots), univariate association analyses (Pearson's correlations, simple linear regression), and multiple regression (Neter et al. 1996). However, because the data under examination represented count data, Poisson and negative binomial models were better suited to fit the data than the linear models. Poisson, negative binomial, and zero-inflated Poisson models were also considered.

Several Poisson models were fit to predict the number of fresh bat casualties found at the site. The Poisson models all had log link and were all of the form:

$$log(\mu) = \beta_0 + \beta_1\chi_1 + \ldots + \beta_\rho\chi_\rho + \varepsilon$$

which related the behavior of the natural logarithm (log) of the mean number of fresh bat mortalities per turbine to a linear function of the set of predictor variables $x_1,...,x_p$. The β_j's are the parameters that specify the nature of the relationship and ε is a random error term. The computer program R[1] was used to fit several alternative models. In particular, step-wise model selection methods based on AIC were used to determine the best fitting Poisson and negative binomial models. The correlation matrix was obtained for all continuous main effects listed above. Variables with pairwise correlations ≥ 0.6 were not allowed to be present in the selected models at the same time. The Poisson and negative binomial models were built using a forward and backward stepwise approach in which main effects entered or left the model based on the AIC 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 AIC decreased, the change in covariates was retained. If AIC increased, that change was discarded and the next covariate was tested. This procedure was repeated until none of the covariate changes produced a lower AIC. Poisson and negative binomial models with the same parameter sets were compared using a goodness-of-fit test (Vuong 1989) that determined there was no distinguishable difference between the best Poisson and best negative binomial model. Therefore, Poisson-based models were used.

Based on the presence of adequate weather data, a total of 72 nights during the Fall 2008 study were used in the analysis. None of the models selected were allowed to contain: (1) both proportion of night with a wind speed of <4 m/s and proportion of night with a wind speed of ≥ 6m/s; (2) both proportion of night with a wind speed ≥6 m/s and mean wind speed; (3) both mean wind speed and proportion of the night with a wind speed of <4 m/s; and (4) both low cloud cover and low ceiling height. These exceptions were due to perceived high correlations between the pairs of variables (Neter et al. 1996).

Similar methods were used to determine the relationship between Anabat data and fresh bat fatalities. Bat activity was measured concurrently with the fatality study using Anabat II™ and CF ZCAIM™ ultrasonic bat detection equipment (Titley Scientific™, Australia). Anabat II detectors use a broadband high-frequency microphone to detect the echolocation calls of foraging and commuting bats in real time. Detectors were set to Division Ratio of 16 and a sensitivity level of 6, which matched settings used during the pre-construction study (Gruver 2008).

Four detector units were used at two fixed stations and one unit was used at rotating stations. Fixed Anabat units were paired at the two met towers on site used during the pre-construction survey (Gruver 2008), with one detector at the base of the tower and one detector raised to a height of approximately 30 m on the met tower. To increase spatial coverage of acoustic detection of bats, we rotated one detector among search turbines. The rotating Anabat unit was placed near the base of a randomly selected turbine for a period of 3 consecutive nights.

Anabat units were placed inside plastic weather-tight containers with a hole cut in the side for the microphone to extend through. Microphones were seated into PVC tubing with drain holes that curve vertically outside the container to minimize the potential for water damage due to rain. Each detector unit was powered with a 12-volt external battery and programmed to turn on

[1] R Development Core Team (2009). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. (http://www.R-project.org)

approximately ½ hour before sunset and turn off at approximately ½ hour after sunrise to conserve power and record only during periods when bats are most active. Detector recorded passively for approximately one week before data retrieval, except the rotating unit, which was serviced every three days.

The measure of activity was number of bat passes per detector-night. A pass was defined as a continuous series of ≥ 2 call notes produced by an individual bat with no pauses between call notes of > 1 second. A detector-night was defined as one detector the operated for an entire night. With five Anabat detectors deployed, each calendar night would have up to 5 detector-nights. Bat activity was determined by downloading the Anabat files to a computer, tallying the number of echolocation passes recorded each night and dividing by the number of detectors working that night. This metric was used as an index of bat activity in the project area. Because the vast majority of fatalities occurred during fall 2008, we used only data from that season in this part of the analysis.

Disposition of Data

During the study, raw data forms were housed with the contractor conducting the study, and individual carcasses collected during the study were housed in a marked freezer at the BSGF Project Office. Individual carcasses not used in trials in 2008 were left in the freezer and were used in trials during the 2009 field season. A total of 26 bat carcasses (19 that were collected at BSGF during fall 2008 searches and seven originally received from WDNR at the beginning of the study) were transferred at the end of the fall 2008 season to WDNR (D. Redell) for use in future studies. Carcasses not used during the study remain in a freezer on-site to possibly be used for future studies at other sites. Decomposed carcasses were discarded.

RESULTS

Search Area and Habitat

Total area searched (m^2), percent area searched as a function of the maximum search area (160 x 160-m plots or 25,600 m^2), and the proportion of detection types within each search plot were calculated for each plot. The proportion of area searched generally decreased as distance from the turbine increased (Table 1). Approximately 66% of possible search area between 0–10 m from the turbines was searched, while approximately 25% of the possible search area between 70–80 m from turbines was searched (Figure 6). In addition, the graveled crane pads and road surfaces within 80 m of the turbine were searched, regardless of whether they were within a search strip. Crane pad area averaged 405 m^2, while road area averaged 332 m^2.

Distance to Wooded Area

We measured the distance from each searched and unsearched turbine to the edge of the nearest wooded area. Four types of wooded areas were classified: Residential Woodlots (RW), Forested Area (FA), Field Strip (FS), and Small Tree Stand (SS); these differed in number, size, and shape. We calculated the area to perimeter ratio for each type. Field Strips and Small Tree Stands had smaller areas relative to their perimeters than Residential Woodlots and Forested Areas (Table 2). Therefore, we combined these four stand types into two types labeled Small (FS and SS) and Large (RW and FA) (Table 2.1).

Searched turbines tended to be closer on average to small woodlots than unsearched turbines, but the difference was not significant ($F_{1,86}$; P=0.166). Searched turbines tended to be farther from a large woodlot than unsearched turbines, but again the difference was not significant ($F_{1,86}$; P=0.203). Mean distance to any wooded area (irrespective of size or shape) also did not differ between searched and unsearched turbines ($F_{1,86}$; P=0.600).

Search Schedule

Searches at turbines began on July 21, 2008 while waiting for soils to dry following very rainy weather during the week of July 14, when searches were scheduled to begin. Due to the amount of precipitation, farm equipment was unable to enter fields to mow search plots and strips; however, we initiated regularly scheduled surveys at turbines but were restricted to searching essentially only the gravel road and pad areas. We searched as much area around each turbine as possible, including un-graveled and unseeded area, until search plots were mowed. Mowing was prioritized based on search schedule and condition of soils. By July 29, 2008 all strips and plots were mowed. Searches proceeded on schedule for the remainder of the study period.

During the fall 2008 study, daily search turbine A33 was inoperable from July 23 to September 1 due to mechanical failure of the electrical generator in the nacelle. Replacement of the generator required a large crane to be brought in and parked on the crane pad. Due to the recent amount of rain, the pad first had to be reconstructed to be able to support the crane. We continued to search the plot to the extent possible. From August 6 to August 24 an area estimated to be 1800 m^2 of the crane pad was blocked by the crane. None of the plot could be searched on August 7-8 for safety issues related to construction. Between August 25 and August 29, approximately 4200 m^2 (66%) of the plot could not be searched due to turbine blades and other equipment on the ground, and no search was conducted on August 29 due to construction. By our September 1 search, the turbine was operational, though some equipment remained on the pad blocking an area of approximately 1000 m^2. By the September 22 search, all equipment was cleared.

In 2008, WEST completed a total of 1,031 searches; 685 searches at daily turbines (mean 68.5 per turbine) and 346 searches at weekly turbines (mean 17.3 per turbine). In addition, we searched turbine B17 on weekly basis from August 26 to October 28. Turbine B17 was added to provide anecdotal information and is not included in the fatality estimates. Given that B17 was located on a knoll and partially surrounded by mature trees, whereas most turbines were completely surrounded by agricultural fields, we added searches at B17 to attempt to evaluate if the fatalities would be appreciably different. A total of three bats and zero birds was found during searches at this site, which suggests fatality rates on par with other turbines. Therefore, B17 was not searched during the spring 2009 survey.

In 2009, WEST completed a total of 838 searches; 558 searches at daily turbines (mean 55.8 per turbine) and 280 searches at weekly turbines (mean 14.0 per turbine). During the spring 2009 survey, bare-ground conditions combined with melting snow and rain turned some plots into muddy quagmires, making searching very difficult at times. In some cases, transects passed through low-lying areas that tended to remain saturated and at times threatened to swallow technicians (Figure 4.2). To our knowledge, all turbines in search plots operated correctly during the 2009 survey.

Bird Fatalities

Characteristics of Bird Fatalities

In total, 43 bird carcasses were recorded during scheduled searches, with one tree swallow, one unidentified bird, and one red-tailed hawk being recovered incidentally (Table 3). Of these, 42 were small birds (e.g., songbirds) and one was a large bird (e.g., crows). Twelve unique identifiable bird species were found at BSGF. Of these, golden-crowned kinglet (n=4; 9.4%), horned lark (n=3, 7.0%), and tree swallow (n=3; 7.0%) were most common, followed by two species with two observations each. Unidentified birds accounted for 44.2% of all carcasses found. Unidentified carcasses included feather-spots, carcasses that were very old and consisted of little more than bones, and those that were too scavenged to make a positive identification.

We calculated separate fatality estimates based on carcasses found during daily and weekly searches, and a total estimate. After accounting for searcher efficiency and scavenger removal, we estimate 11.83 (9.08, 16.43; 90% C.I.) bird fatalities/turbine/year and 7.17 (5.50, 9.94; 90% C.I.) fatalities/MW/year (Table 4).

On a per turbine basis, daily searches yielded an estimated 12.86 (8.81, 17.57; 90% C.I.) fatalities and weekly searches resulted in an estimate of 11.32 (7.72, 17.21; 90% C.I.) fatalities (Table 4.1). On a per MW basis, daily and weekly searches yielded estimates of 7.80 (5.35, 10.66; 90% C.I.) and 6.87 (4.69, 10.44; 90% C.I.), respectively.

Temporal Pattern of Bird Fatalities

Bird fatalities were found throughout the both the fall 2008 and spring 2009 study periods. Most days during which bird fatalities were found had one fatality present; three days had two bird fatalities found, though there is no apparent temporal trend associated with this slightly higher fatality rate (Figure 7).

Bird Fatalities across Turbines

Numbers of bird fatalities varied across turbines. Bird fatalities were found at 22 of 30 search turbines (Figure 8). For turbines searched weekly, bird fatalities ranged from zero to four at any turbine (Figure 8.1), while bird fatalities at turbines searched daily ranged from zero to eight fatalities. The highest number of bird fatalities at turbines searched weekly was at turbine B20 (four fatalities), and the highest number of bird fatalities at turbines searched daily was at turbine D43 (eight fatalities; Figures 8.1 and 8.2).

Distribution of Fatalities: Distance from Turbine

The majority of bird fatalities (40.5%) were found beyond 60m from the search turbine (Table 5). Sixteen of the bird fatalities were found between 60 and 90m from the search turbine, and 13 bird fatalities found between zero and 30m from the turbines (Figure 9). The locations of bird carcasses seemed to follow a bimodal distribution with most carcasses found either within about 30m or greater than 60m away from the turbine. Comparatively few carcasses were found at intermediate distances.

Distribution of Fatalities: Distance from Woodlots

We used linear regression to determine if there was a relationship between number of bird fatalities at a turbine and distance to nearest forest-type. Distance to wooded area, regardless of woodlot size, did not predict number of fatalities at a wind turbine (Table 9).

Bat Fatalities

Characteristics of Bat Fatalities

In total, 247 bat carcasses were found at the Blue Sky Green Field over the course of both study seasons (242 in 2008 and 5 in 2009) (Table 6; Figure 13). Of that total, 221 were found on search plots (194 during scheduled searches), and 26 were found on non-search plots (Table 6.1). Five different bat species were found at BSGF. Little brown bats were most commonly found, accounting for 28.7% of all carcasses found. Silver-haired bats (23.5%), big brown bats (19.0%), and hoary bats (16.6%) also contributed to the majority of total observed bat fatalities at the site. Only 18 eastern red bats were found, representing 7.3% of total bats found (Figure 10). This species composition differs from what has been reported at other midwestern wind farms, where hoary bat and eastern red bats comprise the majority of fatalities (Figure 10.1).

Of the 247 bats found, 72% were adults, 11% were juveniles, and 17% were unable to be aged (Table 6.2). Approximately equal numbers of males and females were found. Age and sex distributions were roughly equal between migratory and non-migratory species, though nearly twice as many of the bats identified as juveniles were migratory species (Table 6.3).

As with birds, we calculated fatality rate estimates based on carcasses found during daily searches, during weekly searches, and an overall estimate. After accounting for searcher efficiency and scavenger removal, we estimate 40.54 (30.98, 51.16; 90% C.I.**)** bat fatalities per turbine and 24.57 (18.78, 31.03; 90% C.I.) bat fatalities per MW (Table 4.1).

We also calculated estimates for migratory and non-migratory species. Big brown, little brown, and *Myotis* spp. bats were considered non-migratory bats, while eastern red, hoary, and silver-haired bats were considered migratory. For non-migratory species, we estimated 21.27 (14.20, 25.21; 90% C.I.) fatalities/turbine and 12.89 (8.61, 15.28; 90% C.I.) fatalities/MW. For migratory species, we estimated 19.26 (16.32, 28.05; 90% C.I.) fatalities/turbine and 11.67 (9.89, 17.00; 90% C.I.) fatalities/MW (Table 4.1)

On a per turbine basis, daily searches yielded an estimated 23.37 (13.51, 27.78; 90% C.I.) fatalities, and weekly searches resulted in an estimate of 20.23 (12.17, 26.14; 90% C.I.) for non-migratory species. The estimates for migratory species are 16.60 (12.99, 21.12; 90% C.I.) and 20.59 (16.33, 32.71; 90% C.I.) fatalities for daily and weekly searches, respectively (Table 4.1).

On a per megawatt (MW) basis, daily searches yielded an estimated 14.18 (8.20, 16.86, 90% C.I.) fatalities, and weekly searches resulted in an estimate of 12.28 (7.39, 15.86; 90% C.I.) for non-migratory species. The estimates for migratory species are 10.07(7.88,12.82; 90% C.I.) and 12.50 (9.91, 19.85; 90% C.I.) fatalities for daily and weekly searches, respectively (Table 4.1).

Distribution of Fatalities: Temporal Patterns

Bat fatalities were most common during the fall 2008 study season, with only 5 bat fatalities being found during scheduled searches during the spring 2009 season (Table 6; Figure 13). The most common bat species fatalities found (little brown and silver-haired bats) were distributed unevenly during the fall 2008 study period (Figures 14, 15). In general, little brown bats were found in the early portion of the fall period, whereas silver-haired bats were more common later in the study. The timing for big brown bats was similar to little brown bats, while hoary and red bats were found sporadically throughout the study period. During the fall season, no fresh bats were found after October 1, although an old carcass (unidentifiable) was found on October 24. The first bat fatality found during the spring 2009 study period was on May 8, 2009 (Figure 13).

Distribution of Fatalities: Spatial Patterns

Search plots were distributed throughout the study area, with 16 search plots (five daily, eleven weekly) in the north and 14 plots (five daily, nine weekly) in the south (Figure 2). Slightly more bat fatalities were found in the northern portion of the study area (Blue Sky; 54.2%) than were found at the southern portion (Green Field; 45.7%) project (Table 7).

Distribution of Fatalities: Turbines

Numbers of bat fatalities varied across turbines (Figures 11 and 11.1). Bat fatalities per turbine on weekly scheduled search plots ranged from one (Turbines B12 and D30) to 13 (Turbine A9), with an average of 5.55 bats found per turbine. For daily scheduled search plots, total bat fatalities per turbine ranged from four (Turbine A33) to 19 (Turbine B22), with an average of 10.90 bats found per turbine. Comparing searches across all turbines, Turbine A9 had the largest number of fatalities per search at 0.43. The minimum number of fatalities per search (0.03) occurred at Turbines B12 and D30. (Figure 11.2)

Distribution of Fatalities: Distance from Turbine

Bat fatalities were generally found closer to turbines than were bird fatalities. The majority of bat fatalities (58.2%) were found within 20m of the search turbine (Table 8), and the number of bat fatalities found declined smoothly as distance from turbine increased (Figure 12).

Distribution of Fatalities: Distance to Woodlot

We used linear regression to determine if there was a relationship between number of bat fatalities at a turbine and distance to nearest forest-type. Distance to wooded area, regardless of woodlot size, did not predict number of fatalities at a wind turbine. This was true when we considered all bat fatalities together and when we examined migratory and non-migratory species separately (Table 9).

Analysis of Fatalities and Meteorological Data

The best model for fresh bat fatality rates as a function of weather data was the zero-inflated Poisson model:

$$Log(mean(fresh\ bat\ fatalities\ per\ search) = -298 + 0.005\ avg.temp + 1.76\ vlow - 0.01\ mean.ws50m - 0.27\ clow$$

This model indicates that the number fatalities found on any given day were positively related to average temperature and proportion of the night with low visibility during the previous night. Similarly, the number of fatalities found was negatively related to mean wind speed and proportion of the night with low ceiling conditions. Figure 16 shows how a change in a particular covariate corresponds to a change in the predicted numbers of bat fatalities, holding all other variables constant at their medians.

Analysis of Fatalities and Acoustic Activity Data

Modeling the Anabat data with the fresh bat fatality data produces a best zero-inflated Poisson model of:

$$Log(mean(fresh\ bat\ fatalities\ per\ search) = -2.49 + 0.023\ ground.only$$

This model indicates that probability of finding fatalities on any given day were positively related to mean number of bat passes detected the previous night. Figure 17 shows how a change in mean bat pass rate corresponds to a change in the predicted numbers of bat fatalities.

Searcher Detection Probability

A total of 31 bat carcasses, 24 large bird carcasses, and 117 small bird carcasses were used in searcher efficiency trials (Table 10). Overall searcher efficiency for bat carcasses was estimated to be 51.6% for all trials, compared to 66.7% for large birds and 61.3% for small birds. These means were used to adjust total fatality estimates up by accounting for carcasses that were present but missed by searchers.

Carcass Removal Trials

In total, 120 carcass removal trials were conducted. We used 51 bat carcasses, 38 large birds, and 31 small birds. By day 5 of the trials, roughly 25% of the bat carcasses, 75% of the large bird carcasses, and 65% of the small bird carcasses remained (Figure 18). These trials were used to account for the probability that a carcass would be available to be found by searches during scheduled searches.

DISCUSSION

Fatality Estimation

The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson et al. (2005), 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. At the BSGF site, red foxes, striped skunks, cats,

dogs, American crows, and ring-billed gulls were observed in or near search plots, and these and other unobserved scavengers (e.g., raccoon, Virginia opossum, white-tailed deer) were likely responsible for carcass removal. 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 search period. We also estimated searcher efficiency rates throughout the search period and in different plot conditions to account for any biases associated with changes in conditions.

The estimation approach assumed that the searcher efficiency rate was constant during the period of study, and we accounted for potential changes in searcher efficiency through time by conducting weekly efficiency trials during the study period. The estimation approach also assumed that detection probabilities for non-trial carcasses were not dependent on the time a carcass was in the field. The study was not designed to test this hypothesis. However, over time the detection probabilities of carcasses that are not found during previous searches may change. Initially, carcasses may increase in detection due to cues such as smell and insect presence due to decomposition. Detection may also increase if partially scavenged and feathers become spread out over a larger area. Over longer periods of time, carcass detection may decrease due to the weathering of carcasses. The assumption of uniform detectability is of most concern with larger search intervals than used in this study.

We calculated separate estimates for bird and bat fatality rates based on search interval. For both birds and bats, confidence intervals overlapped fatality means (see Tables 4 and 7), indicating that there was no difference in the estimates based on search interval. Thus, while daily search intervals can be more useful than weekly intervals for correlating weather events to temporal patterns of fatalities, our data suggest that essentially the same conclusions regarding fatality rates during this study were reached by searching turbines on a weekly interval. This information may be useful when considering the relative costs and goals of future studies in Wisconsin.

As noted in Methods, when calculating fatality estimates, we included all carcasses that were reported or found on search plots, even if those plots were not scheduled to be searched that day. We adopted this conservative approach and included the fatalities because we assumed that they would have been found during the next scheduled search. This approach produced an estimate for bat fatalities that was 10.5% higher than would have been the case had we excluded these fatalities (see Table 6.1). We cannot be sure that this assumption was valid in every case, or that all fatality studies incorporate this approach.

Bird Fatalities

Of the 40 birds that were found during scheduled searches or incidentally and which were identifiable, none were species protected under Threatened or Endangered Species legislation. Of bird carcasses that were identifiable, golden–crowned kinglet was most common, followed by horned lark and tree swallow (Table 3). One raptor, a red-tailed hawk, was found as an incidental fatality. During a concurrent study of bird use at BSGF (Cutright 2009), red-winged blackbird was the most common species observed at point-count stations at turbines, followed by ring-billed gull and Canada goose. None of these species were found during searches, although one of the feather-spots contained feathers from a ring-billed gull

The total number of birds found during this study was relatively low, but because of the distance they were found from the turbine and the area adjustment for distance, the estimates were

inflated by a larger number, resulting in a relatively large estimate. When we removed records of feather-spots, and four other carcasses that may not have been attributable to wind turbine operation, the estimate for birds at BSGF fell to lower levels. Of the species of birds found during searches, none were among the most abundant during concurrent avian use study (Cutright 2009), and all were species that have been observed as fatalities at other wind energy projects (e.g., Erickson et al. 2001)

Bat Fatalities

During this study, the vast majority of bat fatalities occurred during the fall season, with only about 2% of total fatalities occurring during spring migration. This is consistent with other studies that have documented far higher fatality rates during the fall migration season than during the spring (Johnson 2005).

The fatality estimates for bats from this study are within the range of others reported for wind projects in North America (Arnett et al. 2008), yet they were higher than expected, based on either the regional average or the pre-construction acoustic surveys for bats (Gruver 2008). While it is unclear why the estimates for BSGF would be higher than others in the region, we provide possible explanations here, and place the bat fatality estimates in context with other wind energy facilities in North America.

To date, the highest fatality estimates for bats have come from the eastern US, particularly the Appalachian region where estimates have ranged from 20.8 to 69.6 bats per turbine (Arnett et al., 2008). In the Midwest, fatality estimates for bats from wind farms studied between 1998 and 2004 range between 0.1 and 7.8 bats per turbine (Arnett et al. 2008, Kerlinger et al. 2007). Although the regional data pool of similar studies for the Midwest is relatively small (four sites: Howe et al. 2002, Johnson et al. 2003, Jain 2005, Kerlinger et al. 2007), it represents both a range of habitats (e.g., southwestern Minnesota to northern Wisconsin), and a range of survey effort and methodology. For instance, while three of the four fatality monitoring studies from the Midwest were conducted primarily in a matrix of corn, soybeans, and hay, similar to conditions at BSGF, only Jain (2005) attempted to maintain a portion of the search plot in a low- or no-vegetative condition as we did in this study. During the growing season, searching in un-mowed fields becomes progressively more difficult physically, and progressively less effective from a searcher efficiency standpoint (see Figure 4, which shows a mowed transect next to an un-mowed area). Thus the most ready comparison of results from BSGF, based on similarity of methods and habitat, is to Top of Iowa Wind Farm in north-central Iowa (Jain 2005). Interestingly, both Jain (2005) and this study reported higher numbers of fatalities than any of the other midwestern studies that did not clear crops. Our estimate is also slightly higher due in part to the number of incidental finds on scheduled plots that were reported, and which we included in the fatality estimation total (see *Assumptions* above). These incidentals increased our fatality estimate by at least 12% compared to not having included them (Table 6). However, even if we excluded those fatalities our estimates would still be higher than others from the Midwest.

Landscape and habitat context have both been proposed as hypotheses to explain bat fatalities at wind farms. For example, in the eastern US, clearings cut into the forested ridges that some wind farms are built on 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*b*). None of those features are

present at BSGF. In addition, distance to nearest wooded area was not a predictor of bat fatalities in this study.

As has been seen in other studies (see e.g., Arnett et al. 2008), weather variables were correlated with increased fatalities at BSGF. Wind speed and temperature, in particular, were significant predictors of bat fatalities, and it is generally accepted that bats are more active on warm, calm nights than on cool, windy nights. Pre-construction surveys at BSGF found reduced levels of bat activity as the season progressed and on windy nights (Gruver 2008). It seems likely that the correlation of fatalities with temperature may reflect the general decrease in abundance as the fall season progressed, while windy nights may keep bats from flying at heights at which they are likely to encounter spinning turbine blades.

Species composition of fatalities at BSGF differed substantially from three previous midwestern studies (Figures 10, 10.1). The migratory bats (hoary, eastern red, and silver-haired bats) that seem to dominate fatalities at nearly every North American wind farm study published to date, were represented in relatively low numbers as a group at BSGF. An exception was the silver-haired bat, which was the second most abundant bat fatality at BSGF during the Fall 2008 season. Based on the timing of fatalities for hoary and eastern red bats during fall, it seems that they are either resident during the summer, or they migrate through the area in relatively small waves over a longer period. Silver-haired bats on the other hand, may not be resident in the area (or at least may not be present in large numbers), but may migrate through the area during a relatively discrete period during fall. All but one of the silver-haired bats were found during fall were found in the month of September, making it the most punctuated species in terms of timing. Silver-haired bats were also the most abundant species (3/5) found during spring searches.

It is unclear why little brown and big brown bats would appear as fatalities in such high numbers at this site, considering they have generally been only minor contributors to fatality totals at other projects. Numbers of non-migratory bat fatalities were higher than expected at BSGF, with little brown and big brown bats contributing nearly half of the total fatalities found and more than half the estimated fatalities. In total, 71 little brown bats were found during fatality searches. Little brown bats comprised 28.7% of all fatalities recovered, a percentage that is similar to Top of Iowa (Jain 2005) and to a study from Alberta Canada (Brown and Hamilton 2002), though higher than most other published results (Arnett et al. 2008). Similarly, big brown bats comprised 19% of fatalities, which is nearly double the relative proportion found in other studies (Arnett et al. 2008). To our knowledge, non-migratory species have not been found to constitute a large proportion of fatalities at other sites (but see Brown and Hamilton 2002, and Jain 2005 where proportions of little brown bats were similar to those from this study). These are species with continent-wide distributions and are generally abundant throughout their range. As the overwhelming majority were found during the fall 2008 portion of the study, it is possible that the existence of a large regional hibernaculum in the Neda Mine may play a role in concentrating species such as little brown and big brown bats. However, BSGF is located some 30 miles away from the mine, so it seems unlikely that BSGF experiences large increases in numbers of these species as a result of seasonal movement toward the mine, unless the project is located along a migratory route traveled by bats headed to the mine. This study was not designed to address that question, and information on migratory routes by bats (assuming they exist) has proven to be an intractable question to date (Arnett et al. 2008), although a recent study from Alberta Canada provided some evidence of increased migratory activity nearer to the foothill of the Rocky Mountains relative to the prairies (Baerwald and Barclay 2009). A potentially elucidating

comparison would be to contrast estimates of fatalities of these species between BSGF and other recently constructed wind farms that are located closer to the mine, and will require meta-analysis of several regional wind projects.

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Table 1. Proportion of the area searched in 10 m distance bands at Blue Sky Green Field.

Distance from Turbine (m)	Acres Searched (daily)	Total Acres (daily)	Acres Searched (weekly)	Total Acres (weekly)	Acres Searched (cleared)	Total Acres (cleared)
0 to 10	18.72	27.57	11.26	11.74	13.58	20.08
10 to 20	41.61	82.72	34.01	35.61	30.26	60.24
20 to 30	47.10	138.05	57.02	60.33	32.71	100.54
30 to 40	42.06	193.64	80.13	85.94	31.40	141.02
40 to 50	49.10	249.04	103.00	112.24	34.25	181.38
50 to 60	56.47	304.51	125.89	139.35	41.93	221.77
60 to 70	73.67	359.89	148.87	167.19	49.68	262.10
70 to 80	80.00	415.34	169.78	195.84	58.99	302.49
80 to 90	98.05	470.79	122.46	225.27	70.74	342.87
90 to 100	56.15	526.24	64.53	255.47	40.23	383.26
100 to 110	35.65	581.59	28.26	286.41	26.56	423.56

Table 2. Summary statistics for four categories of wooded areas at Blue Sky Green Field.

	N	Mean Ratio (A:P)	SE mean
Field Strip	65	8.4	0.645
Forested Area	88	35.8	2.52
Small Tree Stand	9	5.8	0.732
Wood Residential	16	18.6	1.53

Table 2.1. Summary statistics for 2 categories of wooded area at Blue Sky Green Field. Large Stands include Forested Areas and Wood Residential. Small Stands include Field Strips and Small Tree Stands. See Methods section for detail.

	N	Mean Ratio (A:P)	SE mean
Large Stand	104	33.15	2.23
Small Stand	74	8.12	0.851

Table 3. Summary of bird species found during fatality studies at Blue Sky Green Field.

	Fatalities found at scheduled search plots		All Fatalities	
Species	**Total**	**% Composition**	**Total**	**% Composition**
unidentified bird	18	45.0	19	44.2
golden-crowned kinglet	4	10.0	4	9.3
horned lark	3	7.5	3	7.0
brown-headed cowbird	2	5.0	2	4.7
ruby-crowned kinglet	2	5.0	2	4.7
tree swallow	2	5.0	3	7.0
black-throated green warbler	1	2.5	1	2.3
cedar waxwing	1	2.5	1	2.3
eastern meadowlark	1	2.5	1	2.3
European starling	1	2.5	1	2.3
savannah sparrow	1	2.5	1	2.3
unidentified meadowlark	1	2.5	1	2.3
unidentified sparrow	1	2.5	1	2.3
unidentified swallow	1	2.5	1	2.3
warbling vireo	1	2.5	1	2.3
red-tailed hawk	0	0.0	1	2.3
Overall	**40**	**100**	**43**	**100**

Table 4. Summary of fatalities estimates for birds and bats, including bats by migration status. Fatalities are presented as mean and 90% lower and upper confidence limits.

Taxa	Fatalities/Turbine/Year	Fatalities/MW/Year
All Birds	11.83 (9.08, 16.43)	7.17 (5.50, 9.94)
All Bats	40.54 (30.98, 51.16)	24.57 (18.78, 31.03)
Migratory Bats	19.26 (16.32, 28.05)	11.67 (9.89, 17.00)
Non-migratory Bats	21.27 (14.20, 25.21)	12.89 (8.61, 15.28)

Table 4.1. Summary of adjusted fatality estimates for the fall and spring seasons. Mean and 90% lower (ll) and upper (ul) confidence limits are bootstrap point estimates for daily, weekly and total fatality rates at Blue Sky Green Field during the fall and spring seasons. See Appendix 1 for detail on fatality estimate components.

Per Turbine Fatality Estimates	Daily Searches			Weekly Searches		
	mean	*ll*	*ul*	*mean*	*ll*	*ul*
All Birds Fall08	11.77	7.76	16.55	8.77	5.63	13.8
All Birds Spring09	1.09	0	2.29	2.55	0.9	4.66
All Birds Overall	**12.86**	**8.81**	**17.57**	**11.32**	**7.72**	**17.21**
All Bats Fall08	38.32	29.46	49.24	39.83	30.02	53.74
All Bats Spring09	1.64	0.16	3.8	0.99	0	3.24
All Bats Overall	**39.97**	**30.76**	**50.7**	**40.82**	**28.16**	**54.29**
Migratory Bats Fall08	*15.69*	*12.15*	*19.9*	*20.1*	*14.95*	*27.28*
Migratory Bats Spring09	*0.91*	*0*	*2.6*	*0.5*	*0*	*1.97*
Migratory Bats Overall	***16.6***	***12.99***	***21.12***	***20.59***	***16.33***	***32.71***
Non-migratory Bats Fall08	*22.63*	*13.61*	*28.13*	*19.73*	*13.61*	*28.13*
Non-migratory Bats Spring09	*0.74*	*0*	*2.25*	*0.5*	*0*	*1.92*
Non-migratory Bats Overall	***23.37***	***13.51***	***27.78***	***20.23***	***12.17***	***26.14***
Per MW Fatality Estimates						
All Birds Fall08	7.14	4.71	10.04	5.32	3.42	8.38
All Birds Spring09	0.66	0.00	1.39	1.55	0.55	2.83
All Birds Overall	**7.80**	**5.35**	**10.66**	**6.87**	**4.69**	**10.44**
All Bats Fall08	23.26	17.88	29.88	24.17	18.22	32.61
All Bats Spring09	1.00	0.10	2.31	0.60	0.00	1.97
All Bats Overall	**24.26**	**18.67**	**30.77**	**24.77**	**17.09**	**32.95**
Migratory Bats Fall08	*9.52*	*7.37*	*12.08*	*12.20*	*9.07*	*16.56*
Migratory Bats Spring09	*0.55*	*0.00*	*1.58*	*0.30*	*0.00*	*1.20*
Migratory Bats Overall	***10.07***	***7.88***	***12.82***	***12.50***	***9.91***	***19.85***
Non-migratory Bats Fall08	*13.73*	*8.26*	*17.07*	*11.97*	*8.26*	*17.07*
Non-migratory Bats Spring09	*0.45*	*0.00*	*1.37*	*0.30*	*0.00*	*1.17*
Non-migratory Bats Overall	***14.18***	***8.20***	***16.86***	***12.28***	***7.39***	***15.86***

Table 5. Distribution of bird fatalities by distance from turbines at Blue Sky Green Field.

Distance to Turbine (m)	% Bird Fatalities
0-10	16.7
10-20	9.5
20-30	9.5
30-40	7.1
40-50	7.1
50-60	9.5
>60	40.5

Table 6. Summary of bat species found during fatalities studies at Blue Sky Green Field by season. All fatalities found during the study are represented, including those discovered by facility maintenance personnel.

	Fatalities found, fall 2008		Fatalities found, spring 2009		All Fatalities	
Species	**Total**	**% Total**	**Total**	**% Total**	**Total**	**% Total**
little brown bat	69	28.5	2	40.0	71	28.7
silver-haired bat	55	22.7	3	60.0	58	23.5
big brown bat	47	19.0	0	0	47	19.0
hoary bat	41	16.9	0	0	41	16.6
eastern red bat	18	7.4	0	0	18	7.3
unidentifiable bat	12	4.9	0	0	12	4.9
Overall	**242**	**100**	**5**	**100**	**247**	**100**

Table 6.1. Summary of bat species found during fatalities studies at Blue Sky Green Field. All fatalities found on search plots (scheduled and incidental) were included for the fatality estimation. All Fatalities includes casualties found on both search plots and non-search areas.

	Fatalities found during scheduled searches		Incidental fatalities found on search plots		All Fatalities	
Species	**Total**	**% Total**	**Total**	**% Total**	**Total**	**% Total**
little brown bat	60	30.9	8	29.6	71	28.7
silver-haired bat	51	26.3	4	14.8	58	23.5
big brown bat	33	17.0	8	29.6	47	19.0
hoary bat	29	14.9	5	18.5	41	16.6
eastern red bat	11	5.7	2	7.4	18	7.3
unidentified bat	5	2.6	0	0.0	7	2.8
unknown myotis	4	2.1	0	0.0	4	1.6
unidentified large bat	1	0.5	0	0.0	1	0.4
Overall	**194**	**100**	**27**	**100**	**247**	**100**

Table 6.2. Summary of bat fatalities by age and sex at Blue Sky Green Field.

Age/Sex	Number of Bats	Proportion of Total (Proportion of Group)
Adult	178	0.72
Female	61	0.25 (0.34)
Male	57	0.23 (0.32)
Unknown	60	0.24 (0.34)
Juvenile	26	0.11
Female	10	0.04 (0.38)
Male	8	0.03 (0.31)
Unknown	8	0.03(0.31)
Unknown	43	0.17
Female	5	0.02 (0.11)
Male	4	0.02 (0.09)
Unknown	34	0.14 (0.79)
Total	**247**	

Table 6.3. Summary of bat fatalities by age, sex, and migratory status at Blue Sky Green Field.

	Migration Status		
Age/Sex	**Migratory**	**Non-migratory**	**Total**
Adult	88	90	178
Female	34	27	61
Male	26	31	57
Unknown	28	32	60
Juvenile	17	9	26
Female	6	4	10
Male	5	3	8
Unknown	6	2	8
Unknown	13	30	43
Female	1	4	5
Male	NA	4	NA
Unknown	12	22	34
Total	**118**	**129**	**247**

Table 7. Distribution of fatalities by migration category and Project. Totals include bats found on both search plots and non-search plots.

Project	Migratory	Non-migratory	Unknown	All Bats
Blue Sky	63	68	3	134
Green Field	56	54	3	113
Total	**119**	**122**	**6**	**247**

Table 8. Distribution of bat fatalities by distance from turbines at Blue Sky Green Field.

Distance to Turbine (m)	% Bat Fatalities
0-10	32.4
10-20	25.8
20-30	18.4
30-40	13.5
40-50	4.9
50-60	2.5
>60	2.5

Table 9. Summary of P-values for linear regressions testing number of bat and bird fatalities at a turbine against distance to woodlot. See Methods for descriptions of woodlot types and bat migration status.

Migration Status	Distance to Large Wood	Distance to Small Wood	Distance to Nearest Wood
Migratory[1]	0.77[a]	0.41[a]	0.849[a]
Non-migratory[2]	0.13[b]	0.57[b]	0.65[b]
All Bats	0.22[c]	0.63[c]	0.69[c]
Birds	0.86[d]	0.99[d]	0.84[d]

[1]. Hoary, red and silver-haired bats
[2]. Little brown and big brown bats
[a]. $F_{1,39}$
[b]. $F_{1,32}$
[c]. $F_{1,44}$
[d]. $F_{1,22}$

Table 10. Searcher efficiency at Blue Sky Green Field as a function of date and size.

Date	Type	# Placed	# Available	# Found	% Found
7/31/2008	BAT	1	1	1	100
8/29/2008	BAT	7	7	6	85.7
9/3/2008	BAT	2	2	1	50.0
9/10/2008	BAT	3	3	2	66.7
9/23/2008	BAT	3	3	1	33.3
9/25/2008	BAT	2	2	2	100
10/22/2008	BAT	2	2	1	50.0
3/27/2009	BAT	3	3	0	0
4/7/2009	BAT	3	3	1	33.3
4/17/2009	BAT	2	2	1	50.0
4/24/2009	BAT	3	3	0	0
Overall	**BAT**	**31**	**31**	**16**	**51.6**
8/6/2008	SB	8	7	5	71.4
8/12/2008	SB	8	7	4	57.1
8/20/2008	SB	9	9	4	44.4
8/29/2008	SB	2	1	1	100
9/3/2008	SB	6	5	1	20.0
9/10/2008	SB	6	6	5	83.3
9/23/2008	SB	5	5	3	60.0
9/25/2008	SB	6	6	4	66.7
10/7/2008	SB	9	9	7	77.8
10/21/2008	SB	10	10	5	50.0
10/22/2008	SB	7	7	5	71.4
10/23/2008	SB	10	10	5	50.0
3/27/2009	SB	7	5	1	20.0
4/2/2009	SB	8	8	8	100
4/7/2009	SB	6	6	2	33.3
4/17/2009	SB	5	5	5	100
4/24/2009	SB	5	5	3	60.0
Overall	**SB**	**117**	**111**	**68**	**61.3**
8/6/2008	LB	2	2	1	50.0
8/12/2008	LB	2	2	1	50.0
8/20/2008	LB	1	1	1	100
8/29/2008	LB	1	1	1	100
9/3/2008	LB	2	2	1	50.0
9/10/2008	LB	3	3	2	66.7
9/23/2008	LB	2	2	1	50.0
9/25/2008	LB	1	1	0	0.0
10/7/2008	LB	1	1	1	100
10/22/2008	LB	1	1	0	0.0
4/2/2009	LB	2	2	2	100
4/7/2009	LB	1	1	1	100
4/17/2009	LB	3	3	2	66.7
4/24/2009	LB	2	2	2	100
Overall	**LB**	**24**	**24**	**16**	**66.7**

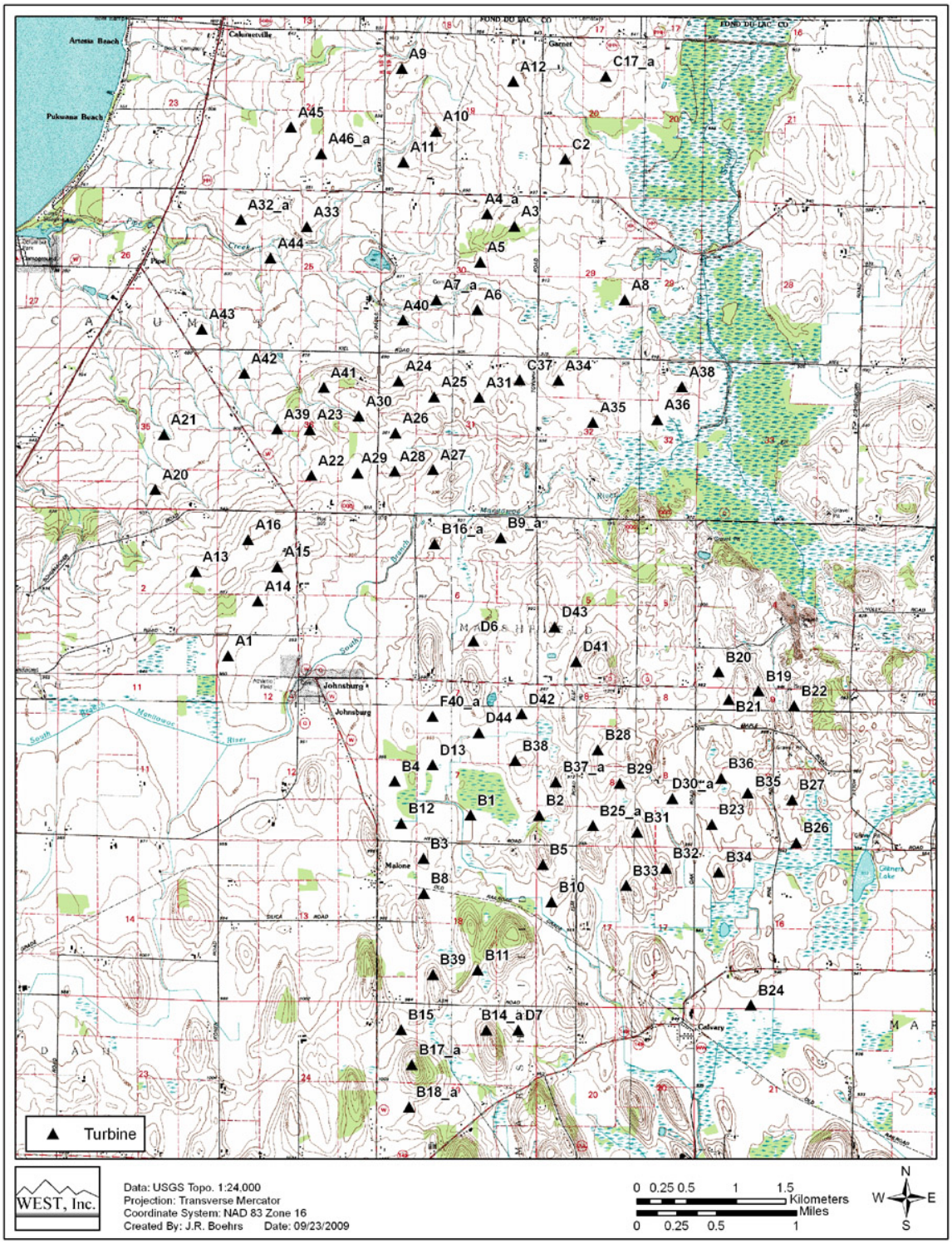

Figure 1. Map of the Blue Sky Green Field turbine locations.

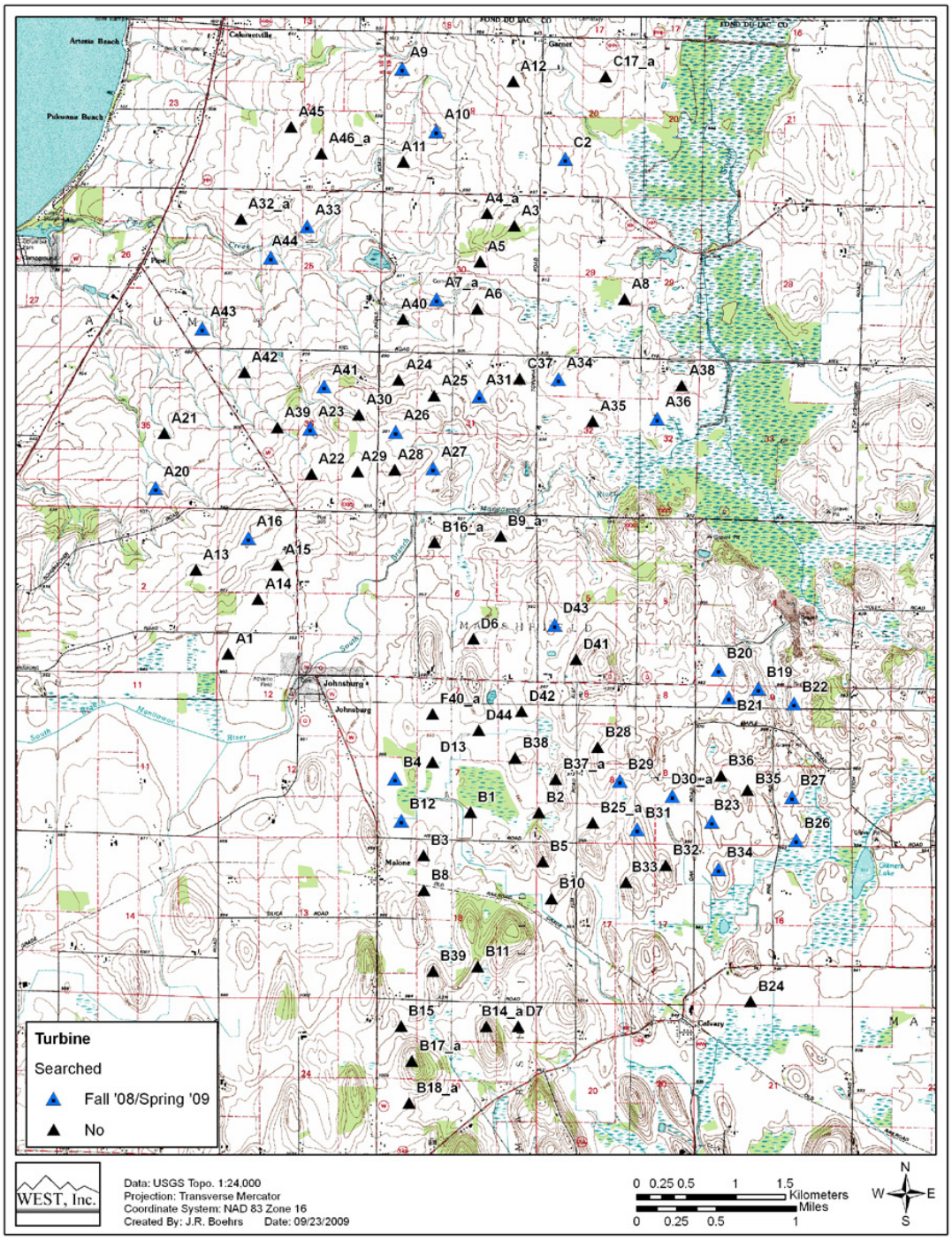

Figure 2. Map of Blue Sky Green Field turbines sampled for fatality studies. Solid circles represent turbines with the entire plot cleared. Non-solid circles represent plots with search strips mowed into the crops.

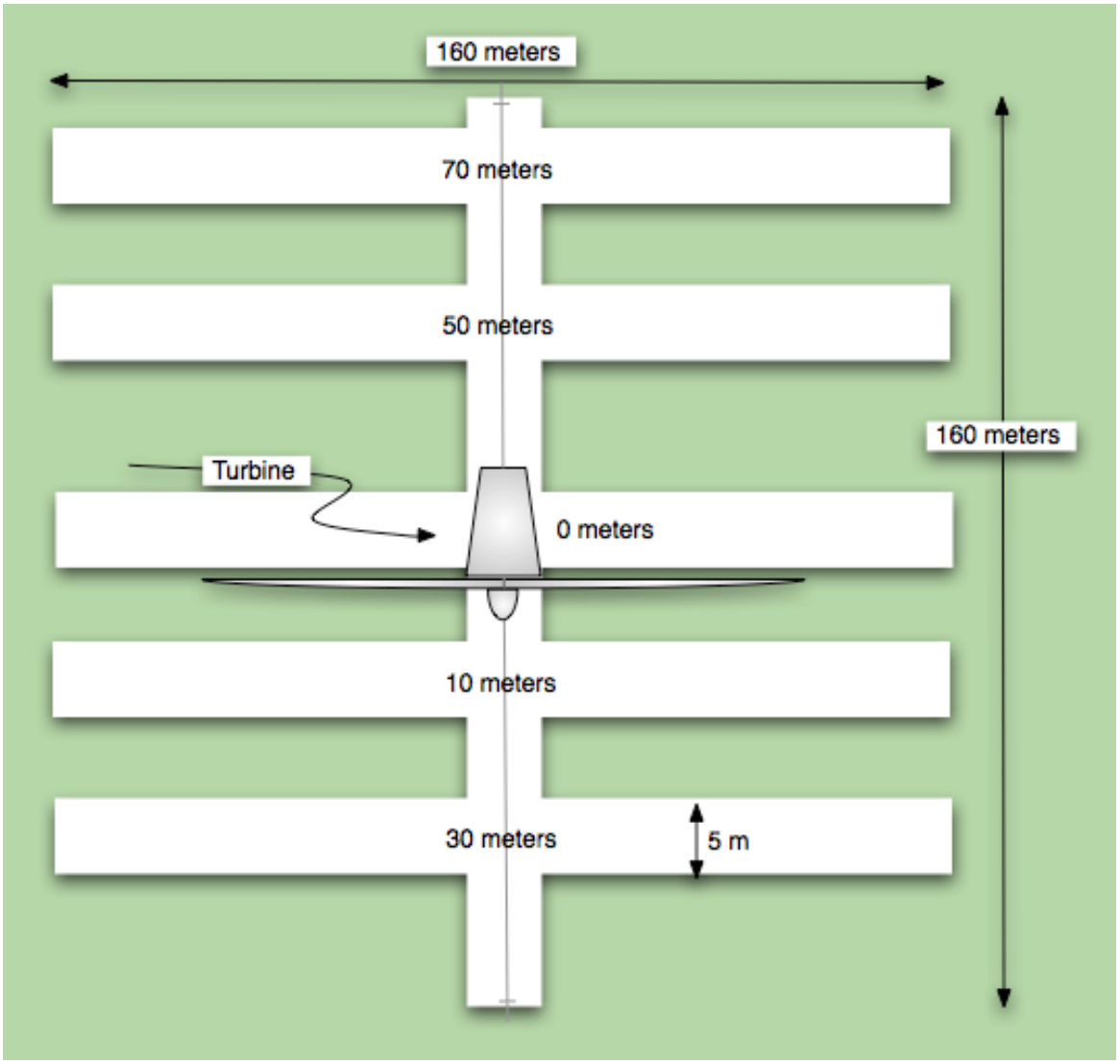

Figure 3. Example of layout of carcass search transects. Turbine pad and access road (not shown) were also searched. The area covered by road and pad varied, but was measured at each turbine searched.

Figure 4. View of a typical search strip and plot condition during the fall survey. Photo was taken on August 19, 2008, approximately 3 weeks after mowing.

Figure 4.1. View of a typical search strip and plot condition during the spring survey. Photo was taken on April 22, 2009.

Figure 4.2. Difficult search plot conditions during the spring survey. Photo was taken on April 1, 2009.

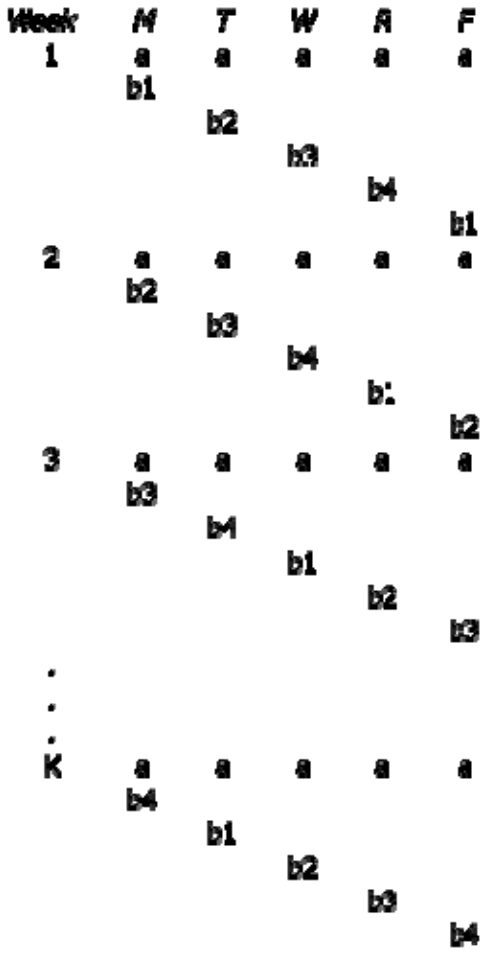

Figure 5. Example of search schedule. Group 'a' turbines (n=10) are searched daily during the week. Group 'b' turbines (n=20) are searched on a 4-6 day interval.

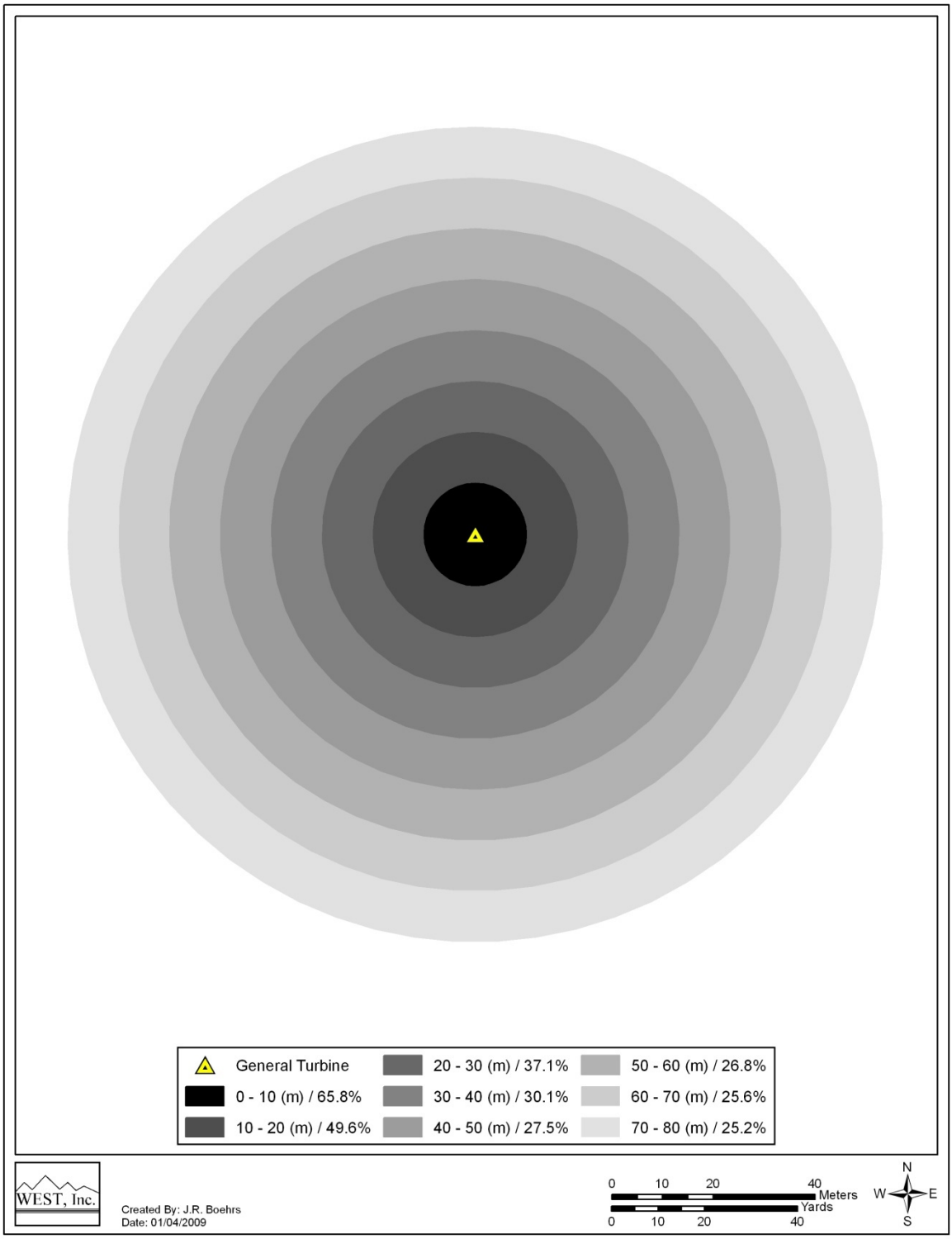

Figure 6. Fatality search area efficiency at Blue Sky Green Field.

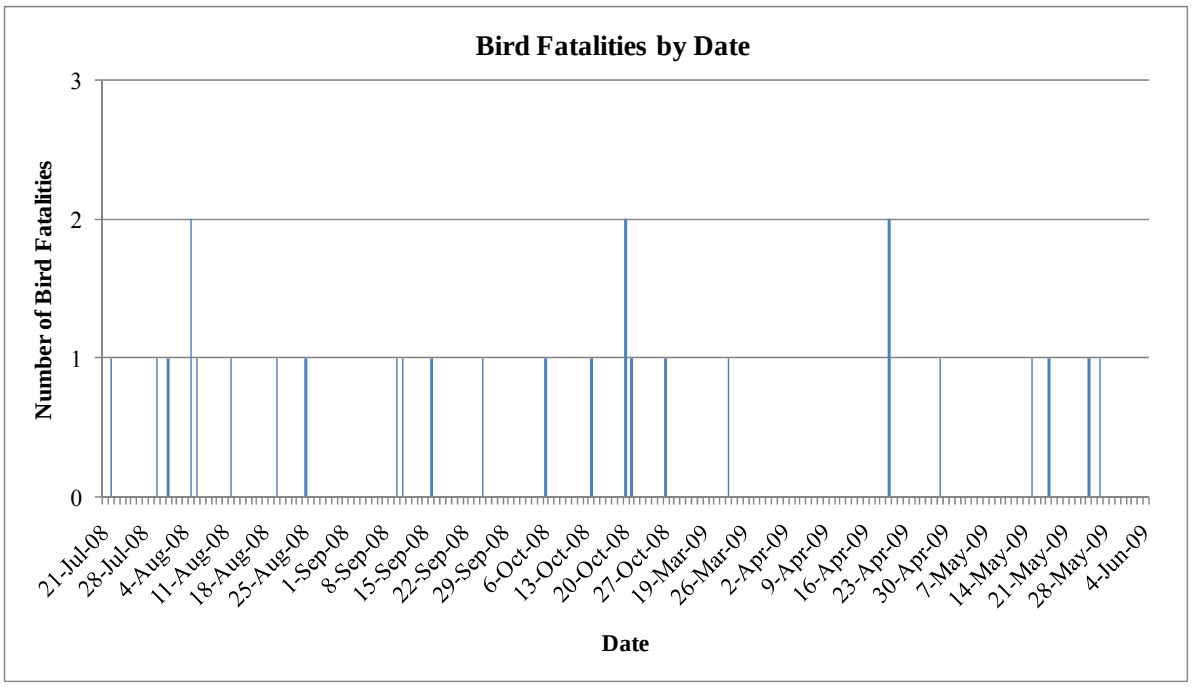

Figure 7. Bird fatalities through time at Blue Sky Green Field. This figure excludes feather spots and carcasses that were too old to reliably estimate time since death.

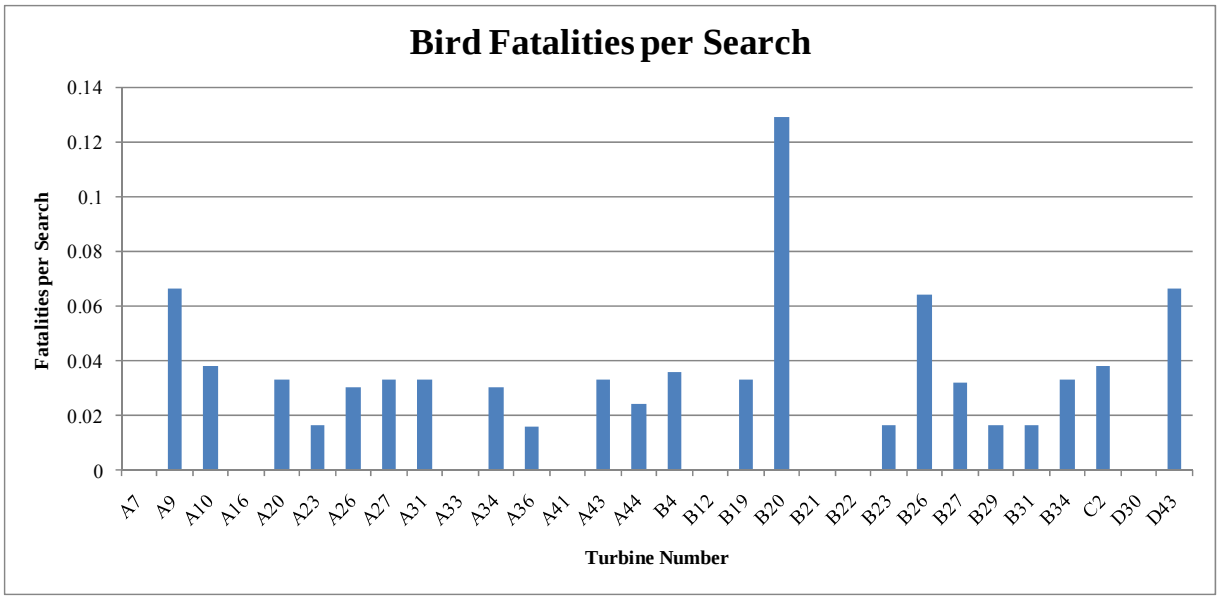

Figure 8. Bird fatalities per search for scheduled search turbines at Blue Sky Green Field.

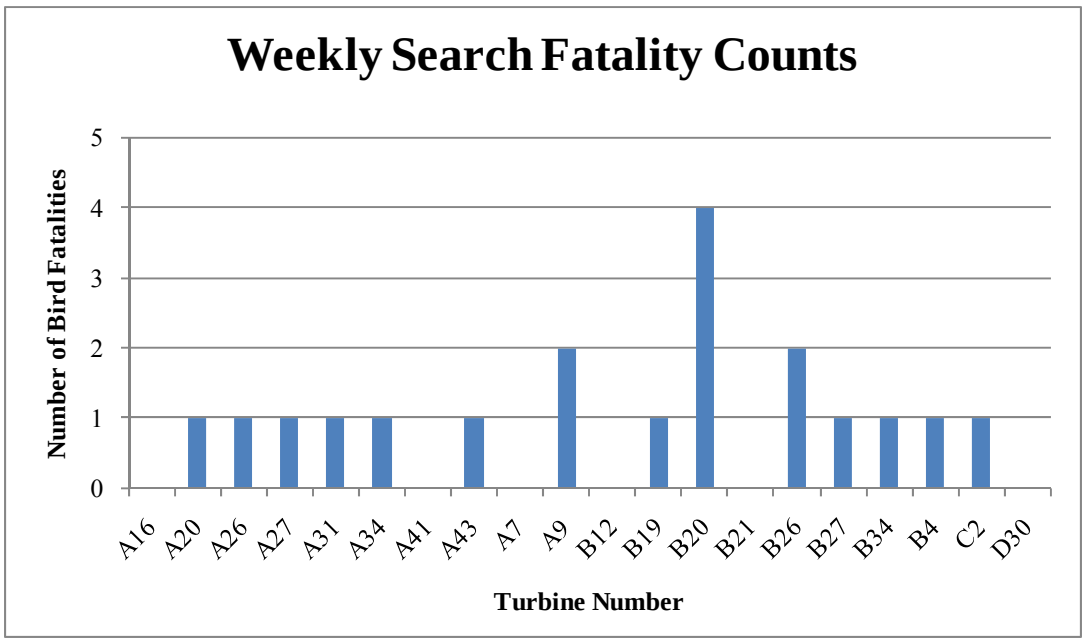

Figure 8.1. Bird fatalities per turbine for turbines searched weekly at the BSGF facility.

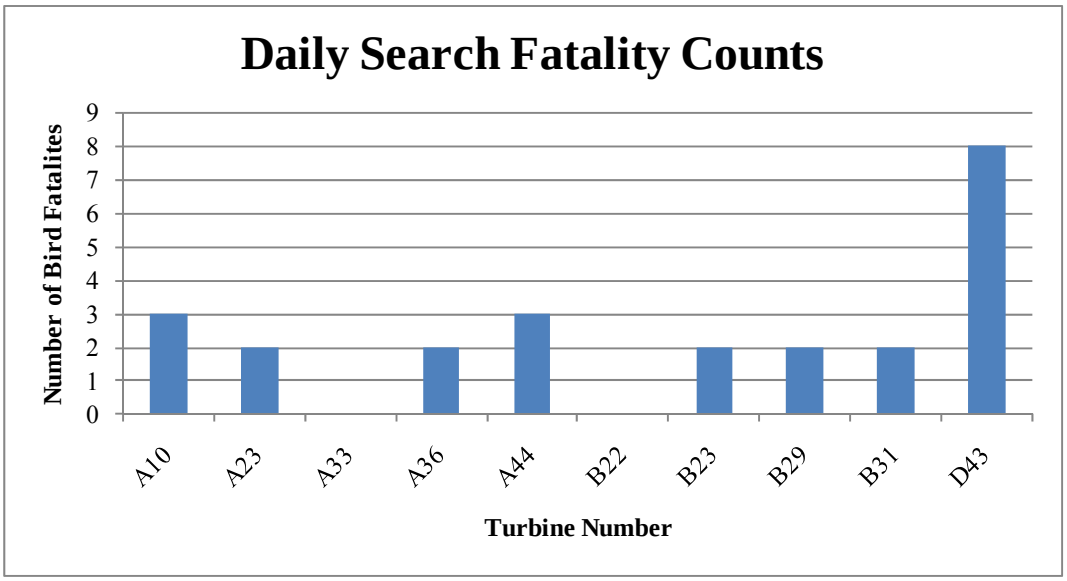

Figure 8.2. Bird fatalities per turbine for turbines searched daily at the BSGF facility.

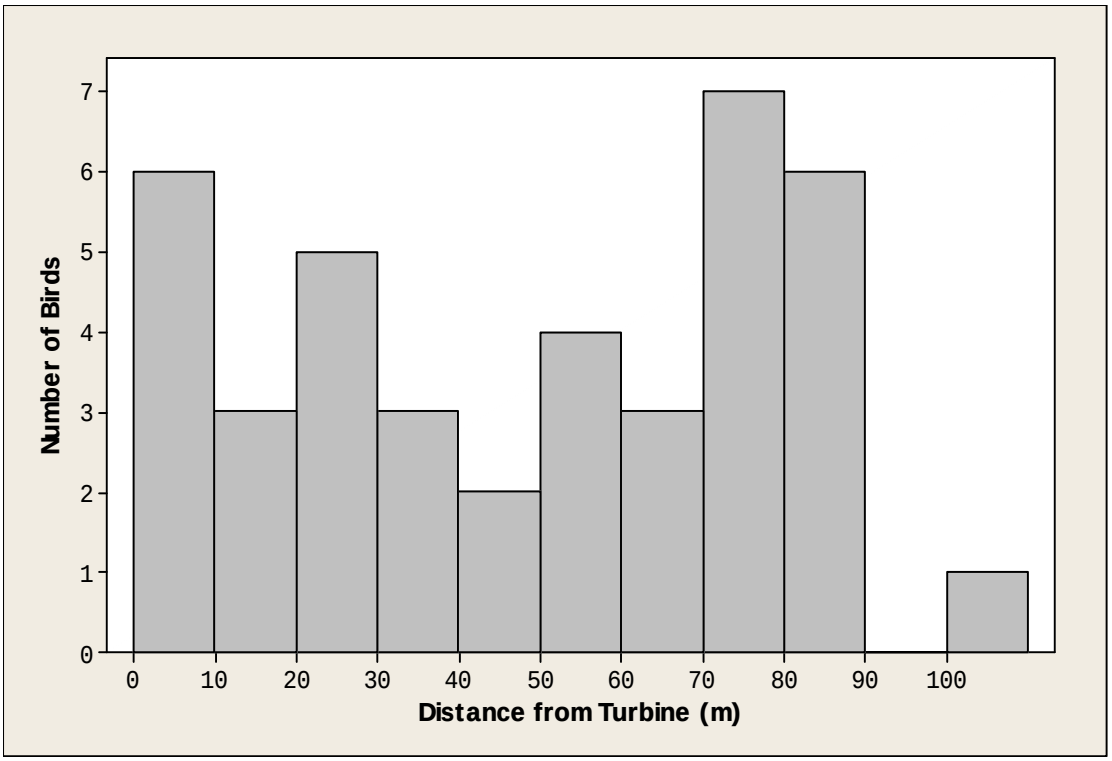

Figure 9. Distance from turbine for bird fatalities at BSGF.

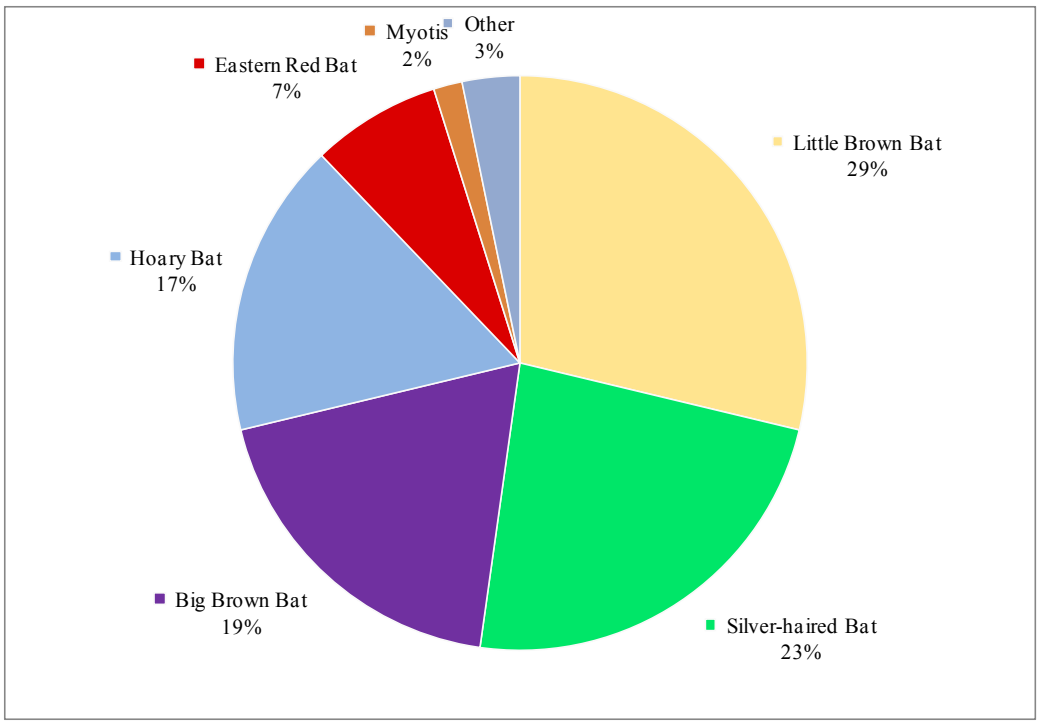

Figure 10. Distribution of bat fatalities during fall 2009 at the BSGF facility.

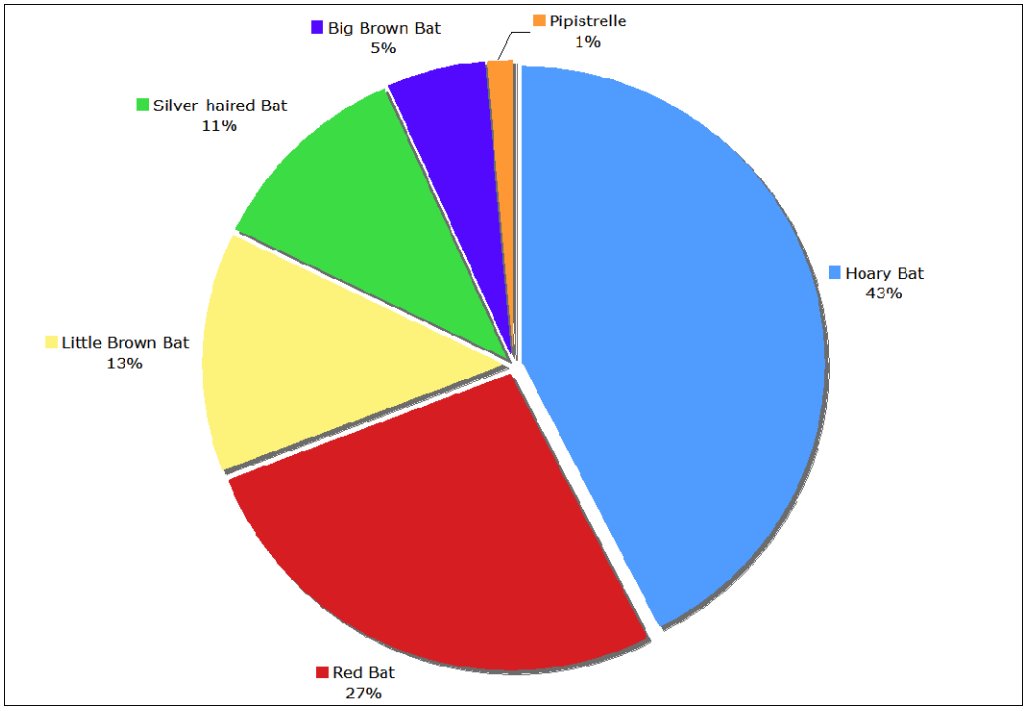

Figure 10.1. Distribution of bat fatalities at three midwestern wind farms with published results (adapted from Arnett et al. 2008).

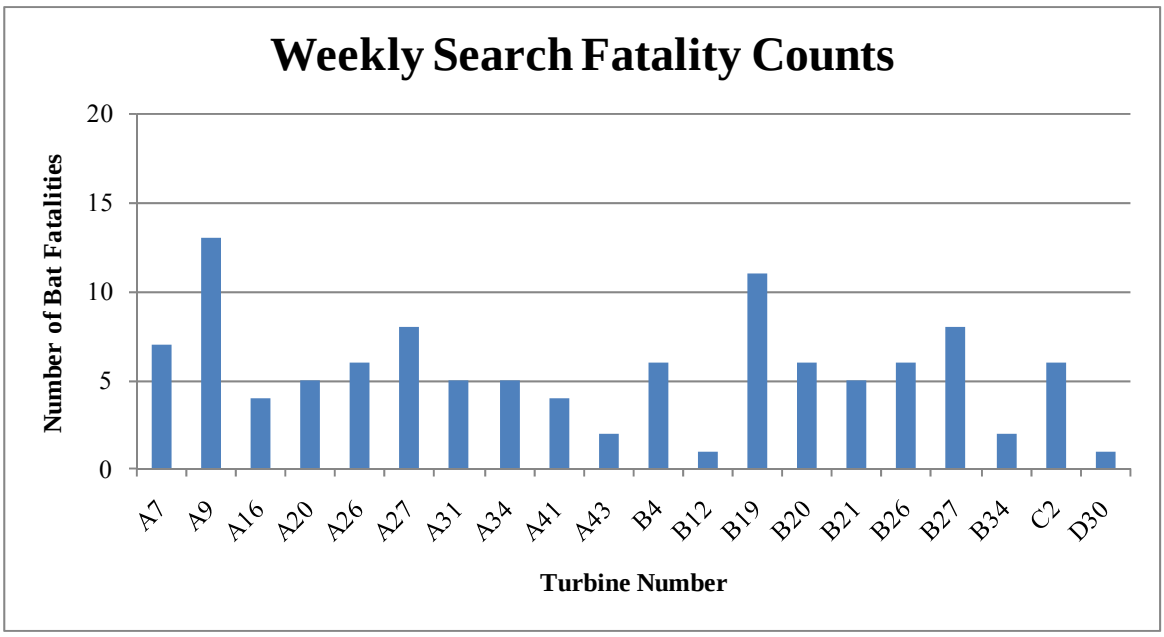

Figure 11. Bat fatalities per turbine for turbines searched weekly at the BSGF facility.

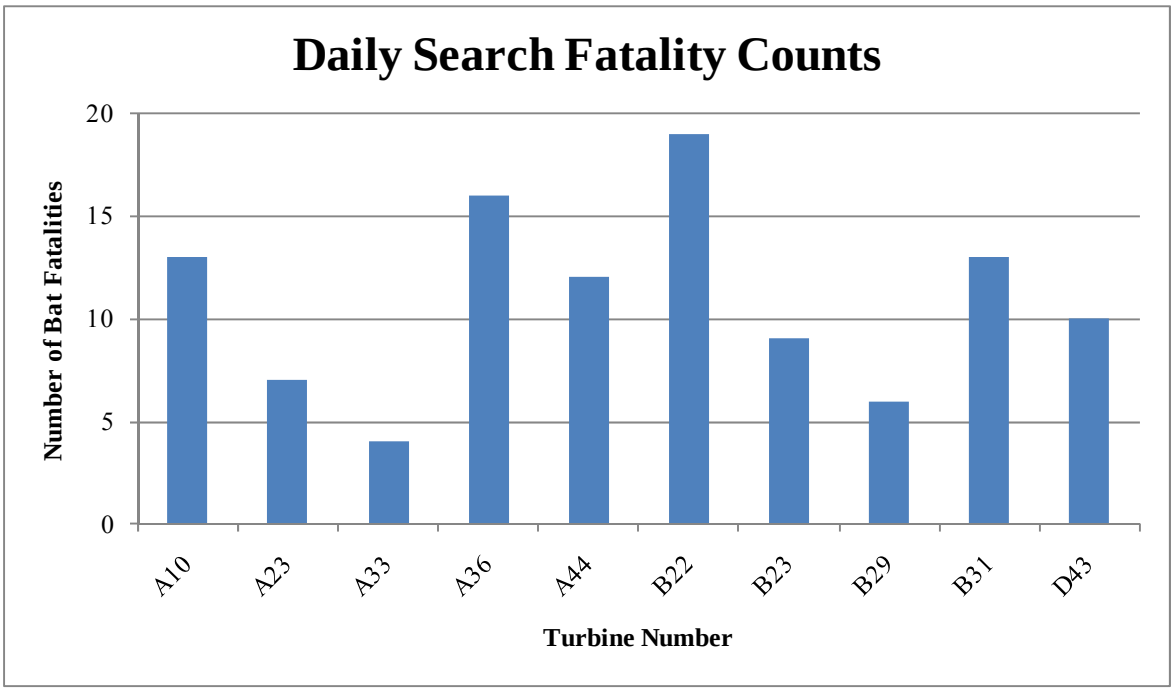

Figure 11.1. Bat fatalities per turbine for turbines searched daily at the BSGF facility.

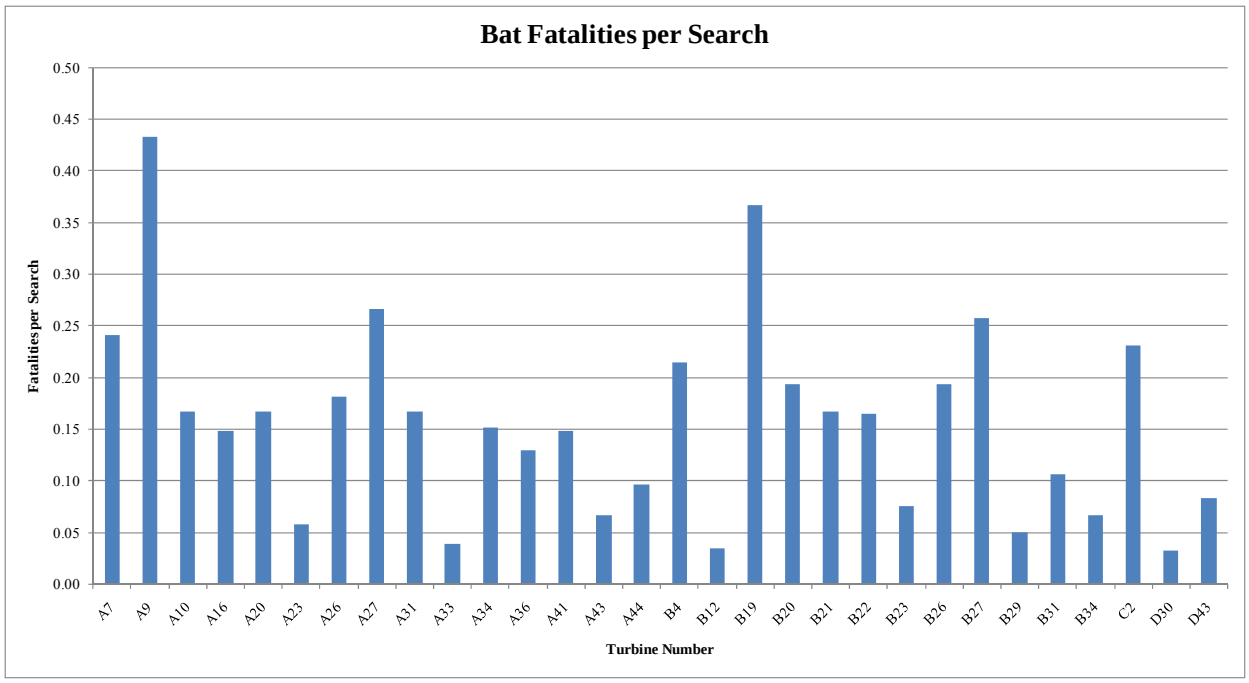

Figure 11.2. Bat fatalities per Search for scheduled search turbines at the BSGF facility.

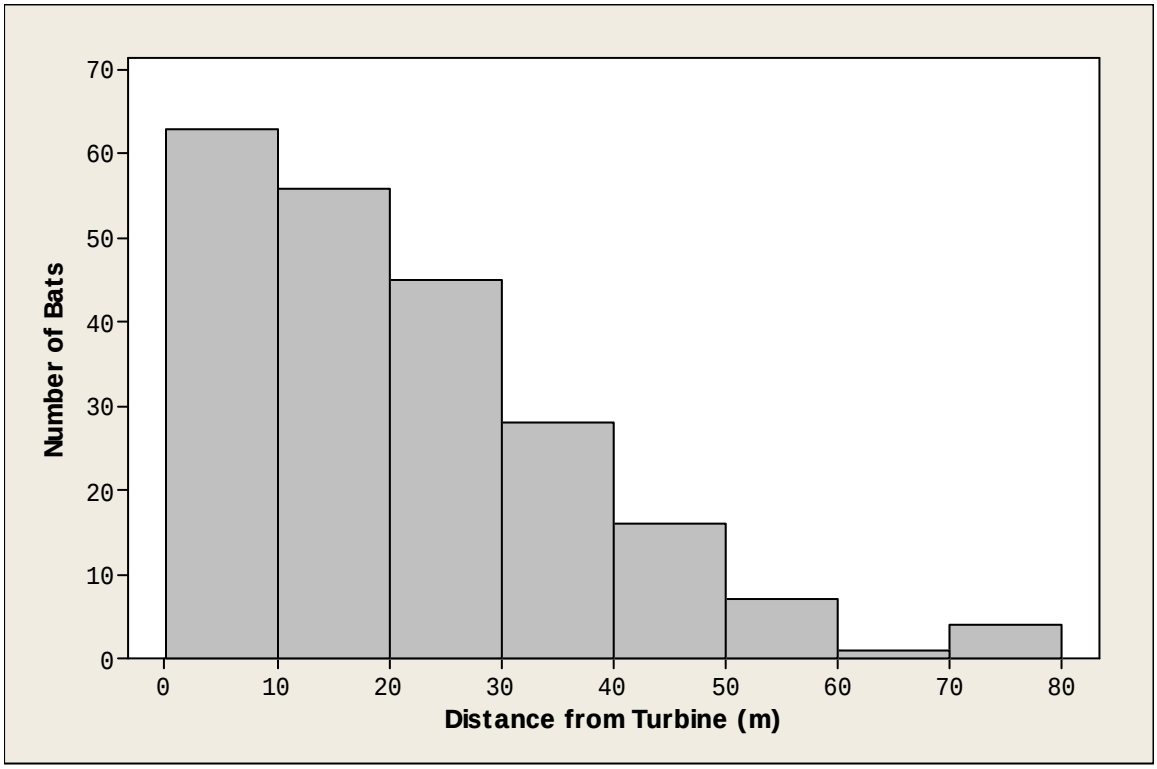

Figure 12. Distance from turbine for bat fatalities at BSGF.

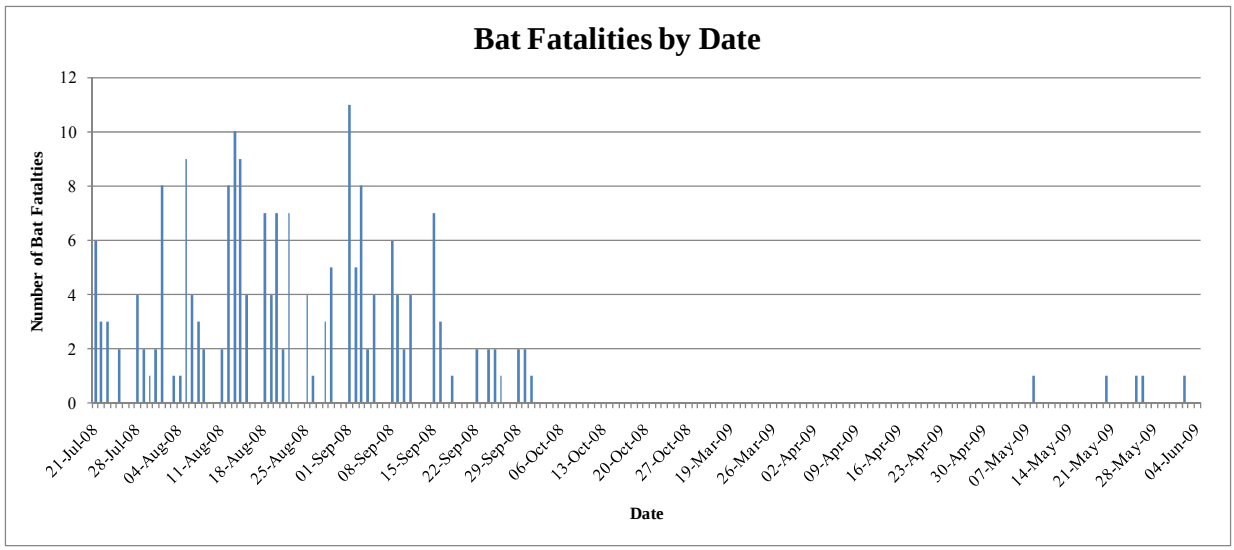

Figure 13. Bat fatalities through time at the BSGF facility.

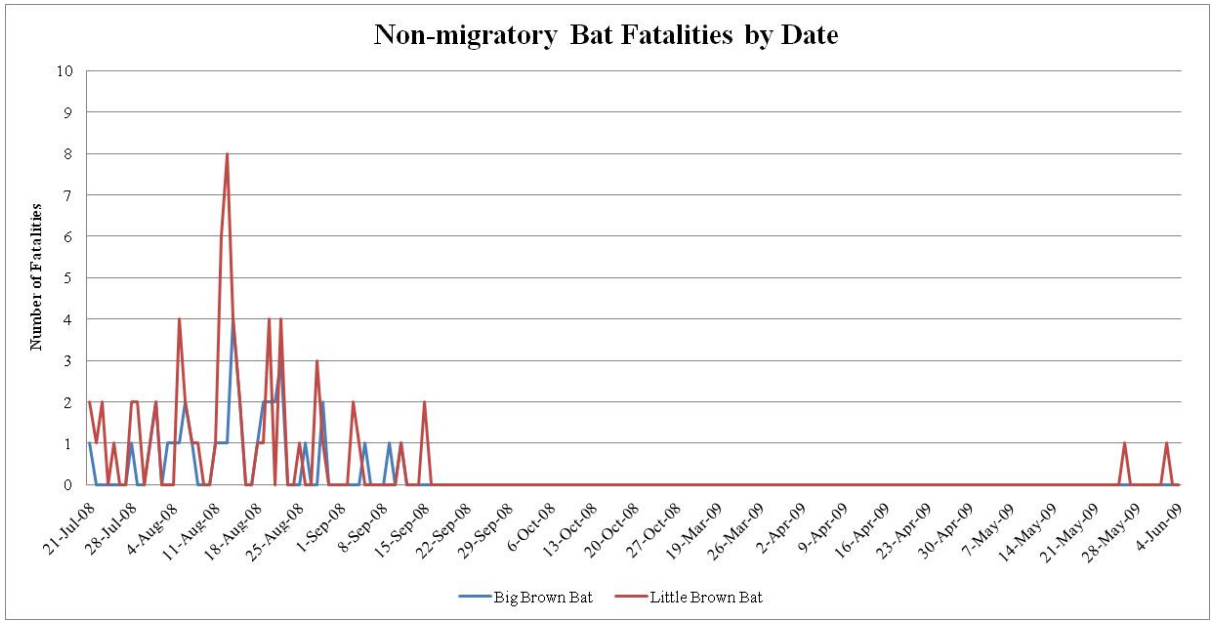

Figure 14. Little brown and big brown bat fatalities through time at the BSGF facility.

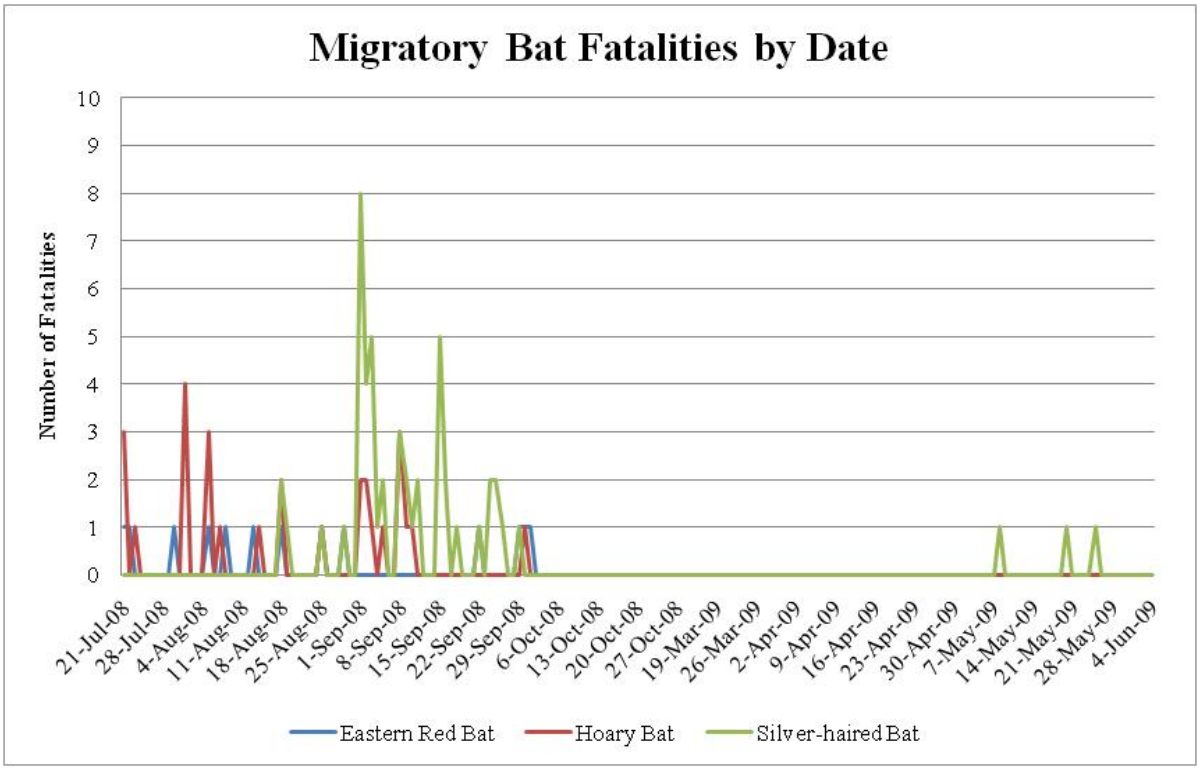

Figure 15. Migratory bat fatalities through time at the BSGF facility.

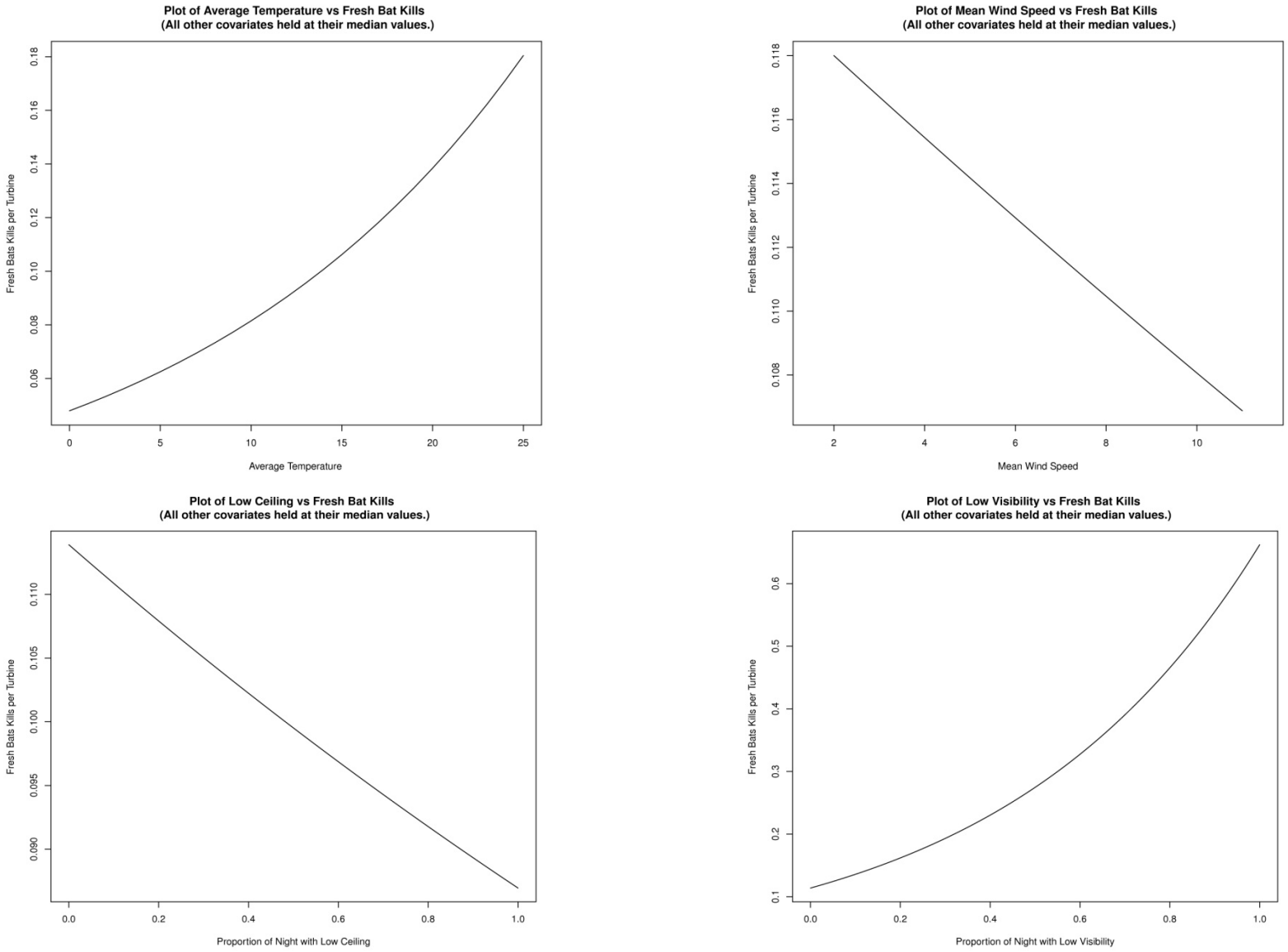

Figure16. Relationship between covariates in the zero-inflated Poisson model and fresh fatalities found the following day.

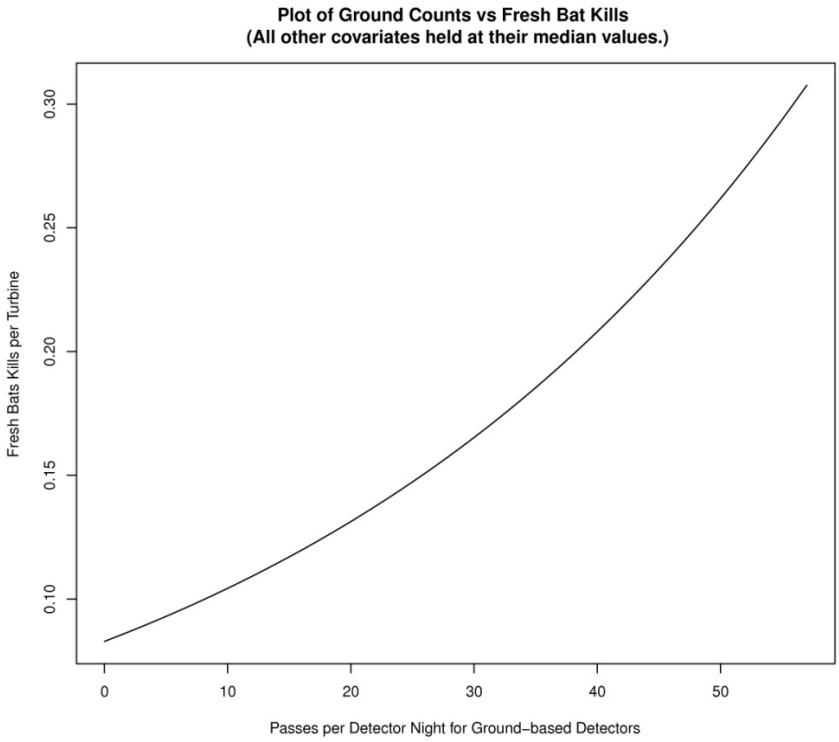

Figure 17. Relationship between mean passes per detector-night recorded at ground-based detectors and fresh fatalities found the following day.

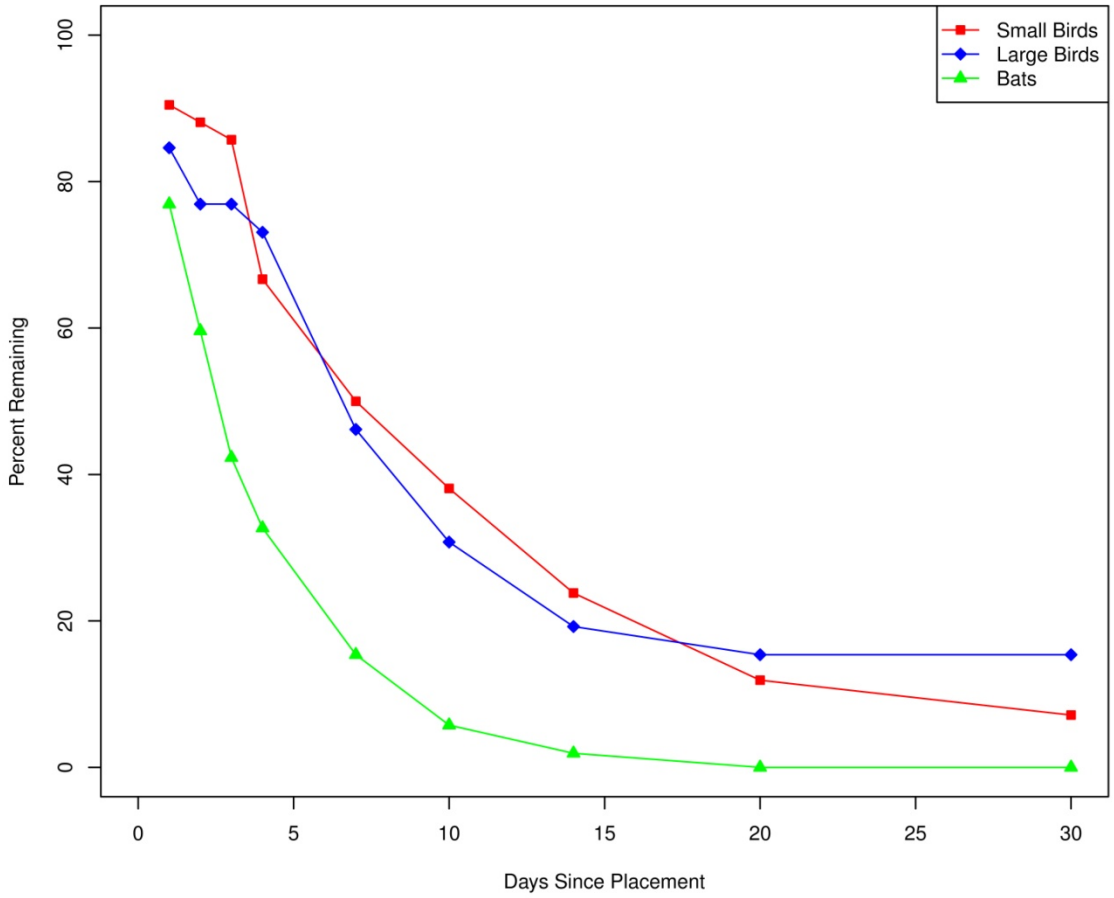

Figure 18. Scavenging trial results for bats, large birds, and small birds at Blue Sky Green Field.

APPENDIX 1. Summary of components used to calculate fatality estimates for daily and weekly searches during the fall and spring seasons at Blue Sky Green Field. Means, standard errors (se), and lower (ll) and upper (ul) 90% confidence limits are bootstrap point estimates.

Table A-1. Fall 2008 fatality estimates and components for birds. Dataset included observations before mowing was complete.

	Daily Searches				Weekly Searches			
			90% C.I.				90% C.I.	
Parameter	***mean***	***se***	***ll***	***ul***	***mean***	***se***	***ll***	***ul***
Search Area Adjustment								
A (small)	6.33							
A (large)	2.11							
Observer Detection								
p (small)	0.60	0.11	0.40	0.75				
p (large)	0.56	0.11	0.40	0.75				
Observed Fatality Rates (Fatalities/turbine)								
Small birds								
$\bar{c}_t$	1.4	0.30	0.90	1.90	0.65	0.13	0.45	0.85
Large birds								
$\bar{c}_t$	0.20	0.12	0	0.40	0	0	0	0
Average Probability of Carcass Availability and Detected								
$\bar{a}_t$ (small)	0.79	0.06	0.66	0.86	0.47	0.08	0.32	0.59
$\bar{a}_t$ (large)	0.82	0.07	0.69	0.90	0.52	0.10	0.34	0.68
Adjusted Fatality Estimates (Fatalities/turbine)								
All birds								
m_i	11.90	2.70	7.76	16.55	8.77	2.57	5.63	13.80
Daily Fatality Rates (Fatalities/turbine/day)								
All birds								
d_i	0.11	0.03	0.07	0.15	0.08	0.02	0.05	0.13

Table A-1.1. Fall 2008 fatality estimates and components for birds. Observations in dataset began when the plot was mowed for the first time.

	Daily Searches				Weekly Searches			
			90% C.I.				90% C.I.	
Parameter	***mean***	***se***	***ll***	***ul***	***mean***	***se***	***ll***	***ul***
Search Area Adjustment								
A (small)	6.78							
A (large)	2.11							
Observer Detection								
p (small)	0.60	0.11	0.40	0.75				
p (large)	0.56	0.11	0.40	0.75				
Observed Fatality Rates (Fatalities/turbine)								
Small birds								
$\bar{c}_t$	1.34	0.31	0.85	1.89	0.60	0.14	0.37	0.83
Large birds								
$\bar{c}_t$	0.21	0.13	0	0.44	0	0	0	0
Average Probability of Carcass Availability and Detected								
$\bar{a}_t$ (small)	0.79	0.06	0.66	0.86	0.47	0.08	0.32	0.59
$\bar{a}_t$ (large)	0.82	0.07	0.69	0.90	0.52	0.10	0.34	0.68
Adjusted Fatality Estimates (Fatalities/turbine)								
All birds								
m_i	12.11	2.96	7.94	17.56	8.62	2.96	4.96	14.63
Daily Fatality Rates (Fatalities/turbine/day)								
All birds								
d_i	0.11	0.03	0.07	0.16	0.08	0.03	0.05	0.14

Table A-2. Fall 2008 fatality estimates and components for all bats and bats by migratory status. Dataset included observations before mowing was complete.

	Daily Searches				Weekly Searches			
			90% C.I.				90% C.I.	
Parameter	***mean***	***se***	***ll***	***ul***	***mean***	***se***	***ll***	***ul***
Search Area Adjustment								
A	2.58							
Observer Detection								
p	0.70	0.07	0.57	0.81				
Observed Fatality Rates (Fatalities/turbine)								
All bats								
$\bar{c}_t$	10.5	1.45	8.10	13.00	5.45	0.65	4.40	6.50
Non-migratory bats								
$\bar{c}_t$	6.2	1.13	4.28	8.10	2.70	0.51	2.91	3.61
Migratory bats								
$\bar{c}_t$	4.30	0.56	3.40	5.30	2.75	0.35	2.15	3.35
Average Probability of Carcass Availability and Detected								
$\hat{R}_t$	0.71	0.04	0.63	0.77	0.35	0.04	0.28	0.42
Adjusted Fatality Estimates (Fatalities/turbine)								
All bats								
m_i	38.32	5.92	29.46	49.24	39.83	7.21	30.02	53.74
Non-migratory bats								
m_i	22.63	4.43	15.61	30.48	19.73	4.57	13.61	28.13
Migratory bats								
m_i	15.69	2.28	12.15	19.90	20.10	3.79	14.95	27.28
Daily Fatality Rates (Fatalities/turbine/day)								
All bats								
d_i	0.35	0.05	0.27	0.46	0.37	0.07	0.28	0.50
Non-migratory bats								
d_i	0.21	0.04	0.14	0.28	0.18	0.04	0.13	0.26
Migratory bats								
d_i	0.15	0.02	0.11	0.18	0.19	0.04	0.14	0.25

Table A-2.1. Fall 2008 fatality estimates and components for all bats and bats by migratory status. Dataset began when the plot was mowed for the first time.

	Daily Searches				Weekly Searches			
			90% C.I.				90% C.I.	
Parameter	*mean*	*se*	*ll*	*ul*	*mean*	*se*	*ll*	*ul*
Search Area Adjustment								
A	2.65							
Observer Detection								
p	0.70	0.07	0.57	0.81				
Observed Fatality Rates (Fatalities/turbine)								
All bats								
$\bar{c}_t$	10.20	1.55	7.68	12.82	5.21	0.66	4.17	6.35
Non-migratory bats								
$\bar{c}_t$	5.82	1.06	4.09	7.60	2.49	0.53	1.69	3.43
Migratory bats								
$\bar{c}_t$	4.38	0.67	3.31	5.50	2.72	0.37	2.12	3.31
Average Probability of Carcass Availability and Detected								
$\hat{\pi}_t$	0.71	0.04	0.63	0.77	0.35	0.04	0.28	0.42
Adjusted Fatality Estimates (Fatalities/turbine)								
All bats								
m_i	38.23	6.40	28.69	49.52	39.11	7.29	28.95	53.13
Non-migratory bats								
m_i	21.81	4.28	15.37	29.29	18.68	4.73	11.92	28.03
Migratory bats								
m_i	16.41	2.75	12.25	21.24	20.42	4.01	15.03	27.78
Daily Fatality Rates (Fatalities/turbine/day)								
All bats								
d_i	0.35	0.06	0.27	0.46	0.36	0.07	0.27	0.49
Non-migratory bats								
d_i	0.20	0.04	0.14	0.27	0.17	0.04	0.11	0.26
Migratory bats								
d_i	0.15	0.03	0.11	0.20	0.19	0.04	0.14	0.26

Table A-3.1. Spring 2009 fatality estimates and components for birds.

Parameter	*mean*	*se*	90% C.I. *ll*	90% C.I. *ul*
Observer Detection				
p (small birds)	0.67	0.06	0.56	0.78
p (large birds)	0.89	0.07	0.78	1

	Daily Searches (not fully cleared)				**Daily Searches (fully cleared)**				**Weekly Searches**			
Search Area Adjustment												
A (small)	5.39				1.13				6.45			
A (large)	---				---				4.49			
			90% C.I.				90% C.I.				90% C.I.	
Parameter	*mean*	*se*	*ll*	*ul*	*mean*	*se*	*ll*	*ul*	*mean*	*se*	*ll*	*ul*
Observed Fatality Rates (Fatalities/turbine)												
Small birds												
$\bar{c}_t$	0.14	0.13	0	0.43	1.33	1.09	0	2.67	0.25	0.12	0.05	0.45
Large birds												
$\bar{c}_t$	0	0	0	0	0	0	0	0	0.05	0.05	0	0.15
Average Probability of Carcass Availability and Detected												
$\hat{\pi}_t$ (small)	0.91	0.02	0.86	0.94	0.91	0.02	0.86	0.94	0.70	0.05	0.61	0.78
$\hat{\pi}_t$ (large)	0.96	0.02	0.91	0.99	0.96	0.02	0.91	0.99	0.87	0.08	0.70	0.95
Adjusted Fatality Estimates (Fatalities/turbine)												
All birds												
m_i	0.85	0.80	0	2.53	1.66	1.37	0	3.48	2.55	1.15	0.90	4.66
Daily Fatality Rates (Fatalities/turbine/day)												
All birds												
d_i	0.01	0.01	0	0.03	0.02	0.02	0	0.04	0.03	0.02	0.01	0.06

Table A-3.2. Spring 2009 fatality estimates and components for all bats and bats by migratory status

Parameter	*mean*	*se*	90% C.I. *ll*	90% C.I. *ul*
Observer Detection				
p (small birds)	0.67	0.06	0.56	0.78
p (large birds)	0.89	0.07	0.78	1

	Daily Searches (not fully cleared)	**Daily Searches (fully cleared)**	**Weekly Searches**
Search Area Adjustment			
A	4.74	1.07	2.99

			90% C.I.				90% C.I.				90% C.I.	
Parameter	*mean*	*se*	*ll*	*ul*	*mean*	*se*	*ll*	*ul*	*mean*	*se*	*ll*	*ul*
Observed Fatality Rates (Fatalities/turbine)												
All bats												
$\bar{c}_i$	0.29	0.17	0	0.57	0.33	0.27	0	0.67	0.1	0.07	0	0.2
Migratory bats												
$\bar{c}_i$	0.14	0.14	0	0.43	0.33	0.27	0	0.67	0.05	0.05	0	0.15
Non-migratory bats												
$\bar{c}_i$	0.14	0.13	0	0.43	0	0	0	0	0.05	0.05	0	0.15
Average Probability of Carcass Availability and Detected												
$\hat{\pi}_i$	0.64	0.12	0.38	0.78	0.64	0.12	0.38	0.78	0.30	0.10	0.13	0.46
Adjusted Fatality Estimates (Fatalities/turbine)												
All bats												
m_i	2.11	1.59	0	5.07	0.56	0.52	0	1.48	0.99	1.16	0	3.24
Migratory bats												
m_i	1.05	1.19	0	3.33	0.56	0.52	0	1.48	0.50	0.76	0	1.97
Non-migratory bats												
m_i	1.05	1.17	0	3.21	0	0	0	0	0.50	0.77	0	1.92
Daily Fatality Rates (Fatalities/turbine/day)												
All bats												
d_i	0.03	0.02	0	0.06	0.01	0.01	0	0.02	0.01	0.01	0	0.04
Migratory bats												
d_i	0.01	0.01	0	0.04	0.01	0.01	0	0.02	0.01	0.01	0	0.02
Non-migratory bats												
d_i	0.01	0.01	0	0.04	0	0	0	0	0.01	0.01	0	0.02

Post-construction Avian Point-Count Study Report

Blue Sky Green Field Wind Project

Fond du Lac County, Wisconsin

Prepared by:

Dr. Noel J. Cutright

Prepared for:

We Energies

March 2009

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Summary

On 23 dates between mid-August and mid November 2008, 10-min avian point counts were made at 30 wind turbine locations at the Blue Sky Green Field wind farm. Seventy-three bird species and 25,512 individual birds were tallied. Three species, Red-winged Blackbird, Ring-billed Gull, and Canada Goose, accounted for 84% of the individuals counted. Data are summarized for the first 3 min, the first 5 min, and for the total 10-min counting period. Ten of the 73 species have some special status as designated by the Wisconsin Department of Natural Resources. The number of species observed at a turbine location ranged between 10 and 34, and the number of individuals observed at a turbine location ranged between 64 and 5,434. A large majority of the birds tallied were more than 100 m from the turbine. Approximately 75% of the birds were observed in flight, and 66% of these flew below 125 ft. A large proportion of the Ring-billed Gulls (98%, n = 3,436) flew in the rotor-swept zone.

A comparison of avian point-count data collected during fall 2005 and 2008 at the Blue Sky Green Field site demonstrated that reasons for observed differences in numbers of species and individuals are difficult to identify and assess. Data variability among years, locations, and daily counts illustrate the difficulties of using abundance data to show that a particular change in the landscape is a reason for an observed change in bird populations.

Avian point-count data collected at operating wind turbines during fall bird migration at the Blue Sky Green Field project did not relate well to bird fatality data obtained at the same turbine locations. After completing analysis of the fall data, I recommended that a similar point count survey scheduled for spring 2009 be terminated as it will not provide any clarification or correlation with bird fatality data. Upon review of the data, the Wisconsin Department of Natural Resources and Public Service Commission of Wisconsin agreed that a spring survey would not provide significant data.

Project Description

The Blue Sky Green Field (BSGF) wind farm is located in the Town of Calumet in Fond du Lac County, Wisconsin, approximately 10-14 mi east-northeast of the city of Fond du Lac. The landscape is largely agricultural, with some scattered deciduous woodlands and a few small wetlands. The wind farm consists of 88 turbines, each capable of producing 1.65 MW of electricity (Figure 1). All of the turbines are located in agricultural areas and most are completely surrounded by cropland. The degree of restoration and re-vegetation of the buffer surrounding the gravel turbine pads and access roads observed during fall 2008 differed among the turbine locations. Each of the turbine locations experienced some manipulation of crops, primarily corn, soybeans, and alfalfa, starting in mid-summer to accommodate bird and bat fatality searches. With a hub height of 262 ft, the 134-ft blades result in a total turbine height of 397 ft. Turbine operation began in May 2008.

Methodology

A pre-construction avian point-count study was conducted by Dr. Noel J. Cutright at the BSGF project on 30 dates at an approximately 8-day interval from 29 March 2005 through 19

November 2005 (Cutright 2006). Three-min counts were made of birds identified at 36 road-side locations on these 30 dates.

To continue monitoring bird use in the immediate vicinity of the turbines and to assess whether these observations might relate to bird mortality being documented at the wind project during fall 2008, Dr. Cutright made 23, 10-min point counts over a 3-month period (mid-August until mid-November) during fall migration. Bird point counts were conducted twice a week during this period. Instead of using any of the pre-construction roadside point count locations, post-construction point count locations were centered at the 30 turbines used for the bat and bird fatality monitoring study (Figure 1).

At all 30 count locations (turbine numbers A07, 09, 10, 16, 20, 23, 26, 27, 31, 33, 34, 36, 41, 43, 44, B04, 12, 19, 20, 21, 22, 23, 26, 27, 29, 31, 34, C02, D30, and 43), 10-min counts were made. Bird data for each of these 10-min counts were partitioned into a 3-min, followed by a 2-min, and finally a 5-min period.

During the 10-minute counts, birds seen within a 0.25-mi radius or heard were recorded and placed into one of three categories based on the estimated distance from the turbine: <50 m, 50-100 m, and >100 m. Flying birds were placed into one of three flight height categories: <128 ft, 128-397 ft, and >397 ft; direction of flight was noted when applicable but are not discussed here. Presence of three introduced species, Rock Pigeon, European Starling, and House Sparrow, was ignored. Each point count survey was started in early morning and was completed in early afternoon. Surveys were conducted under suitable weather conditions. At the beginning and end of the survey, the time and the following weather conditions were noted: temperature, visibility, cloud cover, wind speed, and precipitation. Notes were made of any interesting bird behavior and any other items of interest. The order that the count locations were visited was rotated from survey to survey to minimize any time-of-day bias.

Results and Discussion

A. *Results of Fall 2008 Avian Point Counts*

Twenty-three avian point count surveys were made between 17 August 2008 and 11 November 2008. The earliest and latest times that a survey started in the morning were 5:45 and 7:57 (median = 6:50 a.m.), and the earliest and latest times that a survey ended in the afternoon were 1:07 and 3:30 (median = 2:08 p.m.). A total of 115.0 hr (23 surveys x 30 turbine locations x 10 min) was spent during the active counting period.

A total of 73 species and 25,512 individuals was observed on the 23 surveys (Table 1), with Red-winged Blackbird accounting for 61% of the total. The top three species in numbers, Red-winged Blackbird, Ring-billed Gull, and Canada Goose, accounted for 84% of the total. Excluding these three species, the total number of individuals observed was 4,099.

Approximately 1,000 Red-winged Blackbirds were observed on 4 dates (19 August, and 2, 5, and 29 September), with a peak of 7,630 observed on 16 September. The marshes east of the project area were used as nighttime roosts by migrating blackbirds. Approximately 91% of the 4,171 Ring-billed Gulls counted came from 2 survey dates – 24 and 29 September. Geese

were observed on 15 of the 23 surveys, but 70% of the total (n = 1,590) were counted during 4 surveys between 24 September and 3 October.

The 7 other species rounding out the top 10 in number of individuals were Brown-headed Cowbird (n = 751), American Crow (n = 391), Killdeer (n = 335), Horned Lark (n = 324), Mourning Dove (n = 319), American Goldfinch (n = 307), and American Robin (n = 218). Fifteen species or 21% of the total number of species observed (n = 73) were represented by a single individual.

Table 2 presents data for the first 3 min of the 10-min count period, and Table 3 presents data for the first 5 min (3 min + the next 2 min) of the 10-min count period. Table 4 summarizes the numbers of species and individuals tallied for each of the three time periods (3, 5, and 10 min) using data contained in Tables 1, 2, and 3. As expected, the number of species and individuals increased as the length of the count period increased, because birds move into the area being surveyed, move inside the count area to become visible to the observer, or begin to signal their presence by vocalizing. The number of species tallied for the survey increased 9% when the count period was extended to 5 min from 3 min and 33% when the count was extended to 10 min from 5 min. A greater percent increase was observed among time periods when numbers of individuals are considered compared with numbers of species. Individuals increased 27% when the count period was extended to 5 min from 3 min and 165% when the count was extended to 10 min from 3 min. The number of individuals tallied during the first 5 min of counting was similar to that for the 2nd 5 min (12,202 for 1st 5 min and 13,310 for the 2nd 5 min).

The Wisconsin Department of Natural Resources (WDNR, 2007) lists 115 bird species as either Endangered, Threatened, or of Special Concern. Ten of the 73 species observed during point- count surveys are included on this "Working List." One Osprey* was observed on the wind project area on 22 August. The Osprey was recently downlisted by the WDNR from a Threatened status to a species of Special Concern. Only 1 (Upland Sandpiper*) of the other 9 species is currently being actively tracked by WDNR's Natural Heritage system. Three Upland Sandpipers were observed calling and flying over the wind project area on 25 August. Great Blue Heron (2 sightings on 2 dates), Northern Harrier* (2 sightings on 2 dates), Purple Martin (2 sightings on 1 date), Sedge Wren (4 singing birds on 4 dates at the same location), Brown Thrasher (2 sightings on 2 dates), Bobolink* (11 birds on 4 dates), Eastern Meadowlark* (22 birds on 6 dates), and Rusty Blackbird* (1 bird) are not actively tracked by WDNR's Natural Heritage system.

In the recently completed Wisconsin Wildlife Action Plan (WDNR 2006), there are 84 bird species that are listed as Species of Greatest Conservation Need (SGCN). Six of the 10 species listed above are SGCN species.

The number of species (n = 73) observed at a turbine location ranged between 10 and 34 (mean = 19.2, median = 17.5), and the number of individuals (n = 25,512) observed at a turbine location ranged between 64 and 5,434 (mean = 850, median = 458, Table 5). Total numbers of species and individuals identified at each of the 30 point-count locations (turbine

* Species included as "Species of Greatest Conservation Need" (SGCN) by WDNR

locations) are shown in Figure 2. Detailed count data by species and date for each turbine location are given in Table 6.

The two locations with the highest number of individuals were A36 (n = 5,434) and A34 (n = 4,814) that are located near Kiel Road immediately west of the cat-tail marsh that is associated with the Manitowoc River. Red-winged Blackbirds using this marsh as a nighttime roost were observed at A36 and A34 as they flew from the roost in the morning. Red-wings accounted for 96% and 90% of the individuals observed at these two locations. This species also accounted for 93% of the sightings at B26 where the 5th highest total of individuals was attained. This location is almost 3 miles south of A36 and A34 but also is located near and west of the wetland.

A large flock of Ring-billed Gulls that were using an agricultural field near location A43 was the major contributor to A43 being the location of the 3rd highest number of individuals. This one flock on a single date accounted for 96% of the total observed at this location. The location with the 4th highest total was A7a, and unlike the other four locations that were ranked highest, the total here was influenced by the number of species identified. This location was tied with location A44 for the highest number of species observed (n = 34).

Two of the top three locations with the lowest numbers of individuals were A10 (n = 64) and A9 (n = 66), located in the northwest corner of the wind project area.

Observations of birds were placed into three categories based on the estimated distance from the turbine when they were tallied. The distance categories were <50 m, 50-100 m, and >100 m. Distance data are presented in Table 7. As expected, most birds (89%) were more than 100 m from the turbine. For species with more than one individual observed, only 3 species (House Wren, Yellow Warbler, and Savannah Sparrow), all of which are small landbirds, had more individuals in the <50 m zone that either of the other two distance categories. For the 50-100 m zone, there were 10 species (Downy Woodpecker, Horned Lark, Eastern Bluebird, Gray Catbird, Cedar Waxwing, Chipping Sparrow, White-throated Sparrow, Brown-headed Cowbird, House Finch, and American Goldfinch) with multiple observations that were observed more often within this distance than either of the other two distances.

Birds observed in flight were placed into one of three height categories: <128 ft, 128-397 ft, or >397 ft. These heights represent a low zone beneath the sweep of the turbine blades, a medium zone that is within the rotor-swept area, and a high zone that is above the reach of the blade tips. Some birds were only heard in flight, such as the 3 Upland Sandpipers, and because they were not seen, no height could be estimated for these flying birds. Flight-height data are presented in Table 8. Flight heights were estimated for 38 species or 52% of the total species identified. A majority (75%) of the birds tallied during the study were observed in flight, with two-thirds of these recorded in the lowest zone. Red-winged Blackbirds dominated this low zone with 88% of the total of 12,694 birds. Other common species with more than 90% of the sightings in the low-height category were Sandhill Crane (91%, n = 45), Mourning Dove (98%, n = 44), Barn Swallow (100%, n = 56), American Robin (100%, n = 52), Cedar Waxwing (100%, n = 107), Brown-headed Cowbird (100%, n = 77), and American Goldfinch (95%, n = 199).

The most notable species in the medium category was Ring-billed Gull (98%, n = 3,436). Of the eight species observed in flight within this medium category, only three species were most often found here. These were the Ring-billed Gull just mentioned, and Turkey Vulture (80%, n = 10) and Killdeer (54%, n = 63). Only 4% of the flying birds were in the highest zone, with only Canada Goose (39%, n = 1,358) and Ring-billed Gull (5%, n = 3,436) being noteworthy.

B. *Comparison of Fall 2005 and Fall 2008 Avian Point Counts*

The 115 hours spent counting during fall 2008 compares with 19.8 hours [11 surveys (between 15 August and 19 November) x 36 roadside locations x 3 minutes] for the 2005 fall survey at BSGF (Cutright 2006). When just the 3-min periods are compared, the 19.8 hr spent counting in 2005 compares with 34.5 hr in 2008.

A total of 79 species was observed on the 11 fall surveys in 2005, with a total of 10,158 individuals. In the 2005 study the top three species for the fall season were ranked in the same order of abundance as for 2008 and accounted for 66% of the total, with Red-winged Blackbird accounting for a third of the total. Excluding these three species, the total number of individuals observed in 2005 was 3,415 compared with 4,099 in 2008. Nineteen species observed during the fall 2005 point-count surveys were not recorded in the fall 2008 surveys, and 12 species observed during the fall 2008 surveys were not recorded during the fall 2005 surveys (Table 9). Of these 12 species, all but 2 (Least Sandpiper and Snowy Owl) were recorded from the project area at some time of the year during the 2005 bird surveys.

Several reasons for explaining the differences in the results between these two surveys other that the amount of counting time can be offered. Six more locations were visited during 2005 than in 2008, and in general, more bird species will be encountered when a greater number of different locations are surveyed. Bird populations and movements vary significantly from location to location and from day to day, especially during the two migratory seasons. Even if the same locations are visited the same number of times during the fall season in succeeding years, differences in results, especially in the number of individuals, can be significant.

The longer the interval between surveys, the greater the results likely will differ because bird populations are continually changing over time. Additionally land management practices will change the vegetative cover from year to year, which may influence local bird populations. The roadside counts used in 2005 were distributed over an area of a greater size than that encompassing the turbine count locations. In general, it is likely that a wider distribution of count locations will result in more species being observed than when count locations are more concentrated.

Movement of traffic and associated noise along roads, as well as operation of farming equipment can influence count numbers as may the presence of operating wind turbines and the associated sounds connected with turbine operation.

Finally, and probably the most important variable, are differences in the vegetative types being sampled. Vegetation near the roadside counts in 2005 was more diverse, creating a greater number of habitat types, which included wetlands, shrublands, nearby residences and farm

buildings, roadside ditches, treelines, and woodlands, than the predominant agricultural vegetation associated with turbine locations surveyed in 2008. A more diverse vegetative landscape generally harbors more bird species.

In summary, comparison of the two data sets from 2005 and 2008 indicate a differing number and set of species present, as well as differing total bird abundance. Because of the number of variables inherent in both the study area and in bird population numbers, it is problematic to directly compare the data sets and attempt to assign specific reasons for the observed differences. For these reasons, the collection of spring migration survey data would likely not have provided data that would help to clarify the comparison of pre- and post-construction data sets.

C. *Relationship of 2008 Avian Point Count Results to 2008 Avian Fatality Data*

Conducted in parallel to the fall 2008 avian point-count survey was a bird fatality study. Results of the fatality study will be reported in more detail and discussed by Gruver et al. (2009). Thirty bird carcasses were found between late July and the end of October during dedicated searches beneath the same 30 turbines used for the point-count survey. Because of the scarcity of physical evidence or the condition of the carcass (e.g., a portion of a skeleton, bones, or a few feathers), 16 carcasses could only be identified as being a bird. For the other 14 carcasses, identification was possible to a species level for 11 carcasses. The 14 carcasses included Golden-crowned Kinglet (n = 4), Tree Swallow (n = 2), and 1 individual each of an unidentified swallow species, Horned Lark, Cedar Waxwing, Savannah Sparrow, an unidentified sparrow species, Eastern Meadowlark, an unidentified meadowlark species, and Brown-headed Cowbird. The 7 identified species also were identified during point counts. Presence and abundance of species recorded during the point counts do not relate well to the identification of carcasses found during the fatality study. If we assume that fatality is directly related to diurnal species abundance in the vicinity of the turbine, we would expect to see a significant percentage of fatalities to include such species as Red-winged Blackbird, Canada Goose and Ring-billed Gull, which did not occur in the fatality study.

All search plots for the fatality study measured 160 m on a side centered on the turbine, and the search area within a plot was maintained in a low-growth vegetative condition. At 27 turbines, strips where the crop vegetation was managed plus access road and turbine pad were searched, whereas the entire square plot was searched at 3 turbines. Ten turbines, including the 3 turbines where the entire plot was walked, were searched each work day (Monday – Friday), and 20 turbines were searched on a 4-6 day interval. Total number of bird carcasses found at each of the 30 turbines ranged from 0 to a high of 3.

Based only on area searched, we would expect to find more bird fatalities at those turbines where the entire plot was searched than those where a smaller search area was used. Fatalities at the 3 turbines where the entire plot was searched ranged from 0 at A33 to 2 at B31 to 3 at D43, so this possible relationship does not appear to meet expectations.

Based only on search frequency, we would expect to find more bird fatalities at those turbines searched each workday rather than every 4-6 days because a carcass is more likely to be

found before being scavenged at those locations having more frequent searches. This relationship might exist since 17 of the 30 carcasses were found at the 10 turbines searched daily (1.7/turbine), whereas 13 carcasses were found at the 20 more infrequently searched turbines (0.7/turbine).

Turbine location within a wind farm might be expected to be a factor determining the number of fatalities observed. For the 15 turbines searched in the north portion of the project area (north of Schumacher/Calmar Roads), 16 bird carcasses were found, and for the 15 turbines searched south of these roads, 14 carcasses were found. For the 15 turbines searched in the east portion of the project area (east of Townhall/Elm Roads), 17 bird carcasses were found, and for the 15 turbines searched west of these roads, 13 carcasses were found. Turbine location at the Blue Sky Green Field site does not seem to be a major factor or at least not a strong factor associated with number of bird fatalities.

Recent reviews of research indicate that the vast majority of bird fatalities at wind turbines are songbirds, and most of these collisions occur during the birds' nocturnal migratory flights (Kunz et al. 2007, Kuvlesky, et al. 2007, National Academy of Sciences 2007). Such collisions typically account for roughly 75% of bird fatalities at U. S. wind facilities, resulting in spring and fall peaks in bird fatality rates at most wind facilities. Because of this fact, it is unlikely that diurnal point counts made at turbine locations will relate well to fatalities observed at wind turbines. This appeared to be the situation at Blue Sky Green Field during fall 2008. When both species richness and abundance at each of the 30 turbine locations are compared, there appears to be no relationship between fatality locations and species richness/abundance (Table 10).

The temporal pattern of fatalities showed a distribution across the months, and although there was an increase in both days with at least one bird and number of birds per day in October, the magnitude of the increase is small and its significance is equivocal (Gruver et al. 2009).

When point-count abundance is compared with the number of individuals found for the 7 bird species positively identified as fatalities, there is no apparent relationship (Table 11).

In summary, there are no apparent correlations between the data from the fall bird migration survey and the bird fatality data. It seems apparent that the fall migration survey data are not an accurate predictor for species killed or total number of fatalities. In December 2008, I recommended that the spring bird migration point-count survey for this project site be terminated. Ms. Shari Koslowski of the Wisconsin Department of Natural Resources reviewed the draft of this document at that time and based on the data collected, determined that it was unlikely that a spring survey would yield significant data and agreed that the spring portion of this study could be terminated. The Public Service Commission of Wisconsin agreed with this assessment.

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Table 1

List of Birds by Date Observed for
Entire 10 Minute Observation Period

Species	State Status	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Canada Goose				5				61	34	28	81	22	267	82	307	463	9	111	85		21	14			**1590**
Tundra Swan																								10	**10**
Mallard					4						3														**7**
Ring-necked Pheasant												1													**1**
Wild Turkey								5																	**5**
Great Blue Heron	NH:NT						1													1					**2**
Green Heron		1																							**1**
Turkey Vulture						3					1					2	5	1							**12**
Osprey	T, SGCN			1																					**1**
Northern Harrier	NH:NT, SGCN																1	1							**2**
Cooper's Hawk			1	1	1										1						1				**5**
Red-tailed Hawk		4	6	1	5	1	1	1	3		1		2	2	3	8	2	1	1	2		1		3	**48**
American Kestrel		1	1		1	1	3					1			1		1			1	1	1	1		**14**
Sandhill Crane		2	10	6	4	3	6	15	3	6	8	7		3	5			4		3					**85**
Killdeer		5	17	23	11	10	15	14	55	14	8	7	4	21	14	43	5	32	23	13	1				**335**
Greater Yellowlegs						1																			**1**
Lesser Yellowlegs			1																						**1**
Upland Sandpiper	NH:T, SGCN				3																				**3**
Least Sandpiper		1																							**1**
Pectoral Sandpiper			1																						**1**
Ring-billed Gull			1				4						2500		1294	175	196							1	**4171**
Mourning Dove		4	5	4	3	16	11	47	30	10	11	14	7	20	57	21	18	3	13	19	5			1	**319**
Snowy Owl																							1		**1**
Belted Kingfisher												1													**1**
Red-bellied Woodpecker															1	2	1		1	1				4	**10**
Downy Woodpecker		2				1		1		2	1		2	2	1			1		1	1	4	2	1	**22**
Hairy Woodpecker				1									1	1								1		1	**5**
Northern Flicker		4			1		1	1		4			3	3				2							**19**
Eastern Wood-Pewee			1																						**1**
Eastern Kingbird		5	8	3	1																				**17**
Red-eyed Vireo		1			1	1																			**3**
Blue Jay		5	5	3	3	5	6	5	8	16	10	12	18	24	27	8	7	10	8	8	5	5		5	**203**
American Crow		16	11	16	8	3	30	9	13	7	10	33	16	26	36	15	13	22	24	28	19	19	4	13	**391**
Horned Lark		7	15	2	6	1	3	32	8	21	24	18	8	21	7	22	11	13	18	23	14	21	15	14	**324**
Purple Martin	NH:NT	2																							**2**
Tree Swallow		3									1														**4**
Barn Swallow		22	11	16	5	5	1	1	1																**62**
Black-capped Chickadee									1						2			1		2		5		1	**12**
White-breasted Nuthatch								1				1				1						1		2	**6**
House Wren			1		1	1		1				1	4												**9**
Sedge Wren	NH:NT	1	1	1		1																			**4**
Marsh Wren			1																						**1**
Golden-crowned Kinglet																					1				**1**
Eastern Bluebird												3				3			2		8				**16**
American Robin		10	4	31	6	3	3	3	7	3	8	15	12	1	18	6	7		11	13	46	6		5	**218**
Gray Catbird		2			1	1							2		2	1									**9**
Brown Thrasher	NH:NT, SGCN				1	1																			**2**
Cedar Waxwing		4	1	3		1		2	4	5	6	2	1	4	35				91	34			6		**199**
Tennessee Warbler						1		3																	**4**
Yellow Warbler		1																							**1**
Yellow-rumped Warbler													1		8		4	1		1					**15**
Palm Warbler																			1						**1**
Common Yellowthroat						1								1											**2**
American Tree Sparrow																						1		53	**54**
Chipping Sparrow		4	1		8	4	2	8					6	3	3	1									**40**
Clay-colored Sparrow					1																				**1**
Savannah Sparrow		7	4	3	6	1		9	4		1	2							1	1					**39**

Total Birds for 0 to 10 minute Observation Period

Table 1

List of Birds by Date Observed for
Entire 10 Minute Observation Period

Species	State Status	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Song Sparrow		28	24	13	11	9	4	7	4	3		2	2	3	7	6	3	7	4	11	1				**149**
White-throated Sparrow															6	3	8	1	2	1					**21**
White-crowned Sparrow																		1		1					**2**
Dark-eyed Junco																			13	8	4	4		9	**38**
Lapland Longspur																			5				1		**6**
Northern Cardinal		2	4		2	1		1	1		3	3			2	1	2					1		6	**29**
Indigo Bunting		10	8	2	1			3	3						1										**28**
Bobolink	NH:NT, SGCN		7			1	2	1																	**11**
Red-winged Blackbird		770	1215	87	92	4	966	1053	394	416	7630	32	399	410	1058	23	29	151	120	167	628	5	3		**15652**
Eastern Meadowlark	NH:NT, SGCN	1											1		3	5			8	4					**22**
Rusty Blackbird	NH:NT, SGCN																					1			**1**
Common Grackle				13	5			1							115				1			3			**138**
Brown-headed Cowbird			1				170					13	19		8			444	25	5	66				**751**
Baltimore Oriole		1	2				1																		**4**
House Finch																	3	1		9	10	4	5	7	**39**
American Goldfinch		21	17	25	24	14	8	29	12	7	13	17	9	19	29	15	7	5	7	12	6	4		7	**307**
Total		**947**	**1385**	**260**	**216**	**95**	**1238**	**1314**	**585**	**542**	**7820**	**207**	**3284**	**646**	**3051**	**824**	**332**	**813**	**464**	**369**	**838**	**101**	**38**	**143**	

Total
25,512

NH:T- Natural Heritage Inventory: Tracked Species

SGCN *- Species of Greatest Conservation Need*

T *- Listed as a state threatened species*

NH:NT *- Natural Heritage Inventory - Not a Tracked Species*

Table 3

List of Birds by Date Observed for
3 Minute Observation Period

Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Canada Goose								19	10	50		57	57	67	87		41	85		21				**494**
Mallard				4						3														**7**
Wild Turkey							5																	**5**
Great Blue Heron						1													1					**2**
Turkey Vulture															2	5								**7**
Cooper's Hawk			1	1																1				**3**
Red-tailed Hawk	3	4		4	1	1	1	2				2	1	1	8	1	1	1	2		1		2	**36**
American Kestrel		1		1	1	2					1					1				1	1	1		**10**
Sandhill Crane	2	4	6	2	3		9	3	6	8	7			3			2		3					**58**
Killdeer	1	12	19	4	2	12	13	51	5	7	3	3	19	6	13	3	30	23	7					**233**
Upland Sandpiper				2																				**2**
Pectoral Sandpiper		1																						**1**
Ring-billed Gull														54	175	196								**425**
Mourning Dove	1	3	3	3	13	8	44	29	7	9	5	3	9	4	20	17	2	7		5			1	**193**
Snowy Owl																						1		**1**
Red-bellied Woodpecker														1	1	1							1	**4**
Downy Woodpecker	2				1							1	1	1					1		1	2		**10**
Northern Flicker	2			1		1						1	1				1							**7**
Eastern Kingbird	3	3	3																					**9**
Blue Jay	4	3	2	2		2	3	6	12	7	3	10	20	16	3	1	4	6	5	2	3		3	**117**
American Crow	9	9	12	1	2	2	3	9	4	10	31	11	9	33	9	9	19	19	22	16	14		11	**264**
Horned Lark	6	2	2	4		2	4	8	18	21	4	5	20	3	15	8	6	15	16	10	16	9	14	**208**
Purple Martin	2																							**2**
Tree Swallow	3									1														**4**
Barn Swallow	13	8	9	3																				**33**
Black-capped Chickadee								1						1							2		1	**5**
House Wren		1		1			1					1												**4**
Sedge Wren	1	1	1		1																			**4**
Marsh Wren		1																						**1**
Eastern Bluebird											3				3			2		4				**12**
American Robin	6	4	13		1	2			3	5	8	12		4		2		6	9	18	3		3	**99**
Gray Catbird	1				1							2		1	1									**6**
Brown Thrasher					1																			**1**
Cedar Waxwing	1	1	1		1		1	1	1	2	2		4	35				3	33			6		**92**
Tennessee Warbler							3																	**3**
Yellow-rumped Warbler														2		3	1		1					**7**
Common Yellowthroat					1																			**1**
American Tree Sparrow																					1		50	**51**
Chipping Sparrow				8	1							5		3										**17**
Savannah Sparrow	3	2		5			6	1		1								1						**19**
Song Sparrow	19	18	12	9	4	4	7	2	3			1	2	6	5	1		1	8	1				**103**
White-throated Sparrow														6	3	8	1	2						**20**
Dark-eyed Junco																		13	8	4	4		8	**37**
Lapland Longspur																						1		**1**
Northern Cardinal		2			1			1		2	3			1	1	2							6	**19**
Indigo Bunting	8	3	1	1			3	3						1										**20**
Bobolink							1																	**1**
Red-winged Blackbird	250	3	2	4	1	309	78	322	368	3001	8	262	396	766	1	6	5	58	130	170		1		**6141**
Eastern Meadowlark	1													2				8						**11**
Rusty Blackbird																					1			**1**
Common Grackle			1	4			1							115										**121**
Brown-headed Cowbird												19					444	25		63				**551**
Baltimore Oriole	1	1																						**2**
House Finch																			2	10		5	2	**19**
American Goldfinch	7	9	10	10	4	2	12	4	4	4	7	2	11	18	9	5	5	5	7		1		2	**138**

Total Birds for First 3 minutes Observed

Table 3
List of Birds by Date Observed for
3 Minute Observation Period

Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Total	349	96	98	74	40	348	195	462	441	3131	85	397	550	1150	356	269	562	280	255	326	48	26	104	
																								Total
																								9,642

Table 2

List of Birds by Date Observed for
5 Minute Observation Period

Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Canada Goose								20	10	50		57	62	69	87		41	85		21	14			**516**
Mallard				4						3														**7**
Wild Turkey							5																	**5**
Great Blue Heron						1													1					**2**
Green Heron	1																							**1**
Turkey Vulture															2	5								**7**
Cooper's Hawk			1	1																1				**3**
Red-tailed Hawk	4	5		4	1	1	1	2				2	1	1	8	2	1	1	2		1		2	**39**
American Kestrel	1	1		1	1	2					1					1				1	1	1		**11**
Sandhill Crane	2	7	6	2	3		9	3	6	8	7			3			2		3					**61**
Killdeer	4	14	19	4	4	12	13	51	6	7	4	4	19	6	13	4	30	23	7					**244**
Lesser Yellowlegs		1																						**1**
Upland Sandpiper				2																				**2**
Pectoral Sandpiper		1																						**1**
Ring-billed Gull														904	175	196								**1275**
Mourning Dove	3	3	3	3	13	8	44	29	7	9	6	3	12	7	20	17	2	9		5			1	**204**
Snowy Owl																						1		**1**
Red-bellied Woodpecker														1	1	1			1				2	**6**
Downy Woodpecker	2				1							1	1	1					1		2	2		**11**
Hairy Woodpecker																							1	**1**
Northern Flicker	2			1		1	1		1			1	1				1							**9**
Eastern Wood-Pewee		1																						**1**
Eastern Kingbird	3	5	3																					**11**
Blue Jay	4	3	3	2	2	3	3	7	12	7	4	11	22	21	4	2	4	7	6	3	4		4	**138**
American Crow	9	10	13	6	2	2	4	9	4	10	32	13	12	35	10	9	19	20	22	18	14		13	**286**
Horned Lark	6	3	2	4		2	5	8	18	21	5	5	20	4	17	8	7	15	20	13	18	13	14	**228**
Purple Martin	2																							**2**
Tree Swallow	3									1														**4**
Barn Swallow	18	8	9	4	1																			**40**
Black-capped Chickadee								1						1					2		4		1	**9**
White-breasted Nuthatch																							1	**1**
House Wren		1		1			1				1	1												**5**
Sedge Wren	1	1	1		1																			**4**
Marsh Wren		1																						**1**
Eastern Bluebird											3				3			2		6				**14**
American Robin	7	4	14		1	2			3	8	8	12		8		2		6	10	34	5		3	**127**
Gray Catbird	1				1							2		1	1									**6**
Brown Thrasher					1																			**1**
Cedar Waxwing	1	1	1		1		1	1	1	2	2		4	35				91	33			6		**180**
Tennessee Warbler							3																	**3**
Yellow-rumped Warbler														2		4	1		1					**8**
Common Yellowthroat					1								1											**2**
American Tree Sparrow																					1		50	**51**
Chipping Sparrow				8	1		1					6		3										**19**
Savannah Sparrow	4	3		5			7	1		1								1						**22**
Song Sparrow	23	20	12	10	4	4	7	2	3			1	2	6	5	1		2	10	1				**113**
White-throated Sparrow														6	3	8	1	2	1					**21**
Dark-eyed Junco																		13	8	4	4		8	**37**
Lapland Longspur																		5				1		**6**
Northern Cardinal		4		2	1			1		2	3			1	1	2							6	**23**
Indigo Bunting	8	4	2	1			3	3						1										**22**
Bobolink							1																	**1**
Red-winged Blackbird	375	4	2	4	2	309	958	341	375	3078	15	262	399	887	1	7	6	74	139	271	5	3		**7517**
Eastern Meadowlark	1													2				8						**11**

Table 2

List of Birds by Date Observed for
5 Minute Observation Period

Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/08	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
Rusty Blackbird																					1			**1**
Common Grackle			1	4			1							115							3			**124**
Brown-headed Cowbird												19					444	25	5	63				**556**
Baltimore Oriole	1	1																						**2**
House Finch																			9	10	2	5	4	**30**
American Goldfinch	9	11	11	13	4	3	13	7	4	6	10	4	11	21	9	6	5	5	9	2	2		3	**168**
Total	**495**	**117**	**103**	**86**	**46**	**350**	**1081**	**486**	**450**	**3213**	**101**	**404**	**567**	**2141**	**360**	**275**	**564**	**394**	**290**	**453**	**81**	**32**	**113**	

Total
12,202

Total Birds for 0 to 5 Minutes Observion Period

Table 4

Total Number of Each Species Observed for the
3, 5, and 10 Minute Observation Periods

Species	Counting Period 3 min	5 min	10 min
Canada Goose	494	516	1590
Tundra Swan	0	0	10
Mallard	7	7	7
Ring-necked Pheasant	0	0	1
Wild Turkey	5	5	5
Great Blue Heron	2	2	2
Green Heron	0	1	1
Turkey Vulture	7	7	12
Osprey	0	0	1
Northern Harrier	0	0	2
Cooper's Hawk	3	3	5
Red-tailed Hawk	36	39	48
American Kestrel	10	11	14
Sandhill Crane	58	61	85
Killdeer	233	244	335
Greater Yellowlegs	0	0	1
Lesser Yellowlegs	0	1	1
Upland Sandpiper	2	2	3
Least Sandpiper	0	0	1
Pectoral Sandpiper	1	1	1
Ring-billed Gull	425	1275	4171
Mourning Dove	193	204	319
Snowy Owl	1	1	1
Belted Kingfisher	0	0	1
Red-bellied Woodpecker	4	6	10
Downy Wodpecker	10	11	22
Hairy Woodpecker	0	1	5
Northern Flicker	7	9	19
Eastern Wood-Pewee	0	1	1
Eastern Kingbird	9	11	17
Red-eyed Vireo	0	0	3
Blue Jay	117	138	203
American Crow	264	286	391
Horned Lark	208	228	324
Purple Martin	2	2	2
Tree Swallow	4	4	4
Barn Swallow	33	40	62
Black-capped Chickadee	5	9	12
White-breasted Nuthatch	0	1	6
House Wren	4	5	9
Sedge Wren	4	4	4
Marsh Wren	1	1	1
Golden-crowned Kinglet	0	0	1
Eastern Bluebird	12	14	16
American Robin	99	127	218
Gray Catbird	6	6	9
Brown Thrasher	1	1	2
Cedar Waxwing	92	180	199
Tennessee Warbler	3	3	4
Yellow Warbler	0	0	1

Table 4

Total Number of Each Species Observed for the
3, 5, and 10 Minute Observation Periods

Species	Counting Period 3 min	5 min	10 min
Yellow-rumped Warbler	7	8	15
Palm Warbler	0	0	1
Common Yellowthroat	1	2	2
American Tree Sparrow	51	51	54
Chipping Sparrow	17	19	40
Clay-colored Sparrow	0	0	1
Savannah Sparrow	19	22	39
Song Sparrow	103	113	149
White-throated Sparrow	20	21	21
White-crowned Sparrow	0	0	2
Dark-eyed Junco	37	37	38
Lapland Longspur	1	6	6
Northern Cardinal	19	23	29
Indigo Bunting	20	22	28
Bobolink	1	1	11
Red-winged Blackbird	6141	7517	15652
Eastern Meadowlark	11	11	22
Rusty Blackbird	1	1	1
Common Grackle	121	124	138
Brown-headed Cowbird	551	556	751
Baltimore Oriole	2	2	4
House Finch	19	30	39
American Goldfinch	138	168	307
Total Individuals	**9,642**	**12,202**	**25,512**
Total Species	**55**	**60**	**73**

Table 5

Number of Bird Species and Individuals Recorded at Each of the 30 Turbine Locations

Ranked by # of Species

Turbine #	No. of Species	No. of Individuals
A16	10	202
A26	11	865
B23	11	168
A27	12	827
A10	13	64
B20	13	233
B34	13	277
A31	14	562
D30_a	15	415
A33	16	187
A43	16	2600
B29	16	65
A9	17	66
B22	17	110
D43	17	712
B21	18	988
B4	19	747
A20	20	279
A23	20	417
C2	20	306
B27	21	492
B31	21	260
A36	23	5434
A41	25	330
B12	27	568
B26	27	1167
A34	29	4814
B19	28	636
A44	34	530
A7_a	34	1191

Ranked by # of Individuals

Turbine #	No. of Species	No. of Individuals
A10	13	64
B29	16	65
A9	17	66
B22	17	110
B23	11	168
A33	16	187
A16	10	202
B20	13	233
B31	21	260
B34	13	277
A20	20	279
C2	20	306
A41	25	330
D30_a	15	415
A23	20	417
B27	21	492
A44	34	530
A31	14	562
B12	27	568
B19	28	636
D43	17	712
B4	19	747
A27	12	827
A26	11	865
B21	18	988
B26	27	1167
A7_a	34	1191
A43	16	2600
A34	29	4814
A36	23	5434
Total		**25,512**

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
A10																									
	Red-tailed Hawk	2	2		1	1	1														1				7
	American Kestrel					1	1																		3
	Sandhill Crane		2			3																			5
	Killdeer	1				1	1		2	1					1										7
	Mourning Dove	2								2															4
	Eastern Kingbird		2																						2
	Blue Jay						1							2				1							4
	American Crow	1						3						5		1		2							12
	Horned Lark															1					2	2			5
	American Robin																			2					2
	Song Sparrow	1								1															2
	Red-winged Blackbird													1						9					10
	American Goldfinch				1																				1
A10 Total																									**64**
A16																									
	Canada Goose								1	1		20				28									50
	Killdeer			7	4	3		8	4	2			1												29
	Upland Sandpiper				2																				2
	Mourning Dove				2			42	23	4	1														72
	Blue Jay													1	1					1					3
	American Crow					2							1									1			4
	Horned Lark	2			2				2			2	1	1		6	1		8	2	2	1	2	1	33
	Savannah Sparrow																			1					1
	Eastern Meadowlark												1							4					5
	American Goldfinch	1										2													3
A16 Total																									**202**
A20																									
	Canada Goose														53							14			67
	Killdeer				1							1													2
	Upland Sandpiper				1																				1
	Downy Woodpecker																					1	1		2
	Blue Jay	1							1			1		1	2	1		1							8
	American Crow	1		3						2	4	21		2	3			6		1		1		2	46
	Horned Lark															1				2		1			4
	Black-capped Chickadee																					2			2
	American Robin			1											1										2
	Gray Catbird														1										1
	Cedar Waxwing										2									1			6		9
	American Tree Sparrow																					1		7	8
	Savannah Sparrow	1						2	3		1														7
	Song Sparrow	2	2	1	2		1								1										9
	Dark-eyed Junco																					4		1	5
	Northern Cardinal															1								6	7
	Indigo Bunting	1																							1
	Red-winged Blackbird				87															1					88
	House Finch																	1							1
	American Goldfinch		1		2			2				1			3										9
A20 Total																									**279**
A23																									

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Canada Goose															330									330
	Red-tailed Hawk												1			1						1			3
	Killdeer											1													1
	Ring-billed Gull																							1	1
	Mourning Dove								1							12	2		2						17
	Downy Woodpecker					1																			1
	Hairy Woodpecker													1											1
	Eastern Kingbird	1	1	1																					3
	Red-eyed Vireo					1																			1
	Blue Jay					1			1		2		1	1				1						1	8
	American Crow	1											6			2					1				10
	Barn Swallow		1			2																			3
	American Robin	4	1			1		3	1			5	2						2		1				20
	Cedar Waxwing					1																			1
	Chipping Sparrow	1																							1
	Savannah Sparrow				1																				1
	Song Sparrow	1		1												1				1					4
	Indigo Bunting	1	1																						2
	Red-winged Blackbird					1														3	1				5
	American Goldfinch	1		1					1			1													4
A23 Total																									**417**
A26																									
	Canada Goose															8	8								16
	American Kestrel																1								1
	Killdeer		1												1	2									4
	Mourning Dove																6								6
	Blue Jay									1				1	3		1								6
	American Crow	1															2				2				5
	Horned Lark													2	2		1					1			6
	Barn Swallow			2																					2
	Savannah Sparrow							1																	1
	Red-winged Blackbird		800										13												813
	American Goldfinch	1		2			1				1														5
A26 Total																									**865**
A27																									
	Red-tailed Hawk																	1							1
	Killdeer		1											1				2		6					10
	Northern Flicker													1											1
	Horned Lark	1	1	1	2			2						2			1		1	3			1		15
	Barn Swallow		1																						1
	American Robin			1																					1
	Common Yellowthroat													1											1
	Savannah Sparrow							2																	2
	Song Sparrow	1	1		1																				3
	Indigo Bunting	1																							1
	Red-winged Blackbird	690					3				76	8		10					2						789
	American Goldfinch			1			1																		2
A27 Total																									**827**
A31																									
	Canada Goose										31			57											88

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Sandhill Crane		3																					3
	Killdeer	1	1		2		8							1	2	3	2							20
	Ring-billed Gull														7									7
	Mourning Dove					2																		2
	Blue Jay	1									1				1									3
	American Crow		1	3											1									5
	Horned Lark		2				1	2			2		1	9			3	2	1	3	2			28
	Barn Swallow		1	1																				2
	Savannah Sparrow	1	1																					2
	Song Sparrow	1	2																					3
	Red-winged Blackbird										29									1	194			224
	Brown-headed Cowbird						170																	170
	American Goldfinch		1	1	1			1	1															5
A31 Total																								**562**
A33																								
	Canada Goose															**69**								69
	Red-tailed Hawk														**1**									1
	Killdeer									**2**	**6**													8
	Downy Woodpecker	**1**																						1
	Northern Flicker									**1**			**1**											2
	Eastern Kingbird	**1**																						1
	Blue Jay									**1**			**3**	**1**	**1**					**1**				7
	American Crow	**5**											**2**			**3**				**1**				11
	Horned Lark			**1**									**1**			**4**	**2**		**1**	**2**		**3**		14
	Barn Swallow			**1**																				1
	American Robin	**1**														**2**	**1**							4
	Gray Catbird	**1**																						1
	Yellow-rumped Warbler														**1**									1
	Song Sparrow	**2**		**1**																				3
	Red-winged Blackbird														**35**		**1**	**2**		**6**				44
	American Goldfinch	**1**		**2**				**1**		**1**				**3**	**6**	**2**			**1**	**2**				19
A33 Total																								**187**
A34																								
	Canada Goose								13				210	18										241
	Red-tailed Hawk															1				1				2
	American Kestrel	1					1								1					1				4
	Killdeer				1		1			1			1	1	1	1								7
	Lesser Yellowlegs		1																					1
	Mourning Dove						2						2	9	36	2	9	1	7	1	2		1	72
	Red-bellied Woodpecker															1				1				2
	Downy Woodpecker												1									1		2
	Northern Flicker												1											1
	Eastern Wood-Pewee		1																					1
	Blue Jay	1	1									1	2	2	2	1		1		1	2		1	15
	American Crow		1									2		3			2			1	1	1		11
	Barn Swallow	2	3	2	1	1	1																	10
	Black-capped Chickadee																					1		1
	White-breasted Nuthatch																					1		1
	Eastern Bluebird															3					2			5
	American Robin												2	1	1		2		2		9			17

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	American Tree Sparrow																							1	1
	Savannah Sparrow	1																							1
	Song Sparrow	1	1											1						2					5
	White-throated Sparrow																4	1							5
	White-crowned Sparrow																			1					1
	Bobolink		1																						1
	Red-winged Blackbird						660			31	3015		165	390	18				18	3	30		3		4,333
	Eastern Meadowlark														2										2
	Brown-headed Cowbird																				63				63
	Baltimore Oriole						1																		1
	House Finch																						3	2	5
	American Goldfinch				1				1													1			3
A34 Total																									**4,814**
A36																									
	Canada Goose									1	50		47	2											100
	Mallard										3														3
	Great Blue Heron						1																		1
	Osprey			1																					1
	Red-tailed Hawk		1											1		2								1	5
	Sandhill Crane		1								3														4
	Killdeer		2		1		1			1		1		1	1	3	1								12
	Mourning Dove				1																				1
	Snowy Owl																						1		1
	Red-bellied Woodpecker																		1						1
	Northern Flicker													1											1
	Blue Jay									1			1	2	1										5
	American Crow		1				1							4					1	1	2	1	2		13
	Horned Lark																	1	1	1			2		5
	Barn Swallow	1		4	1																				6
	Marsh Wren		1																						1
	American Robin																			1	1				2
	Song Sparrow		2	2	1	1											1		3	2					12
	Bobolink		2																						2
	Red-winged Blackbird		12	1		1	110	25		367	4436		208	5	5	13	5	22	8	6		1			5,225
	Common Grackle			1																					1
	Brown-headed Cowbird											13						14							27
	American Goldfinch							2			1	1												1	5
A36 Total																									**5,434**
A41																									
	Red-tailed Hawk		1										1	1										1	4
	Killdeer													1		1		1							3
	Mourning Dove	1						1		1				8			1								12
	Red-bellied Woodpecker																1								1
	Downy Woodpecker										1			1										1	3
	Northern Flicker	2																							2
	Blue Jay		1					2		1	3	2	1	1			1	1			1	1			15
	American Crow	2												3	4				1	2	2				14
	Horned Lark																		1						1
	Purple Martin	1																							1
	Barn Swallow	1	1		1																				3

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	House Wren												1												1
	Golden-crowned Kinglet																				1				1
	American Robin										3				4		2		5		14	4			32
	Cedar Waxwing										2														2
	Chipping Sparrow				1		2	8					5	3	3										22
	Savannah Sparrow					1																			1
	Song Sparrow	2	2		1												1								6
	White-throated Sparrow																1								1
	Northern Cardinal		1								1	1													3
	Indigo Bunting	1	1																						2
	Red-winged Blackbird																8	4	22		124				158
	Brown-headed Cowbird																		13		3				16
	House Finch																3			2	3	2	2	3	15
	American Goldfinch		1		1	1	1	4					1		1		1								11
A41 Total																									**330**
A43																									
	Red-tailed Hawk								1						1										2
	American Kestrel											1													1
	Sandhill Crane																	2							2
	Killdeer	1					1		1						1	3			1						8
	Ring-billed Gull												2500				1								2,501
	Mourning Dove	1				1																			2
	Blue Jay												1	1	1	1		1							5
	American Crow	1			1								2	1	2			1	3	3		3			17
	Horned Lark															2						3			5
	Barn Swallow	1							1																2
	American Robin														1										1
	Savannah Sparrow	1																							1
	Song Sparrow	1																							1
	Red-winged Blackbird															1			1	34		4			40
	Eastern Meadowlark	1														5									6
	American Goldfinch	1			1	1		2							1										6
A43 Total																									**2,600**
A44																									
	Canada Goose															26									26
	Great Blue Heron																			1					1
	Cooper's Hawk		1	1																					2
	Killdeer	1							1				1	8		2		1							14
	Ring-billed Gull		1				4								47	175									227
	Mourning Dove							1			1									8					10
	Red-bellied Woodpecker																							1	1
	Downy Woodpecker												1							1		1			3
	Hairy Woodpecker																							1	1
	Northern Flicker									1															1
	Eastern Kingbird	3	2	1	1																				7
	Blue Jay					2	1		1				3	1	3	1		1						2	15
	American Crow							1				1				1						2			5
	Horned Lark															1									1
	Black-capped Chickadee														1										1
	White-breasted Nuthatch							1																1	2

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	House Wren												1												1
	American Robin	1											3		2	3	2					1			12
	Gray Catbird	1				1							2												4
	Cedar Waxwing									2															2
	Tennessee Warbler					1																			1
	Yellow-rumped Warbler																2								2
	Common Yellowthroat					1																			1
	Chipping Sparrow				3	1																			4
	Clay-colored Sparrow				1																				1
	Savannah Sparrow		1	2	2			1																	6
	Song Sparrow	2	2		2	4		1								2		1							14
	White-throated Sparrow																			1					1
	Northern Cardinal		1		1	1			1								2								6
	Indigo Bunting	1	1																						2
	Red-winged Blackbird														115				1	19					135
	Common Grackle																					3			3
	Baltimore Oriole	1																							1
	American Goldfinch	1	1	3	1	1		2	1					1	2	2	1							1	17
A44 Total																									**530**
A7_a																									
	Canada Goose														12	2			23						37
	Green Heron	1																							1
	Red-tailed Hawk	1	1		1										1		1			1				1	7
	Greater Yellowlegs					1																			1
	Mourning Dove					2	1	1	3	1					14										22
	Red-bellied Woodpecker														1	1								1	3
	Downy Woodpecker	1								1				1	1										4
	Northern Flicker						1							1											2
	Eastern Kingbird		2																						2
	Red-eyed Vireo	1																							1
	Blue Jay	2			1		2		1	1					1	1	2		2	1	1				15
	American Crow											2	1			2	1		3	4					13
	Black-capped Chickadee														1										1
	White-breasted Nuthatch															1									1
	House Wren				1								1												2
	Eastern Bluebird																				4				4
	American Robin	3	2		5	2	3		1	2		1	4			1					1				25
	Gray Catbird				1											1									2
	Brown Thrasher				1																				1
	Cedar Waxwing	1	1	3				2	1	1	2	2		4	35				88	9					149
	Yellow Warbler	1																							1
	American Tree Sparrow																							18	18
	Chipping Sparrow	3	1		4																				8
	Savannah Sparrow				2																				2
	Song Sparrow	3	2	2			1	1	1	1				2		2	1	1			1				18
	White-throated Sparrow														3	2	3		2						10
	Dark-eyed Junco																				4			2	6
	Northern Cardinal	1																							1
	Indigo Bunting	2	1	2																					5
	Red-winged Blackbird				1	1	180			13		5	4		80	4	3		13	18					322

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Brown-headed Cowbird		1										19		8			430	12	5				475
	Baltimore Oriole		1																					1
	House Finch																			7	7			2	16
	American Goldfinch	1		1	3			2				1		1						2	2			2	15
A7_a Total																									**1,191**
A9																									
	Canada Goose													5											5
	Red-tailed Hawk	1		1	1																				3
	Killdeer				1											25									26
	Pectoral Sandpiper		1																						1
	Mourning Dove																	1							1
	Eastern Kingbird		1	1																					2
	Blue Jay									1				2											3
	American Crow						1						1												2
	Horned Lark					1												1		2					4
	Purple Martin	1																							1
	Barn Swallow	1																							1
	American Robin	1																							1
	Savannah Sparrow		1																						1
	Song Sparrow	1	2				1	1																	5
	Red-winged Blackbird									1															1
	Eastern Meadowlark																		8						8
	American Goldfinch		1																						1
A9 Total																									**66**
B12																									
	Canada Goose									10															10
	Turkey Vulture																	1							1
	Sandhill Crane														2										2
	Killdeer			1																					1
	Red-bellied Woodpecker																							1	1
	Northern Flicker							1																	1
	Blue Jay				1			1		1		1		1	1				1						7
	American Crow			2	1								1						1			2		1	8
	Horned Lark																		1						1
	Barn Swallow	1																							1
	Black-capped Chickadee								1																1
	White-breasted Nuthatch																							1	1
	House Wren		1										1												2
	Eastern Bluebird											3													3
	American Robin				1																				1
	Gray Catbird														1										1
	Cedar Waxwing								1																1
	Tennessee Warbler							3																	3
	Yellow-rumped Warbler														3		1								4
	Palm Warbler																		1						1
	Song Sparrow	3	1	1	1	1									2										9
	White-throated Sparrow														3										3
	Northern Cardinal										2	2													4
	Indigo Bunting		1						2						1										4
	Red-winged Blackbird		385		3	1									46				2		42				479

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Common Grackle				4																				4
	American Goldfinch	2	2	1	2	1	1	1	1	1				1								1			14
B12 Total																									**568**
B19																									
	Canada Goose														65		1	16							82
	Wild Turkey							5																	5
	Turkey Vulture															1	5								6
	Cooper's Hawk				1										1										2
	Red-tailed Hawk		1						1							2									4
	American Kestrel				1																				1
	Sandhill Crane		3	3			3	6		3								2							20
	Killdeer														2										2
	Ring-billed Gull														220										220
	Mourning Dove		2			2					1		2												7
	Downy Woodpecker																				1		1		2
	Hairy Woodpecker																					1			1
	Northern Flicker	1																1							2
	Blue Jay		1	1			2		1	6	1		1				1	1		2					17
	American Crow	4		4			27	1	2	3					20	3		2	4	8	2	1		3	84
	Horned Lark														1							3	2		6
	Barn Swallow					1																			1
	Black-capped Chickadee																			1		1			2
	American Robin			4						1	3									3				4	15
	Yellow-rumped Warbler																1								1
	Song Sparrow		1	1											1			1		2					6
	Dark-eyed Junco																							1	1
	Northern Cardinal														1										1
	Indigo Bunting		1																						1
	Red-winged Blackbird																				130				130
	Eastern Meadowlark														1										1
	Rusty Blackbird																					1			1
	American Goldfinch					3					1		1		4	1		1		1	2			1	15
B19 Total																									**636**
B20																									
	Canada Goose																	8							8
	Sandhill Crane				2																				2
	Killdeer			1		1				1	1			5											9
	Mourning Dove			2		2	1					1													6
	Blue Jay										1									1					2
	American Crow				5		1	1								1		4		1					13
	Horned Lark										1			1								1	1		4
	American Tree Sparrow																							2	2
	Savannah Sparrow		1																						1
	Song Sparrow	1										1													2
	Bobolink		3				1																		4
	Red-winged Blackbird	65	1					54	7					3				3		24	7				164
	American Goldfinch		1	3	2	1	1	3			1	1						1		2					16
B20 Total																									**233**
B21																									
	Canada Goose																	42							42

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Northern Harrier																	1							1
	Killdeer		1											1											2
	Ring-billed Gull														850										850
	Mourning Dove			1																					1
	Blue Jay										1	1			1		1								4
	American Crow											1		1			2	1			2			1	8
	Horned Lark							1						1			1			1	1	1			6
	Tree Swallow										1														1
	House Wren											1													1
	American Robin														2										2
	Song Sparrow			1																					1
	Northern Cardinal														1										1
	Indigo Bunting	1																							1
	Bobolink						1	1																	2
	Red-winged Blackbird			8			4	20							3					3	18				56
	Baltimore Oriole		1																						1
	American Goldfinch		1						1		1						2	1			2				8
B21 Total																									**988**
B22																									
	Canada Goose											2													2
	Red-tailed Hawk																1								1
	Sandhill Crane						3	3																	6
	Killdeer		1															1							2
	Mourning Dove		1								5		1	2											9
	Northern Flicker									1															1
	Blue Jay			1						1		1	2	1		1			2		1			1	11
	American Crow		6	1					4			1	1	2			1	5			1				22
	Horned Lark																	1							1
	Eastern Bluebird																				2				2
	American Robin			1							2	5	1						1		1				11
	Yellow-rumped Warbler																	1							1
	Chipping Sparrow					3																			3
	Dark-eyed Junco																			8					8
	Northern Cardinal		1																						1
	Red-winged Blackbird										4	8								2	6				20
	American Goldfinch		2			2		1			1		1			1				1					9
B22 Total																									**110**
B23																									
	Canada Goose														12										12
	American Kestrel																						1		1
	Killdeer		1									1													2
	Mourning Dove											1			3										4
	American Crow		1					1				1			1									2	6
	Horned Lark													1		1		3		3		3	3		14
	Song Sparrow														1										1
	Lapland Longspur																	5							5
	Bobolink		1																						1
	Red-winged Blackbird		2	1					65						9		3	30							110
	American Goldfinch	3		1	1	1		1		1				1	1	2									12
B23 Total																									**168**

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
B26																								
	Canada Goose			1											42									43
	Tundra Swan																						10	10
	Ring-necked Pheasant											1												1
	Turkey Vulture					3																		3
	Cooper's Hawk																				1			1
	Sandhill Crane			3								5		3										11
	Killdeer						1																	1
	Mourning Dove					3	1				1	10		1				1						17
	Downy Woodpecker									1														1
	Blue Jay											1	1	2	3			1						8
	American Crow			1					1					3					2				2	9
	Barn Swallow	1																						1
	House Wren							1																1
	Sedge Wren	1	1	1		1																		4
	American Robin			16								1			1									18
	Cedar Waxwing								2															2
	American Tree Sparrow																						24	24
	Chipping Sparrow												1											1
	Savannah Sparrow							2																2
	Song Sparrow							3	2	1			1			1		4	1					13
	White-throated Sparrow															1								1
	White-crowned Sparrow																	1						1
	Dark-eyed Junco																						5	5
	Northern Cardinal							1																1
	Indigo Bunting	1						3																4
	Red-winged Blackbird			16				880				1	9		2					25	10			943
	American Goldfinch	1	1	1				2	1	1	5	2	5	6	5	7	1		2	1				41
B26 Total																								**1,167**
B27																								
	Canada Goose							61		16								25						102
	Turkey Vulture										1					1								2
	Red-tailed Hawk															1								1
	American Kestrel		1																			1		2
	Killdeer			2	1			1			1													5
	Ring-billed Gull														5		195							200
	Mourning Dove		2	1			5		3			2	1						2	9				25
	Belted Kingfisher											1												1
	Downy Woodpecker							1																1
	Blue Jay							1				3			1	1				1				7
	American Crow		1						1			3		2	2					1	3		1	14
	Horned Lark																	1	1					2
	Barn Swallow			2																				2
	White-breasted Nuthatch											1												1
	American Robin		1	8								1			1						17			28
	Cedar Waxwing									2														2
	Song Sparrow											1			2					2				5
	Northern Cardinal				1																			1
	Red-winged Blackbird							58				2			3			2	2		8			75
	Common Grackle							1																1

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	American Goldfinch	2	1	3	1			1	1			3					1			2					15
B27 Total																								**492**
B29																								
	Canada Goose								5															5
	Red-tailed Hawk				1																			1
	Mourning Dove														1	1								2
	Blue Jay												1	2	2		1					2		8
	American Crow			2		1		1					1			1								6
	Horned Lark									1								1					2	4
	Barn Swallow			4																				4
	House Wren					1																		1
	Yellow-rumped Warbler														2									2
	American Tree Sparrow																						1	1
	Savannah Sparrow				1				1															2
	Song Sparrow	1	1			1	1		1															5
	Indigo Bunting				1				1															2
	Bobolink					1																		1
	Red-winged Blackbird																		3		5			8
	American Goldfinch	1	1	1	2	1	1		1			2			1		1		1					13
B29 Total																								**65**
B31																								
	Canada Goose			4					14						46									64
	Red-tailed Hawk							1	1															2
	Sandhill Crane							3	3	3	3				3					2				17
	Killdeer					2		4	23	1		1	1											32
	Downy Woodpecker																	1						1
	Blue Jay								2						1				3					6
	American Crow															1	2		5					8
	Horned Lark				1		2	24	4		8	14	5	4	2	4						1	1	70
	Barn Swallow	2	2					1																5
	Black-capped Chickadee																	1						1
	American Robin														1									1
	Brown Thrasher					1																		1
	Cedar Waxwing	3																						3
	Yellow-rumped Warbler														2									2
	Savannah Sparrow																		1					1
	Song Sparrow	1	1		1	1																		4
	Northern Cardinal	1																						1
	Red-winged Blackbird			27					2							1		3						33
	Common Grackle				1																			1
	House Finch																					2		2
	American Goldfinch	1		1	1									1	1									5
B31 Total																								**260**
B34																								
	Northern Harrier																1							1
	Red-tailed Hawk															1								1
	Sandhill Crane	2									2													4
	Killdeer					2			1			1		1	1									6
	Mourning Dove						1	1												1	3			6
	American Crow				1				2	1		1								1			1	7

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
	Horned Lark																	1			1		1	2	5
	Tree Swallow	3																							3
	Barn Swallow	12																							12
	American Robin								1																1
	Song Sparrow			1		1																			2
	Red-winged Blackbird							16							80		4	115							215
	American Goldfinch	1			1		1	1		2		2		5	1										14
B34 Total																									**277**
B4																									
	Red-tailed Hawk										1														1
	Mourning Dove							1		1															2
	Red-bellied Woodpecker																							1	1
	Hairy Woodpecker			1									1												2
	Northern Flicker				1					1			1												3
	Red-eyed Vireo				1																				1
	Blue Jay		1	1	1	1			1	1		1	1									1			9
	American Crow							1	1										1			2			5
	Horned Lark																					2	1		3
	Barn Swallow		2			1																			3
	Black-capped Chickadee																			1		1		1	3
	American Robin								4			2			1					5	2	1		1	16
	Cedar Waxwing												1							24					25
	Yellow-rumped Warbler												1												1
	Song Sparrow	2						1												1					4
	Northern Cardinal		1																			1			2
	Red-winged Blackbird	15		34											450		5			6	13				523
	Common Grackle			12											115										127
	American Goldfinch	2	2	2	1	2		2	1									2						2	16
B4 Total																									**747**
C2																									
	Canada Goose												10						62						72
	Red-tailed Hawk				1														1						2
	Sandhill Crane		1																	1					2
	Killdeer					1				2				1		1		1		1					7
	Mourning Dove					4				1			1												6
	Northern Flicker	1																							1
	Blue Jay									1				2											3
	Horned Lark																			4				1	5
	Barn Swallow				1																				1
	Eastern Bluebird																		2						2
	American Robin														1				1	2					4
	Cedar Waxwing																		3						3
	Yellow-rumped Warbler																			1					1
	Chipping Sparrow															1									1
	Savannah Sparrow	3		1				1				2													7
	Song Sparrow	1	1		1								1							1					5
	Dark-eyed Junco																		13						13
	Indigo Bunting	1	1																						2
	Red-winged Blackbird													1	150					7					158
	American Goldfinch		1	1	1			1	1		1								3	1		1			11

Table 6

Number of Birds at each of the 30 Turbine Locations
by Date Observed

Turbine #	Species	8/17/08	8/19/08	8/22/08	8/25/08	8/29/08	9/2/2008	9/5/08	9/9/08	9/12/08	9/16/08	9/18/08	9/24/08	9/26/08	9/29/08	10/3/08	10/8/08	10/10/08	10/15/08	10/17/08	10/25/08	11/1/08	11/4/08	11/11/08	Total
C2 Total																									**306**
D30_a																									
	Canada Goose								1																1
	Mallard				4																				4
	American Kestrel						1																		1
	Sandhill Crane				2							2													4
	Killdeer						1			1		1				1									4
	Mourning Dove														3	6			2						11
	Blue Jay					1									1										2
	American Crow																					2	2		4
	Horned Lark				1			1	2	2	1	2						2		2	3		1	2	19
	American Robin														1										1
	Song Sparrow	1	1	1	1																				4
	Lapland Longspur																						1		1
	Red-winged Blackbird		1		1		9		320			7			2	4			6						350
	Common Grackle																		1						1
	American Goldfinch	1								1	1		1		3							1			8
D30_a Total																									**415**
D43																									
	Canada Goose														77			20			21				118
	Sandhill Crane							3																	3
	Killdeer	1	9	12			1	1	23	2					4	1	2	26	22	6	1				111
	Least Sandpiper	1																							1
	Ring-billed Gull														165										165
	Mourning Dove										2														2
	Downy Woodpecker																					1			1
	Northern Flicker																	1							1
	Blue Jay		1					1			1				1	1		1				1			7
	American Crow								2	1	6				3		3	1	5	2	3	3			29
	Horned Lark	4	12					2		18	12				2	3	1	3		1		2	1	2	63
	Barn Swallow				1																				1
	American Robin														1										1
	Song Sparrow		2	1																					3
	Indigo Bunting		1																						1
	Red-winged Blackbird		14							4	70	1			60				12		40				201
	American Goldfinch				1		1		1			1													4
D43 Total																									**712**
Grand Total																									**25,512**

Table 7
Distance From Turbine
Summarized for Each Species

Species	Distance From Tubine			
	No Data [1]	<50 m	50-100 m	>100 m
Canada Goose		49	1	1540
Tundra Swan				10
Mallard				7
Ring-necked Pheasant				1
Wild Turkey				5
Great Blue Heron			1	1
Green Heron				1
Turkey Vulture				12
Osprey				1
Northern Harrier				2
Cooper's Hawk		1		4
Red-tailed Hawk			1	47
American Kestrel				14
Sandhill Crane		3	18	64
Killdeer	3	7	111	214
Greater Yellowlegs			1	
Lesser Yellowlegs				1
Upland Sandpiper				3
Least Sandpiper		1		
Pectoral Sandpiper				1
Ring-billed Gull			1	4170
Mourning Dove		22	88	209
Snowy Owl				1
Belted Kingfisher				1
Red-bellied Woodpecker			1	9
Downy Woodpecker	2	1	10	9
Hairy Woodpecker			2	3
Northern Flicker			2	17
Eastern Wood-Pewee				1
Eastern Kingbird			4	13
Red-eyed Vireo			1	2
Blue Jay	4	6	13	180
American Crow	2	6	23	360
Horned Lark	1	85	147	91
Purple Martin				2
Tree Swallow			1	3
Barn Swallow		8	24	30
Black-capped Chickadee			5	7
White-breasted Nuthatch			1	5
House Wren		4	3	2
Sedge Wren				4
Marsh Wren			1	
Golden-crowned Kinglet			1	
Eastern Bluebird			11	5
American Robin	3	11	32	172

1) "No Data" - indicates incident of bird counted but distance not observed (no visual).

Distance Data indicate number of individual birds at specific distance range

Table 7
Distance From Turbine
Summarized for Each Species

Species	Distance From Tubine			
	No Data [1]	<50 m	50-100 m	>100 m
Gray Catbird		1	7	1
Brown Thrasher				2
Cedar Waxwing	1	7	140	51
Tennessee Warbler		4		
Yellow Warbler			1	
Yellow-rumped Warbler		7	1	7
Palm Warbler		1		
Common Yellowthroat				2
American Tree Sparrow		26	1	27
Chipping Sparrow	1	7	31	1
Clay-colored Sparrow			1	
Savannah Sparrow	2	16	12	9
Song Sparrow		18	51	80
White-throated Sparrow		9	10	2
White-crowned Sparrow		1	1	
Dark-eyed Junco		6	12	20
Lapland Longspur			1	5
Northern Cardinal		4	6	19
Indigo Bunting	1	6	8	13
Bobolink			2	9
Red-winged Blackbird	1	8	1071	14572
Eastern Meadowlark				22
Rusty Blackbird				1
Common Grackle			4	134
Brown-headed Cowbird	1	13	430	307
Baltimore Oriole			3	1
House Finch		3	23	13
American Goldfinch	4	65	150	88
Totals	**26**	**406**	**2,470**	**22,610**

1) "No Data" - indicates incident of bird counted but distance not observed (no visual).

Distance Data indicate number of individual birds at specific distance range

Table 8
Flight Height
Summarized for each Bird Species

Species	No Flight Data[1]	Low (<128 ft.)	Med (128-397 ft.)	High (>397 ft.)
Canada Goose	161	743	163	523
Tundra Swan	10			
Mallard		7		
Ring-necked Pheasant	1			
Wild Turkey	5			
Great Blue Heron	1	1		
Green Heron	1			
Turkey Vulture	2	1	8	1
Osprey	1			
Northern Harrier		2		
Cooper's Hawk	3	2		
Red-tailed Hawk	25	16	6	1
American Kestrel	10	2	1	1
Sandhill Crane	40	41		4
Killdeer	270	20	36	9
Greater Yellowlegs			1	
Lesser Yellowlegs				1
Upland Sandpiper	3			
Least Sandpiper		1		
Pectoral Sandpiper				1
Ring-billed Gull	440		3552	179
Mourning Dove	273	43	3	
Snowy Owl	1			
Belted Kingfisher	1			
Red-bellied Woodpecker	10			
Downy Woodpecker	22			
Hairy Woodpecker	4	1		
Northern Flicker	17	2		
Eastern Wood-Pewee	1			
Eastern Kingbird	17			
Red-eyed Vireo	3			
Blue Jay	196	6		1
American Crow	353	23	10	5
Horned Lark	244	54	25	1
Purple Martin	1			1
Tree Swallow		3	1	
Barn Swallow	6	56		
Black-capped Chickadee	12			
White-breasted Nuthatch	6			
House Wren	9			
Sedge Wren	4			
Marsh Wren	1			
Golden-crowned Kinglet	1			
Eastern Bluebird	9	5	2	
American Robin	160	52	6	

Rotor Swept Zone is 128 ft. to 397 ft.

1) "No Flight Data" - Indicates incident of bird counted but not in flight or height not observed (no visual).

Table 8
Flight Height
Summarized for each Bird Species

Species	No Flight Data[1]	Low (<128 ft.)	Med (128-397 ft.)	High (>397 ft.)
Gray Catbird	9			
Brown Thrasher	2			
Cedar Waxwing	92	107		
Tennessee Warbler	4			
Yellow Warbler	1			
Yellow-rumped Warbler	9	6		
Palm Warbler	1			
Common Yellowthroat	2			
American Tree Sparrow	54			
Chipping Sparrow	39	1		
Clay-colored Sparrow	1			
Savannah Sparrow	37	2		
Song Sparrow	149			
White-throated Sparrow	21			
White-crowned Sparrow	2			
Dark-eyed Junco	37	1		
Lapland Longspur	1		5	
Northern Cardinal	29			
Indigo Bunting	28			
Bobolink	1	6	2	2
Red-winged Blackbird	2175	11198	2199	80
Eastern Meadowlark	22			
Rusty Blackbird	1			
Common Grackle	119	14	4	1
Brown-headed Cowbird	674	77		
Baltimore Oriole	3	1		
House Finch	29	10		
American Goldfinch	99	190	17	1
		In Flight		
Totals	**5,965**	**12,694**	**6,041**	**812**

Total Number of Birds Counted
25,512

Total Number of Birds Seen in Flight
19,547

Total Number of Birds Seen Flying Within Height Range of RSZ
6,041

Rotor Swept Zone is 128 ft. to 397 ft.

1) "No Flight Data" - Indicates incident of bird counted but not in flight or height not observed (no visual).

Table 9

Bird Species Differences on Point-Count Surveys
Between Fall 2005 and 2008

Species Observed on Fall 2005 Point-Count Survey (Not Observed on Fall 2008 Point-Count Survey)	**Species Observed on Fall 2008 Point-Count Survey** (Not Observed on Fall 2005 Point-Count Survey)
Wood Duck	Tundra Swan
Blue-winged Teal	Osprey
Green-winged Teal	Lesser Yellowlegs
Sora	Upland Sandpiper
Solitary Sandpiper	Least Sandpiper
Spotted Sandpiper	Pectoral Sandpiper
Eurasian Collared-Dove	Snowy Owl
Red-headed Woodpecker	Belted Kingfisher
Warbling Vireo	Golden-crowned Kinglet
Bank Swallow	Brown Thrasher
Ruby-crowned Kinglet	Clay-colored Sparrow
Hermit Thrush	Eastern Meadowlark
Swainson's Thrush	
American Pipit	
American Redstart	
Snow Bunting	
Rose-breasted Grosbeak	
Purple Finch	
Pine Siskin	
Sp. Count	Sp. Count
19	**12**

Table 10

Number of Bird Species, Total Number of Birds, and Number of Fatalities for each of the 30 Turbine Locations

Turbine #	No. of Species	No. of Individuals	No. of Carcasses
A10	13	64	3
A16	10	202	0
A20	20	279	1
A23	20	417	2
A26	11	865	1
A27	12	827	1
A31	14	562	1
A33	16	187	0
A34	29	4814	1
A36	23	5434	2
A41	25	330	0
A43	16	2600	1
A44	34	530	2
A7_a	34	1191	0
A9	17	66	1
B12	27	568	0
B19	28	636	1
B20	13	233	2
B21	18	988	0
B22	17	110	0
B23	11	168	1
B26	27	1167	1
B27	21	492	1
B29	16	65	2
B31	21	260	2
B34	13	277	1
B4	19	747	0
C2	20	306	0
D30_a	15	415	0
D43	17	712	3
	Total	**25,512**	**30**

Note: A total of 31 fatalities were observed, however only 17 carcasses indentifiable. The other 14 carcasses were either feather spots or too decomposed for species identification

Table 11

Comparison of Abundance
Between Point Counts and Fatalities

Species	**No. of Individuals**	
	Point Counts	Fatalities
Golden-crowned Kinglet	1	4
Tree Swallow	4	2
Eastern Meadowlark	22	1
Chimney Swift	0	1
Horned Lark	324	1
Cedar Waxwing	199	1
Savannah Sparrow	39	1
Red-winged Blackbird	15,652	1
Brown-headed Cowbird	751	1
Total	**16,992**	**13**

Note: A total of 30 fatalities were observed, however only 13 carcasses indentifiable. Other 17 carcasses were either feather spots or too decomposed for species identification

Table 12

Weather Conditions for 23 Blue Sky Green Field Avian Point Counts

Date	Temperature (F)		Wind (Diretion/mph)		Cloud Cover (%)		Precipitation		Visibility	
	Start	End	Start	End	Start	End	Start	End	Start	End
8/17/2008	63	82	WSW 3-5	WSW 7-12	10	15	0	0	excell	excell
8/19/2008	55	71	NE 3-5	ENE 7-12	0	100	0	0	excell	excell
8/22/2008	70	70	S 5-10	S 10-20	100	70	0	0	hazy	humid-hazy
8/25/2008	48		NE 3-5	NE 3-7	5	20	0	0	excell	excell
8/29/2008	60	77	NW 3-7	NW 7-10	0	0	0	0	gnd fog rain last night	excell
9/2/2008	67	92	S 5-10	SW 10-15	0	5	0	0	excell	excell slight haze
9/5/2008	55	64	NNW 7-12	WNW 5-10	100	70	0	0	some haze/fog	excell
9/9/2008	44	64	NW 3-7	NNW 7-12	0	5	0	0	excell	excell
9/12/2008	67	62	W 3-5	NE 5-7	100	100	0	light mist	very hazy	very low ceiling
9/16/2008	47	72	SW 507	SSW	0	0	0	0	excell	excell
9/18/2008	47	71	E 0-5	SE 7-10	0	20	0	0	excell - some ground fog	excell
9/24/2008	63	75	S 3-7	W 5-7	30	50	0	0	excell	excell
9/26/2008	53	80	SSE 5-10	SSW 5-10	5	10	0	0	excell	excell
9/29/2008	52	60	SE 2-5	N 5-7	100	100	0	0		slightly hazy - early sprinkles
10/3/2008	33	53	NE 3-5	NW 7-12	0	50	0	0	excell	excell
10/8/2008	55	60	W 7-10	NW 10-15	100	10	0	0	slightly misty	excell
10/10/2008	42	66	NE 3-5	SE 5-7	5	0	0	0	excell	excell
10/15/2008	48	48	W 5-7	SW 5-7	100	100	showers	showers		
10/17/2008	33	53	SE 3-7	SE 0-5	20	100	0	0	good slight ground fog	good
10/25/2008	37	51	SW 5-7	SW 10-15	85	60	0	0	good showers overnight	excell
11/1/2008	52	65	SW 3-5	SW 5-10	0	0	0	0	Slight Haze	
11/4/2008	59	72	SW 5-12	SW 6-12	0	0	0	0	excellent	excellent
11/11/2008	18	41	0	SE 5-7	10	100	0	0	excellent	good

Table 12
Weather Conditions for 23 Blue Sky Green Field Avian Point Counts

23 Point Count Dates