

**2011 Post-Construction Monitoring Study  
Criterion Wind Project  
Garrett County, Maryland**

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**April 2011 – November 2011**



*Prepared for:*

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NATURAL RESOURCES ♦ SCIENTIFIC SOLUTIONS

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## EXECUTIVE SUMMARY

Criterion Power Partners, LCC, completed construction and initiated operation of the Criterion Wind Project in Garrett County, Maryland in 2010. The project includes 28, 2.5 megawatt wind turbine generators for a total generating capacity of 70 MW. Beginning in April 2011, Criterion initiated the first year of post-construction monitoring surveys to estimate the impacts of project operations on bird and bat species. The following report contains results of the fatality and associated field surveys conducted from April to November 2011.

The primary objective of the fatality monitoring study was to determine the level of bird and bat mortality attributable to collisions with wind turbines for the entire facility for the study period. The monitoring study consisted of four components: 1) standardized carcass surveys of the project turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species calculated by correcting survey results for potential biases (e.g., area searched, searcher efficiency, carcass removal).

The monitoring study period was from April 5 to November 15, 2011. Search plots were established around all 28 turbines in the project and the carcass search schedule was for daily searches at all turbines (weather and safety permitting). Search plot size varied in shape and size, due to habitat constraints, but in most cases areas up to approximately 40-50 m (~130-165 ft) from the turbines were cleared of vegetation for access and construction purposes and this area was used as the search plot. Parallel transects were spaced and delineated approximately 5 m (~16 ft) apart within the search plot and surveyors systematically walked the transects while scanning the ground for fatalities or injured birds or bats.

During the study, 262 birds representing 46 species and 706 bats representing eight species were found either during standardized carcass searches or incidentally during the study period. The most commonly found bird species were red-eyed vireo and blackpoll warbler, while eastern red bat and hoary bat accounted for the majority of the bat fatalities found. Bird and bat fatalities were spread throughout entire survey period and throughout the entire project with the number of fatalities peaking for both birds and bats in the fall.

A total of 78 bird carcasses and 72 bat carcasses were placed for searcher efficiency trials. Searcher efficiency was estimated for the first half of the study period (April 5 to July 15 – labeled the spring) and the second half (July 16-November 15 – labeled the fall) to investigate potential changes over time. For small birds searcher efficiency was 0.70 in spring and 0.32 in fall, for large birds was 0.87 in spring and fall, and for bats was 0.72 in spring and 0.38 in fall. A total of 168 carcasses were placed for carcass removal trials. The mean carcass removal rate was similar between spring and fall for small and large birds and over the entire study period

was 11.57 days for small birds and 10.94 for large birds. Mean carcass removal for bats varied by season and was 19.50 days for the spring and 13.33 days for the fall.

The probability that a carcass would remain in a search plot and be found by a searcher was 0.91 in the spring and 0.79 in fall for small birds and was 0.93 in spring and fall for large birds. The probability that a bat carcass was available and detected was 0.95 in spring and 0.84 in the fall.

Fatality estimates were adjusted based on the corrections for carcass removal, observer detection bias, and the area searched to account for carcasses potentially falling outside the plot. Combining both spring and fall estimates, the overall adjusted estimate for small birds was 15.25 small birds per turbine for the study period or 6.10 small birds per MW. For large birds the overall adjusted fatality estimate was 0.76 large birds per turbine for the study period or 0.30 large birds per MW. The fatality estimate for all birds combined was 16.01 birds per turbine or 6.40 birds per MW for the study period. For bats the overall estimate fatality estimate was 39.03 bats per turbine for the study period or 15.61 bats per MW.

Because the study utilized daily carcass searches the time of death for most casualties recovered was known, and an analysis to investigate the influence of nightly weather on fatality rate was conducted. The analysis utilized weather data collected at the turbines to investigate the correlation between weather variables and bird and bat mortality as well as an analysis to model what combination of weather variables was best predictive of mortality. Visibility data collected from a Maryland State Highway weather monitoring station was used to investigate the correlation between nightly visibility and mortality. Bat mortality was negatively correlated with wind speed and positively correlated with temperature; that is, as average nightly wind speed increased or the proportion of nights with wind speed greater than 6 m/s increased bat mortality decreased, and as average nightly temperature increased bat mortality increased. Mean nightly temperature, nightly wind speed, and the interaction of temperature and wind speed were the best variables for predicting nightly bat mortality. Bird mortality was negatively correlated with wind speed but was not correlated with nightly temperature. Bird mortality was negatively correlated with visibility. That is, as visibility increased bird mortality decreased.

## REPORT REFERENCE

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## ACKNOWLEDGEMENTS

This study was the first year of post-construction monitoring of the Criterion Wind Project to fulfill commitments of Criterion Power Partners (CPP) to the State of Maryland, Public Service Commission to monitor the site for three years. While the project gained a waiver from acquiring a Certificate of Public Convenience and Necessity (CPCN), CPP has committed to monitoring for a three year period. CPP intends to monitor for two more year under the Habitat Conservation Plan (HCP) developed for the Project.

The staff and crew of the Criterion Wind Project were extremely helpful in implementing the monitoring study. We wish to thank all the CPP personnel who facilitated completion of the study including: Ed Tracey, Von Abernethy, Don Shilobod, Randall Smallman, Lisa Taylor-Horvath, Brad Rush, Billy Bentley, Jeff Bailey, and Jeremy Bosley. We also appreciate the support and hospitality of the private landowners that allowed access to their lands for this study.

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## **INTRODUCTION**

Criterion Power Partners, LLC (CPP), a wholly owned subsidiary of Constellation Energy, acquired the Criterion Wind Project (CWP; Project) from Clipper Windpower, Inc. CPP completed construction and initiated operation of the CWP in 2010, which is located in Garrett County, Maryland. CPP requested Western EcoSystems Technology, Inc. (WEST) to develop and implement a post-construction monitoring study for the purpose of estimating the impacts of the wind energy facility on birds and bats. This is the first of a three year post-construction monitoring study, and was developed with a similar protocol used at other wind energy facilities across the nation. The protocol has been developed based on WEST's experience studying wildlife and wind turbine interactions at projects throughout the U.S. and the Appalachian Mountain region. This report presents the results of the first year of standardized avian and bat mortality surveys within the project area.

The primary objective of the monitoring study was to estimate the level of bird and bat mortality attributable to wind turbines for the entire facility period of study. The methods for the fatality study are broken into four primary components: 1) standardized carcass surveys of turbines; 2) searcher efficiency trials to estimate the percentage of carcasses found by searchers; 3) carcass removal trials to estimate the length of time that a carcass remains in the field for possible detection; and 4) adjusted fatality estimates for bird and bat species calculated by correcting survey results for potential biases (e.g., area searched, searcher efficiency, carcass removal).

## **STUDY AREA**

The CWP is located east of the town of Oakland in Garrett County, Maryland (Figure 1). The Project is a 70 MW wind energy facility consisting of 28 2.5 megawatt (MW) wind turbine generators and is situated along the ridge of Backbone Mountain extending to the northeast from Allegheny Heights approximately five miles (Figure 1). The topography of the Project area is steeply sloping on the western side of the ridge and relatively gently sloping on the eastern side; and the ridgeline maintains an elevation of approximately 3,200 ft (975 m) above mean sea level. The CWP falls within the Ridge and Valley province of the Central Appalachian Ecoregion. This region is characterized by heavily forested, steep ridges that alternate with folded sandstone crests and limestone plateaus. The Project is situated on largely undeveloped, previously logged forestland interspersed with some open farmland and consists of rugged terrain traversed with old logging roads and dotted with seasonally used camps. Land use in the vicinity of the Project is dominated by forest and agriculture, consistent with the rural character of Garrett County.



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Criterion Wind Project

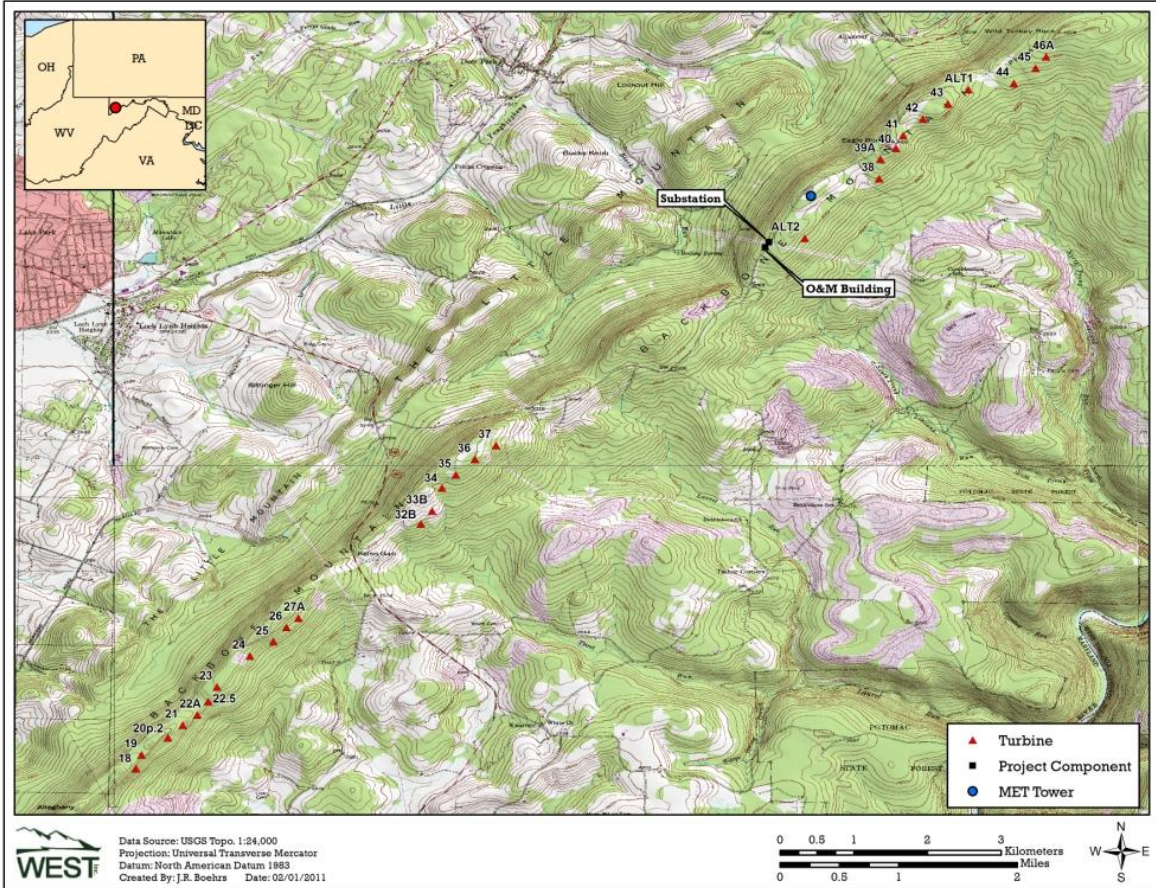


Figure 1. Location of the Criterion Wind Project.

For the area encompassed by a one-mile radius around the turbines, approximately 80% is composed of deciduous forest, while 12% is hay/pasture (Figure 2). All other land use types make up less than 5% of the total cover.

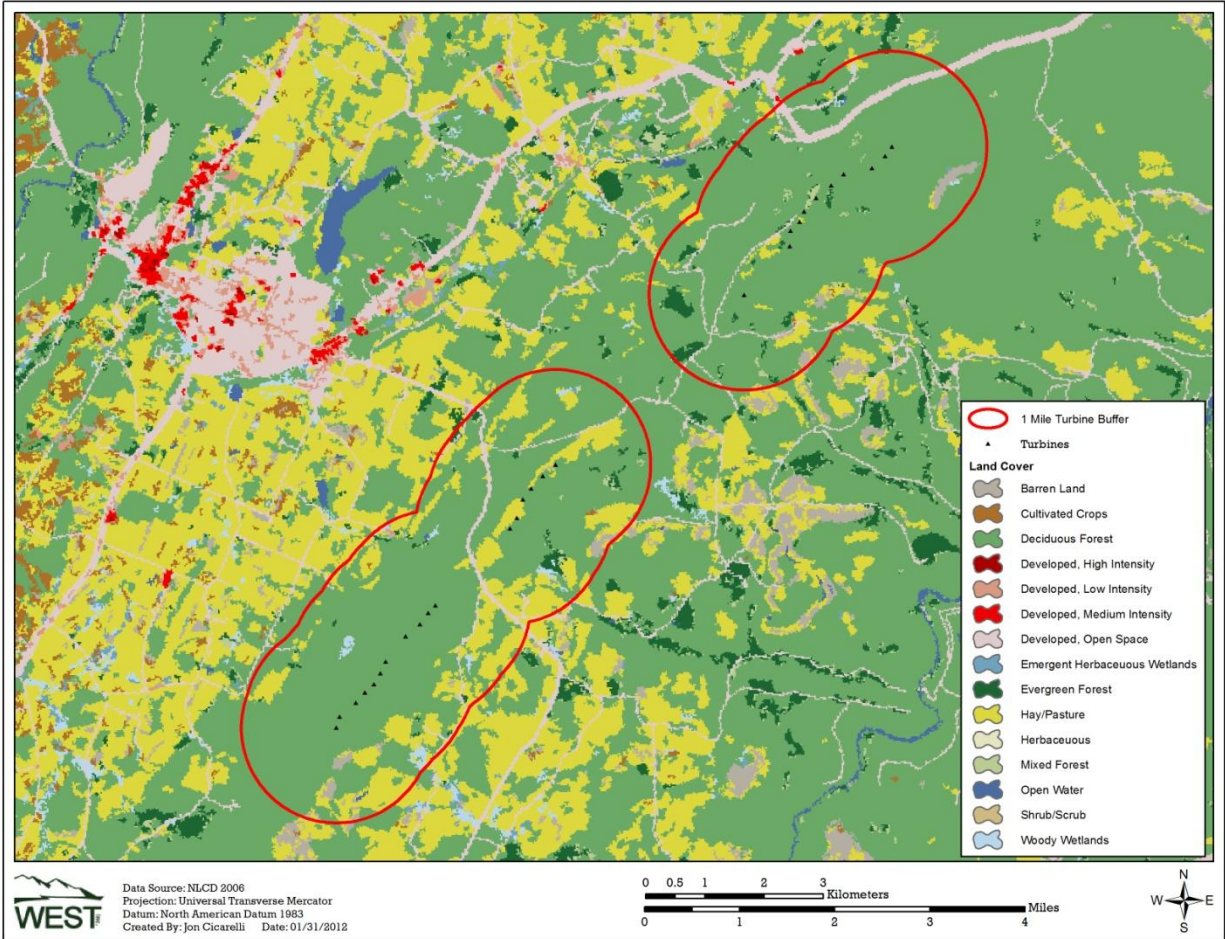


Figure 2. Land use/land cover within and surrounding the Criterion Wind Project area.

## **METHODS**

### **Avian and Bat Mortality Surveys**

The field and analytical methods for the monitoring study were broken into four primary components: 1) standardized carcass searches; 2) searcher efficiency trials; 3) carcass removal trials; and 4) data analysis to determine adjusted fatality estimates for bird and bat species.

There are three scenarios under which casualties could be found during the study period: 1) during the standardized carcass searches; 2) while observers were on site, but not conducting a standardized search (an incidental find); and 3) by facility personnel or others on site for other purposes, such as turbine maintenance. Casualties found by study personnel, regardless of timing (i.e., during a standardized survey or not), were recorded using the methods described below. All casualties found within a search plot, even if outside of the standard survey period, were included in the dataset under the assumption that these casualties would have been found during standardized searches. Carcasses were also included in the fatality estimate when the cause of death was not apparent.

### **Search Plots and Sample Size**

Search plots were established around all 28 turbines and were delineated in the field with a GPS for detailed mapping. Due to the variable nature of the habitat in the CWP, the cleared area around turbines varied in shape and size. In most cases areas up to approximately 40-50 m (~130-165 ft) from the turbines were generally cleared of vegetation for access and construction purposes. Given the difficulty in finding birds and bats within thick shrub cover or forested areas, the search area was limited to the cleared areas around the turbines. Efforts were made to maximize the search plots but searches were not conducted in forested areas or areas with steep rocky slopes or waste rock piles from construction.

Search plots were generally up to 40 m (~130 ft) radius totaling roughly 80 m<sup>2</sup> (~860 ft<sup>2</sup>). The shape of the search plots was variable due primarily to the size of the area cleared for construction. The maximum distance searched from any one turbine was 100 m (~328.0 ft), but in most cases the maximum search plot radius was approximately 50 m (~165 ft). Parallel transects were spaced approximately 5 m (~16 ft) apart within the search plot and delineated with colored flagging.

### **Standardized Carcass Surveys**

The objective of the standardized searches was to systematically search the project for bird and bat casualties that were attributable to collision with the turbines. Standardized carcass surveys were conducted daily at all 28 turbines throughout the study period (April 5 – November 15). Personnel trained in proper search techniques conducted the searches. During a carcass search, searchers walked at a rate of approximately 45-60 m/min (~145 to 195 ft/min) along each transect in the search plot searching both sides out to approximately 2 to 3 m (~7 to 10 ft). Search area and speed were occasionally adjusted during any given search for the searcher to investigate potential casualties. Searches for any give day began at randomly-selected turbines

shortly after sunrise, when there was enough ambient light for locating and identifying carcasses, and continued until all turbines had been searched.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined, if possible, based on field inspection of the carcass. The condition of each carcass found was recorded using the following categories:

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

All carcasses were labeled with a unique number, bagged and frozen for future reference and possible further analysis (e.g., genetic determination of species if needed). A copy of the data sheet for each carcass was maintained, bagged and frozen with the carcass at all times. For all casualties found, data recorded included species, sex and age when possible, date and time collected, GPS location, condition (above), and any comments that indicated possible cause of death. All casualties were photographed as found and plotted on a map of the study area showing the location of the wind turbines and associated facilities such as overhead power lines and met towers. In addition to carcasses, any injured bird or bat observed in the search plots was recorded and treated as a casualty. Dominant vegetation cover and visibility index within a 1-m (~3-ft) radius of the carcass location were also recorded.

Casualties found outside the formal search area by carcass search technicians were treated following the above protocol as closely as possible. Casualties observed in non-search areas or observed within search areas but outside of the standard search period, were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Casualties where the cause of death was not apparent were included in the fatality estimates. Casualties found by maintenance personnel and others not conducting the formal searches were similarly documented and included in the overall dataset.

### **Searcher Efficiency Trials**

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

Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Carcasses used for searcher efficiency trials were primarily non-native/non-protected or commercially available species. House sparrow (*Passer domesticus*) was used to represent small-sized birds while rock pigeons (*Columba livia*) and commercially raised mallards (*Anas platyrhynchos*) were used to represent large-sized birds. Carcasses of non-*Myotis* bat species, including hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), and silver-haired bat (*Lasiorycteris noctivagans*), recovered during the study were used in the searcher efficiency trials.

All trial carcasses were placed at pre-determined, randomly-selected locations within search plots prior to the standardized carcass searches on the same day. Carcasses were dropped from shoulder or waist height to simulate a falling bird or bat. Each trial carcass was discreetly marked so that it could be identified as a study carcass after it was found.

The number and location of the searcher efficiency carcasses found during the carcass surveys was recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses. A carcass missed by the searcher but retrieved by the person conducting the trial, was determined to be available but undetected. A carcass missed by the searcher and not subsequently found by the person conducting the trial was determined to be unavailable. Trial carcasses that were not found on the first day were left in place for possible detection on subsequent days (e.g., day two, day three, day four, etc.).

### **Carcass Removal Trials**

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

Trial carcasses were distributed throughout the study period in a staggered fashion to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Trial species composition was the same as those used for searcher efficiency trials (see above).

A typical carcass removal trial occurred over a seven to 14-day period unless all trial carcasses were removed sooner. For each trial, between one and 17 carcasses were placed at pre-determined, randomly-selected locations within search plots of randomly selected turbines. 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) partially hidden; or 3) mostly hidden to simulate a crippled bird or bat (e.g., placed beneath vegetation). Carcasses were checked daily for the first seven days and then checked on Day 10 and Day 14, after which any remaining evidence of the carcass was removed. This schedule varied somewhat depending on weather and coordination with the other survey work. Removal trial

carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial.

### **Statistical Analysis**

The total bird and bat mortality attributable to the project was estimated by adjusting the observed number of casualties for removal bias (length of stay in the field), searcher efficiency bias (percent found), and distribution around the turbine to account for casualties that may have fallen outside the survey plot.

The study period was divided into two “seasons”, spring and fall. Spring was defined as the period from April 5 to July 15 and fall was July 16 to November 15. These periods encompass bird and bat seasonal migration periods and the summer breeding season.

For carcasses where the cause of death was not apparent, the assumption that the fatality was a wind turbine related casualty was made for the analysis. This approach likely leads to an overestimate of the true number of facility-related fatalities, but provides a conservative estimate of total project related mortality.

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

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

### **Data Compilation and Storage**

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

### **Fatality Surveys**

#### ***Casualty Estimates***

Estimates of facility-related fatalities are based on:

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

- (2) Non-removal rates expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the searchers during removal trials; and
- (3) Searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

Fatality estimates will be provided for five categories: 1) small birds, 2) large birds, 3) raptors, 4) all birds, and d) bats.

### 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
$l$	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:

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

### 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:

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

### 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 will be estimated by carcass size and season.

### Estimation of Facility-Related Fatality Rates

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

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

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 will be pooled across the study to estimate  $\hat{\pi}$ .

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

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of  $m$  and associated standard errors and 90% confidence intervals will be 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,  $\bar{c}$ ,  $\bar{t}$ ,  $p$ ,  $\hat{p}$ , and  $m$  are calculated. A total of 1,000 bootstrap samples will be used. The reported estimates are the mathematical means of the 1,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5<sup>th</sup> and upper 95<sup>th</sup> percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals.

### **Weather and Visibility Analysis**

Associations between weather characteristics (Table 1) and fresh bird and bat casualties were investigated using univariate association analyses (Pearson's correlations, simple linear regression), and multiple regression (Neter et al. 1996). The linear regression dependent variable was the average number of fresh bat casualties per turbine per night. Independent variables used in our analyses were quantified from data gathered at turbines and the Project met tower.

The program R was used to fit several regression models to predict the number of fresh casualties found at the site. The linear regression models were all of the form:

$$y = \beta_0 + \beta_1 x_1 + \dots + \beta_p x_p + \varepsilon,$$

which related the behavior of  $y$ , and index of the number of fresh casualties, to a linear function of the set of predictor variables  $x_1, \dots, x_p$ . The  $\beta_j$ 's are the parameters that specify the nature of the relationship and  $\varepsilon$  is a random error term  $\sim N(0, \sigma^2)$ . Program R was used to fit several alternative models using least squares regression (Neter et al. 1996), but no model contained: (1) both proportion of night with a wind speed of <4 m/s and median and mean wind speed at turbines, or proportion of night with a wind speed of > 6m/s; (2) proportion of night with a wind speed  $\geq 6$  m/s and median and mean wind speed at turbines, and proportion of night with wind speed between 4 m/s and 6 m/s; and (3) mean and median wind speed at turbines. These exceptions were due to perceived high correlations between the pairs of variables that could have resulted in severe multicollinearity problems (Neter et al. 1996). To investigate the overall goodness of fit of each model, the coefficient of multiple determination ( $R^2$ ) was calculated, which measures the proportionate reduction of total variation in fresh casualties associated with using the model's predictor variables (Neter et al. 1996). For inferences about each parameter in every model fit, the student's  $t$  statistic and p-value were calculated using standard statistical procedures for least squares regression models (Neter et al. 1996).

**Table 1. Descriptions of predictor variables used in the analyses for associations between weather characteristics and mortality.**

Predictor Variable [abbreviation]	Description
<b>Temperature</b>	
[tempc]	Mean nightly temperature; measured at turbines and averaged across turbines at site.
<b>Wind Speed</b>	
[wspc]	Mean nightly wind speed; measured at turbines and averaged across turbines at a site.
[wspm]	Median nightly wind speed; measured at turbines and averaged across turbines at a site.
[wsp2]	Quadratic term for mean nightly wind speed.
[wspm2]	Quadratic term for median nightly wind speed.
[p2c]	Proportion of night (10 min intervals) from 1800 to 0600 hr with wind speed of 0–4 m/s; measured at turbines and averaged across turbines.
[p4c]	Proportion of night (10 min intervals) from 1800 to 0600 hr with wind speed of 4–6 m/s; measured at turbines and averaged across turbines.
[p6c]	Proportion of night (10 min intervals) from 1800 to 0600 hr with wind speed of >6 m/s; measured at turbines and averaged across turbines.

To determine the “best” model, the second order variant of Akaike’s Information Criterion (AICc) was used (Burnham and Anderson 2002). The model with the lowest AICc value within the set of models was chosen as the best model. The AICc value for each model was calculated as:

$$AICc = n \ln(\hat{\sigma}^2) + 2K + \frac{2K(K+1)}{n-K-1},$$

where  $n$  was the number of observations,  $\ln$  was the natural logarithm,  $K$  was the number of parameters in the model + 1 (for  $\hat{\sigma}^2$ ), and  $\hat{\sigma}^2$  was the maximum likelihood estimate of  $\sigma^2$ , estimated by:

$$\hat{\sigma}^2 = \frac{\sum \varepsilon_i^2}{n}.$$

Visibility data was obtained from the Maryland State Highway Administration. The data used in the analysis came from the Maryland State Highway weather monitoring station at Interstate 68 and US Highway 219, approximately 20 miles from the Criterion site. The values for visibility are in miles with a maximum of 1.1 miles. Associations between visibility and fresh casualties were investigated using univariate association analyses (Pearson’s correlations, simple linear regression) (Neter et al. 1996) during the spring and fall migration seasons. The linear

regression dependent variable was the average number of fresh bird casualties per turbine per night. The independent variable used in the analyses was visibility in miles.

## RESULTS

Monitoring surveys began on April 5 and continued through November 15, 2011<sup>1</sup>.

### Avian and Bat Fatality Surveys

All 28 wind turbines were searched on an approximately daily basis over the course of the monitoring period, for a total of 5,316 turbine searches. Some searches were missed occasionally due to unsafe weather conditions or other safety concerns such as turbine maintenance. The shape of the search plots was variable due primarily to the size of the area cleared for construction. The maximum distance searched from any one turbine was 100 m (~328 ft), but in most cases the maximum search plot radius was approximately 50 m (~164 ft; Table 2). The percentage of the total area searched decreased with distance from the turbine due to the constraints of the irregular search plots (Table 2).

**Table 2. Proportion of plots searched within the Criterion Wind Energy Project.**

Distance (m)	Area Searched (sq. m)	Total Area (sq. m)	Percent Area Searched
10	8,181.64	8,788.17	93.1
20	24,195.94	26,364.50	91.8
30	37,237.17	43,940.83	84.7
40	42,986.84	61,517.16	69.9
50	37,637.84	79,093.50	47.6
60	27,358.02	96,669.83	28.3
70	17,224.81	114,246.16	15.1
80	8,663.08	131,822.50	6.6
90	2,590.51	149,236.64	1.7
100	696.75	165,890.29	0.4

A total of 262 birds (246 small birds and 16 large birds) and 706 bats were found during standardized carcass surveys or incidentally (Table 3). A full listing of casualties found and the locations of casualties are presented in Appendix A and Appendix B.

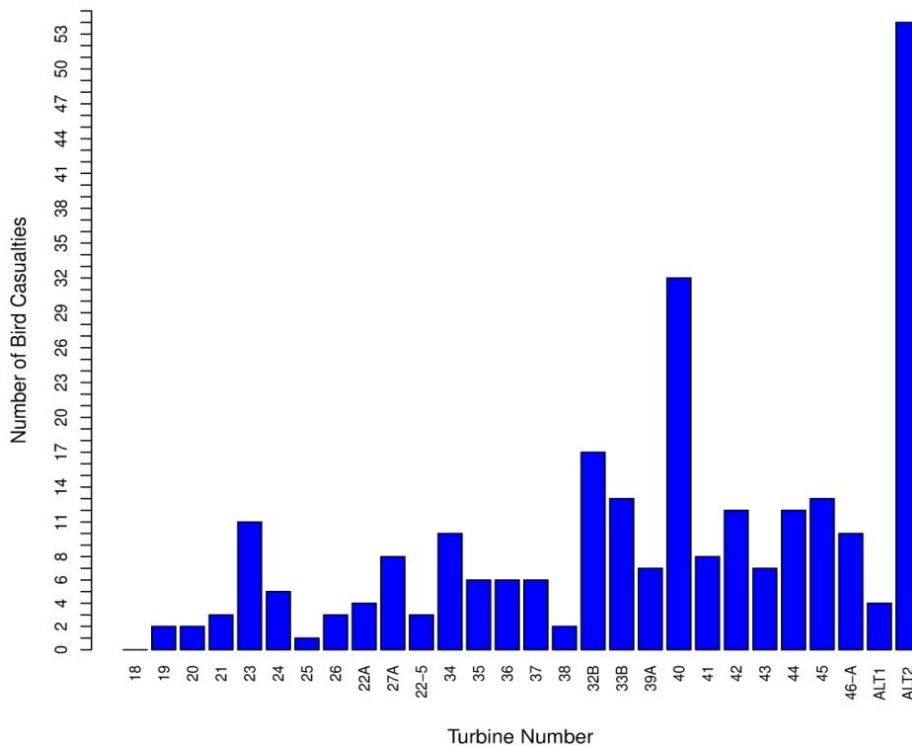
### Bird Fatalities

During the standardized carcass searches, 241 birds comprising 46 identifiable species were found (Table 3). The most commonly found bird species were red-eyed vireo (*Vireo olivaceus*; 67 carcasses), blackpoll warbler (*Dendroica striata*; 23 carcasses), magnolia warbler (*Setophaga magnolia*; 12 carcasses), and wood thrush (*Hylocichla mustelina*; 11 carcasses). All

<sup>1</sup> It was the intent to initiate the field surveys on April 1, 2011; however, due to inclement weather, and in particular snow cover, site access was compromised and the field surveys were delayed until the site could be accessed safely.

other bird fatalities were represented by nine or less carcasses for each individual species. One broad-winged hawk (*Buteo platypterus*) was found during scheduled surveys, and was the only raptor found during the monitoring period. An additional 20 carcasses were found incidentally within the search plots, of which eight were red-eyed vireos (Table 3).

The greatest number of bird fatalities were found at Turbine ALT2 (53 carcasses) and Turbine 40 (32 carcasses). All other turbines ranged from zero (Turbine 18) to 17 bird carcasses (Turbine 32; Figure 3). Of the bird fatalities, 97.3% were found within 50 m (~164 ft) of the turbines (Table 4 and Figure 4). Most of the bird fatalities occurred during the fall season in the period from September 2 to October 6 (Figure 5).



**Figure 3. Number of bird fatalities by turbine at the CWP.**

**Table 3. Total number and species composition of bird and bat casualties discovered at the CWP.**

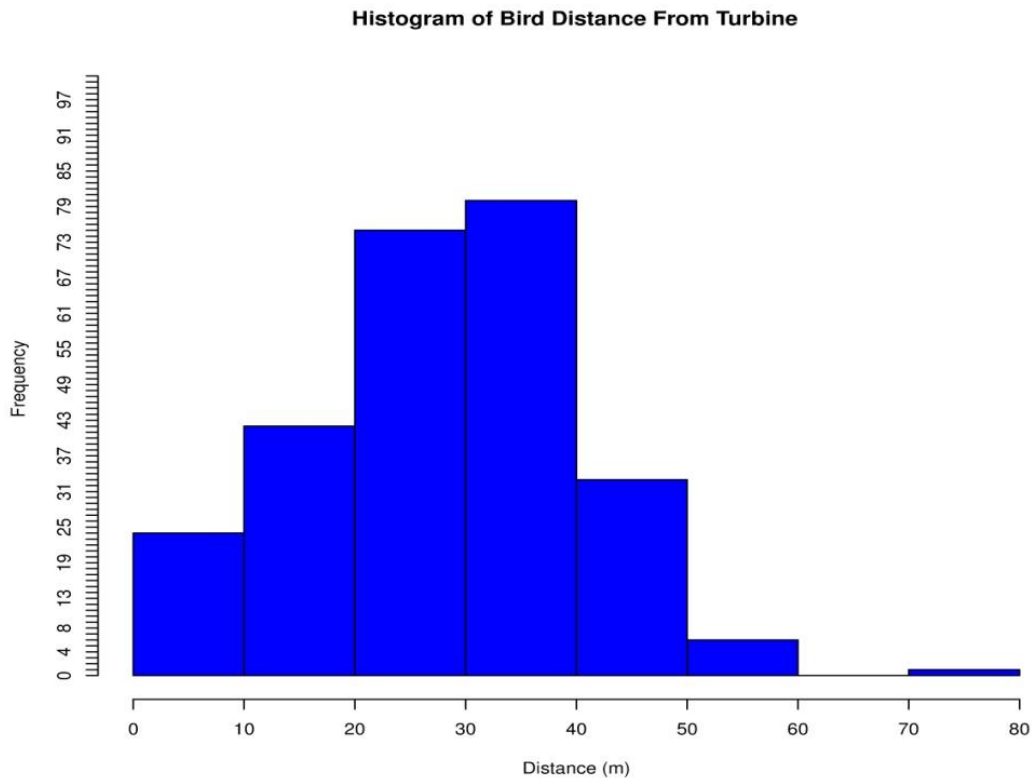
Species	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots		Other Incidentals		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
<b>Birds</b>								
red-eyed vireo	67	27.8	8	40.0	0	0	75	28.6
blackpoll warbler	23	9.5	1	5.0	0	0	24	9.2
unidentified passerine	18	7.5	0	0	0	0	18	6.9
magnolia warbler	12	5.0	0	0	0	0	12	4.6
wood thrush	11	4.6	0	0	0	0	11	4.2
Cape May warbler	9	3.7	1	5.0	0	0	10	3.8
golden-crowned kinglet	9	3.7	2	10.0	0	0	11	4.2
black-throated green warbler	8	3.3	0	0	0	0	8	3.1
yellow-rumped warbler	6	2.5	0	0	0	0	6	2.3
black-throated blue warbler	5	2.1	1	5.0	0	0	6	2.3
ovenbird	5	2.1	0	0	0	0	5	1.9
Swainson's thrush	5	2.1	0	0	0	0	5	1.9
yellow-billed cuckoo	5	2.1	2	10.0	0	0	7	2.7
unidentified bird	4	1.7	0	0	0	0	4	1.5
bay-breasted warbler	3	1.2	0	0	0	0	3	1.2
chestnut-sided warbler	3	1.2	0	0	0	0	3	1.2
gray-cheeked thrush	3	1.2	1	5.0	0	0	4	1.5
ruby-crowned kinglet	3	1.2	0	0	0	0	3	1.2
unidentified empidonax	3	1.2	0	0	0	0	3	1.2
veery	3	1.2	0	0	0	0	3	1.2
Blackburnian warbler	2	0.8	0	0	0	0	2	0.8
bobolink	2	0.8	0	0	0	0	2	0.8
field sparrow	2	0.8	0	0	1	100	3	1.2
unidentified bird (small)	2	0.8	0	0	0	0	2	0.8
unidentified flycatcher	2	0.8	0	0	0	0	2	0.8
yellow-bellied sapsucker	2	0.8	0	0	0	0	2	0.8
black-billed cuckoo	1	0.4	0	0	0	0	1	0.4
broad-winged hawk	1	0.4	0	0	0	0	1	0.4
Canada warbler	1	0.4	0	0	0	0	1	0.4
cliff swallow	1	0.4	0	0	0	0	1	0.4
common nighthawk	1	0.4	0	0	0	0	1	0.4
common yellowthroat	1	0.4	1	5.0	0	0	2	0.8
eastern phoebe	1	0.4	0	0	0	0	1	0.4

**Table 3. Total number and species composition of bird and bat casualties discovered at the CWP.**

Species	Fatalities during Scheduled Searches		Incidental Fatalities at Search Plots		Other Incidentals		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
European starling	1	0.4	0	0	0	0	1	0.4
gray catbird	1	0.4	0	0	0	0	1	0.4
Lincoln's sparrow	1	0.4	0	0	0	0	1	0.4
northern parula	1	0.4	0	0	0	0	1	0.4
northern waterthrush	1	0.4	0	0	0	0	1	0.4
palm warbler	1	0.4	0	0	0	0	1	0.4
Philadelphia vireo	1	0.4	0	0	0	0	1	0.4
red-breasted nuthatch	1	0.4	0	0	0	0	1	0.4
rose-breasted grosbeak	1	0.4	0	0	0	0	1	0.4
ruffed grouse	1	0.4	0	0	0	0	1	0.4
savannah sparrow	1	0.4	0	0	0	0	1	0.4
scarlet tanager	1	0.4	0	0	0	0	1	0.4
slate-colored junco	1	0.4	0	0	0	0	1	0.4
Tennessee warbler	1	0.4	1	5.0	0	0	2	0.8
unidentified warbler	1	0.4	0	0	0	0	1	0.4
winter wren	1	0.4	0	0	0	0	1	0.4
yellow-bellied flycatcher	1	0.4	0	0	0	0	1	0.4
American redstart	0	0	1	5.0	0	0	1	0.4
turkey vulture	0	0	1	5.0	0	0	1	0.4
<b>Overall Birds</b>	<b>241</b>	<b>100</b>	<b>20</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>262</b>	<b>100</b>
<b>Bats</b>								
eastern red bat	231	34.8	13	31.0	0	0	244	34.6
hoary bat	216	32.5	20	47.6	0	0	236	33.4
silver-haired bat	96	14.5	7	16.7	0	0	103	14.6
tricolored bat	47	7.1	0	0	0	0	47	6.7
big brown bat	37	5.6	1	2.4	0	0	38	5.4
little brown bat	30	4.5	1	2.4	0	0	31	4.4
unidentified bat	5	0.8	0	0	0	0	5	0.7
Seminole bat	1	0.2	0	0	0	0	1	0.1
unidentified myotis	1	0.2	0	0	0	0	1	0.1
<b>Overall Bats</b>	<b>664</b>	<b>100</b>	<b>42</b>	<b>100</b>	<b>0</b>	<b>100</b>	<b>706</b>	<b>100</b>

**Table 4. Distribution of distances of bird and bat casualties from turbines.**

Distance to Turbine (m)	Percent of Bird Casualties	Cumulative Percent of Birds	Percent of Bat Casualties	Cumulative Percent of Bats
0 to 10	9.2	9.2	10.5	10.5
10 to 20	16.1	25.3	27.5	38.0
20 to 30	28.7	54.0	26.3	64.3
30 to 40	30.7	84.7	24.4	88.7
40 to 50	12.6	97.3	8.6	97.3
50 to 60	2.3	99.6	2.0	99.3
60 to 70	0	99.6	0.3	99.6
70 to 80	0.4	100	0.3	99.9
>80	0	100	0.1	100



**Figure 4. Distance of bird casualties from the turbine.**

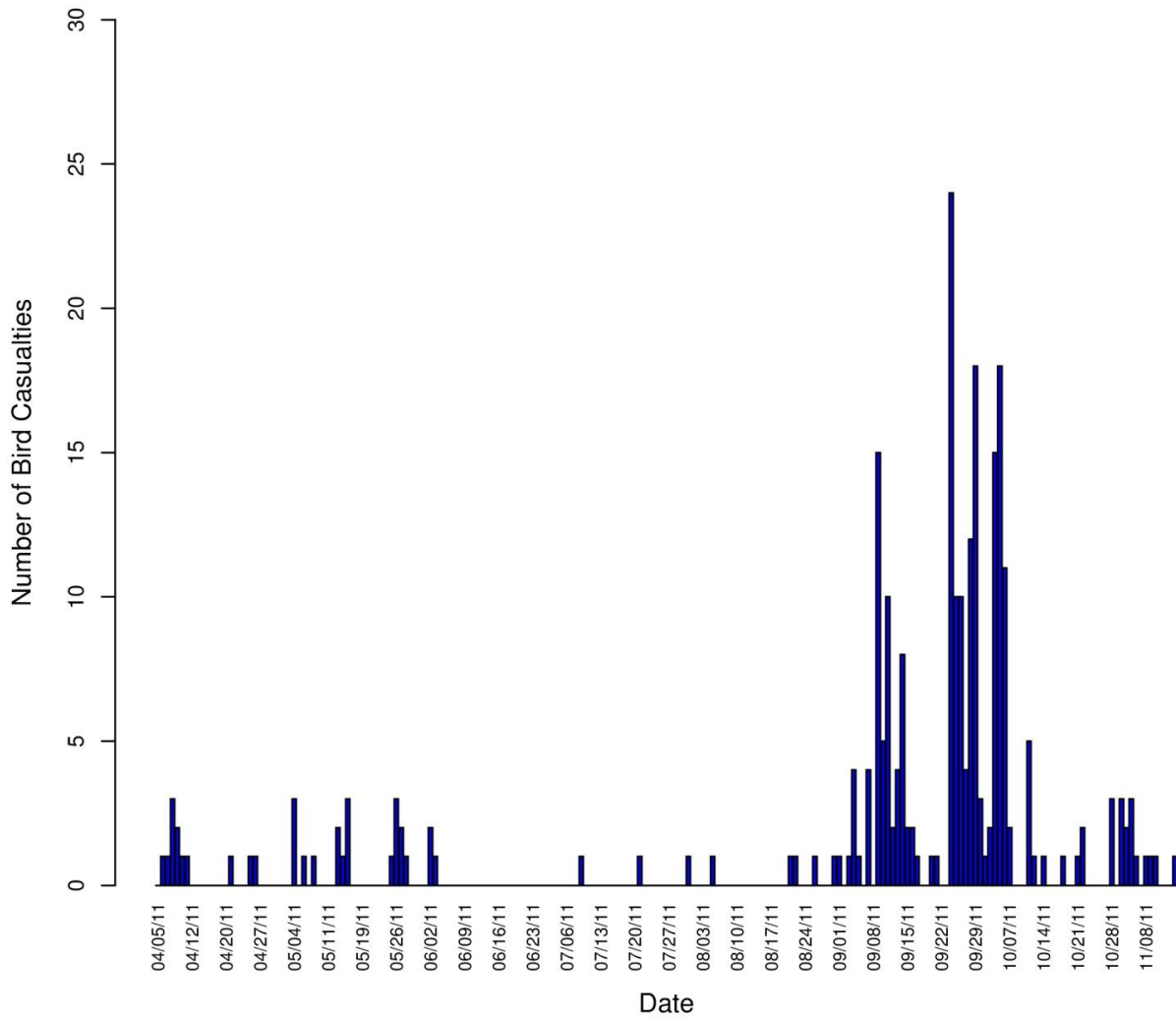


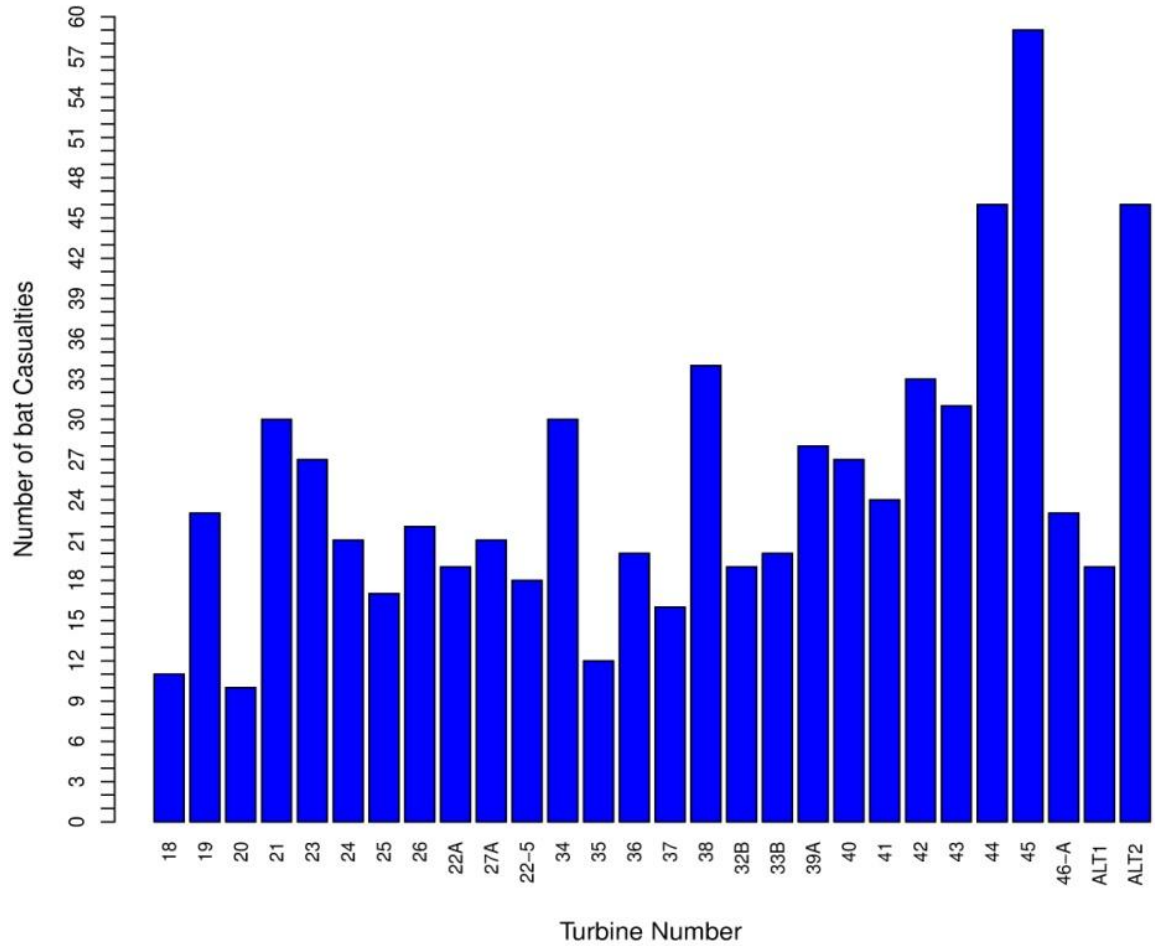
Figure 5. Timing of bird fatalities over the study period.



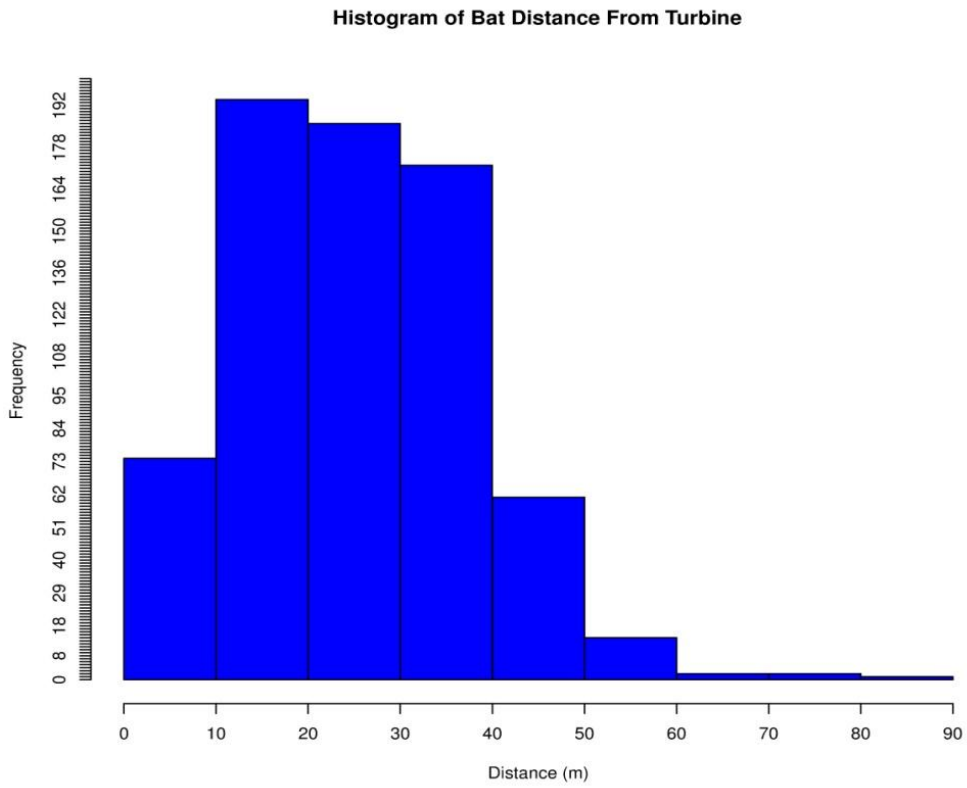
### **Bat Fatalities**

A total of 664 bat fatalities were found during scheduled turbine searches, representing seven identifiable species. The bat species most commonly found during searches were eastern red bat (*Lasiurus borealis*; 231 carcasses) and hoary bat (*L. cinereus*; 216 carcasses). Other bat species found during the scheduled searches included silver-haired bat (*Lasionycteris noctivagans*; 96 carcasses), tricolored bat (*Pipistrellus subflavus*; 47 carcasses), big brown bat (*Eptesicus fuscus*; 37 carcasses), little brown bat (*Myotis lucifugus*, 30 carcasses), and Seminole bat (*L. seminolus*, one carcass). A total of 42 bats were found incidentally within search plots (Table 3).

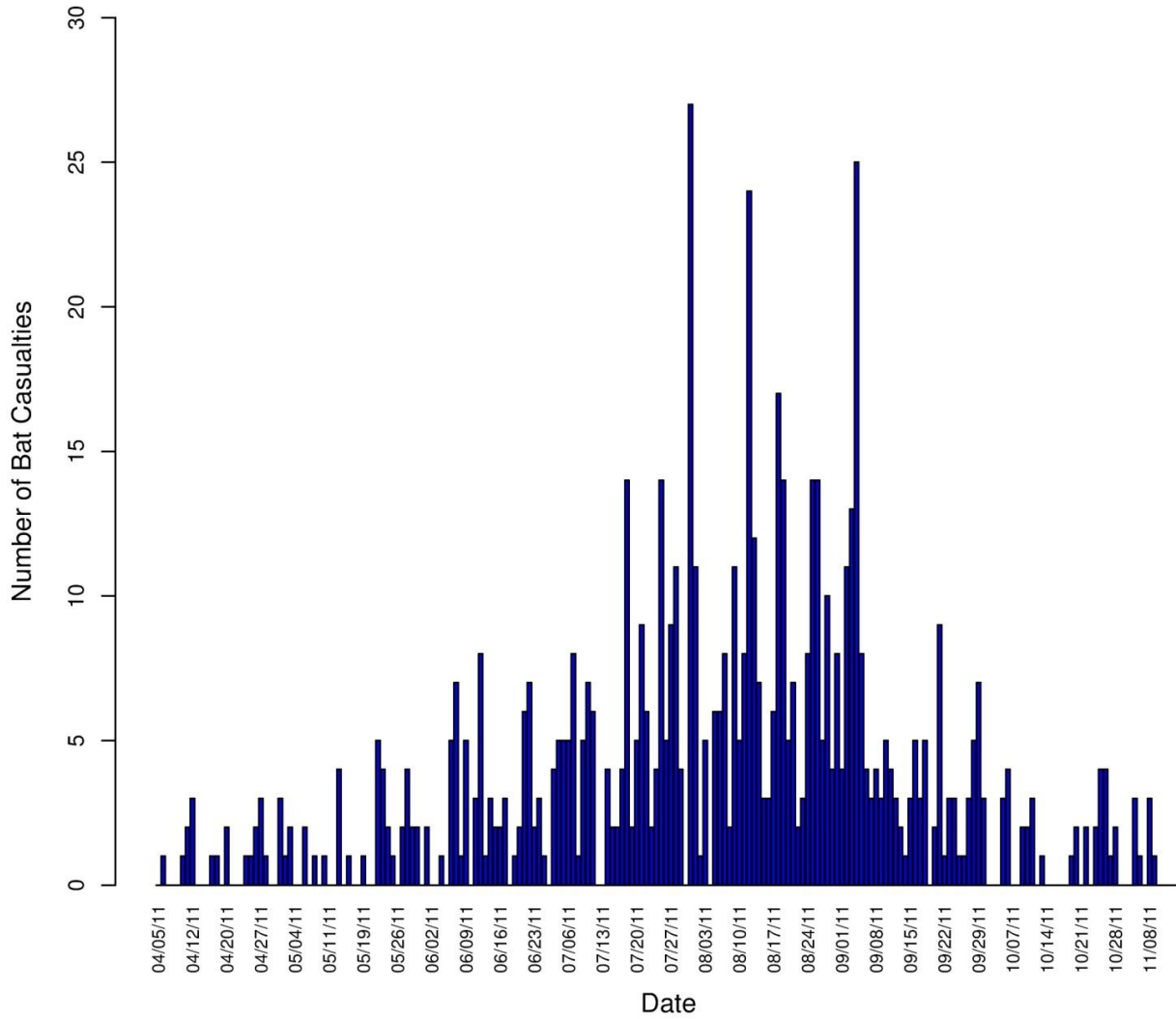
The greatest number of bat fatalities was found at Turbine 45 (59 carcasses), followed by Turbines 44 and ALT2 (46 carcasses each; Figure 6). The number of fatalities found at all other turbines ranged from 10 to 34 carcasses. Bats were typically found closer to the turbines than bird fatalities; however, a similar percentage (97.3%) of all bat fatalities was found within 50 m (~164 ft) from the turbine (Table 4, Figure 7). Bat fatalities were highest during the period July 15 to September 8, and peaked from September 2 to 8 (n=78 bat carcasses, Figure 8). The first bat fatality was found on April 6 and no bat fatalities were found from November 11 to 15.



**Figure 6. Number of bat fatalities by turbine at the CWP.**



**Figure 7. Distance of bat fatalities from the turbine.**



**Figure 8. Timing of bat fatalities over the study period.**

### Searcher Efficiency Trials

A total of 78 bird carcasses (55 small birds and 23 large birds) and 72 bat carcasses were placed throughout the project area for the searcher efficiency trials (Table 5). The overall searcher efficiency rate for small birds was 49%, compared to 87% for large birds and 54.5% for bats (Table 5). Searcher efficiency for small birds was 0.70 in spring and 0.32 in fall, while searcher efficiency for large birds was 0.87 in both spring and fall. Searcher efficiency varied by season for bats with 0.72 in spring compared to 0.38 in fall (Table 6).

**Table 5. Searcher efficiency results at the Criterion Wind Energy Project as a function of season and carcass size.**

Size	Date	Number Placed	Number Available	Number Found	Percent Found
<i>Small Birds</i>	5/4/2011	3	3	1	33.3
	5/11/2011	4	4	3	75.0
	5/20/2011	2	2	1	50.0
	5/27/2011	3	3	2	66.7
	6/3/2011	3	3	3	100
	6/10/2011	3	3	2	66.7
	6/15/2011	2	2	2	100
	6/22/2011	2	2	1	50.0
	7/8/2011	4	1	1	100
	7/13/2011	1	0	0	-
	7/20/2011	3	3	1	33.3
	7/27/2011	1	1	1	100
	8/3/2011	3	3	2	66.7
	8/10/2011	2	2	0	0
	8/17/2011	1	1	1	100
	8/26/2011	2	2	1	50.0
	8/31/2011	1	1	1	100
	9/7/2011	2	2	0	0
	9/15/2011	1	1	0	0
	9/22/2011	2	2	0	0
	9/29/2011	2	2	0	0
10/13/2011	5	5	1	20.0	
10/20/2011	1	1	0	0	
10/27/2011	1	1	1	100	
11/10/2011	1	1	0	0	
		<b>55</b>	<b>51</b>	<b>25</b>	<b>49.0</b>
<i>Large Birds</i>	5/4/2011	1	1	1	100
	5/11/2011	1	1	1	100
	5/20/2011	1	1	1	100
	5/27/2011	1	1	0	0
	6/3/2011	2	2	2	100
	6/10/2011	1	1	1	100
	6/15/2011	1	1	1	100
	6/22/2011	1	1	1	100
	7/8/2011	1	1	1	100
	7/13/2011	2	2	1	50.0
	7/20/2011	1	1	1	100
7/27/2011	1	1	1	100	
8/3/2011	1	1	1	100	

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	8/26/2011	1	1	1	100
	9/15/2011	1	1	1	100
	9/22/2011	1	1	1	100
	9/29/2011	1	1	1	100
	10/6/2011	1	1	1	100
	10/20/2011	1	1	0	0
	11/3/2011	1	1	1	100
	11/10/2011	1	1	1	100
		<b>23</b>	<b>23</b>	<b>20</b>	<b>87.0</b>
	5/4/2011	4	4	4	100
	5/11/2011	3	3	2	66.7
	5/20/2011	5	5	3	60.0
	5/27/2011	4	4	3	75.0
	6/3/2011	4	4	4	100
	6/10/2011	5	5	4	80.0
	6/15/2011	3	3	2	66.7
	6/22/2011	2	2	0	0
	7/8/2011	6	2	1	50.0
	7/13/2011	2	0	0	-
	7/20/2011	2	2	2	100
<i>Bats</i>	7/27/2011	2	2	2	100
	8/3/2011	4	4	0	0
	8/10/2011	3	3	1	33.3
	8/17/2011	3	3	0	0
	8/26/2011	2	2	0	0
	8/31/2011	2	2	0	0
	9/7/2011	2	2	2	100
	9/15/2011	2	2	1	50.0
	9/22/2011	1	1	0	0
	9/29/2011	3	3	1	33.3
	10/6/2011	2	2	0	0
	10/20/2011	1	1	0	0
	10/27/2011	3	3	3	100
	11/10/2011	2	2	1	50.0
		<b>72</b>	<b>66</b>	<b>36</b>	<b>54.5</b>

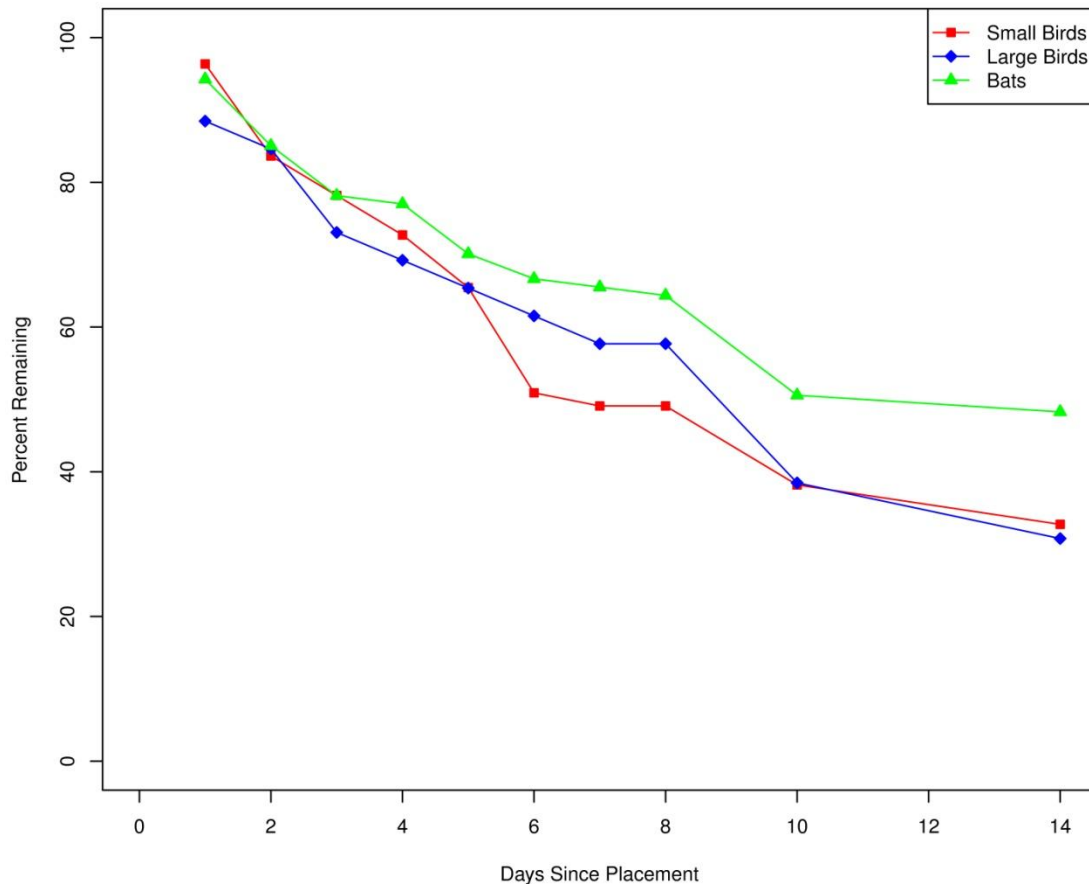
**Table 6. Searcher efficiency estimates for the CWP for the spring and fall periods.**

Parameter	Spring		Fall	
	Mean	CL	Mean	CL
<b>Observer Detection</b>				
<i>p (small birds)</i>	0.70	0.52 - 0.83	0.32	0.18 - 0.46
<i>p (large birds)</i>	0.87	0.74 - 0.96	0.87	0.74 - 0.96
<i>p (bats)</i>	0.72	0.59 - 0.84	0.38	0.24 - 0.53

### Carcass Removal Trials

A total of 169 carcasses (26 large birds, 55 small birds, and 87 bats) were placed in the project area throughout the study period for carcass removal trials. By Day 5, approximately 70% of all bird and bat carcasses remained. Approximately 40% of small and large bird carcasses remained after Day 10, compared to 50% of bat carcasses. At Day 14, when trial carcasses

were removed, approximately 35% of small and large bird carcasses and 45% of bat carcasses remained (Figure 9). Mean carcass removal was 11.57 days (90% CI 8.56-15.71) for small birds compared to 10.94 days (90% CI 7.48-16.64) for large birds. Bat removal varied by season; for spring mean carcass removal was 19.50 days (90% CI 13.76-28.68) and for fall carcass removal was 13.33 days (90% CI 9.15-19.45) (Tables 6 and 7).



**Figure 9. Carcass removal rates at the CWP.**

### Adjusted Fatality Estimates

Fatality estimates and 90% confidence intervals were calculated for birds and bats by season due to significant differences in searcher efficiency for small birds and bats between the two seasons (Tables 7 and 8). The fatality estimates are adjusted based on the corrections for carcass removal, observer detection bias, and the search area correction factor. Searcher efficiency was higher in spring compared to fall for both small birds and bats (Table 6), but remained constant for large birds (Table 6). For small birds, the probability that a carcass would remain in the search plot and be found by a searcher was 0.91 in the spring and 0.79 in the fall;

for large birds, this probability was higher and remained constant between seasons, 0.93 (Table 7). For bats, the probability that a carcass would remain in the search plot and be found by a searcher was 0.95 in the spring and 0.84 in the fall (Table 8).

**Table 7. Adjusted bird fatality estimates for the CWP for the spring and fall periods.**

Parameter	Spring		Fall	
	Mean	CL	Mean	CL
<b>Observed Fatality Rates (Fatalities/turbine/study period)</b>				
<i>Small birds</i>	1.18	0.86 - 1.54	7.57	5.00 - 11.04
<i>Large birds</i>	0.07	0 - 0.14	0.50	0.25 - 0.79
<i>Raptors</i>	0.00	-	0.04	0 - 0.11
<i>All birds</i>	1.25	0.93 - 1.61	8.07	5.46 - 11.43
<b>Average Probability of Carcass Availability and Detected</b>				
<i>Small birds</i>	0.91	0.86 - 0.94	0.79	0.64 - 0.86
<i>Large birds</i>	0.93	0.90 - 0.96	0.93	0.89 - 0.96
<b>Search Area Adjustment</b>				
<i>Small birds</i>	1.40	-	1.40	-
<i>Large birds</i>	1.25	-	1.25	-
<b>Adjusted Fatality Estimates (Fatalities/turbine/study period)</b>				
<i>Small birds</i>	1.81	1.31 - 2.37	13.43	8.70 - 20.99
<i>Large birds</i>	0.10	0 - 0.20	0.67	0.33 - 1.07
<i>Raptors</i>	0.00	-	0.05	0 - 0.14
<i>All birds</i>	1.90	1.40 - 2.49	14.11	9.47 - 21.39

**Table 8. Adjusted bat fatality estimate for the CWP for the spring and fall periods.**

Parameter	Spring		Fall	
	Mean	CL	Mean	CL
<b>Observed Fatality Rates (Fatalities/turbine/study period)</b>				
<i>Bats</i>	6.21	5.36 - 7.07	19.00	16.25 - 22.18
<b>Average Probability of Carcass Availability and Detected</b>				
<i>Bats</i>	0.95	0.92 - 0.96	0.84	0.73 - 0.90
<b>Search Area Adjustment</b>				
<i>Bats</i>	1.34	-	1.34	-
<b>Adjusted Fatality Estimates (Fatalities/turbine/study period)</b>				
<i>Bats</i>	8.78	7.61 - 10.06	30.25	25.85 - 37.22

Overall fatality rates were calculated by combining the two seasonal estimates. The estimated fatality rate for small birds was 15.25 fatalities per turbine per study period, large birds 0.76, raptor 0.05, all birds 16.01, and bats 39.03 (Table 9). Based on the 2.5 MW capacities of the turbines at the site, the estimated fatality rate for small birds was 6.10 birds per MW per study period; 0.30 for large birds; 0.02 for raptors; 6.40 for all birds combined; and 15.61 bats per MW per study period (Table 9).



**Table 9. Overall adjusted bird and bat fatality estimates for the CWP for the entire study period.**

	<b>Corrected Fatality Estimate</b>
<i>Number of fatalities/turbine/study period</i>	
<b>Small Birds</b>	15.25 (10.50-22.77)
<b>Large Birds</b>	0.76 (0.39-1.18)
<b>Raptors</b>	0.05 (0.00-0.14)
<b>All Birds</b>	16.01 (11.26-23.49)
<b>Bats</b>	39.03 (34.38-46.51)
<i>Number of fatalities/MW/study period</i>	
<b>Small Birds</b>	6.10 (4.20-9.11)
<b>Large Birds</b>	0.30 (0.16-0.47)
<b>Raptors</b>	0.02 (0.00-0.06)
<b>All Birds</b>	6.40 (4.50-9.40)
<b>Bats</b>	15.61 (13.75-18.60)

### **Weather and Visibility Analysis**

Weather data from the project for the period April 5 through November 15, 2011 were used in the analyses. All weather factors were significantly correlated ( $p < 0.1$ ) to bat mortality, including temperature ( $r = 0.45$ ,  $p = <0.001$ ), mean wind speed ( $r = -0.41$ ,  $p < 0.001$ ), mean wind speed squared ( $r = -0.37$ ,  $p < 0.001$ ), median wind speed ( $r = -0.40$ ,  $p < 0.001$ ), median wind speed squared ( $r = -0.37$ ,  $p < 0.001$ ), and the proportion of nights with wind speed  $<4\text{m/sec}$ ,  $4\text{-}6\text{m/sec}$ , or  $>6\text{m/sec}$  ( $r = 0.35$ ,  $p < 0.001$ ;  $r = 0.37$ ,  $p < 0.001$ ; and  $r = -0.43$ ,  $p < 0.001$ , respectively) (Table 10). A positive value for the correlation coefficient suggests that the two variables are positively correlated, indicating that an increase in the variable corresponds to an increase in bat mortality. A negative value for the correlation coefficient suggests that the two variables are negatively correlated, indicating that an increase in the variable corresponds to a decrease in bat mortality.

All weather factors except average nightly temperature were significantly correlated ( $p < 0.1$ ) to bird mortality, mean wind speed ( $r = -0.25$ ,  $p = 0.009$ ), mean wind speed squared ( $r = -0.22$ ,  $p = 0.021$ ), median wind speed ( $r = -0.24$ ,  $p = 0.010$ ), median wind speed squared ( $r = -0.22$ ,  $p = 0.021$ ), and the proportion of nights with wind speed  $<4\text{m/sec}$ ,  $4\text{-}6\text{m/sec}$ , or  $>6\text{m/sec}$  ( $r = 0.23$ ,  $p = 0.017$ ;  $r = 0.21$ ,  $p = 0.028$ ; and  $r = -0.25$ ,  $p = 0.007$ , respectively; Table 11). A positive value for the correlation coefficient suggests that the two variables are positively correlated, indicating that an increase in the variable corresponds to an increase in bird mortality. A negative value for the correlation coefficient suggests that the two variables are negatively correlated, indicating that an increase in the variable corresponds to a decrease in bird mortality.

**Table 10. Univariate regressions between nightly weather and nightly bat mortality.**

Variable	B <sub>0</sub>	B <sub>1</sub>	se	p	R <sup>2</sup>	r
temperature (avg. nightly)	-0.081	0.013	0.002	<0.001	0.20	0.45
wind speed (mean nightly)	0.328	-0.030	0.005	<0.001	0.16	-0.41
mean wind speed (squared)	0.212	-0.002	0.001	<0.001	0.14	-0.37
proportion of night with wind speed <4 m/sec	0.068	0.287	0.053	<0.001	0.12	0.35
wind speed (median nightly)	0.316	-0.028	0.004	<0.001	0.15	-0.40
proportion of night with wind speed >6 m/sec	0.266	-0.238	0.035	<0.001	0.18	-0.43
median wind speed (squared)	0.209	-0.002	0.001	<0.001	0.13	-0.37
proportion of night with wind speed 4-6 m/sec	0.036	0.392	0.068	<0.001	0.13	0.37

B<sub>0</sub> = constant or intercept  
 B<sub>1</sub> = slope coefficient  
 se = standard error for slope coefficient  
 p = p-value for test of B<sub>1</sub>=0  
 R<sup>2</sup> = R-squared for regression  
 r = Pearson's correlation coefficient

**Table 11. Univariate regressions between nightly weather and nightly bird mortality rate.**

Variable	B <sub>0</sub>	B <sub>1</sub>	se	p	R <sup>2</sup>	r
temperature (avg. nightly)	0.041	0.003	0.003	0.298	0.001	0.10
wind speed (mean nightly)	0.200	-0.016	0.006	<b>0.009</b>	0.05	-0.25
mean wind speed (squared)	0.131	-0.001	0.001	<b>0.021</b>	0.04	-0.22
proportion of night with wind speed <4 m/sec	0.052	0.201	0.083	<b>0.017</b>	0.04	0.23
wind speed (median nightly)	0.195	-0.015	0.006	<b>0.010</b>	0.05	-0.24
proportion of night with wind speed >6 m/sec	0.174	-0.140	0.051	<b>0.007</b>	0.06	-0.25
median wind speed (squared)	0.130	-0.001	0.001	<b>0.021</b>	0.04	-0.22
proportion of night with wind speed 4-6 m/sec	0.040	0.204	0.092	<b>0.028</b>	0.03	0.21

B<sub>0</sub> = constant or intercept  
 B<sub>1</sub> = slope coefficient  
 se = standard error for slope coefficient  
 p = p-value for test of B<sub>1</sub>=0  
 R<sup>2</sup> = R-squared for regression  
 r = Pearson's correlation coefficient

Multiple linear regression models were used to investigate all possible models with at least two predictor variables, and interactions of variables for predicting bird and bat mortality. AICc values were used to determine the five best linear regression models of the total possible model combinations (Table 12 and 13). For bat mortality, all of the top models selected as the best linear regression models included the variable tempc (mean nightly temperature; measured at turbines and averaged across turbines). Other variables that showed up more than once in the top 10 models included the variables proportion of nights with wind speed 0-4m/sec, proportion of nights with wind speed 4-6m/sec, proportion of nights with wind speed >6m/sec, and the

interaction term for average nightly temperature and proportion of nights with wind speed 4-6./sec. The  $R^2$  values for the top five models ranged from 0.36–0.40, indicating moderate fit to the variation in the data.

For bird mortality, the model selected as the best linear regression model included the variable proportion of night with wind speed >6m/sec. Variables that showed up more than once in the top five models included the variables proportion of nights with wind speed 0-4m/sec, proportion of nights with wind speed >6m/sec, average nightly wind speed (measured at turbines and averaged across turbines), and average nightly temperature (measured at turbines and averaged across turbines). The  $R^2$  values for the top ten models ranged from 0.04–0.06, indicating poor fit to the variation in the data.

**Table 12. Multiple regression models containing the best predictor variables and possible interactions between nightly weather variables and nightly bat mortality.**

Variable	Coeff	SE	p
<b>Model 1: AICc=-235.55, R2=0.40</b>			
Mean nightly temperature	0.034	0.004	<0.001
Proportion of night with wind speed >6m/s	0.317	0.084	<0.001
Interaction variable between mean nightly temperature and proportion of night with wind speed >6m/s	-0.032	0.001	<0.001
<b>Model 2: AICc=-229.35, R2=0.38</b>			
Mean nightly temperature	0.001	0.002	0.633
Proportion of night with wind speed from 0-2 m/s	0.175	0.048	<0.001
Proportion of night with wind speed from 4-6 m/s	-0.801	0.180	<0.001
Interaction variable between mean nightly temperature and proportion of night with wind speed from 4-6m/s	0.065	0.011	<0.001
<b>Model 3: AICc=-228.75, R2=0.38</b>			
Mean nightly temperature	0.043	0.005	<0.001
Mean nightly wind speed	0.036	0.009	<0.001
Interaction variable between mean nightly temperature and mean nightly wind speed	-0.004	0.001	<0.001
<b>Model 4: AICc=-223.66, R2=0.36</b>			
Mean nightly temperature	0.040	0.005	<0.001
Median nightly wind speed	0.032	0.009	0.001
Interaction variable between mean nightly temperature and median nightly wind speed	-0.004	0.001	<0.001
<b>Model 5: AICc=-222.20, R2=0.36</b>			
Mean nightly temperature	0.028	0.003	<0.001
Quadratic term for mean nightly wind speed	0.002	0.001	<0.001
Interaction variable between mean nightly temperature and quadratic term for mean nightly wind speed	-0.001	0.001	<0.001

**Table 13. Multiple regression models containing the best predictor variables and possible interactions between nightly weather variables and nightly bird mortality.**

Variable	Coeff	SE	p
<b>Model 1: AICc=-94.20, R2=0.06</b>			
Proportion of night with wind speed >6m/s	-0.140	0.051	0.007
<b>Model 2: AICc=-93.72, R2=0.05</b>			
Mean nightly wind speed	-0.016	0.006	0.009
<b>Model 3: AICc=-93.45, R2=0.05</b>			
Median nightly wind speed	-0.015	0.001	0.010
<b>Model 4: AICc=-92.53, R2=0.04</b>			
Proportion of night with wind speed of 0–4 m/s	0.201	0.083	0.017
<b>Model 5: AICc=-92.34, R2=0.06</b>			
Mean nightly temperature	0.011	0.008	0.177
Proportion of night with wind speed >6m/s	0.046	0.139	0.743
Interaction variable between mean nightly temperature and proportion of night with wind speed >6m/s	-0.014	0.010	0.151

Visibility data for the period April 1 through May 31, 2011 were used in the spring bird migration analysis and from September 1 through October 31, 2011 were used in the fall bird migration analysis. For bats, visibility data from period April 1 through May 31, 2011 were used in the spring migration analysis and for the period August 1 through October 31, 2011 were used in the fall migration analysis. Mean nightly visibility was significantly correlated to bird mortality during fall migration season ( $r = -0.42$ ,  $p = 0.001$ ). A negative value for the correlation coefficient suggests that the two variables are negatively correlated, indicating that an increase in mean nightly visibility variable corresponds to a decrease in bird mortality. Mean nightly visibility was not significantly correlated to bird mortality during spring migration season ( $r = -0.15$ ,  $p = 0.397$ ). Mean nightly visibility was significantly correlated to bat mortality during fall migration season ( $r = 0.19$ ,  $p = 0.077$ ) and was not significantly correlated to bat mortality during spring migration season ( $r = 0.22$ ,  $p = 0.199$ ). A positive value for the correlation coefficient suggests that the two variables are positively correlated, indicating that an increase in mean nightly visibility variable corresponds to an increase in bat mortality.

**Table 14. Univariate regressions between nightly visibility and nightly bird mortality.**

Variable	B <sub>0</sub>	B <sub>1</sub>	se	p	R <sup>2</sup>	r
Fall Bird Migration period – mean nightly visibility	0.539	-0.419	0.122	<b>0.001</b>	0.16	-0.42
Spring Bird Migration period - mean nightly visibility	0.539	-0.035	0.041	<b>0.397</b>	-0.01	-0.15
Fall Bat Migration period – mean nightly visibility	-0.053	0.218	0.122	<b>0.077</b>	0.03	0.19
Spring Bat Migration period - mean nightly visibility	-0.031	0.064	0.049	<b>0.199</b>	0.02	0.22

B<sub>0</sub> = constant or intercept  
 B<sub>1</sub> = slope coefficient  
 se = standard error for slope coefficient  
 p = p-value for test of B<sub>1</sub>=0  
 R<sup>2</sup> = R-squared for regression  
 r = Pearson's correlation coefficient

## DISCUSSION AND IMPACT ASSESSMENT

The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, searcher efficiency rates, carcass removal rates, and area searched biases. There are numerous factors that could contribute to both positive and negative biases in estimating fatality rates (Erickson 2006). The overall design of this study incorporates several assumptions or factors that affect the results of the fatality estimates. First, all bird casualties found within the standardized search plots during the study were included in the analysis. Second, it was assumed that all carcasses found during the study were due to collision with wind turbines. True cause of death may be unknown for many of the fatalities, especially if they have been scavenged or are heavily decomposed. It is possible that some of the bird fatalities were caused by predators (e.g. feather spots are often left behind at the site of a raptor kill) or other natural causes (e.g., disease, background mortality). However, it is typically thought that most, if not all, of the bat fatalities are due to collisions with the turbines.

The search plot distance for this study was selected based on constraints from habitat in the study area. Typically the area out to 40-50 m from the turbine was cleared to accommodate construction of the turbine. The search plot for any given turbine was typically defined by this cleared area. For this study this search plot appeared adequate as based on the distribution of fatalities as a function of distance from turbines (see Figures 4 and 7). For both birds and bats >97% of the casualties were located within 50 m of the turbine and only a small percentage of bird and bat fatalities were located beyond 50 m of the turbine. This suggests that only a small percentage of bird or bat casualties fell outside the search plots and may have been missed. The area search factor for both birds and bats was relatively small (see Tables 7 and 8) and did not have a large influence on the overall fatality estimates.

Other potential biases are associated with the experimental carcasses used in searcher efficiency and carcass removal trials and whether or not they are representative of actual carcasses. This may occur if the types of birds used are larger or smaller than the carcasses of

actual fatalities or more or less cryptic in color and appearance than the actual fatalities. House sparrow, mallards, and rock pigeons were used to represent the range of bird fatalities expected. It is believed that this range captures the range of sizes and other characteristics of actual fatalities and should provide a reasonable representation of searcher efficiency and carcass removal rates for birds as a group. Additionally, bats carcasses retrieved during the study were used to estimate search efficiency and carcass removal for bats specifically, thus providing a reasonable representation of these biases for bats.

### **Weather Analysis**

Because the study utilized daily carcass searches the time of death for most casualties recovered was known (i.e., the night before) and therefore an analysis to investigate the influence of nightly weather on fatality rate was possible. The analysis utilized weather data collected at the turbines to investigate the correlation between weather variables and bird and bat mortality as well as an analysis to model what combination of weather variable was best predictive of bat mortality. The analysis also used visibility data from a regional highway weather monitoring station in similar topography and elevation to investigate the correlation between visibility (fog) and mortality. Similar to other studies in the region (see for example, Arnett et al. 2005, Young et al. 2010a, Young et al. 2011a, Arnett et al. 2009), the analysis confirmed the relationships of bat mortality with wind speed and temperature. Bat mortality was negatively correlated with wind speed and positively correlated with temperature; that is, as average nightly wind speed increased or the proportion of nights with wind speed greater than 6 m/s increased bat mortality decreased, and as average nightly temperature increased bat mortality increased. Bird mortality was also negatively correlated with wind speed but was not correlated with temperature. Bird mortality was negatively correlated with visibility, that is, as visibility increase bird mortality decreased. This provides corroborating evidence for the premise that birds may migrate at lower altitude on nights with poor visibility or low cloud cover.

The weather analysis also used a modeling approach to investigate what combination of weather variables best predicted bat mortality. Mean nightly temperature was included in the top five models along with one or more of the wind speed variables and the interaction effect of the two variables. Interaction effects represent the combined effects of variables on the criterion or dependent measure, in this case bat mortality. When an interaction effect is present, the impact of one variable depends on the level of the other variable. In general, this suggests that while nightly temperature and wind speed variables both have significant influence on bat mortality, the combination of the two variables may have an even greater effect. For bird mortality the top five models all included a wind speed variable. The interaction of wind speed and temperature did come in to one of the top five best predictor models but temperature was not a significant individual variable for predicting bird mortality.

### **Turbine Lighting**

Bird mortality appeared to be inflated at two of the turbines in the project, turbines 40 and Alt 2, when compared to the other turbines. When this issue was noted, operations and maintenance staff were asked to investigate and it was determined that internal lights in the nacelle of these

turbines were on and light pollution was emitting from the tops of the nacelles via skylights. The lights were turned off on October 5, 2011 for turbine Alt2 and on October 12, 2011 for turbine 40, and bird mortality subsequently appeared to drop. It is unclear how long the lights were on in each turbine. To investigate the effects that these lit turbines may have had on overall bird mortality at the CWP, the data for these two turbines was removed and the analyses re-run. Without turbines 40 and Alt 2 included, overall adjusted bird mortality dropped to 11.00 (90% CI 8.68-14.26) for small birds and 0.52 (90% CI 0.21-0.84) birds per turbine per study period, or 4.40 small birds per MW and 0.21 large birds per MW.

This issue with the lighting at the turbines was discussed with the USFWS according to commitments of Criterion outlined in their Avian and Bat Protection Plan for the CWP. Actions have been taken by Criterion to insure that turbine lights remain off during night time periods unless emergency maintenance activities are occurring. Both turbines 40 and Alt 2 will be included in the 2012 monitoring study to investigate further the impact from these turbines without the lights on.

### **Comparison with Regional Data**

Bird fatality estimates based on publically available information for wind energy facilities across North America have ranged from 0.15 (Buffalo Gap, Texas) to 11.02 birds per MW per year (Buffalo Mountain, Tennessee). For more regional studies, the estimated bird fatality rate at CWP, 16.0 birds per turbine or 6.4 birds per MW for the study period is higher than fatality estimates at facilities where monitoring study results are available within approximately a 40-mile radius of the project (Table 15). To standardize the estimates from these studies to area of risk as defined by the rotor-swept area (RSA), the estimated mortality was calculated per 1000 m<sup>2</sup> of RSA (Table 15).

Publically-available bat fatality estimates from other wind projects in the U.S. have ranged from near zero (Buffalo Gap, Texas) to 40 bats per MW per study period (Buffalo Mountain, Tennessee). The estimated bat fatality rate at CWP of 39.0 bats per turbine or 15.6 bats per MW for the study period is comparable to bat fatalities estimates from projects where monitoring study results are available within approximately a 40-mile radius of the CWP (Table 16).

Species composition of fatalities at the CWP is similar to that at most other wind energy facilities, in that more than 80% of identified bat fatalities were comprised of the three migratory tree bat species, namely hoary bat, eastern red bat, and silver-haired bat. Based on the timing of fatalities for these species most of the fatalities were apparently fall migrants through the site or occurred during what is considered the late summer swarming (mating) period, as is the case at virtually all other wind energy facilities in North America (Johnson 2005, Arnett et al. 2008).

**Table 15. Summary of bird casualties from post-construction fatality monitoring studies conducted at wind-energy facilities in the vicinity of CWP.**

Project Name, State	Project size (No. of Turbines)	No. of Turbine Searches	Estimated # birds/turbine/study period <sup>1</sup>	Estimated # birds/1000 m <sup>2</sup> RSA/study period	90% CI	Study Year	Reference
Criterion, MD	28	5,316	16.0	2.3	1.6, 3.4	2011	This study
Mountaineer, WV	44	998	4.0	1.0	0.6, 2.0	2003	Kerns & Kerlinger 2004
Casselman, PA	23	2,040	4.7 <sup>2</sup>	1.0 <sup>2</sup>	0.3, 3.0 <sup>3</sup>	2008	Arnett <i>et al.</i> 2009
Casselman, PA	23	nr	4.3	0.9	0.6, 1.4 <sup>3</sup>	2009	Capouillez and Mumma 2010
Mt Storm, WV	132	2,520	8.7 <sup>4</sup>	1.7 <sup>4</sup>	1.0, 2.5	2009	Young <i>et al.</i> 2009b, 2010a
Mt Storm, WV	132	4,401	6.7 <sup>4</sup>	1.3 <sup>4</sup>	0.8, 2.0	2010	Young <i>et al.</i> 2010b, 2011a
Mt Storm, WV	132	3,794	8.0 <sup>4</sup>	1.6 <sup>4</sup>	1.3, 2.5	2011	Young <i>et al.</i> 2011b, 2012

nr = not reported

RSA equivalent was determined by dividing the total estimated bird mortality by total RSA for the project as determined by the rotor dimensions for the specific turbines at that site

<sup>1</sup>study period is approximately the period from April through October which is similar to the monitoring period for CWP <sup>2</sup>based on the Huso estimator; <sup>3</sup>estimated based on the reported as 95% CI. ; <sup>4</sup>estimate was derived by combining the results from two non-overlapping study periods (spring and fall) which used the same study plots

**Table 16. Summary of bat casualties from post-construction fatality monitoring studies conducted at wind-energy facilities in the vicinity of CWP.**

Project Name, State	Project size (No. of Turbines)	No. of Turbine Searches	Estimated # bats/turbine/study period <sup>1</sup>	Estimated # bats/1000 m <sup>2</sup> RSA/study period <sup>1</sup>	90% CI	Study Year	Reference
Criterion, MD	28	5,316	39.0	5.7	5.1, 6.8	2011	This study
Mountaineer, WV	44	998	47.5	11.7	7.8, 22.5	2003	Kerns & Kerlinger 2004
Casselman, PA	23	2,040	18.9	4.1 <sup>2</sup>	3.3, 4.9 <sup>3</sup>	2008	Arnett <i>et al.</i> 2009
Casselman, PA	23	nr	12.9	2.8	2.1, 3.5 <sup>3</sup>	2009	Capouillez and Mumma 2010
Mt Storm, WV	132	2,520	28.6	5.7 <sup>4</sup>	3.7, 8.1	2009	Young <i>et al.</i> 2009b, 2010a
Mt Storm, WV	132	4,401	32.4	6.4 <sup>4</sup>	5.3, 8.6	2010	Young <i>et al.</i> 2010b, 2011a
Mt Storm, WV	132	3,794	14.9	3.0 <sup>4</sup>	2.4, 3.6	2011	Young <i>et al.</i> 2011b, 2012

nr = not reported

RSA equivalent was determined by dividing the total estimated bird mortality by total RSA for the project as determined by the rotor dimensions for the specific turbines at that site

<sup>1</sup>study period is approximately the period from April through October which is similar to the monitoring period for CWP <sup>2</sup>based on the Huso estimator; <sup>3</sup>estimated based on the reported as 95% CI. ; <sup>4</sup>estimate was derived by combining the results from two non-overlapping study periods (spring and fall) which used the same study plots



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**Appendix A. Complete fatality listing for the Criterion Wind Energy Project**

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
7/18/2011	eastern red bat	27A	28	carcass search	Daily	complete
7/18/2011	eastern red bat	39A	48	incidental find	Daily	complete
7/18/2011	big brown bat	46-A	31	carcass search	Daily	partial
7/18/2011	hoary bat	38	18	carcass search	Daily	complete
7/18/2011	eastern red bat	38	17	carcass search	Daily	complete
7/18/2011	hoary bat	21	12	carcass search	Daily	complete
7/19/2011	little brown bat	24	40	carcass search	Daily	scavenged
7/19/2011	hoary bat	34	8	carcass search	Daily	complete
7/20/2011	hoary bat	ALT2	31	carcass search	Daily	complete
7/20/2011	eastern red bat	ALT2	24	carcass search	Daily	complete
7/20/2011	eastern red bat	23	13	carcass search	Daily	complete
7/20/2011	eastern red bat	38	25	carcass search	Daily	complete
6/6/2011	silver-haired bat	43	24	carcass search	Daily	complete
6/7/2011	hoary bat	22-5	17	carcass search	Daily	complete
6/7/2011	tricolored bat	35	23	carcass search	Daily	complete
6/7/2011	silver-haired bat	25	12	carcass search	Daily	complete
6/7/2011	tricolored bat	33B	15	carcass search	Daily	complete
6/7/2011	silver-haired bat	45	10	carcass search	Daily	complete
6/7/2011	silver-haired bat	34	20	carcass search	Daily	scavenged
6/7/2011	silver-haired bat	32B	21	carcass search	Daily	complete
6/8/2011	silver-haired bat	23	48	incidental find	Daily	complete
6/9/2011	silver-haired bat	25	17	carcass search	Daily	complete
6/9/2011	silver-haired bat	34	37	carcass search	Daily	complete
6/22/2011	hoary bat	22-5	26	carcass search	Daily	complete
6/22/2011	hoary bat	40	26	carcass search	Daily	complete
6/23/2011	hoary bat	40	39	incidental find	Daily	complete
6/23/2011	eastern red bat	33B	7	carcass search	Daily	complete
6/24/2011	hoary bat	37	40	incidental find	Daily	scavenged
6/24/2011	eastern red bat	18	5	carcass search	Daily	complete
6/24/2011	eastern red bat	42	32	carcass search	Daily	complete
6/25/2011	eastern red bat	45	28	carcass search	Daily	complete
6/27/2011	big brown bat	40	36	carcass search	Daily	complete
6/27/2011	little brown bat	40	32	carcass search	Daily	complete
6/27/2011	eastern red bat	ALT2	54	carcass search	Daily	complete
6/27/2011	big brown bat	22-5	18	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
5/22/2011	tricolored bat	19	35	carcass search	Daily	complete
5/22/2011	big brown bat	24	33	carcass search	Daily	complete
5/22/2011	silver-haired bat	26	49	carcass search	Daily	partial
5/22/2011	silver-haired bat	26	12	carcass search	Daily	complete
5/22/2011	hoary bat	44	14	carcass search	Daily	complete
5/23/2011	hoary bat	38	5	carcass search	Daily	complete
5/23/2011	silver-haired bat	41	22	carcass search	Daily	complete
5/23/2011	silver-haired bat	41	27	carcass search	Daily	complete
5/23/2011	silver-haired bat	46-A	26	carcass search	Daily	complete
5/24/2011	eastern red bat	ALT2	38	carcass search	Daily	scavenged
6/9/2011	eastern red bat	36	83	incidental find	Daily	complete
6/9/2011	silver-haired bat	39A	18	carcass search	Daily	complete
6/9/2011	silver-haired bat	43	12	carcass search	Daily	complete
6/11/2011	little brown bat	38	4	carcass search	Daily	complete
6/11/2011	hoary bat	45	27	carcass search	Daily	complete
6/11/2011	eastern red bat	44	35	carcass search	Daily	complete
6/12/2011	silver-haired bat	21	59	carcass search	Daily	scavenged
6/12/2011	silver-haired bat	19	54	carcass search	Daily	complete
6/12/2011	hoary bat	34	31	carcass search	Daily	complete
6/12/2011	hoary bat	ALT1	23	carcass search	Daily	complete
6/12/2011	hoary bat	45	33	carcass search	Daily	complete
7/7/2011	tricolored bat	22A	21	carcass search	Daily	scavenged
7/8/2011	hoary bat	23	5	carcass search	Daily	complete
7/9/2011	hoary bat	43	39	carcass search	Daily	scavenged
7/9/2011	hoary bat	45	11	carcass search	Daily	complete
7/9/2011	red-eyed vireo	46-A	2	incidental find	Daily	complete
7/9/2011	hoary bat	26	31	carcass search	Daily	complete
7/9/2011	hoary bat	27A	26	carcass search	Daily	complete
7/9/2011	tricolored bat	38	6	carcass search	Daily	complete
7/10/2011	eastern red bat	18	18	carcass search	Daily	complete
7/10/2011	eastern red bat	45	21	carcass search	Daily	complete
7/10/2011	hoary bat	45	30	carcass search	Daily	complete
7/10/2011	tricolored bat	44	22	carcass search	Daily	complete
7/10/2011	tricolored bat	37	22	carcass search	Daily	complete
5/24/2011	eastern red bat	42	25	carcass search	Daily	scavenged

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
5/25/2011	hoary bat	22A	17	carcass search	Daily	scavenged
5/25/2011	red-eyed vireo	32B	21	carcass search	Daily	partial
5/26/2011	red-eyed vireo	44	28	carcass search	Daily	complete
5/26/2011	yellow-billed cuckoo	40	80	incidental find	Daily	complete
5/26/2011	field sparrow	32B	34	carcass search	Daily	complete
5/27/2011	red-eyed vireo	22A	2	carcass search	Daily	complete
5/27/2011	red-eyed vireo	22A	1	carcass search	Daily	complete
5/27/2011	hoary bat	19	49	carcass search	Daily	complete
5/27/2011	hoary bat	33B	21	carcass search	Daily	scavenged
4/4/2011	golden-crowned kinglet	23	40	incidental find	Daily	complete
4/6/2011	little brown bat	38	40	incidental find	Daily	complete
4/6/2011	golden-crowned kinglet	33B	23	carcass search	Daily	complete
6/28/2011	tricolored bat	42	2	carcass search	Daily	complete
6/28/2011	big brown bat	38	16	carcass search	Daily	complete
7/5/2011	unidentified bat	34	11	carcass search	Daily	scavenged
7/5/2011	hoary bat	ALT1	1	carcass search	Daily	scavenged
7/5/2011	eastern red bat	42	22	carcass search	Daily	scavenged
7/5/2011	eastern red bat	ALT1	13	carcass search	Daily	scavenged
7/5/2011	little brown bat	ALT1	5	carcass search	Daily	complete
7/6/2011	hoary bat	33B	5	carcass search	Daily	complete
7/6/2011	hoary bat	42	31	carcass search	Daily	complete
7/6/2011	hoary bat	40	49	carcass search	Daily	complete
5/28/2011	hoary bat	ALT1	27	carcass search	Daily	complete
5/28/2011	hoary bat	45	21	carcass search	Daily	complete
5/28/2011	hoary bat	38	22	carcass search	Daily	complete
5/28/2011	hoary bat	40	6	carcass search	Daily	complete
5/28/2011	bobolink	32B	26	carcass search	Daily	complete
5/29/2011	hoary bat	43	31	carcass search	Daily	complete
5/29/2011	little brown bat	40	33	carcass search	Daily	complete
5/30/2011	eastern red bat	23	21	carcass search	Daily	complete
5/30/2011	big brown bat	32B	15	carcass search	Daily	complete
6/1/2011	eastern red bat	18	39	carcass search	Daily	complete
6/1/2011	hoary bat	43	26	carcass search	Daily	complete
6/2/2011	red-eyed vireo	44	7	carcass search	Daily	partial
6/2/2011	turkey vulture	39A	38	incidental find	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
6/3/2011	red-eyed vireo	24	2	carcass search	Daily	complete
6/4/2011	eastern red bat	34	12	carcass search	Daily	complete
6/6/2011	silver-haired bat	ALT2	29	carcass search	Daily	complete
6/6/2011	big brown bat	35	1	carcass search	Daily	complete
6/6/2011	hoary bat	37	26	carcass search	Daily	complete
6/6/2011	eastern red bat	43	28	carcass search	Daily	complete
6/12/2011	big brown bat	45	45	carcass search	Daily	complete
6/12/2011	silver-haired bat	45	44	carcass search	Daily	complete
6/12/2011	eastern red bat	46-A	17	carcass search	Daily	complete
6/13/2011	tricolored bat	21	43	carcass search	Daily	complete
6/14/2011	hoary bat	40	36	carcass search	Daily	complete
9/4/2011	hoary bat	43	32	carcass search	Daily	complete
9/4/2011	silver-haired bat	43	11	carcass search	Daily	complete
9/4/2011	hoary bat	44	7	carcass search	Daily	complete
9/4/2011	hoary bat	44	22	carcass search	Daily	complete
9/4/2011	silver-haired bat	45	13	carcass search	Daily	complete
9/4/2011	Cape May warbler	45	41	carcass search	Daily	complete
9/4/2011	hoary bat	45	26	carcass search	Daily	complete
9/4/2011	hoary bat	46-A	43	carcass search	Daily	complete
9/4/2011	hoary bat	46-A	27	carcass search	Daily	complete
9/4/2011	Blackburnian warbler	46-A	13	carcass search	Daily	complete
9/4/2011	silver-haired bat	46-A	25	carcass search	Daily	scavenged
9/4/2011	eastern red bat	42	17	carcass search	Daily	injured
9/4/2011	red-eyed vireo	41	49	incidental find	Daily	complete
9/4/2011	hoary bat	39A	17	incidental find	Daily	complete
9/5/2011	hoary bat	21	13	carcass search	Daily	scavenged
9/5/2011	eastern red bat	19	12	carcass search	Daily	scavenged
9/5/2011	silver-haired bat	18	21	carcass search	Daily	injured
9/5/2011	big brown bat	24	1	carcass search	Daily	complete
9/5/2011	hoary bat	24	10	carcass search	Daily	complete
9/5/2011	silver-haired bat	36	26	carcass search	Daily	complete
9/5/2011	red-eyed vireo	24	32	carcass search	Daily	complete
9/5/2011	hoary bat	24	14	carcass search	Daily	complete
9/5/2011	hoary bat	24	17	carcass search	Daily	complete
9/6/2011	hoary bat	35	7	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/6/2011	little brown bat	42	11	carcass search	Daily	injured
9/6/2011	hoary bat	27A	31	carcass search	Daily	complete
9/6/2011	hoary bat	33B	21	carcass search	Daily	injured
4/12/2011	eastern red bat	23	20	carcass search	Daily	complete
4/12/2011	hoary bat	18	18	carcass search	Daily	complete
4/12/2011	hoary bat	27A	11	carcass search	Daily	complete
4/13/2011	field sparrow	OM		incidental find		complete
4/16/2011	eastern red bat	20	17	carcass search	Daily	complete
4/17/2011	eastern red bat	24	36	carcass search	Daily	scavenged
4/20/2011	hoary bat	24	28	carcass search	Daily	scavenged
4/20/2011	hoary bat	22A	16	carcass search	Daily	complete
4/21/2011	field sparrow	36	49	carcass search	Daily	complete
4/24/2011	tricolored bat	19	28	carcass search	Daily	complete
4/25/2011	hoary bat	36	47	carcass search	Daily	complete
4/25/2011	yellow-bellied sapsucker	41	23	carcass search	Daily	complete
7/17/2011	little brown bat	42	12	carcass search	Daily	complete
7/17/2011	eastern red bat	38	12	carcass search	Daily	complete
7/18/2011	hoary bat	45	38	carcass search	Daily	complete
7/18/2011	eastern red bat	ALT1	12	carcass search	Daily	complete
7/18/2011	eastern red bat	ALT1	14	carcass search	Daily	complete
7/18/2011	big brown bat	45	11	carcass search	Daily	partial
7/18/2011	hoary bat	45	29	incidental find	Daily	complete
7/18/2011	hoary bat	25	42	carcass search	Daily	partial
7/18/2011	eastern red bat	27A	5	carcass search	Daily	complete
7/18/2011	eastern red bat	27A	12	carcass search	Daily	scavenged
7/20/2011	hoary bat	43	41	incidental find	Daily	complete
7/21/2011	eastern red bat	ALT2	36	carcass search	Daily	complete
7/21/2011	hoary bat	21	8	carcass search	Daily	complete
7/21/2011	hoary bat	21	9	carcass search	Daily	complete
7/21/2011	hoary bat	22A	12	carcass search	Daily	complete
7/21/2011	cliff swallow	23	29	carcass search	Daily	complete
7/21/2011	hoary bat	37	1	carcass search	Daily	complete
7/21/2011	hoary bat	40	21	carcass search	Daily	complete
7/21/2011	hoary bat	41	40	carcass search	Daily	complete
7/21/2011	eastern red bat	44	18	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
7/21/2011	hoary bat	46-A	40	carcass search	Daily	complete
7/22/2011	eastern red bat	ALT2	38	carcass search	Daily	complete
9/7/2011	unidentified flycatcher	46-A	44	carcass search	Daily	scavenged
9/7/2011	unidentified flycatcher	46-A	16	carcass search	Daily	complete
9/7/2011	eastern red bat	22A	31	carcass search	Daily	scavenged
9/7/2011	red-eyed vireo	32B	44	carcass search	Daily	complete
9/7/2011	hoary bat	34	26	carcass search	Daily	scavenged
9/7/2011	red-eyed vireo	37	26	carcass search	Daily	complete
9/7/2011	eastern red bat	37	45	carcass search	Daily	complete
9/8/2011	hoary bat	23	30	incidental find	Daily	complete
7/31/2011	little brown bat	19	11	carcass search	Daily	complete
7/31/2011	eastern red bat	19	11	carcass search	Daily	complete
7/31/2011	eastern red bat	ALT2	35	carcass search	Daily	complete
7/31/2011	eastern red bat	22A	1	carcass search	Daily	complete
7/31/2011	eastern red bat	23	6	carcass search	Daily	complete
7/31/2011	big brown bat	24	23	carcass search	Daily	complete
7/31/2011	eastern red bat	27A	42	carcass search	Daily	complete
7/31/2011	eastern red bat	27A	21	carcass search	Daily	complete
7/31/2011	eastern red bat	34	38	carcass search	Daily	scavenged
7/31/2011	hoary bat	36	32	carcass search	Daily	complete
7/31/2011	hoary bat	37	18	carcass search	Daily	complete
4/7/2011	golden-crowned kinglet	36	35	carcass search	Daily	complete
4/8/2011	golden-crowned kinglet	ALT1	47	carcass search	Daily	complete
4/8/2011	golden-crowned kinglet	43	31	carcass search	Daily	complete
4/8/2011	golden-crowned kinglet	40	47	carcass search	Daily	complete
4/9/2011	golden-crowned kinglet	25	17	carcass search	Daily	complete
4/9/2011	slate-colored junco	27A	16	carcass search	Daily	complete
4/10/2011	eastern red bat	40	13	carcass search	Daily	complete
4/10/2011	ruby-crowned kinglet	42	40	carcass search	Daily	scavenged
4/11/2011	eastern red bat	43	51	carcass search	Daily	complete
4/11/2011	unidentified passerine	43	51	carcass search	Daily	scavenged
4/11/2011	eastern red bat	38	18	carcass search	Daily	injured
4/26/2011	red-breasted nuthatch	42	35	carcass search	Daily	complete
4/26/2011	tricolored bat	38	17	carcass search	Daily	complete
4/26/2011	tricolored bat	27A	16	carcass search	Daily	complete



**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
4/27/2011	hoary bat	43	31	carcass search	Daily	complete
4/27/2011	hoary bat	27A	49	carcass search	Daily	complete
4/27/2011	hoary bat	35	21	carcass search	Daily	complete
4/28/2011	silver-haired bat	37	45	carcass search	Daily	complete
5/1/2011	hoary bat	42	34	carcass search	Daily	complete
5/1/2011	eastern red bat	34	48	carcass search	Daily	complete
5/1/2011	hoary bat	44	46	incidental find	Daily	complete
5/2/2011	hoary bat	45	43	incidental find	Daily	complete
5/3/2011	big brown bat	44	73	carcass search	Daily	complete
5/3/2011	silver-haired bat	25	73	incidental find	Daily	complete
5/4/2011	red-eyed vireo	27A	6	carcass search	Daily	complete
5/4/2011	red-eyed vireo	38	9	carcass search	Daily	complete
5/4/2011	red-eyed vireo	ALT2	37	carcass search	Daily	complete
5/6/2011	black-throated green warbler	40	31	carcass search	Daily	complete
5/6/2011	tricolored bat	19	17	carcass search	Daily	complete
5/6/2011	tricolored bat	33B	31	carcass search	Daily	scavenged
5/8/2011	eastern red bat	22-5	41	carcass search	Daily	complete
5/8/2011	red-eyed vireo	32B	40	carcass search	Daily	complete
5/10/2011	hoary bat	37	43	carcass search	Daily	complete
5/14/2011	hoary bat	41	11	carcass search	Daily	complete
5/14/2011	red-eyed vireo	34	29	incidental find	Daily	complete
5/14/2011	hoary bat	25	18	incidental find	Daily	complete
5/14/2011	red-eyed vireo	27A	17	carcass search	Daily	complete
5/14/2011	eastern red bat	23	28	incidental find	Daily	complete
5/14/2011	eastern red bat	20	12	carcass search	Daily	complete
5/15/2011	red-eyed vireo	23	40	carcass search	Daily	complete
5/16/2011	magnolia warbler	ALT1	44	carcass search	Daily	complete
5/16/2011	red-eyed vireo	32B	23	carcass search	Daily	complete
5/16/2011	hoary bat	32B	38	carcass search	Daily	complete
5/16/2011	blackpoll warbler	35	53	carcass search	Daily	scavenged
5/19/2011	silver-haired bat	19	35	carcass search	Daily	complete
8/26/2011	hoary bat	27A	17	carcass search	Daily	complete
8/26/2011	eastern red bat	27A	14	carcass search	Daily	complete
8/26/2011	eastern red bat	25	12	carcass search	Daily	complete
8/26/2011	hoary bat	22A	31	carcass search	Daily	injured

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/26/2011	hoary bat	22A	52	carcass search	Daily	complete
8/26/2011	eastern red bat	20	30	carcass search	Daily	complete
8/26/2011	hoary bat	20	26	carcass search	Daily	complete
8/27/2011	eastern red bat	44	13	carcass search	Daily	complete
8/27/2011	hoary bat	26	13	carcass search	Daily	complete
8/27/2011	eastern red bat	44	16	carcass search	Daily	complete
8/27/2011	Seminole bat	44	23	carcass search	Daily	complete
8/27/2011	hoary bat	45	40	carcass search	Daily	complete
8/17/2011	hoary bat	19	26	incidental find	Daily	complete
8/17/2011	eastern red bat	20	46	carcass search	Daily	complete
8/17/2011	eastern red bat	41	12	carcass search	Daily	complete
8/17/2011	hoary bat	39A	24	carcass search	Daily	complete
8/17/2011	eastern red bat	38	12	carcass search	Daily	complete
8/17/2011	tricolored bat	32B	0	carcass search	Daily	scavenged
8/18/2011	eastern red bat	23	13	carcass search	Daily	complete
8/18/2011	eastern red bat	23	49	carcass search	Daily	complete
8/18/2011	eastern red bat	21	37	carcass search	Daily	complete
8/18/2011	hoary bat	21	9	carcass search	Daily	complete
8/18/2011	eastern red bat	18	21	carcass search	Daily	complete
8/18/2011	big brown bat	39A	29	carcass search	Daily	complete
8/1/2011	eastern red bat	19	7	carcass search	Daily	complete
8/1/2011	eastern red bat	21	21	carcass search	Daily	complete
8/1/2011	eastern red bat	22A	12	carcass search	Daily	complete
8/1/2011	eastern red bat	23	36	carcass search	Daily	complete
8/1/2011	hoary bat	24	17	carcass search	Daily	complete
8/1/2011	eastern red bat	25	12	carcass search	Daily	complete
8/1/2011	eastern red bat	32B	46	incidental find	Daily	complete
8/1/2011	eastern red bat	41	35	carcass search	Daily	complete
8/1/2011	eastern red bat	44	32	carcass search	Daily	complete
8/1/2011	eastern red bat	45	14	carcass search	Daily	complete
8/1/2011	eastern red bat	46-A	12	carcass search	Daily	complete
8/2/2011	eastern red bat	44	34	carcass search	Daily	complete
8/3/2011	eastern red bat	18	23	carcass search	Daily	scavenged
8/3/2011	big brown bat	21	15	carcass search	Daily	complete
8/3/2011	hoary bat	34	15	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/3/2011	eastern red bat	23	16	carcass search	Daily	complete
8/3/2011	eastern red bat	ALT2	32	incidental find	Daily	complete
8/5/2011	unidentified empidonax	26	22	carcass search	Daily	complete
8/5/2011	eastern red bat	ALT2	26	carcass search	Daily	complete
8/5/2011	eastern red bat	42	54	carcass search	Daily	complete
8/5/2011	big brown bat	23	17	carcass search	Daily	complete
8/5/2011	eastern red bat	27A	30	carcass search	Daily	scavenged
8/5/2011	tricolored bat	43	37	carcass search	Daily	complete
6/14/2011	silver-haired bat	32B	21	carcass search	Daily	complete
6/14/2011	silver-haired bat	32B	47	carcass search	Daily	complete
6/15/2011	little brown bat	26	6	carcass search	Daily	complete
6/15/2011	silver-haired bat	45	37	carcass search	Daily	complete
6/16/2011	big brown bat	32B	24	carcass search	Daily	complete
6/16/2011	hoary bat	34	26	carcass search	Daily	complete
6/17/2011	silver-haired bat	22A	7	carcass search	Daily	complete
6/17/2011	silver-haired bat	42	34	carcass search	Daily	complete
6/17/2011	hoary bat	42	7	carcass search	Daily	complete
6/19/2011	hoary bat	42	17	carcass search	Daily	complete
6/20/2011	hoary bat	21	16	carcass search	Daily	complete
6/20/2011	silver-haired bat	25	54	incidental find	Daily	complete
6/21/2011	hoary bat	26	14	carcass search	Daily	complete
6/21/2011	hoary bat	24	26	carcass search	Daily	complete
6/21/2011	hoary bat	21	30	carcass search	Daily	complete
6/21/2011	hoary bat	32B	27	carcass search	Daily	complete
6/21/2011	silver-haired bat	41	6	carcass search	Daily	partial
6/21/2011	hoary bat	41	38	carcass search	Daily	complete
6/22/2011	hoary bat	36	49	carcass search	Daily	complete
6/22/2011	eastern red bat	42	38	carcass search	Daily	complete
6/22/2011	eastern red bat	44	8	carcass search	Daily	complete
6/22/2011	hoary bat	45	35	carcass search	Daily	complete
6/22/2011	hoary bat	45	39	incidental find	Daily	complete
6/28/2011	big brown bat	26	10	carcass search	Daily	complete
6/28/2011	eastern red bat	ALT1	17	carcass search	Daily	complete
6/28/2011	hoary bat	ALT1	16	carcass search	Daily	complete
7/6/2011	hoary bat	34	27	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
7/6/2011	unidentified myotis	43	11	carcass search	Daily	complete
7/7/2011	hoary bat	36	28	carcass search	Daily	complete
7/7/2011	eastern red bat	ALT2	22	carcass search	Daily	complete
7/7/2011	hoary bat	40	14	carcass search	Daily	complete
7/7/2011	big brown bat	43	26	carcass search	Daily	complete
7/7/2011	little brown bat	45	18	carcass search	Daily	complete
7/7/2011	eastern red bat	26	29	carcass search	Daily	complete
7/7/2011	hoary bat	25	10	carcass search	Daily	complete
7/10/2011	big brown bat	36	26	carcass search	Daily	complete
7/10/2011	eastern red bat	26	10	carcass search	Daily	complete
7/11/2011	hoary bat	22-5	32	carcass search	Daily	complete
7/11/2011	hoary bat	22-5	31	carcass search	Daily	complete
7/11/2011	hoary bat	22-5	31	carcass search	Daily	complete
7/11/2011	hoary bat	37	26	carcass search	Daily	complete
7/11/2011	eastern red bat	39A	26	carcass search	Daily	complete
7/11/2011	eastern red bat	42	20	carcass search	Daily	complete
7/14/2011	little brown bat	ALT1	23	carcass search	Daily	complete
7/14/2011	hoary bat	39A	33	carcass search	Daily	injured
7/14/2011	eastern red bat	21	14	carcass search	Daily	complete
7/14/2011	little brown bat	35	29	carcass search	Daily	complete
7/15/2011	eastern red bat	ALT2	35	carcass search	Daily	complete
7/15/2011	little brown bat	39A	46	carcass search	Daily	scavenged
7/16/2011	big brown bat	21	12	carcass search	Daily	complete
7/16/2011	hoary bat	33B	40	carcass search	Daily	complete
7/17/2011	hoary bat	45	26	carcass search	Daily	complete
7/17/2011	eastern red bat	42	30	carcass search	Daily	complete
7/22/2011	eastern red bat	19	34	carcass search	Daily	complete
7/22/2011	hoary bat	26	32	carcass search	Daily	complete
7/22/2011	hoary bat	45	40	carcass search	Daily	complete
7/22/2011	eastern red bat	45	45	carcass search	Daily	complete
7/22/2011	little brown bat	45	10	carcass search	Daily	complete
7/23/2011	eastern red bat	21	26	carcass search	Daily	complete
7/23/2011	hoary bat	25	26	carcass search	Daily	complete
7/24/2011	hoary bat	ALT2	25	carcass search	Daily	complete
7/24/2011	eastern red bat	21	12	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
7/24/2011	hoary bat	34	26	carcass search	Daily	complete
7/24/2011	eastern red bat	40	33	carcass search	Daily	partial
7/25/2011	hoary bat	20	22	carcass search	Daily	complete
7/25/2011	hoary bat	21	21	carcass search	Daily	complete
7/25/2011	big brown bat	25	12	carcass search	Daily	complete
7/25/2011	big brown bat	36	36	carcass search	Daily	complete
7/25/2011	big brown bat	36	16	carcass search	Daily	complete
7/25/2011	hoary bat	36	35	carcass search	Daily	complete
7/25/2011	eastern red bat	40	31	carcass search	Daily	complete
7/25/2011	eastern red bat	42	28	carcass search	Daily	complete
7/25/2011	eastern red bat	42	31	carcass search	Daily	complete
7/25/2011	eastern red bat	43	11	carcass search	Daily	complete
7/25/2011	eastern red bat	43	26	carcass search	Daily	complete
7/25/2011	hoary bat	44	21	carcass search	Daily	complete
7/25/2011	eastern red bat	46-A	20	carcass search	Daily	complete
7/25/2011	eastern red bat	46-A	16	carcass search	Daily	complete
7/26/2011	hoary bat	21	22	carcass search	Daily	complete
7/26/2011	tricolored bat	21	31	carcass search	Daily	complete
7/26/2011	tricolored bat	38	27	carcass search	Daily	complete
7/26/2011	big brown bat	39A	26	carcass search	Daily	complete
7/26/2011	hoary bat	45	17	carcass search	Daily	complete
7/27/2011	eastern red bat	ALT2	18	carcass search	Daily	complete
7/27/2011	eastern red bat	21	11	carcass search	Daily	complete
7/27/2011	hoary bat	23	40	carcass search	Daily	complete
7/27/2011	hoary bat	25	11	carcass search	Daily	complete
7/27/2011	eastern red bat	27A	23	carcass search	Daily	complete
7/27/2011	eastern red bat	35	21	carcass search	Daily	complete
7/27/2011	hoary bat	39A	31	incidental find	Daily	complete
7/27/2011	big brown bat	41	11	carcass search	Daily	complete
7/27/2011	hoary bat	44	31	carcass search	Daily	injured
7/28/2011	hoary bat	ALT2	28	carcass search	Daily	complete
7/28/2011	eastern red bat	ALT2	12	carcass search	Daily	complete
7/28/2011	little brown bat	19	8	carcass search	Daily	complete
7/28/2011	eastern red bat	22A	25	carcass search	Daily	complete
7/28/2011	eastern red bat	22-5	14	carcass search	Daily	scavenged

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
7/28/2011	eastern red bat	25	0	carcass search	Daily	complete
7/28/2011	eastern red bat	26	9	carcass search	Daily	complete
7/28/2011	hoary bat	42	36	carcass search	Daily	complete
7/28/2011	big brown bat	42	19	carcass search	Daily	complete
7/28/2011	hoary bat	43	30	carcass search	Daily	complete
7/28/2011	big brown bat	46-A	28	carcass search	Daily	complete
7/29/2011	big brown bat	27A	40	carcass search	Daily	scavenged
7/29/2011	hoary bat	41	17	incidental find	Daily	complete
7/29/2011	eastern red bat	42	23	carcass search	Daily	complete
7/29/2011	eastern red bat	44	18	carcass search	Daily	complete
7/31/2011	tricolored bat	37	31	carcass search	Daily	complete
7/31/2011	little brown bat	39A	33	carcass search	Daily	complete
7/31/2011	eastern red bat	39A	20	carcass search	Daily	complete
7/31/2011	hoary bat	41	22	carcass search	Daily	complete
7/31/2011	hoary bat	42	31	carcass search	Daily	complete
7/31/2011	eastern red bat	42	23	carcass search	Daily	complete
7/31/2011	eastern red bat	42	52	carcass search	Daily	scavenged
7/31/2011	Canada warbler	43	24	carcass search	Daily	complete
7/31/2011	eastern red bat	43	33	carcass search	Daily	complete
7/31/2011	hoary bat	43	40	carcass search	Daily	complete
7/31/2011	eastern red bat	ALT1	18	carcass search	Daily	complete
7/31/2011	eastern red bat	ALT1	8	carcass search	Daily	complete
7/31/2011	eastern red bat	44	34	carcass search	Daily	complete
7/31/2011	tricolored bat	45	32	carcass search	Daily	complete
7/31/2011	little brown bat	45	35	carcass search	Daily	complete
7/31/2011	hoary bat	46-A	56	carcass search	Daily	complete
7/31/2011	eastern red bat	46-A	5	carcass search	Daily	complete
8/5/2011	eastern red bat	23	55	carcass search	Daily	complete
8/6/2011	hoary bat	45	42	carcass search	Daily	complete
8/6/2011	hoary bat	45	37	carcass search	Daily	complete
8/6/2011	hoary bat	45	25	carcass search	Daily	complete
8/6/2011	hoary bat	42	32	carcass search	Daily	complete
8/6/2011	eastern red bat	38	55	carcass search	Daily	complete
8/6/2011	hoary bat	38	15	carcass search	Daily	complete
8/7/2011	eastern red bat	44	6	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/7/2011	eastern red bat	ALT2	27	carcass search	Daily	complete
8/7/2011	eastern red bat	ALT2	33	carcass search	Daily	complete
8/7/2011	unidentified bat	37	21	carcass search	Daily	scavenged
8/7/2011	big brown bat	25	31	carcass search	Daily	scavenged
8/7/2011	hoary bat	33B	17	carcass search	Daily	complete
8/7/2011	big brown bat	34	17	carcass search	Daily	complete
8/7/2011	big brown bat	20	22	carcass search	Daily	complete
8/8/2011	hoary bat	22A	17	carcass search	Daily	complete
8/8/2011	hoary bat	44	42	carcass search	Daily	complete
8/9/2011	tricolored bat	34	17	carcass search	Daily	complete
8/9/2011	tricolored bat	34	28	carcass search	Daily	complete
8/9/2011	hoary bat	34	21	carcass search	Daily	complete
8/12/2011	hoary bat	41	37	carcass search	Daily	complete
8/9/2011	hoary bat	18	18	carcass search	Daily	complete
8/9/2011	hoary bat	38	22	carcass search	Daily	complete
8/9/2011	big brown bat	36	53	incidental find	Daily	scavenged
8/9/2011	hoary bat	37	23	carcass search	Daily	complete
8/9/2011	tricolored bat	23	35	carcass search	Daily	scavenged
8/9/2011	eastern red bat	24	21	carcass search	Daily	complete
8/9/2011	eastern red bat	27A	12	carcass search	Daily	complete
8/9/2011	hoary bat	45	27	carcass search	Daily	complete
8/10/2011	big brown bat	33B	32	carcass search	Daily	complete
8/10/2011	hoary bat	23	45	carcass search	Daily	complete
8/10/2011	hoary bat	32B	4	carcass search	Daily	complete
8/10/2011	hoary bat	44	31	carcass search	Daily	complete
8/10/2011	eastern red bat	ALT1	11	carcass search	Daily	complete
8/11/2011	eastern red bat	27A	21	carcass search	Daily	complete
8/11/2011	hoary bat	23	23	carcass search	Daily	complete
8/11/2011	eastern red bat	40	30	carcass search	Daily	complete
8/11/2011	eastern red bat	39A	49	carcass search	Daily	scavenged
8/11/2011	eastern red bat	45	31	carcass search	Daily	complete
8/11/2011	tricolored bat	44	7	carcass search	Daily	scavenged
8/11/2011	eastern red bat	38	7	incidental find	Daily	injured
8/11/2011	eastern red bat	38	1	incidental find	Daily	complete
8/12/2011	eastern red bat	ALT2	35	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/12/2011	eastern red bat	39A	16	carcass search	Daily	complete
8/12/2011	eastern red bat	39A	6	carcass search	Daily	complete
8/12/2011	eastern red bat	41	14	carcass search	Daily	complete
8/12/2011	eastern red bat	32B	26	carcass search	Daily	complete
8/12/2011	eastern red bat	32B	43	carcass search	Daily	complete
8/12/2011	hoary bat	34	25	carcass search	Daily	complete
8/12/2011	eastern red bat	34	34	carcass search	Daily	complete
8/12/2011	hoary bat	19	17	carcass search	Daily	scavenged
8/12/2011	silver-haired bat	46-A	28	carcass search	Daily	complete
8/12/2011	tricolored bat	45	30	carcass search	Daily	complete
8/12/2011	eastern red bat	45	25	carcass search	Daily	complete
8/12/2011	eastern red bat	44	31	carcass search	Daily	complete
8/12/2011	eastern red bat	44	20	carcass search	Daily	complete
9/3/2011	eastern red bat	18	12	carcass search	Daily	scavenged
9/3/2011	silver-haired bat	25	14	carcass search	Daily	partial
9/3/2011	hoary bat	26	37	carcass search	Daily	complete
9/3/2011	eastern red bat	26	35	carcass search	Daily	complete
9/3/2011	hoary bat	26	28	carcass search	Daily	complete
9/3/2011	eastern red bat	45	36	carcass search	Daily	complete
9/3/2011	hoary bat	45	32	carcass search	Daily	scavenged
9/3/2011	hoary bat	44	38	incidental find	Daily	complete
9/3/2011	eastern red bat	25	16	carcass search	Daily	complete
9/4/2011	hoary bat	33B	23	carcass search	Daily	complete
9/4/2011	hoary bat	41	45	carcass search	Daily	complete
9/4/2011	eastern red bat	41	35	carcass search	Daily	complete
9/4/2011	silver-haired bat	40	26	carcass search	Daily	complete
9/4/2011	silver-haired bat	40	43	carcass search	Daily	complete
9/4/2011	hoary bat	40	40	carcass search	Daily	complete
9/4/2011	eastern red bat	39A	12	carcass search	Daily	scavenged
9/4/2011	hoary bat	39A	14	carcass search	Daily	complete
9/4/2011	silver-haired bat	ALT2	18	carcass search	Daily	complete
9/4/2011	silver-haired bat	ALT2	18	carcass search	Daily	complete
9/4/2011	ovenbird	ALT2	7	carcass search	Daily	scavenged
9/4/2011	hoary bat	ALT2	40	carcass search	Daily	complete
9/4/2011	silver-haired bat	ALT2	25	carcass search	Daily	complete



**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/4/2011	tricolored bat	ALT2	18	carcass search	Daily	injured
9/4/2011	eastern red bat	33B	17	carcass search	Daily	complete
8/12/2011	eastern red bat	44	27	carcass search	Daily	complete
8/12/2011	eastern red bat	44	31	carcass search	Daily	complete
8/12/2011	eastern red bat	43	20	carcass search	Daily	complete
8/12/2011	eastern red bat	43	24	carcass search	Daily	complete
8/12/2011	hoary bat	37	32	carcass search	Daily	complete
8/12/2011	eastern red bat	36	37	carcass search	Daily	complete
8/12/2011	eastern red bat	36	14	carcass search	Daily	complete
8/12/2011	hoary bat	25	38	carcass search	Daily	complete
8/12/2011	little brown bat	23	0	carcass search	Daily	injured
8/13/2011	tricolored bat	23	17	carcass search	Daily	complete
8/13/2011	hoary bat	22A	16	carcass search	Daily	complete
8/13/2011	eastern red bat	33B	48	carcass search	Daily	
8/13/2011	little brown bat	41	15	carcass search	Daily	complete
8/13/2011	eastern red bat	39A	20	carcass search	Daily	complete
8/13/2011	tricolored bat	38	11	carcass search	Daily	
8/13/2011	eastern red bat	42	28	carcass search	Daily	scavenged
8/13/2011	hoary bat	42	46	carcass search	Daily	
8/13/2011	hoary bat	42	41	carcass search	Daily	complete
8/13/2011	eastern red bat	46-A	34	carcass search	Daily	complete
8/13/2011	hoary bat	45	39	carcass search	Daily	scavenged
8/13/2011	eastern red bat	44	21	carcass search	Daily	complete
8/14/2011	hoary bat	ALT2	27	carcass search	Daily	complete
8/14/2011	tricolored bat	40	17	carcass search	Daily	complete
8/14/2011	tricolored bat	45	33	carcass search	Daily	complete
8/14/2011	eastern red bat	43	35	carcass search	Daily	complete
8/14/2011	eastern red bat	33B	7	carcass search	Daily	complete
8/14/2011	hoary bat	20	21	incidental find	Daily	complete
8/14/2011	hoary bat	22-5	46	carcass search	Daily	complete
8/15/2011	eastern red bat	41	12	carcass search	Daily	complete
8/15/2011	eastern red bat	21	21	carcass search	Daily	scavenged
8/15/2011	hoary bat	34	26	carcass search	Daily	complete
8/16/2011	eastern red bat	36	28	carcass search	Daily	scavenged
8/16/2011	tricolored bat	45	35	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/16/2011	eastern red bat	24	9	carcass search	Daily	complete
8/18/2011	hoary bat	39A	12	carcass search	Daily	complete
8/18/2011	hoary bat	22-5	2	carcass search	Daily	complete
8/18/2011	tricolored bat	45	3	carcass search	Daily	complete
8/18/2011	hoary bat	45	40	carcass search	Daily	complete
8/18/2011	big brown bat	24	16	carcass search	Daily	complete
8/18/2011	eastern red bat	44	41	carcass search	Daily	complete
8/18/2011	hoary bat	44	34	carcass search	Daily	complete
8/18/2011	hoary bat	ALT1	30	carcass search	Daily	complete
8/18/2011	little brown bat	ALT1	32	carcass search	Daily	complete
8/18/2011	eastern red bat	34	9	carcass search	Daily	complete
8/18/2011	hoary bat	ALT2	45	carcass search	Daily	complete
8/19/2011	eastern red bat	45	19	carcass search	Daily	complete
8/19/2011	tricolored bat	45	18	carcass search	Daily	complete
8/19/2011	eastern red bat	45	39	carcass search	Daily	complete
8/19/2011	eastern red bat	26	13	carcass search	Daily	complete
8/19/2011	hoary bat	44	17	carcass search	Daily	complete
8/19/2011	eastern red bat	23	18	carcass search	Daily	complete
8/19/2011	hoary bat	18	11	carcass search	Daily	complete
8/19/2011	hoary bat	19	21	carcass search	Daily	complete
8/19/2011	hoary bat	38	24	carcass search	Daily	complete
8/19/2011	hoary bat	35	45	carcass search	Daily	complete
8/19/2011	tricolored bat	27A	16	carcass search	Daily	complete
8/19/2011	eastern red bat	27A	3	carcass search	Daily	complete
8/19/2011	silver-haired bat	36	7	carcass search	Daily	scavenged
8/19/2011	eastern red bat	22A	10	carcass search	Daily	complete
8/20/2011	hoary bat	39A	13	carcass search	Daily	complete
8/20/2011	eastern red bat	34	27	carcass search	Daily	scavenged
8/20/2011	eastern red bat	34	26	carcass search	Daily	scavenged
8/20/2011	silver-haired bat	34	15	carcass search	Daily	complete
8/20/2011	eastern red bat	24	27	carcass search	Daily	complete
8/21/2011	hoary bat	40	39	incidental find	Daily	complete
8/21/2011	hoary bat	41	17	incidental find	Daily	complete
8/21/2011	eastern red bat	41	30	incidental find	Daily	complete
8/21/2011	eastern red bat	45	43	carcass search	Daily	scavenged

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/21/2011	tricolored bat	38	14	carcass search	Daily	complete
8/21/2011	eastern red bat	45	35	carcass search	Daily	complete
8/21/2011	Blackburnian warbler	44	42	carcass search	Daily	complete
8/21/2011	hoary bat	41	31	carcass search	Daily	partial
8/22/2011	eastern red bat	ALT1	33	carcass search	Daily	injured
8/22/2011	yellow-billed cuckoo	34	26	carcass search	Daily	complete
8/22/2011	hoary bat	22-5	21	carcass search	Daily	complete
8/23/2011	eastern red bat	45	17	carcass search	Daily	complete
8/23/2011	eastern red bat	38	6	carcass search	Daily	complete
8/23/2011	eastern red bat	26	35	carcass search	Daily	complete
8/24/2011	hoary bat	22A	31	incidental find	Daily	complete
8/24/2011	hoary bat	22A	19	incidental find	Daily	complete
8/24/2011	hoary bat	26	43	carcass search	Daily	complete
8/24/2011	hoary bat	39A	37	carcass search	Daily	complete
8/24/2011	little brown bat	ALT2	22	carcass search	Daily	scavenged
8/24/2011	eastern red bat	36	38	carcass search	Daily	scavenged
8/24/2011	eastern red bat	46-A	68	incidental find	Daily	scavenged
8/24/2011	silver-haired bat	45	26	incidental find	Daily	scavenged
8/26/2011	hoary bat	44	26	carcass search	Daily	complete
8/26/2011	hoary bat	46-A	36	carcass search	Daily	complete
8/26/2011	hoary bat	37	21	carcass search	Daily	complete
8/26/2011	eastern red bat	34	4	carcass search	Daily	complete
8/26/2011	hoary bat	33B	26	carcass search	Daily	complete
8/26/2011	eastern red bat	33B	42	carcass search	Daily	complete
8/26/2011	hoary bat	27A	9	carcass search	Daily	complete
8/27/2011	eastern red bat	46-A	31	carcass search	Daily	complete
8/27/2011	eastern red bat	ALT2	27	carcass search	Daily	complete
8/27/2011	hoary bat	ALT2	38	carcass search	Daily	complete
8/27/2011	eastern red bat	ALT2	21	carcass search	Daily	complete
8/27/2011	hoary bat	39A	46	carcass search	Daily	complete
8/27/2011	hoary bat	39A	35	carcass search	Daily	complete
8/27/2011	common nighthawk	41	33	carcass search	Daily	complete
8/27/2011	little brown bat	32B	27	carcass search	Daily	complete
8/27/2011	eastern red bat	22A	31	carcass search	Daily	complete
8/27/2011	eastern red bat	22-5	44	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
8/28/2011	silver-haired bat	24	17	carcass search	Daily	
8/28/2011	eastern red bat	26	8	carcass search	Daily	
8/28/2011	eastern red bat	45	38	carcass search	Daily	scavenged
8/28/2011	eastern red bat	22-5	12	carcass search	Daily	scavenged
8/28/2011	hoary bat	ALT2	41	carcass search	Daily	complete
8/29/2011	eastern red bat	ALT2	34	carcass search	Daily	injured
8/29/2011	silver-haired bat	39A	14	carcass search	Daily	complete
8/29/2011	little brown bat	38	16	carcass search	Daily	complete
8/29/2011	little brown bat	ALT2	18	carcass search	Daily	complete
8/29/2011	silver-haired bat	23	42	carcass search	Daily	complete
8/29/2011	little brown bat	43	38	carcass search	Daily	scavenged
8/29/2011	little brown bat	43	40	carcass search	Daily	complete
8/29/2011	eastern red bat	ALT1	31	carcass search	Daily	complete
8/29/2011	tricolored bat	44	5	carcass search	Daily	complete
8/29/2011	little brown bat	44	35	carcass search	Daily	complete
8/30/2011	hoary bat	21	41	carcass search	Daily	complete
8/30/2011	big brown bat	24	13	carcass search	Daily	complete
8/30/2011	silver-haired bat	26	32	carcass search	Daily	complete
8/30/2011	eastern red bat	34	22	carcass search	Daily	complete
8/31/2011	big brown bat	36	26	carcass search	Daily	scavenged
8/31/2011	red-eyed vireo	36	31	carcass search	Daily	scavenged
8/31/2011	tricolored bat	37	26	carcass search	Daily	scavenged
8/31/2011	eastern red bat	21	10	carcass search	Daily	scavenged
8/31/2011	big brown bat	21	37	carcass search	Daily	complete
8/31/2011	silver-haired bat	21	40	carcass search	Daily	complete
8/31/2011	silver-haired bat	26	31	carcass search	Daily	complete
8/31/2011	silver-haired bat	32B	5	carcass search	Daily	complete
8/31/2011	silver-haired bat	46-A	40	carcass search	Daily	complete
9/1/2011	silver-haired bat	22-5	49	incidental find	Daily	complete
9/1/2011	Cape May warbler	22-5	53	incidental find	Daily	complete
9/1/2011	hoary bat	34	34	incidental find	Daily	complete
9/1/2011	eastern red bat	19	30	carcass search	Daily	
9/1/2011	eastern red bat	19	7	carcass search	Daily	complete
9/2/2011	silver-haired bat	44	13	carcass search	Daily	complete
9/2/2011	hoary bat	42	32	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/2/2011	eastern red bat	35	17	carcass search	Daily	scavenged
9/2/2011	hoary bat	34	17	carcass search	Daily	complete
9/2/2011	tricolored bat	23	12	carcass search	Daily	complete
9/2/2011	silver-haired bat	21	17	carcass search	Daily	complete
9/2/2011	eastern red bat	32B	20	carcass search	Daily	complete
9/2/2011	silver-haired bat	33B	10	carcass search	Daily	complete
9/2/2011	silver-haired bat	39A	6	carcass search	Daily	complete
9/2/2011	silver-haired bat	38	18	carcass search	Daily	complete
9/2/2011	silver-haired bat	22-5	12	carcass search	Daily	complete
9/3/2011	silver-haired bat	40	40	carcass search	Daily	complete
9/3/2011	big brown bat	39A	35	carcass search	Daily	complete
9/3/2011	hoary bat	39A	5	carcass search	Daily	complete
9/3/2011	black-throated blue warbler	19	45	carcass search	Daily	partial
9/3/2011	eastern red bat	19	65	incidental find	Daily	scavenged
9/8/2011	hoary bat	23	9	carcass search	Daily	complete
9/8/2011	hoary bat	ALT2	15	carcass search	Daily	complete
9/8/2011	hoary bat	40	46	carcass search	Daily	scavenged
9/9/2011	red-eyed vireo	46-A	45	carcass search	Daily	partial
9/9/2011	red-eyed vireo	42	12	carcass search	Daily	complete
9/9/2011	eastern red bat	41	26	carcass search	Daily	complete
9/9/2011	unidentified passerine	40	14	carcass search	Daily	feather spot
9/9/2011	red-eyed vireo	40	26	carcass search	Daily	complete
9/9/2011	veery	40	16	carcass search	Daily	complete
9/9/2011	red-eyed vireo	40	26	carcass search	Daily	complete
9/9/2011	hoary bat	21	21	carcass search	Daily	complete
9/9/2011	eastern red bat	22-5	31	carcass search	Daily	complete
9/9/2011	unidentified empidonax	ALT2	33	carcass search	Daily	complete
9/9/2011	red-eyed vireo	ALT2	36	carcass search	Daily	complete
9/9/2011	red-eyed vireo	ALT2	43	carcass search	Daily	complete
9/9/2011	red-eyed vireo	ALT2	31	carcass search	Daily	complete
9/9/2011	red-eyed vireo	ALT2	45	carcass search	Daily	complete
9/9/2011	yellow-billed cuckoo	ALT2	21	carcass search	Daily	partial
9/9/2011	scarlet tanager	ALT2	7	carcass search	Daily	complete
9/9/2011	Cape May warbler	ALT2	17	carcass search	Daily	complete
9/9/2011	red-eyed vireo	40	40	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/10/2011	red-eyed vireo	20	40	carcass search	Daily	complete
9/10/2011	eastern red bat	23	35	carcass search	Daily	complete
9/10/2011	red-eyed vireo	23	43	carcass search	Daily	complete
9/10/2011	red-eyed vireo	27A	15	carcass search	Daily	complete
9/10/2011	silver-haired bat	35	26	carcass search	Daily	complete
9/10/2011	veery	35	26	carcass search	Daily	complete
9/10/2011	eastern red bat	40	26	carcass search	Daily	complete
9/10/2011	red-eyed vireo	44	39	carcass search	Daily	complete
9/10/2011	eastern red bat	45	31	carcass search	Daily	complete
9/10/2011	silver-haired bat	45	29	carcass search	Daily	complete
9/11/2011	silver-haired bat	44	28	carcass search	Daily	complete
9/11/2011	tricolored bat	ALT2	36	carcass search	Daily	complete
9/11/2011	silver-haired bat	ALT2	36	carcass search	Daily	injured
9/11/2011	red-eyed vireo	ALT2	34	carcass search	Daily	complete
9/11/2011	little brown bat	ALT2	17	carcass search	Daily	complete
9/11/2011	magnolia warbler	ALT2	32	carcass search	Daily	complete
9/11/2011	red-eyed vireo	ALT2	21	carcass search	Daily	complete
9/11/2011	veery	ALT2	21	carcass search	Daily	scavenged
9/11/2011	magnolia warbler	39A	23	carcass search	Daily	complete
9/11/2011	red-eyed vireo	41	36	carcass search	Daily	scavenged
9/11/2011	black-throated blue warbler	42	35	carcass search	Daily	complete
9/11/2011	red-eyed vireo	42	22	carcass search	Daily	complete
9/11/2011	red-eyed vireo	42	31	carcass search	Daily	complete
9/11/2011	northern waterthrush	33B	38	carcass search	Daily	complete
9/12/2011	hoary bat	21	16	carcass search	Daily	injured
9/12/2011	eastern red bat	44	14	carcass search	Daily	complete
9/12/2011	red-eyed vireo	44	26	carcass search	Daily	scavenged
9/12/2011	tricolored bat	43	31	carcass search	Daily	scavenged
9/12/2011	red-eyed vireo	41	35	carcass search	Daily	complete
9/13/2011	yellow-bellied flycatcher	27A	27	carcass search	Daily	complete
9/13/2011	tricolored bat	23	46	carcass search	Daily	complete
9/13/2011	black-throated blue warbler	33B	43	carcass search	Daily	scavenged
9/13/2011	red-eyed vireo	34	38	carcass search	Daily	complete
9/13/2011	eastern red bat	38	13	carcass search	Daily	complete
9/13/2011	unidentified passerine	40	13	carcass search	Daily	scavenged

## Appendix A. Complete fatality listing for the Criterion Wind Energy Project.

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/14/2011	red-eyed vireo	23	50	carcass search	Daily	complete
9/14/2011	red-eyed vireo	23	31	carcass search	Daily	complete
9/14/2011	silver-haired bat	33B	44	carcass search	Daily	scavenged
9/14/2011	red-eyed vireo	ALT2	44	carcass search	Daily	complete
9/14/2011	Cape May warbler	ALT2	21	carcass search	Daily	complete
9/14/2011	red-eyed vireo	ALT2	18	carcass search	Daily	scavenged
9/14/2011	chestnut-sided warbler	40	28	carcass search	Daily	complete
9/14/2011	red-eyed vireo	19	49	carcass search	Daily	complete
9/14/2011	red-eyed vireo	21	49	carcass search	Daily	scavenged
9/15/2011	hoary bat	19	31	carcass search	Daily	complete
9/15/2011	unidentified passerine	33B	44	carcass search	Daily	feather spot
9/15/2011	hoary bat	33B	29	carcass search	Daily	complete
9/15/2011	silver-haired bat	24	11	carcass search	Daily	complete
9/15/2011	red-eyed vireo	24	21	carcass search	Daily	complete
9/16/2011	eastern red bat	40	35	carcass search	Daily	complete
9/16/2011	silver-haired bat	40	17	carcass search	Daily	complete
9/16/2011	red-eyed vireo	22A	5	carcass search	Daily	complete
9/16/2011	hoary bat	44	18	carcass search	Daily	complete
9/16/2011	unidentified passerine	42	40	carcass search	Daily	partial
9/16/2011	hoary bat	21	5	carcass search	Daily	complete
9/16/2011	eastern red bat	22-5	31	carcass search	Daily	complete
9/17/2011	eastern red bat	46-A	59	incidental find	Daily	complete
9/17/2011	silver-haired bat	45	35	carcass search	Daily	complete
9/17/2011	unidentified passerine	44	45	carcass search	Daily	scavenged
9/17/2011	eastern red bat	42	6	carcass search	Daily	partial
9/18/2011	eastern red bat	45	40	carcass search	Daily	complete
9/18/2011	hoary bat	45	35	carcass search	Daily	complete
9/18/2011	silver-haired bat	24	20	carcass search	Daily	complete
9/18/2011	eastern red bat	32B	7	carcass search	Daily	scavenged
9/18/2011	hoary bat	38	35	carcass search	Daily	complete
9/20/2011	hoary bat	35	18	carcass search	Daily	complete
9/20/2011	red-eyed vireo	22A	2	carcass search	Daily	complete
9/20/2011	unidentified bat	38	21	carcass search	Daily	scavenged
9/21/2011	silver-haired bat	ALT2	23	carcass search	Daily	complete
9/21/2011	eastern red bat	32B	1	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/21/2011	silver-haired bat	36	14	carcass search	Daily	complete
9/21/2011	silver-haired bat	19	13	carcass search	Daily	complete
9/21/2011	broad-winged hawk	45	10	carcass search	Daily	complete
9/21/2011	hoary bat	38	26	carcass search	Daily	complete
9/21/2011	silver-haired bat	33B	12	carcass search	Daily	complete
9/21/2011	hoary bat	34	31	carcass search	Daily	complete
9/21/2011	hoary bat	34	12	carcass search	Daily	complete
9/21/2011	silver-haired bat	27A	6	carcass search	Daily	complete
9/22/2011	eastern red bat	ALT2	26	carcass search	Daily	scavenged
9/23/2011	tricolored bat	46-A	12	carcass search	Daily	complete
9/23/2011	silver-haired bat	43	26	carcass search	Daily	complete
9/23/2011	tricolored bat	42	18	carcass search	Daily	complete
9/24/2011	hoary bat	ALT2	27	carcass search	Daily	injured
9/24/2011	wood thrush	ALT2	27	carcass search	Daily	complete
9/24/2011	Cape May warbler	ALT2	32	carcass search	Daily	complete
9/24/2011	blackpoll warbler	ALT2	17	carcass search	Daily	complete
9/24/2011	rose-breasted grosbeak	ALT2	10	carcass search	Daily	complete
9/24/2011	blackpoll warbler	ALT2	13	carcass search	Daily	complete
9/24/2011	ovenbird	ALT2	7	carcass search	Daily	complete
9/24/2011	hoary bat	44	20	carcass search	Daily	complete
9/24/2011	black-throated blue warbler	45	32	incidental find	Daily	complete
9/24/2011	red-eyed vireo	45	40	incidental find	Daily	complete
9/24/2011	yellow-billed cuckoo	45	31	incidental find	Daily	complete
9/24/2011	blackpoll warbler	ALT2	37	carcass search	Daily	complete
9/24/2011	blackpoll warbler	ALT2	31	carcass search	Daily	complete
9/24/2011	Swainson's thrush	23	29	carcass search	Daily	complete
9/24/2011	red-eyed vireo	32B	21	carcass search	Daily	complete
9/24/2011	Cape May warbler	32B	14	carcass search	Daily	complete
9/24/2011	red-eyed vireo	32B	24	carcass search	Daily	partial
9/24/2011	blackpoll warbler	34	22	carcass search	Daily	complete
9/24/2011	Swainson's thrush	37	37	carcass search	Daily	complete
9/24/2011	red-eyed vireo	37	29	carcass search	Daily	complete
9/24/2011	red-eyed vireo	37	8	carcass search	Daily	complete
9/24/2011	silver-haired bat	40	31	carcass search	Daily	scavenged
9/24/2011	blackpoll warbler	40	35	carcass search	Daily	complete



**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/24/2011	blackpoll warbler	40	26	carcass search	Daily	complete
9/24/2011	blackpoll warbler	40	31	carcass search	Daily	complete
9/24/2011	Cape May warbler	42	12	carcass search	Daily	complete
9/24/2011	wood thrush	42	35	carcass search	Daily	partial
9/25/2011	bobolink	40	31	carcass search	Daily	complete
9/25/2011	red-eyed vireo	32B	10	carcass search	Daily	complete
9/25/2011	red-eyed vireo	32B	23	carcass search	Daily	complete
9/25/2011	chestnut-sided warbler	43	26	carcass search	Daily	partial
9/25/2011	blackpoll warbler	22-5	35	carcass search	Daily	complete
9/25/2011	little brown bat	43	28	carcass search	Daily	complete
9/25/2011	gray-cheeked thrush	40	49	carcass search	Daily	complete
9/25/2011	blackpoll warbler	40	16	carcass search	Daily	complete
9/25/2011	northern parula	40	21	carcass search	Daily	complete
9/25/2011	blackpoll warbler	40	21	carcass search	Daily	complete
9/25/2011	wood thrush	40	28	carcass search	Daily	complete
9/26/2011	wood thrush	ALT2	31	carcass search	Daily	complete
9/26/2011	bay-breasted warbler	ALT2	32	carcass search	Daily	complete
9/26/2011	chestnut-sided warbler	46-A	30	carcass search	Daily	complete
9/26/2011	yellow-billed cuckoo	46-A	14	carcass search	Daily	complete
9/26/2011	Cape May warbler	45	37	carcass search	Daily	complete
9/26/2011	blackpoll warbler	45	40	carcass search	Daily	complete
9/26/2011	yellow-billed cuckoo	27A	17	carcass search	Daily	complete
9/26/2011	bay-breasted warbler	39A	31	carcass search	Daily	complete
9/26/2011	Swainson's thrush	40	12	carcass search	Daily	complete
9/26/2011	ovenbird	40	40	carcass search	Daily	complete
9/26/2011	silver-haired bat	19	19	carcass search	Daily	complete
9/27/2011	hoary bat	44	35	carcass search	Daily	complete
9/27/2011	magnolia warbler	42	16	carcass search	Daily	complete
9/27/2011	silver-haired bat	22A	49	carcass search	Daily	complete
9/27/2011	blackpoll warbler	40	31	carcass search	Daily	complete
9/27/2011	red-eyed vireo	40	31	carcass search	Daily	complete
9/27/2011	hoary bat	41	12	carcass search	Daily	complete
9/27/2011	magnolia warbler	37	5	carcass search	Daily	scavenged
9/28/2011	eastern red bat	41	17	incidental find	Daily	injured
9/28/2011	Cape May warbler	44	17	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/28/2011	red-eyed vireo	42	42	carcass search	Daily	complete
9/28/2011	blackpoll warbler	23	54	incidental find	Daily	complete
9/28/2011	common yellowthroat	23	46	incidental find	Daily	complete
9/28/2011	red-eyed vireo	23	12	incidental find	Daily	complete
9/28/2011	silver-haired bat	18	21	carcass search	Daily	complete
9/28/2011	red-eyed vireo	21	28	carcass search	Daily	complete
9/28/2011	red-eyed vireo	ALT2	35	carcass search	Daily	complete
9/28/2011	silver-haired bat	ALT2	21	carcass search	Daily	complete
9/28/2011	blackpoll warbler	ALT2	5	carcass search	Daily	complete
9/28/2011	unidentified passerine	ALT2	35	carcass search	Daily	feather spot
9/28/2011	unidentified bat	ALT2	27	carcass search	Daily	scavenged
9/28/2011	silver-haired bat	38	24	carcass search	Daily	complete
9/28/2011	ovenbird	40	26	carcass search	Daily	complete
9/28/2011	red-eyed vireo	27A	14	carcass search	Daily	complete
9/28/2011	red-eyed vireo	24	26	carcass search	Daily	complete
9/29/2011	eastern red bat	44	20	incidental find	Daily	complete
9/29/2011	Tennessee warbler	44	21	incidental find	Daily	complete
9/29/2011	red-eyed vireo	44	18	incidental find	Daily	injured
9/29/2011	wood thrush	ALT2	34	carcass search	Daily	complete
9/29/2011	unidentified passerine	ALT2	35	carcass search	Daily	feather spot
9/29/2011	magnolia warbler	ALT2	18	carcass search	Daily	complete
9/29/2011	red-eyed vireo	ALT2	12	carcass search	Daily	complete
9/29/2011	hoary bat	ALT2	26	carcass search	Daily	complete
9/29/2011	unidentified warbler	ALT2	1	carcass search	Daily	partial
9/29/2011	magnolia warbler	ALT2	21	carcass search	Daily	complete
9/29/2011	unidentified passerine	ALT2	26	carcass search	Daily	feather spot
9/29/2011	red-eyed vireo	40	31	carcass search	Daily	complete
9/29/2011	red-eyed vireo	40	26	carcass search	Daily	complete
9/29/2011	blackpoll warbler	40	2	carcass search	Daily	complete
9/29/2011	eastern red bat	44	21	carcass search	Daily	complete
9/29/2011	hoary bat	42	21	carcass search	Daily	partial
9/29/2011	wood thrush	42	43	carcass search	Daily	partial
9/29/2011	red-eyed vireo	37	16	incidental find	Daily	complete
9/29/2011	silver-haired bat	43	28	incidental find	Daily	complete
9/29/2011	black-throated green warbler	27A	28	carcass search	Daily	complete

## Appendix A. Complete fatality listing for the Criterion Wind Energy Project.

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
9/29/2011	ovenbird	21	28	carcass search	Daily	complete
9/29/2011	hoary bat	19	16	carcass search	Daily	complete
9/29/2011	red-eyed vireo	32B	22	carcass search	Daily	complete
9/29/2011	silver-haired bat	43	38	carcass search	Daily	complete
9/29/2011	black-throated green warbler	41	34	carcass search	Daily	complete
9/30/2011	hoary bat	ALT1	36	carcass search	Daily	complete
9/30/2011	American redstart	40	28	incidental find	Daily	complete
9/30/2011	eastern red bat	20	26	carcass search	Daily	complete
9/30/2011	red-eyed vireo	40	26	carcass search	Daily	complete
9/30/2011	red-eyed vireo	40	38	carcass search	Daily	complete
9/30/2011	silver-haired bat	40	42	carcass search	Daily	complete
10/1/2011	eastern phoebe	33B	16	carcass search	Daily	complete
10/2/2011	wood thrush	46-A	15	carcass search	Daily	complete
10/2/2011	wood thrush	45	23	carcass search	Daily	complete
10/4/2011	wood thrush	46-A	23	carcass search	Daily	complete
10/4/2011	black-throated green warbler	ALT1	26	carcass search	Daily	complete
10/4/2011	blackpoll warbler	44	26	carcass search	Daily	complete
10/4/2011	black-throated green warbler	ALT2	23	carcass search	Daily	complete
10/4/2011	unidentified passerine	ALT2	30	carcass search	Daily	complete
10/4/2011	unidentified passerine	ALT2	26	carcass search	Daily	feather spot
10/4/2011	Swainson's thrush	ALT2	21	carcass search	Daily	complete
10/4/2011	unidentified passerine	ALT2	23	carcass search	Daily	feather spot
10/4/2011	gray-cheeked thrush	ALT2	14	incidental find	Daily	complete
10/4/2011	bay-breasted warbler	38	12	carcass search	Daily	complete
10/4/2011	blackpoll warbler	39A	37	carcass search	Daily	complete
10/4/2011	unidentified bird	40	38	carcass search	Daily	feather spot
10/4/2011	Tennessee warbler	40	33	carcass search	Daily	complete
10/4/2011	gray-cheeked thrush	26	26	carcass search	Daily	complete
10/4/2011	Philadelphia vireo	35	38	carcass search	Daily	complete
10/5/2011	blackpoll warbler	32B	26	carcass search	Daily	complete
10/5/2011	magnolia warbler	32B	31	carcass search	Daily	complete
10/5/2011	unidentified bird (small)	33B	22	carcass search	Daily	feather spot
10/5/2011	wood thrush	20	26	carcass search	Daily	complete
10/5/2011	savannah sparrow	33B	31	carcass search	Daily	complete
10/5/2011	black-throated blue warbler	ALT1	33	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
10/5/2011	silver-haired bat	ALT1	48	incidental find	Daily	complete
10/5/2011	silver-haired bat	45	33	carcass search	Daily	complete
10/5/2011	silver-haired bat	44	23	carcass search	Daily	complete
10/5/2011	Swainson's thrush	45	46	carcass search	Daily	complete
10/5/2011	blackpoll warbler	46-A	26	carcass search	Daily	complete
10/5/2011	red-eyed vireo	41	21	incidental find	Daily	complete
10/5/2011	red-eyed vireo	34	40	carcass search	Daily	complete
10/5/2011	gray catbird	35	6	carcass search	Daily	complete
10/5/2011	magnolia warbler	35	29	carcass search	Daily	complete
10/5/2011	black-throated green warbler	23	35	carcass search	Daily	complete
10/5/2011	black-throated blue warbler	39A	26	carcass search	Daily	complete
10/14/2011	unidentified passerine	ALT2	36	carcass search	Daily	feather spot
10/18/2011	palm warbler	45	54	carcass search	Daily	complete
10/19/2011	eastern red bat	42	48	carcass search	Daily	complete
10/20/2011	silver-haired bat	35	38	carcass search	Daily	complete
10/20/2011	silver-haired bat	44	42	carcass search	Daily	complete
10/21/2011	ruby-crowned kinglet	ALT2	45	carcass search	Daily	complete
10/22/2011	silver-haired bat	22A	17	carcass search	Daily	complete
10/22/2011	black-billed cuckoo	43	26	carcass search	Daily	partial
10/22/2011	unidentified passerine	24	21	carcass search	Daily	scavenged
10/22/2011	silver-haired bat	32B	54	carcass search	Daily	complete
10/24/2011	eastern red bat	45	31	carcass search	Daily	complete
10/24/2011	eastern red bat	44	36	carcass search	Daily	complete
10/25/2011	silver-haired bat	23	0	carcass search	Daily	scavenged
10/25/2011	silver-haired bat	24	15	carcass search	Daily	complete
10/25/2011	silver-haired bat	26	26	carcass search	Daily	complete
10/25/2011	eastern red bat	33B	23	carcass search	Daily	complete
10/26/2011	silver-haired bat	21	16	carcass search	Daily	complete
10/26/2011	hoary bat	39A	21	carcass search	Daily	complete
10/26/2011	unidentified bat	36	22	carcass search	Daily	complete
10/26/2011	silver-haired bat	ALT2	12	carcass search	Daily	complete
10/27/2011	silver-haired bat	40	40	carcass search	Daily	complete
10/28/2011	eastern red bat	41	22	carcass search	Daily	complete

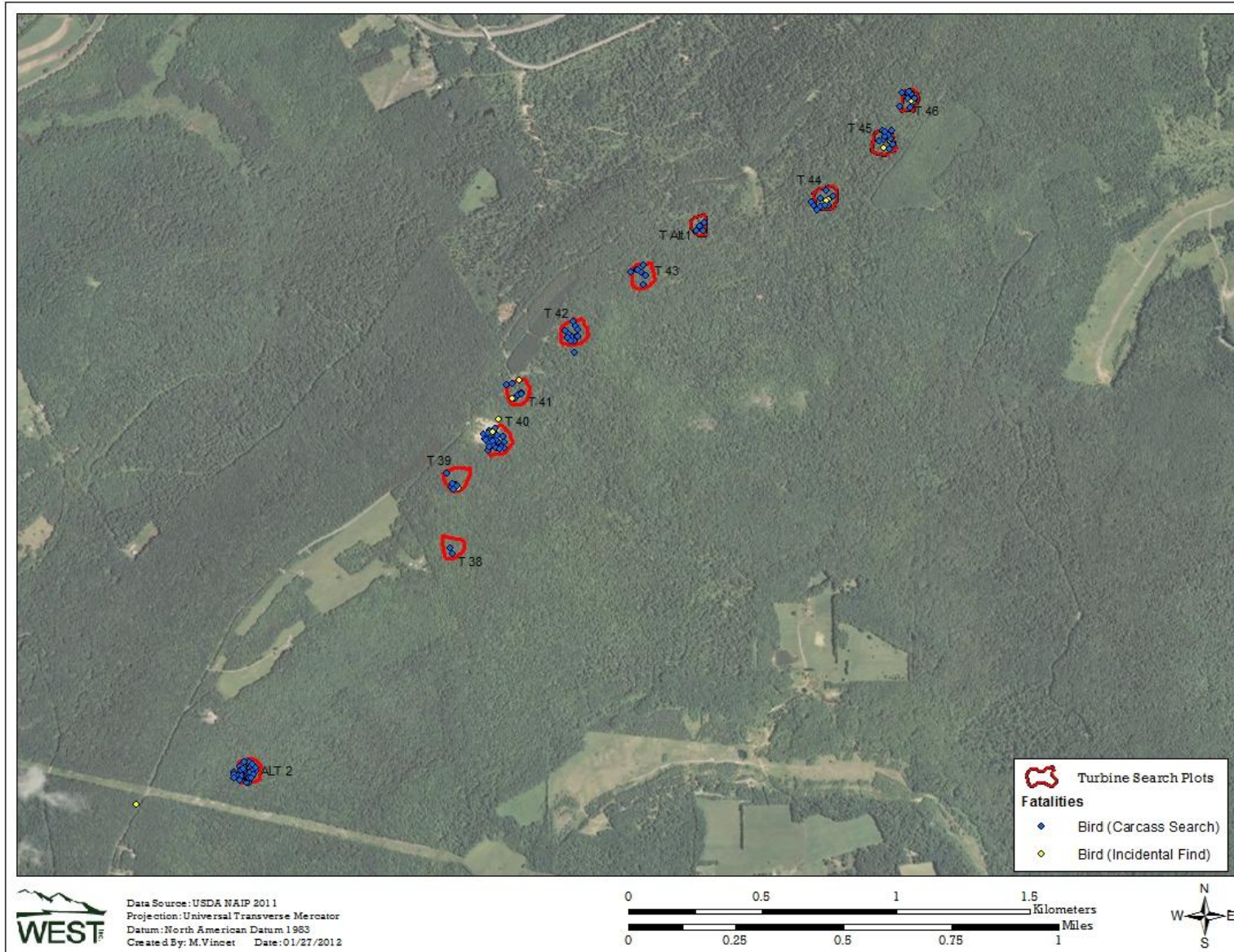
**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
10/28/2011	yellow-bellied sapsucker	39A	33	carcass search	Daily	complete
10/28/2011	yellow-rumped warbler	33B	24	carcass search	Daily	complete
10/5/2011	blackpoll warbler	ALT2	15	carcass search	Daily	complete
10/5/2011	blackpoll warbler	ALT2	40	carcass search	Daily	complete
10/5/2011	black-throated green warbler	ALT2	18	carcass search	Daily	complete
10/5/2011	Lincoln's sparrow	ALT2	5	carcass search	Daily	complete
10/6/2011	magnolia warbler	45	42	carcass search	Daily	complete
10/6/2011	silver-haired bat	43	17	carcass search	Daily	complete
10/6/2011	common yellowthroat	43	34	carcass search	Daily	complete
10/6/2011	tricolored bat	ALT2	21	carcass search	Daily	complete
10/6/2011	unidentified bird	ALT2	5	carcass search	Daily	feather spot
10/6/2011	unidentified bird	ALT2	28	carcass search	Daily	feather spot
10/6/2011	gray-cheeked thrush	ALT2	40	carcass search	Daily	complete
10/6/2011	tricolored bat	46-A	17	carcass search	Daily	complete
10/6/2011	unidentified passerine	35	20	carcass search	Daily	partial
10/6/2011	eastern red bat	35	45	carcass search	Daily	complete
10/6/2011	blackpoll warbler	34	16	carcass search	Daily	partial
10/6/2011	red-eyed vireo	34	21	carcass search	Daily	complete
10/6/2011	magnolia warbler	34	32	carcass search	Daily	complete
10/6/2011	Cape May warbler	33B	12	carcass search	Daily	scavenged
10/6/2011	wood thrush	33B	35	carcass search	Daily	complete
10/7/2011	black-throated green warbler	32B	13	carcass search	Daily	complete
10/7/2011	unidentified empidonax	41	36	carcass search	Daily	complete
10/9/2011	eastern red bat	38	19	carcass search	Daily	complete
10/9/2011	tricolored bat	46-A	32	carcass search	Daily	complete
10/10/2011	tricolored bat	38	21	carcass search	Daily	complete
10/10/2011	silver-haired bat	43	21	carcass search	Daily	complete
10/11/2011	unidentified passerine	33B	21	carcass search	Daily	feather spot
10/11/2011	unidentified bird (small)	33B	17	carcass search	Daily	feather spot
10/11/2011	magnolia warbler	32B	27	carcass search	Daily	complete

**Appendix A. Complete fatality listing for the Criterion Wind Energy Project.**

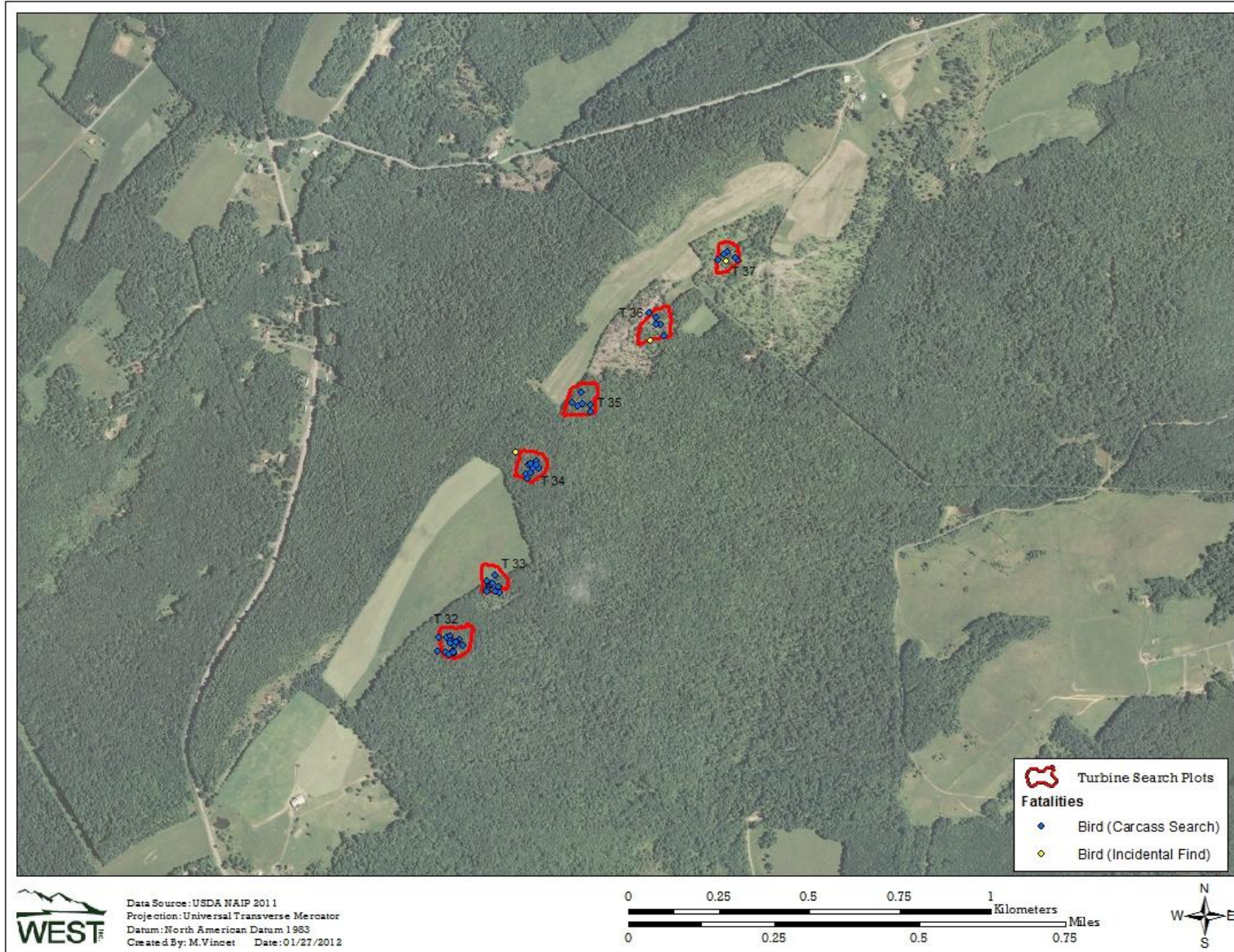
Date	Common Name	Location	Distance from Turbine	Type of Find	Search Type	Condition
10/11/2011	eastern red bat	20	17	carcass search	Daily	complete
10/11/2011	silver-haired bat	26	18	carcass search	Daily	complete
10/11/2011	yellow-billed cuckoo	36	26	carcass search	Daily	feather spot
10/11/2011	unidentified bird	ALT2	42	carcass search	Daily	feather spot
10/11/2011	eastern red bat	38	20	carcass search	Daily	complete
10/12/2011	unidentified passerine	ALT2	40	carcass search	Daily	feather spot
10/13/2011	hoary bat	38	31	carcass search	Daily	complete
10/28/2011	yellow-rumped warbler	33B	33	carcass search	Daily	complete
10/28/2011	silver-haired bat	32B	32	carcass search	Daily	complete
11/2/2011	yellow-rumped warbler	32B	34	carcass search	Daily	complete
11/2/2011	yellow-rumped warbler	34	16	carcass search	Daily	complete
11/2/2011	golden-crowned kinglet	44	42	carcass search	Daily	complete
11/3/2011	yellow-rumped warbler	34	37	carcass search	Daily	complete
11/3/2011	winter wren	39A	14	carcass search	Daily	complete
11/4/2011	eastern red bat	37	29	carcass search	Daily	scavenged
11/4/2011	eastern red bat	22-5	45	carcass search	Daily	complete
11/4/2011	silver-haired bat	45	23	carcass search	Daily	complete
11/4/2011	golden-crowned kinglet	44	35	carcass search	Daily	complete
11/4/2011	European starling	26	44	carcass search	Daily	complete
11/4/2011	yellow-rumped warbler	45	42	carcass search	Daily	complete
11/5/2011	silver-haired bat	36	30	carcass search	Daily	complete
11/5/2011	ruby-crowned kinglet	36	56	carcass search	Daily	complete
11/8/2011	eastern red bat	19	40	carcass search	Daily	complete
11/8/2011	golden-crowned kinglet	36	47	incidental find	Daily	complete
11/8/2011	eastern red bat	ALT2	21	carcass search	Daily	scavenged
11/8/2011	little brown bat	44	38	carcass search	Daily	complete
11/9/2011	unidentified passerine	22-5	16	carcass search	Daily	feather spot
11/9/2011	eastern red bat	24	21	carcass search	Daily	complete
11/10/2011	golden-crowned kinglet	43	31	carcass search	Daily	complete
11/15/2011	ruffed grouse	45	7	carcass search	Daily	complete

**Appendix B. Locations of Casualties found during the 2011 monitoring study at CWP.**

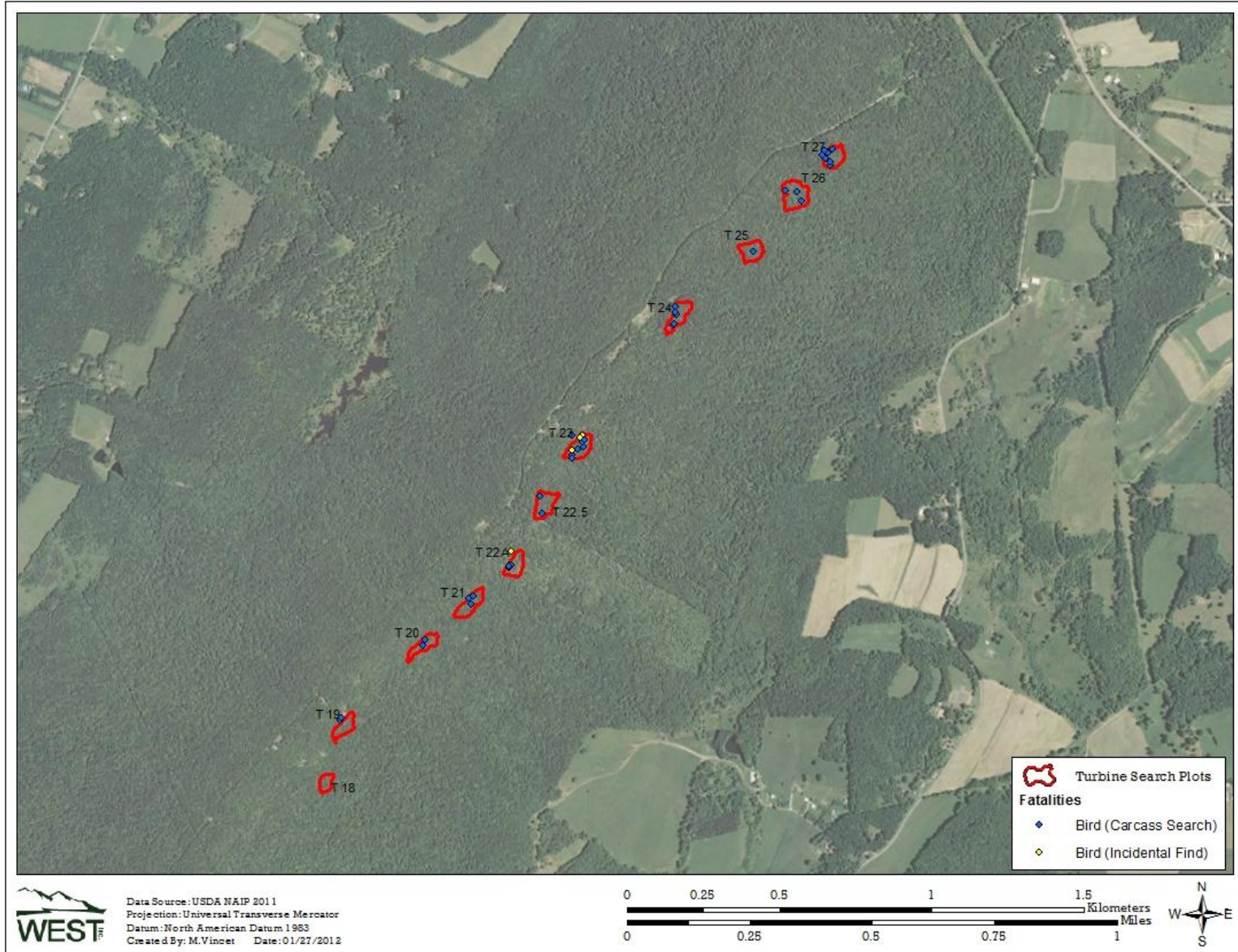


Search plots and locations of bird casualties found in the northern portion of the CWP.

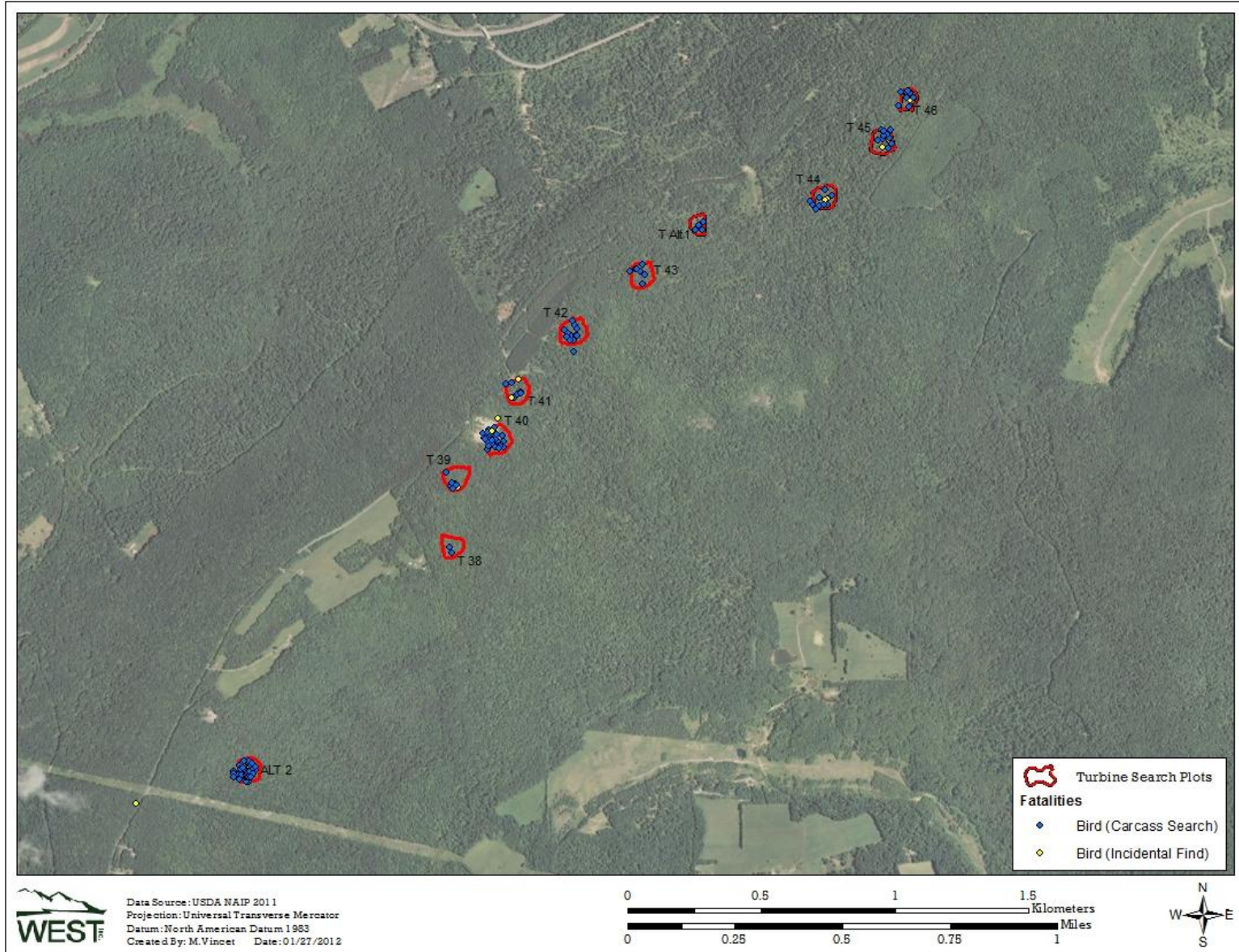




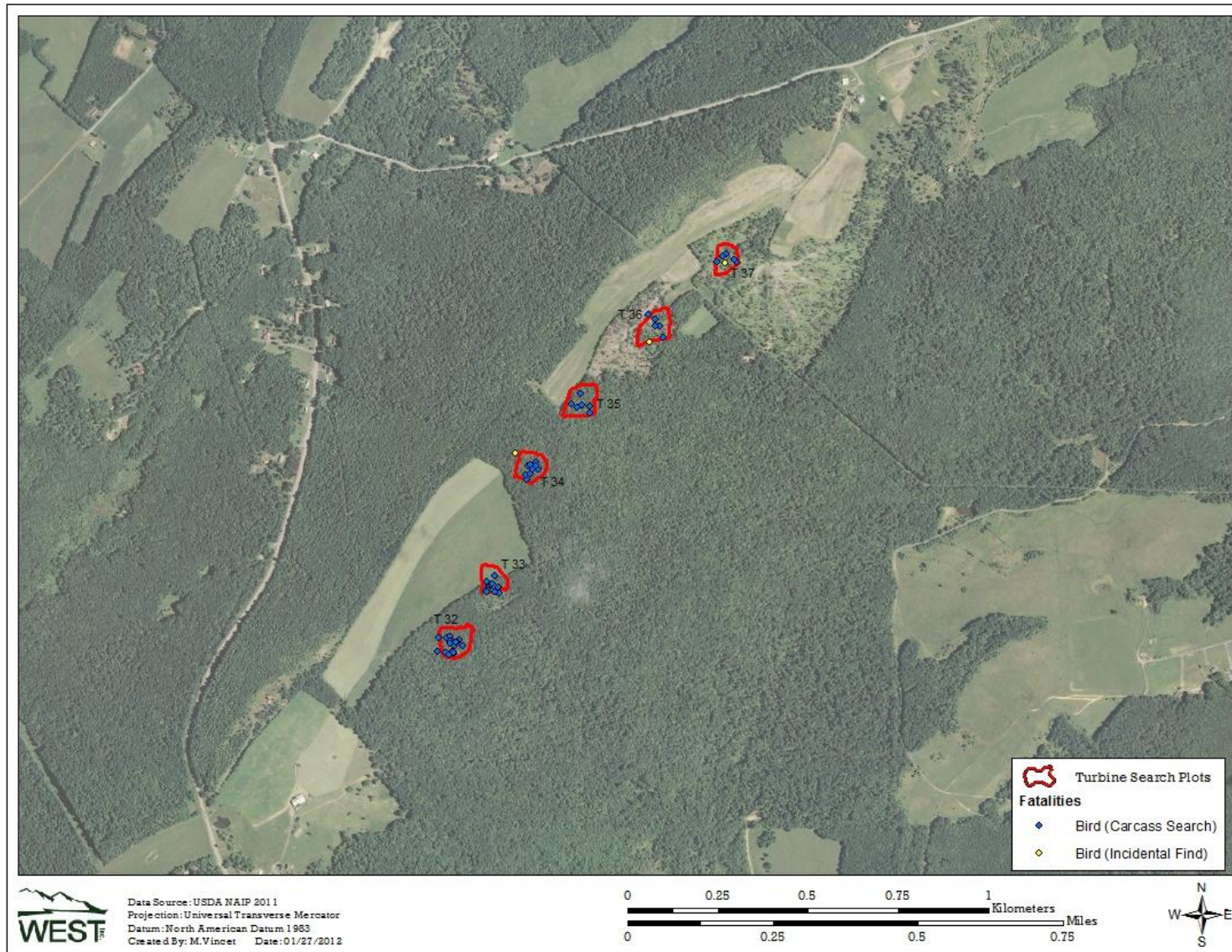
Search plots and locations of bird casualties found in the central portion of the CWP.



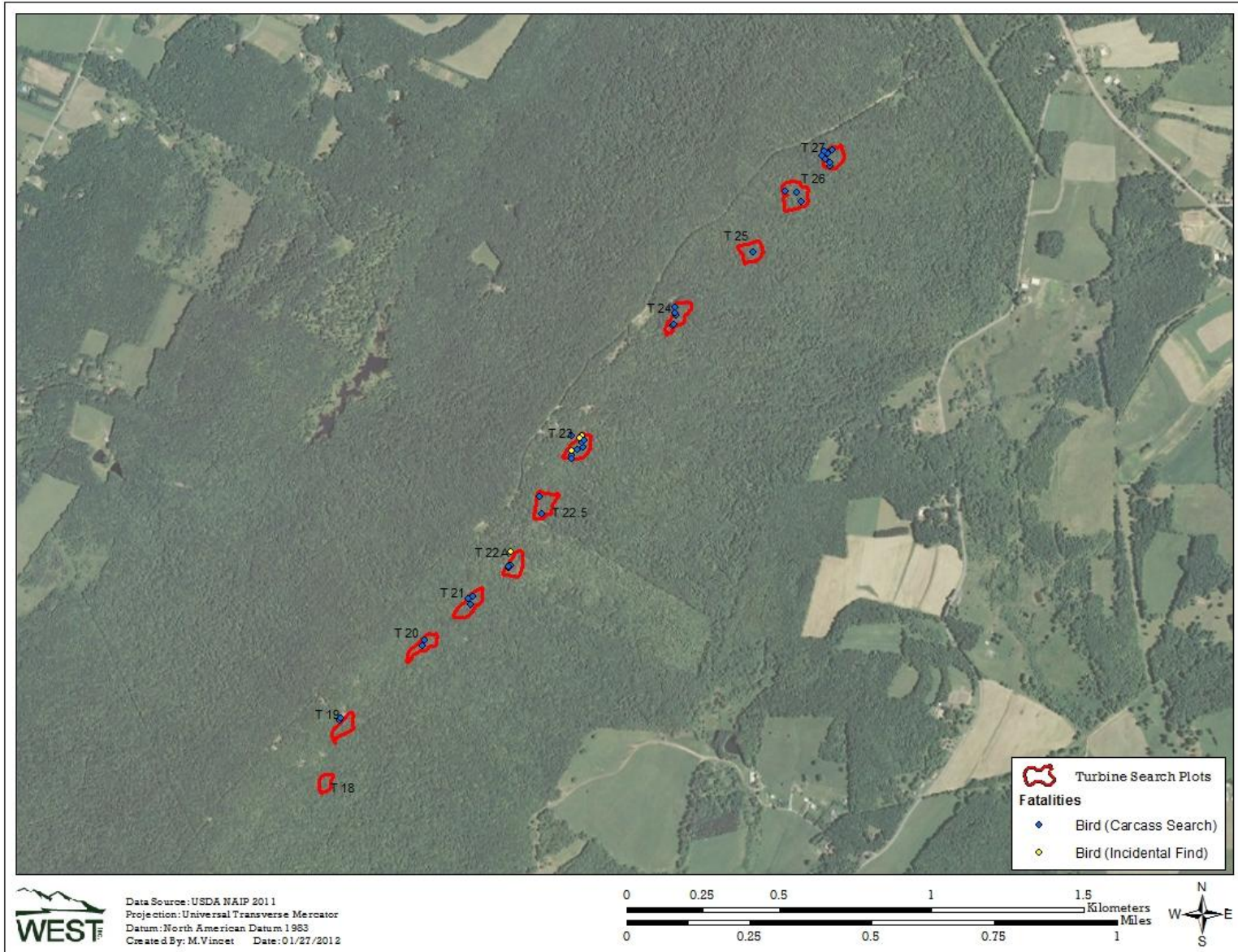
Search plots and locations of bird casualties found in the southern portion of the CWP



Search plots and locations of bat casualties found in the northern portion of the CWP.



Search plots and location of bat casualties found in the central portion of the CWP.



Search plots and locations of bat casualties found in the southern portion of the CWP.

