Post-Construction Fatality Surveys

for Lempster Wind Project

Iberdrola Renewables

Prepared for:

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1.0 EXECUTIVE SUMMARY

Iberdrola Renewables contracted Western EcoSystems Technology, Inc. (WEST) to develop a post-construction fatality survey at the Lempster Wind Power Project (LWPP) to assess the level of impacts of the project on birds and bats. The LWPP consists of 12 2.0 megawatt Gamesa G87 wind turbines and one meteorological tower. The turbines are distributed along a forested ridgeline in a relatively variable formation, approximately 300 – 500 meters apart. Monitoring at the Lempster Wind Power Project in 2009 occurred during the spring (April 15-June 1) and fall (July 15 – October 31). This report presents the results of both seasons of monitoring.

The primary objective of the monitoring study was to estimate the level of bird and bat mortality attributable to collisions with wind turbines for the facility. The monitoring study consisted of four components: (1) standardized carcass surveys of selected turbines and meteorological towers, (2) searcher efficiency trials to estimate the percentage of carcasses found by searchers, (3) carcass removal trials to estimate the length of time that a carcass remained in the field for possible detection, and (4) adjusted fatality estimates for birds and bats calculated using the results from searcher efficiency trials and carcass removal trials to estimate the approximate level of bird and bat mortality within the Lempster Wind Power Project.

Four turbines were searched daily throughout the two monitoring periods. The meteorological tower was also searched on a weekly basis. Plots were established around each search turbine and meteorological tower as far out from the structure as possible, to a maximum of 120 x 130 meters (15,600 square meters). Due to the topography and ground cover found at the Lempster Wind Power Project, search plot size is variable, ranging from 3,737.50 to 8,038.68 square meters. Transects were delineated at six-meter intervals across plots, and trained field technicians walked the transects while scanning the ground on either side for casualties.

A total of nine birds and ten bats were found during standardized searches; of which only one bird and one bat were found during the spring period. No bird fatalities were found at Turbine 9 or the meteorological tower; and three bird fatalities were found at each of Turbine 1, Turbine 5, and Turbine 8. Half of the bat fatalities were found at Turbine 1: two bats were found at Turbine 5 and Turbine 8, and one bat was found at Turbine 9. An additional four birds and two bats were recorded as incidental observations, of which two birds were found in the spring period. None of the incidental findings occurred at search plots and were therefore omitted from the fatality estimate. No bird fatalities were found at Turbine 9, and no bird or bat fatalities were recorded at the meteorological tower. Seven species of bird and four species of bat were recorded as casualties. Bird species included magnolia warbler, Swainson's thrush, common yellowthroat, golden-crowned kinglet, ovenbird, red-eyed vireo, and unidentified flycatcher. Bat species included silver-haired bats, hoary bats, big brown bats, and little brown bat[1].No state- or federal-listed species were included. Almost 85

[1] Identification of Myotis species were independently verified by the USFWS on February 9, 2010, and two preliminarily identified little brown bats were revised as big-brown bats, including the bat reported incorrectly as a little brown bat in the Spring 2009 Interim Report (Tidhar 2009).

percent of bird fatalities were found within 50 meters of the search turbine, and no bird carcass were found beyond 70 meters. The majority of bird casualties occurred between September 7 and 23; while the majority of bat casualties occurred between August 13 and 23, suggesting fall nocturnal migrants comprised the majority of fatalities at the Lempster Wind Power Project.

Searcher efficiency and carcass removal trials were conducted throughout the two search periods to account for any changes in either over time. Searcher efficiency trials occurred on 16 occasions over the duration of the study, during which time an average of 11 carcasses were placed throughout the five search plots. A total of 191 carcasses (129 small birds, 54 large birds, and eight bats) were deployed; of which 88 percent were available to be found. Observer detection rates were highest for large birds (77.4 percent), and similar for small birds (53.9 percent) and bats (57.1 percent). Searcher efficiency rates were adjusted for visibility class; however, due to low sample sizes, moderate/difficult/very difficult (M/D/VD) classes were pooled. In both the spring and fall, a higher proportion of small bird/bat carcasses and large birds were found in easy (E) visibility class compared to M/D/VD-class.

Analysis of correlation between weather variables and fatality patterns of bats was conducted. Due to small sample size of fatality data, it was not possible to find any significant correlations between weather and mortality.

A total of 136 carcasses were deployed during carcass removal trials within the project area throughout the duration of the monitoring period. This included 40 small birds and 18 large birds in the spring; and 54 small birds, six bats, and 24 large birds in the fall. Small birds were scavenged at a faster rate than either bats or large birds, with only 35 percent remaining after seven days of monitoring. In comparison, almost 70 percent of the bat carcasses and 60 percent of the large bird carcasses remained after seven days. When carcass removal rates were further evaluated based on visibility class, small bird/bat carcasses were scavenged faster when placed in E-class compared to M/D/VD-class in both seasons. A similar pattern was seen for large bird carcasses in the fall season.

Fatality estimates were calculated for small birds and bats based on the results of standardized carcass searches, searcher efficiency and carcass removal trials, and search plot area. Estimates could not be calculated for large birds because no large bird casualties were found at the facility. Fatality estimates were much higher for both small birds and bats in the fall compared to the spring. The seasonal fatality estimate for small birds was 0.80 birds/turbine (90% CI: 0, 2.29) in the spring and 5.95 birds/turbine (2.86, 8.66) in the fall; while for bats it was 0.66 bats/turbine (0, 1.90) in the spring and 5.55 bats/turbine (2.61, 8.72) in the fall.

Fatality estimates were adjusted for visibility class, however, there were very low sample sizes per visibility class. When adjusted for visibility class, fatality estimates were reduced slightly for small birds (0.70 birds/turbine (0, 1.97) in the spring and slightly increased (6.15 birds/turbine (2.7, 10.97)) in the fall. Estimates decreased slightly for bats (0.58 bats/turbine (0, 1.63) in the spring and 5.51 bats/turbine (1.96, 10.00) in the fall.

Combined seasonal fatality estimates were calculated using fatality estimates not adjusted for visibility class. The fatality estimate for both seasons combined was 6.75 small birds/turbine (3.75, 9.78) and 6.21bats/turbine (3.08, 9.84). Turbines within the Lempster Wind Power Project have a 2.0-megawatt capacity; and as such, the combined seasonal fatality estimate for the site is 3.38 fatalities/megawatt for birds and 3.08 fatalities/megawatt for bats. The combined 2009 spring and fall fatality estimates fall within the range of fatality estimates derived at other regional studies. The combined seasonal estimates for all 12 2.0 megawatt turbines at the Lempster Wind Power Project based on these estimates is 81.12 bird and 73.92 bat fatalities. An annual fatality estimate is not possible because of differences in mortality rates during the winter and the summer. Therefore, this estimate is only applicable for the study period.

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2.0 INTRODUCTION

Iberdrola Renewables (Iberdrola) completed construction and initiated operation of the Lempster Wind Power Project (LWPP) in the town of Lempster, in Sullivan County, New Hampshire in November 2008. Iberdrola contracted Western Ecosystems Technology, Inc. (WEST) to develop and implement a post-construction fatality survey (PCFS) at Lemspter consistent with permit condition 1c; to determine the "estimates of the overall annual rate of fatalities at the project" (*Application of Lempster Wind, LLC*, NH Site Evaluation Committee Docket No. 2006-01, Order Issuing Certificate of Site and Facility [June 28, 2007], Appendix II at p.17-18). The study was designed to estimate the direct impact of the facility in terms of estimated mortality rates of birds and bats caused by collisions with turbines. The study was designed to meet this objective and provide results which may be compared with fatality studies conducted at other existing wind-energy facilities in the region, as well as nationally. A Technical Committee (TC) proposed study methodologies (*Combined Avian and Bat Fatality Monitoring: Lempster Wind Facility April 2009*) for the two-year long study; however, due to maintenance associated with select turbines, the original sampling design was changed for the 2009 study year to accommodate access and availability of operational turbines (Tidhar 2009).

The 2009 monitoring study occurred from April 15 – October 31, 2009. A detailed study plan and spring interim report were prepared for the TC in July 2009 (Tidhar 2009). The purpose of the interim spring report was to describe preliminary results of fatalities which had occurred during the spring (April 15 – June 1, 2009) season. This report presents results of the full 2009 PCFS conducted at the LWPP. The monitoring study design for the LWPP consisted of the following components:

(1) Standardized carcass surveys of selected turbines within a search plot centered on the turbine,

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

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

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

3.0 STUDY AREA

The LWPP consists of 12 2.0-megawatt (MW) Gamesa G87 wind turbines and one meteorological tower (Figure 3.1-1). The turbines are distributed along a forested ridgeline in a relatively variable formation, approximately 300 – 500 meters apart. The surface elevation of the project area ranges from 570 meters above sea level (ASL) to 690 meters ASL. Turbine tip heights are up to 120 meters from ground level. The single meteorological tower reaches a height of 80 meters and is lattice-framed. The facility is lighted in accordance with Federal Aviation Agency (FAA) guidelines. No guy wires are associated with the meteorological tower or wind turbines, and there are no locations suitable for perching or nesting by birds on the turbines. Access roads connecting the turbines allowed vehicular access to conduct this study. The facility has been operational since November 2008. Detailed information on landcover and vegetation found at the LWPP is contained within the *Application of Lempster Wind, LLC*, New Hampshire Site Evaluation Committee Docket No. 2006-01.

Figure 3.1-1. Map of the Lempster Wind Power Project. Turbines 1, 5, 8, and 9 were included in the 2009 study.

4.0 METHODS

The primary objectives of the post-construction fatality studies were to:

(1) Estimate bird and bat mortality attributable to the project, primarily during the migration (spring and fall) seasons;

(2) Provide a general understanding of the factors associated with the timing, extent, species composition, distribution, and location of the estimated fatalities; and

(3) Compare fatality estimates under varying weather conditions.

The monitoring study began after the LWPP became fully operational in November 2008. Monitoring occurred during the spring (April 15-June 1) and fall (July 15-October 15) seasons. The methods for the fatality study include four primary components:

(1) Standardized carcass surveys of selected turbines,

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

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

(4) Adjusted fatality estimates for bird and bat species calculated using the results from searcher efficiency trials and carcass removal trials to estimate the total number of bird and bat fatalities within the LWPP.

There are three scenarios under which casualties were found in the LWPP:

(1) During the standardized surveys for the study;

(2) While observers were on site, but not conducting a standardized search (i.e., an incidental find); and

(3) By facility personnel or others on site for other purposes (e.g., turbine maintenance).

Casualties found by study personnel regardless of timing (i.e., during a standardized survey or not) were recorded by the methods described below.

All bird and bat casualties located within the search areas, regardless of species, were recorded and a cause of death determined (if possible) based on field inspection of the carcass. The total number of bird and bat carcasses was estimated by adjusting for search frequency, removal bias (length of stay in the field), searcher efficiency bias (percent found), and proportion of the survey plot searched. For carcasses where the cause of death was not apparent, the assumption that the fatality was a wind turbine collision casualty was made for the analysis. It is unlikely that any of the bat fatalities were caused by sources not related to interactions with wind turbines; however, other sources of mortality for birds (Johnson et al 2000) may be present and confound determination of cause of death. There is a high cost and difficulty associated with obtaining accurate estimates of natural or reference mortality (see Johnson et al. 2000). For this reason, the assumption that all bird and bat carcasses found are attributable to the facility is made for the fatality estimate. This likely leads to an over-estimation for bird mortalities attributable to turbine collision.

Four turbines (T1, T5, T8, and T9), representing one-third of total turbines, were searched on a daily basis (Figure 4.1-1). In addition, the meteorological tower was searched weekly. These four turbines were selected to accommodate access and availability of turbines during the first year of operations.

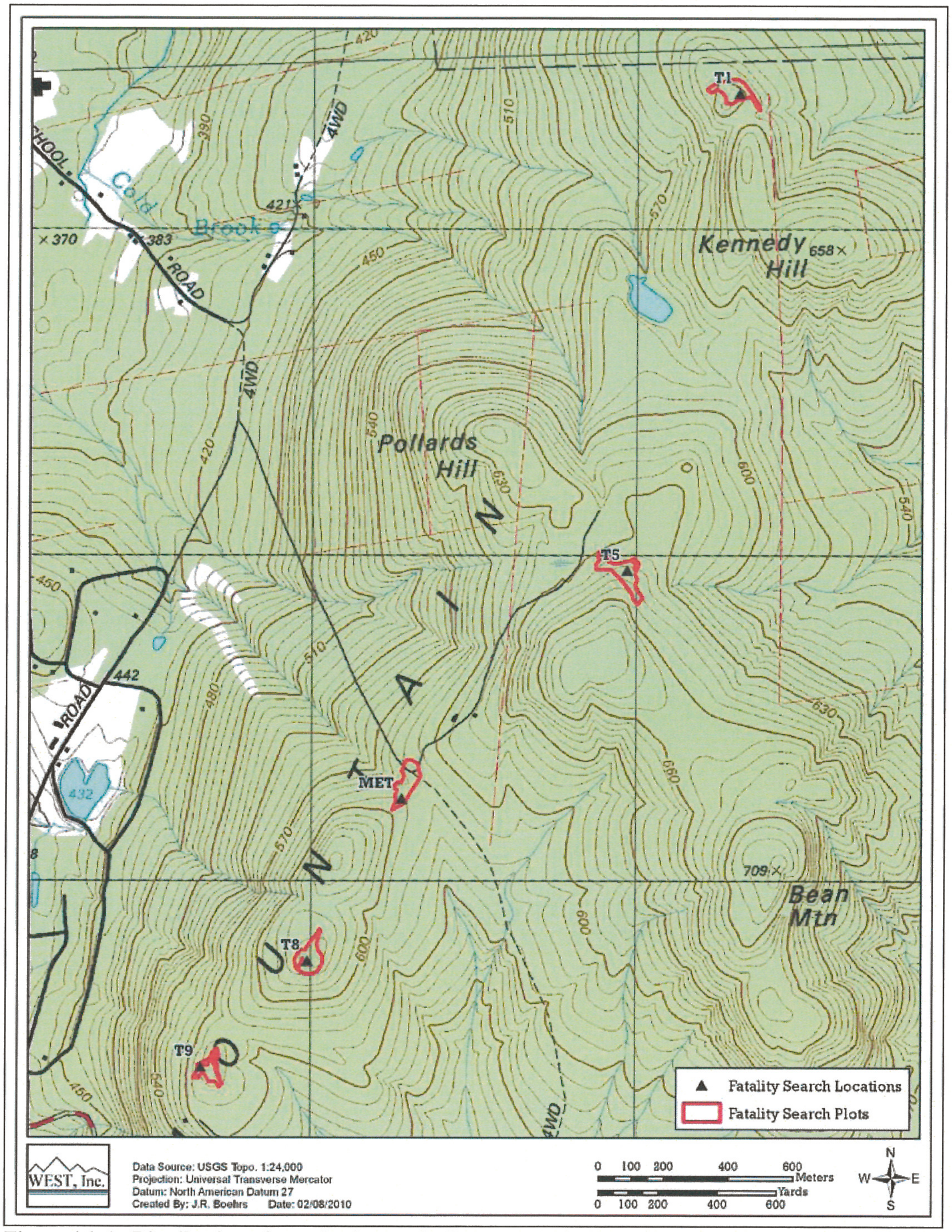


Figure 4.1-1. Distribution of search plots at the Lempster Wind Power Project.

The surveys were divided into two study periods to encompass both peak neo-tropical bird migration in the spring and peak bat, songbird, and raptor migration in the fall. The first study period was from April 15[2]to June 1, and the second study period was from July 15 to October 31. These periods cover the peak of the spring (April-May) and fall (September-October) raptor and songbird and fall bat (August-September) migrations. Fatality studies of bats at wind projects in the U.S. have generally shown peak mortality in August and September (Johnson 2005; Arnett et al. 2008). As directed in the permit, the study will comprise a total of two years with a review of study methodology after the first year.

Search plots of up to a maximum of 120 x 130 meters were established around each search turbine and meteorological tower as far out from the structure as possible, and delineated with a global positioning system (GPS) unit (Garmin GPSmap 76CSx). Site characteristics within the immediate vicinity of turbines included steep rocky embankments, rocky-boulder areas, shrub/scrublands, forested edges, small grasslands, and cleared (graveled) turbine pads and roads. Given the difficulty in finding birds and bats within thick shrub cover, steep or creviced rocky areas or forested areas, the search areas were limited to cleared areas such as roads and turbine pads, grassy areas, and rocky areas lacking steep slopes and/or deep crevices (Table 4.1.1). Landcover/vegetation mapping was conducted several times during each season, depending on local patterns of vegetation growth and the ability to detect carcasses during searcher efficiency trials. Information on the visibility index (see Searcher Efficiency Trials below) at each search plot was collected during each habitat mapping survey. Land cover characteristics for search plots are summarized in Table 4.1-1. Land cover and visibility index maps are included in Appendix A and B.

Table 4.1-1. Characteristics of search plots included in 2009 monitoring at the Lempster Wind Power Project, including area and landcover.

Plot	Landcover	Area (m^2)	% Composition
Met	Grasslands	3,243.15	50.1
	Pads & Roads	3,120.23	48.2
	Rocky Areas	105.80	1.6
	Total	**6,469.18**	**100**
T1	Grasslands	855.33	13.7
	Pads & Roads	4,413.90	70.9
	Rocky Areas	960.35	15.4
	Total	**6,229.58**	**100**
T5	Grasslands	2,007.37	25.0
	Non-searchable	64.28	0.8
	Pads & Roads	4,899.26	60.9
	Rocky Areas	1,067.77	13.3
	Total	**8,038.68**	**100**
T8	Grassland	3,337.12	52.9
	Pads & Roads	2,158.53	34.2
	Rocky Areas	815.68	12.9
	Total	**6,311.33**	**100**

[2] Due to changes to the monitoring protocol and safety concerns, daily monitoring at T1, T5, T8, and T9 during the spring 2009 season began on April 18 (see Tidhar 2009).

Table 4.1-1. Characteristics of search plots included in 2009 monitoring at the Lempster Wind Power Project, including area and landcover (continued).

T9 Fall	Pads & Roads	2,781.96	74.4
	Rocky Areas	955.54	25.6
	Total	**3,737.50**	**100**
T9 Spring	Pads & Roads	2,781.96	67.2
	Rocky Areas	1,086.21	26.2
	Shrublands	274.48	6.6
	Total	**4,142.65**	**100**

Following the spring 2009 survey, WEST recommended (Tidhar 2009) that mowing be initiated at portions of search plots T1, T5, and T8, to increase the potential that searchers could detect carcasses within grassland areas through the summer growing season. Iberdrola coordinated with WEST and the local landowner and mowing was implemented on an as-needed basis throughout the remainder of the study season. Mowing operations were coordinated to be conducted following completion of daily carcass searching to reduce the likelihood that a carcass would be destroyed by mowing. The size of search plot T9 was constrained due to vegetation growth (primarily vine and fern) prior to the initiation of fall 2009 surveys and characteristics are presented separately by season for this plot.

4.1 STANDARDIZED CARCASS SURVEYS

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

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

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

All carcasses were labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A 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 (intact, scavenged, feather spot), and any comments that indicated possible cause of death. All casualties were photographed as found and plotted on a detailed map of the study area showing the location of the wind turbines and associated facilities (e.g., overhead power lines and met towers). In addition to carcasses, any injured birds or bats observed in the search plots were recorded and treated as fatalities. Casualties found outside the formal search area were treated following the above protocol as closely as possible. Casualties observed in non-search areas (generally at turbines not included in the study) were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Casualties found by maintenance personnel and others not conducting the formal searches were similarly documented and included in the overall dataset.

All *Myotis* bats were tentatively identified by WEST biologists and retained for confirmatory identification following the field season by Susi von Oettingen, Endangered Species Biologist, U.S. Fish and Wildlife Service (USFWS).

4.2 SEARCHER EFFICIENCY TRIALS

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

Searcher efficiency trials were conducted 16 times throughout the study period (six in the spring and ten in the fall). Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. A total of 191 carcasses (54 large birds, 129 small birds, and eight bats) were placed on 16 dates. Carcasses used for searcher efficiency trials were primarily non-native/non-protected or commercially available species such as house sparrows (*Passer domesticus*) and mallards (*Anas platyrhynchos*), but also included non-listed bird species and non-*Myotis* bats collected as fatalities at the LWPP. All searcher efficiency trial carcasses were placed at random locations within the search area prior to that day's scheduled carcass survey. Each trial carcass was discreetly marked so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey was recorded. The number of carcasses available[3] for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Searcher efficiency results were further evaluated based on visibility class to further enhance estimates of carcass detection rates. Landcover for each turbine was evaluated prior to searcher efficiency trials to determine the difficulty of finding carcasses within varying groundcover types. Terrain was broken into to four separate groups:

- E = Easy (e.g., > 90 percent bare ground; spare ground cover < 6 inches tall);
-
- M = Moderate (e.g., > 25 percent bare ground; ground cover < 6 inches tall and mostly sparse)
-
- D = Difficult (e.g., < 25 percent bare ground; < 25 percent of ground cover is > 12 inches tall)
-
- VD = Very difficult (e.g., little or no bare ground; > 25 percent of ground cover is > 12 inches tall)

The aforementioned ground cover types were used to evaluate the probability that a carcass would be discovered by searchers. These results are presented in addition to standard searcher efficiency results conducted within the project area. Visibility index characteristics for each search plot are summarized in Table 4.2-1.

[3] Available carcasses are those which have at least some probability of detection during searches. Carcasses which cannot be detected by the searcher or the Field Technician conducting the trial are not considered available due to: 1) scavenging between the period when the trial is blindly initiated and the period when the searcher is at the turbine; or 2) the carcass is undetectable (e.g. due to it falling into a rock crevice).

Table 4.2-1. Characteristics of search plots included in 2009 monitoring at the Lempster Wind Power Project, including area and visibility index.

Plot	Visibility	Area (m^2)	Percent Composition
Met	Easy	3,120.23	48.2
	Moderate	3,243.15	50.1
	Difficult	105.80	1.6
	Total	**6,469.18**	**100**
T1	Easy	4,413.90	70.9
	Moderate	145.65	2.3
	Difficult	1,175.29	18.9
	Very Difficult	494.74	7.9
	Total	**6,229.58**	**100**
T5	Easy	4,899.26	60.9
	Moderate	1,177.42	14.6
	Difficult	829.95	10.3
	Very Difficult	1,067.77	13.3
	Not Searchable	64.28	0.8
	Total	**8,038.68**	**100**
T8	Easy	2,158.53	34.2
	Moderate	3,337.12	52.9
	Difficult	569.81	9.0
	Very Difficult	245.87	3.9
	Total	**6,311.33**	**100**
T9 Fall	Easy	2,781.96	74.4
	Moderate	0	0
	Difficult	212.25	5.7
	Very Difficult	743.28	19.9
	Total	**3,737.50**	**100**
T9 Spring	Easy	2,781.96	67.2
	Moderate	0	0
	Difficult	274.48	6.6
	Very Difficult	1,086.21	26.2
	Total	**4,142.65**	**100**

4.3 CARCASS REMOVAL TRIALS

The objective of carcass removal trails was to estimate the average length of time a carcass remained in the study area and was potentially detectable. Carcass removal included removal by predation or scavenging, or any other means by which a carcass would no longer be found on a search plot. Carcass removal studies were conducted during each season, outside of the carcass search plots (i.e., near turbines that were not included in the standard search plots). Estimates of carcass removal were used to adjust the total number of carcasses found for those removed from the study area, correcting for removal bias.

Trials were spread throughout the study period to incorporate the effects of varying weather, climatic conditions, and scavenger densities. A total of 136 carcasses were placed throughout the monitoring period (April 20 – June 1 and July 15 - October 22, 2009), including 42 large birds, 88 small birds, and six bats. Carcass composition was similar to that used for searcher efficiency trials.

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

Personnel conducting carcass searches monitored the trial birds over a 7-day period, checking the carcasses every day. Removal trial carcasses were marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel, and left at the location until the end of the carcass removal trial. At the end of the 7-day period, any remaining evidence of the carcass was removed.

Carcass removal rates will also be further evaluated based on groundcover difficulty, using the same distinctions used for searcher efficiency trials. This analysis will allow for more accurate rates of carcass removal based upon the varying ground cover types present within the project area.

4.4 SEARCH AREA

Due to the topography and ground cover at the LWPP, search plot size is variable (Figure 2), ranging from 3,737.50 to 8038.68 square meters (Table 4.2-1). The target search plot size was 120 meters (394 feet) by 130 meters (427 feet)., though this size was not possible at any turbine within the project area due to constraints of topography and ground cover. The proportion of the maximum 120 x 130 meter search plot (15,600 square meter) available to be searched for each plot was: 41.5 percent for the meteorological tower, 39.9 percent for T1, 51.5 percent for T5, 40.5 percent for T8 and 24.0 percent for T9. Turbine pads were constructed such that turbines are not centered within a cleared area and are instead typically setback against a forest edge. Construction of the facility minimized site clearing in order to protect the surrounding land cover to the extent possible. Search plots were delineated to maximize the searchable area with the highest potential for bat and bird fatalities.

Searchable areas of the turbines did not include forest, heavily creviced or steep rocky/boulder slopes, shrub/scrub, or dense weed/vine areas. Searchable areas included moderately rocky areas with few crevices or cracks, turbine pads and roads, and grassy areas (Table 4.1-1). Grassy areas remained relatively sparse, or overall heights of grass were low, throughout the spring 2009 season. Studies at other facilities with large turbines, such as the Klondike Wind Resource Area in Oregon (Johnson et al. 2003a); the Combine Hills facility, also in Oregon (Young et al. 2005); and the Crescent Ridge facility in Illinois (Kerlinger et al. 2007) indicate that most fatalities are found within a distance that is roughly equivalent to the height of the turbine tower (120 meters). Search plots were established to the extent possible to encompass the most likely area of fatality locations. Adjustments to the fatality estimates were made to account for un-sampled areas beyond 90 meters using information regarding spatial distribution of fatalities within the search plots and existing information from other projects (e.g., Erickson et al. 2003b).

4.5 STATISTICAL METHODS

4.5.1 Statistical Methods for Fatality Estimates

Estimates of facility-related fatalities are based on:

(1) Observed number of carcasses found during standardized searches during the monitoring year 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 were calculated for all birds, small birds, large birds, and bats. The number of bird and bat fatalities attributable to operation of the project, based on the number of bird and bat fatalities found at the facility site whose death appears related to facility operation, were reported. All carcasses located within areas surveyed, regardless of species, were recorded and (if possible) a cause of death was determined based on a cursory field necropsy. Total numbers of bird and bat carcasses were estimated by adjusting for removal and searcher efficiency bias. If the cause of death was not apparent, a "worst case" estimate was made by attributing the mortality to the operation of the project

4.5.2 Definition of Variables

The following variables are used in the equations below:

- c_i The number of carcasses detected at plot i for the study period of interest, for which the cause of death is either unknown or is attributed to the facility;
- n The number of search plots;
- k The number of turbines searched;
- $\bar{c}$ The average number of carcasses observed per turbine per monitoring period;
- s The number of carcasses used in removal trials;
- s_c The number of carcasses in removal trials that remain in the study area after 30 days;
- se Standard error (square of the sample variance of the mean);

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

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

- d The total number of carcasses placed in searcher efficiency trials;

- p The estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials;

- I The average interval between standardized carcass searches, in days;

- A Proportion of the search area of a turbine actually searched;

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

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

4.5.3 Observed Number of Carcasses

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

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

4.5.4. Estimation of Carcass Non-Removal Rates

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

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

4.5.5. Estimation of Searcher Efficiency Rates

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

4.5.6. Estimation of Facility-Related Fatality Rates

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

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

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

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

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

This formula has been independently verified by Shoenfeld (2004). The final reported estimates of *m* and associated standard errors and 90 percent confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and confidence intervals for complicated test statistics. For each bootstrap sample, $\bar{c}$, $\bar{t}$, p, $\hat{\pi}$, and m were calculated. A total of 5,000 bootstrap samples were used. The reported estimates were the mathematical means of the 5,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower fifth and upper ninety-fifth percentiles of the 5,000 bootstrap estimates are estimates of the lower limit and upper limit of 90 percent confidence intervals.

4.6 WEATHER EVALUATION

Wind speed, temperature, and barometric pressure data were obtained from the meteorological tower at the LWPP and used to assess the relationship between bat mortality and weather. Weather data (Table 4.6-1) were obtained in 10-minute increments from 6:00 pm the night before the carcass search to 6:00 am the morning of the carcass search (i.e., 720 values per night). The average of these values was then correlated with the number of bat casualties found per turbine during carcass searches on that date. For example, the results of carcass searches (per turbine) conducted on July 15 would be correlated with weather data from 6:00 pm on July 14 through 6:00 am on July 15.

Table 4.6-1 Predictors used to assess the relationship between weather characteristics and bat mortality for the 2009 Lempster Wind Power Project study.

Predictor Variable [abbreviation]	Description
Temperature	
[avg.temp]	Mean nightly temperature; averaged across 10-minute increments.
[temp.squ]	Quadratic term, mean nightly temperature squared.
Barometric Pressure	
[avg.press]	Mean nightly barometric pressure; averaged across 10-minute increments.
[press.squ]	Quadratic term, mean nightly barometric pressure squared.
Wind Speed	
[avg.wsp]	Mean nightly wind speed; averaged across 10-minute increments.
[wsp.squ]	Quadratic term, mean nightly wind speed squared.
[ws.0 to 4]	Proportion of night (10-minute intervals) from 1800 to 0600 hours with wind speed of 0 – 4 meters per second.
[ws.4 to 6]	Proportion of night (10-minute intervals) from 1800 to 0600 hours with wind speed of 4 – 6 meters per second.
[ws.gt 6]	Proportion of night (10-minute intervals) from 1800 to 0600 hours with wind speed of > 6 meters per second.

The relationship between weather variables (Table 4.6-1) and fresh bat casualties was investigated using graphical methods (i.e., least squares regression lines, scatter plots), univariate association analyses (i.e., Pearson's correlations, simple linear regression), and multiple regression (Neter et al. 1996). Poisson, negative binomial, and zero-inflated Poisson models were also considered. Using the Vuong test, it was determined that there was no distinguishable difference between the best poisson and negative binomial models (Vuong, 1989).

The fitted poisson models all had log link and were of the form:

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

which relates the behavior of the natural logarithm of the mean number of fresh bat mortalities per turbine, to a linear function of the set of predictor variables $x_1,\ldots,x_p$. The β_j's are the parameters that specify the nature of the relationship, and ε is a random error term.

The fitted linear models were all of the form:

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon$$

which relates the behavior of the mean number of fresh bat mortalities per turbine, to a linear function of the set of predictor variables $x_1,...,x_p$. As before, the β_j's are the parameters that specify the nature of the relationship, and ε is a random error term.

The program R was used to fit alternative models. In particular, step-wise model selection methods based on Akaike Information Criterion (AIC) were used to determine the best fitting linear and poisson models. The correlation matrix was obtained for all continuous main effects listed above. Variables with pairwise correlations ≥ 0.6 were not allowed to be present in the models at the same time. The models were built using a forward and backward step-wise approach in which main effects entered or left the model based on the AIC value. The first step began with the full model containing all parameters. In the next step, covariates were added or subtracted from the model one at a time. If the model AIC decreased, the change in covariates was retained. If AIC increased, that change was discarded and the next covariate was tested. This procedure was repeated until none of the covariate changes produced a lower AIC. Additionally, residuals were plotted from selected models to determine goodness of fit.

None of the models selected were allowed to contain:

(1) Both average wind speed and either proportion of night with a wind speed < 4 meters/second or proportion of night with a wind speed $\geq$ 6 meters/second, or

(2) Both proportion of the night with wind speed $\geq$ 6 meter/second and proportion of the night with wind speed of 0 to 4 meters/second.

These exceptions were due to perceived high correlations between the pairs of variables (Neter et al. 1996). Models with a squared term were also required to include the lower order variable.

5.0 RESULTS

5.1 STANDARDIZED CARCASS SURVEYS

Four wind turbines and one meteorological tower were searched over the course of the post-construction fatality surveys, for a total of 598 turbine searches. No casualties of state- or federally-listed bird or bat species were documented as casualties either during carcass searches or incidentally.

A total of 13 bird carcasses were found within the LWPP; nine were found during standardized carcass searches, and an additional four were recorded as incidental finds (Table 5.1-1). All incidental finds were located outside of search plots outside of standardized searches and were therefore excluded from fatality estimates. All bird fatalities recorded either during scheduled searches or incidentally were small birds; no large bird carcasses were found during the study. Seven species of bird were found as fatalities (Tables 5.1-1, 5.1-2).

Table 5.1-1. Summary of bird casualties found at the Lempster Wind Power Project; April 15 – October 31, 2009.

	Scheduled Searches		Total with Incidental	
Species	**Total**	**% Composition**	**Total**	**% Composition**
Magnolia warbler	2	22.2	2	15.4
Swainson's thrush	2	22.2	2	15.4
Common yellowthroat	1	11.1	1	7.7
Golden-crowned kinglet	1	11.1	3	23.1
Ovenbird	1	11.1	1	7.7
Red-eyed vireo	1	11.1	2	15.4
Unidentified flycatcher	1	11.1	2	15.4
Overall	**9**	**100**	**13**	**100**

Table 5.1-2. Bird and bat casualties found at the Lempster Wind Power Project; April 15 – October 31, 2009.

Season	Date	Taxa	Species	Location	SCS or IF[1]	Distance to nearest turbine	Condition
Spring	9/4/2009	Bat	Silver-haired bat	T3	IF	21	Complete
Fall	10/5/2009	Bat	Silver-haired bat	T3	IF	26	Complete
Fall	5/25/2009	Bat	Big brown bat	T8	SCS	41	Complete
Fall	8/13/2009	Bat	Big brown bat	T11	SCS	25	Complete
Fall	8/15/2009	Bat	Hoary bat	T5	SCS	25	Complete
Fall	8/16/2009	Bat	Hoary bat	T9	SCS	6	Complete
Fall	8/20/2009	Bat	Little brown bat	T1	SCS	55	Partial
Fall	8/23/2009	Bat	Hoary bat	T1	SCS	35	Complete
Fall	9/9/2009	Bat	Silver-haired bat	T8	SCS	27	Complete
Fall	9/21/2009	Bat	Silver-haired bat	T1	SCS	17	Complete
Fall	10/11/2009	Bat	Silver-haired bat	T5	SCS	26	Scavenged
Fall	10/30/2009	Bat	Silver-haired bat	T1	SCS	24	Scavenged
Spring	4/20/2009	Bird	Golden-crowned Kinglet	T11	IF	33	Complete
Spring	5/4/2009	Bird	Golden-crowned Kinglet	T8	SCS	14	Scavenged
Spring	5/30/2009	Bird	Red-eyed Vireo	T6	IF	31	Complete
Fall	7/27/2009	Bird	Swainson's Thrush	T8	SCS	26	Complete
Fall	8/26/2009	Bird	Unidentified flycatcher (*Empidonax* spp.)	T5	SCS	21	Complete
Fall	8/30/2009	Bird	Unidentified flycatcher (*Empidonax* spp.)	T3	IF	15	Complete
Fall	9/8/2009	Bird	Ovenbird	T1	SCS	61	Complete
Fall	9/13/2009	Bird	Common Yellowthroat	T1	SCS	10	Scavenged
Fall	9/13/2009	Bird	Magnolia Warbler	T5	SCS	14	Scavenged
Fall	9/14/2009	Bird	Swainson's Thrush	T5	SCS	30	Complete
Fall	9/17/2009	Bird	Magnolia Warbler	T1	SCS	19	Complete
Fall	9/23/2009	Bird	Red-eyed Vireo	T8	SCS	26	Complete
Fall	10/27/2009	Bird	Golden-crowned Kinglet	T11	IF	55	Complete

[1]SCS = Scheduled carcass search; IF = Incidental find

No bird fatalities were found at T9 or the meteorological tower; and three bird fatalities were found at each of T1, T5, and T8 (Figure 5.1-1). Almost 85 percent of bird fatalities were found within 50 meters of the search turbine, and no bird carcass were found beyond 70 meters (Figure 5.1-2; Appendix A and B).

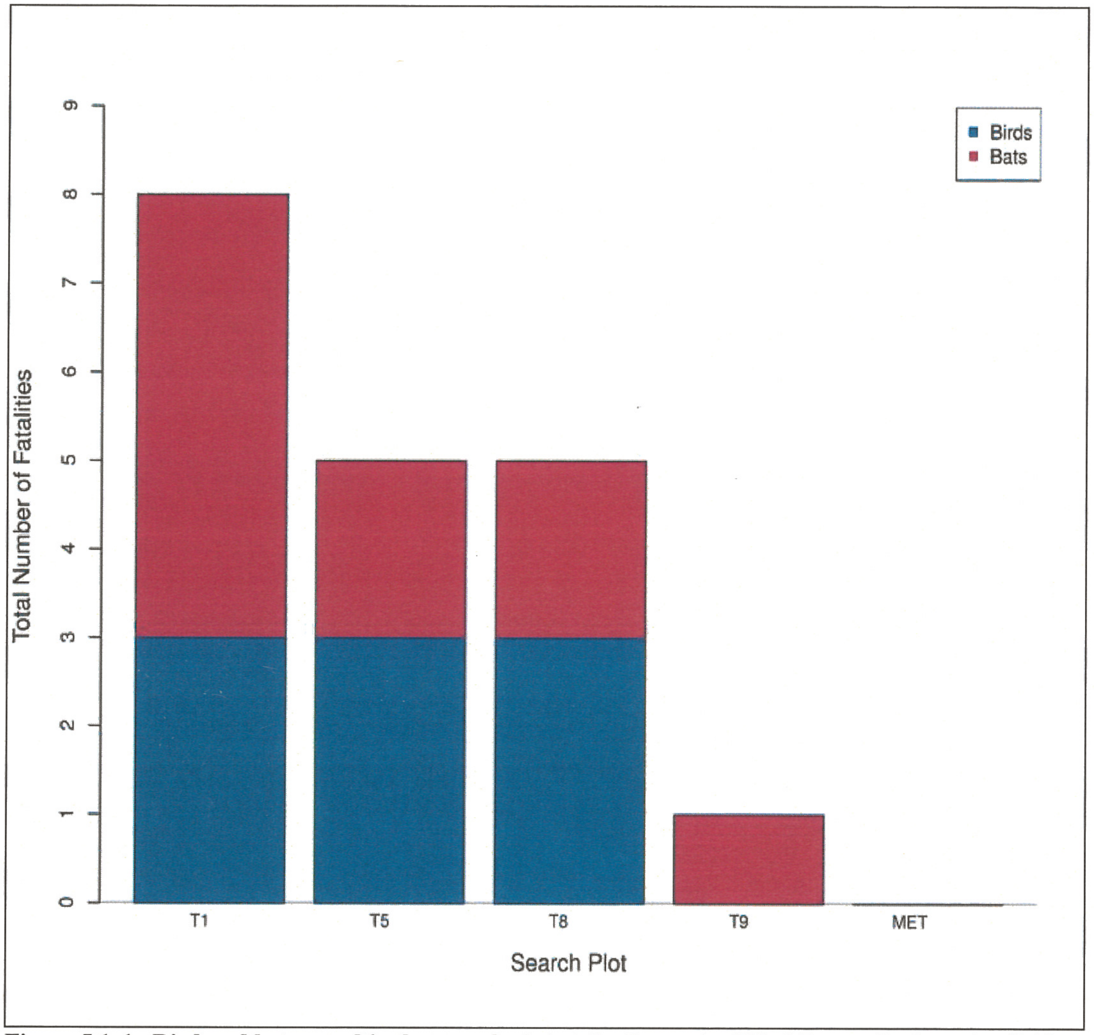


Figure 5.1-1. Bird and bat casualties by search plot at the Lempster Wind Power Project; April 15 – October 31.

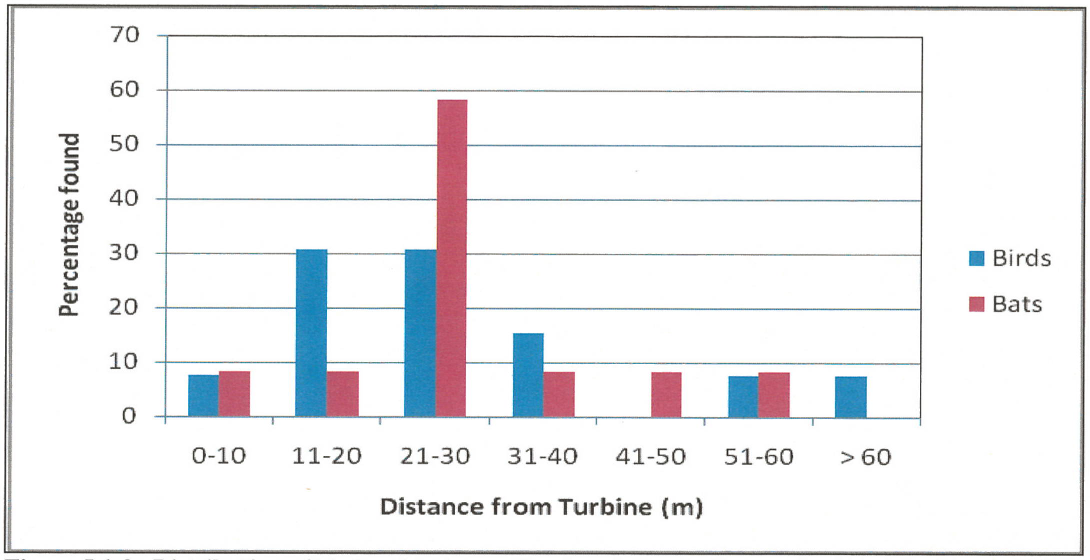


Figure 5.1-2. Distribution of bird and bat casualties in relation to the search plot at the Lempster Wind Power Project; April 15 – October 31.

Only three bird carcasses were found during the spring surveys, two of which were located during scheduled searches (Table 5.1-2; Figure 5.1-3). The majority (n = 5; 71.4 percent) of bird carcasses found during scheduled carcass searches occurred between September 7 and September 20; corresponding to the peak fall migration period for nocturnal passerines (Table 5.1-2; Figure 5.1-4).

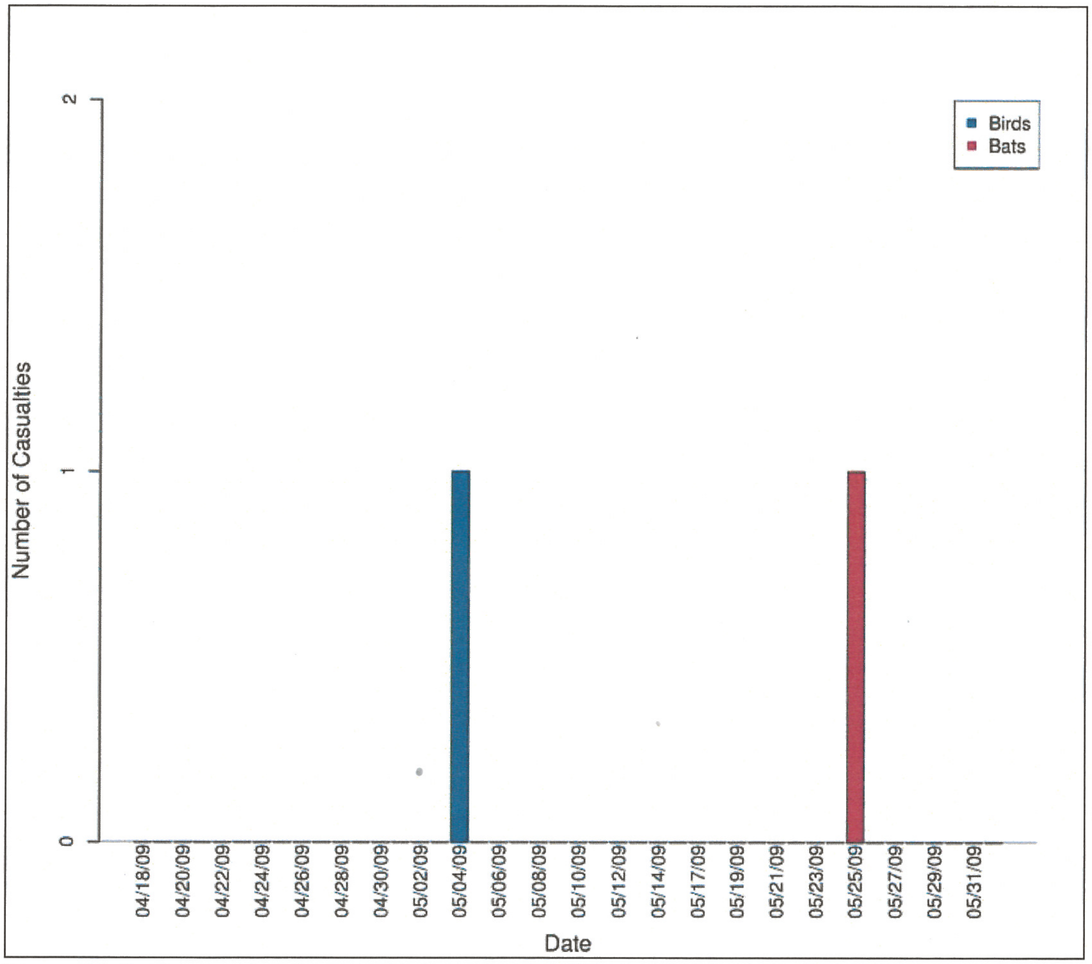


Figure 5.1-3. Temporal patterns of bird and bat fatalities located during scheduled carcass searches during the Spring 2009 season at the Lempster Wind Power Project. An incidentally detected bird (golden-crowned kinglet) was also found on April 20, 2009.

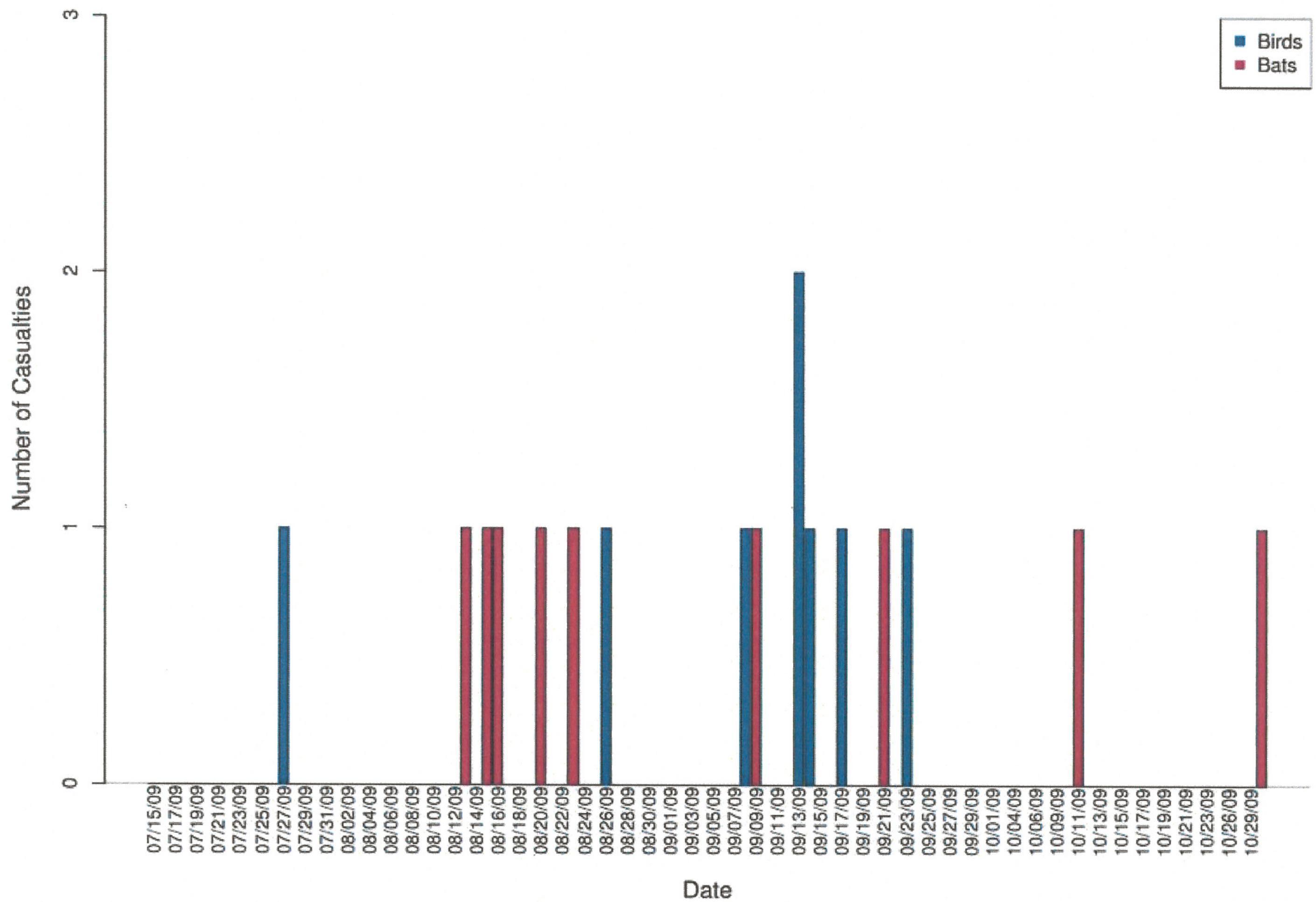


Figure 5.1-4. Temporal patterns of fatalities located during scheduled carcass searches during the Fall 2009 season at the Lempster Wind Power Project.

A total of ten bat fatalities were found during scheduled carcass searches; including four silver-haired bats (*Lasionycteris noctivagans*), three hoary bats (*Lasiurus cinereus*), two big brown bats (*Eptesicus fuscus*), and one little brown bat[4] (*Myotis lucifugus*; Tables 5.1-2, 5.1-3). An additional two silver-haired bats were recorded as incidental finds (Table 5.1-2).

Table 5.1-3. Summary of bat casualties found at the Lempster Wind Power Project; April 6 – October 30, 2009.

	Scheduled Searches		Total	
Species	**Total**	**Percent Composition**	**Total**	**Percent Composition**
Silver-haired bat	4	40.0	6	50.0
Hoary bat	3	30.0	3	25.0
Big-brown bat	2	20.0		
Little brown bat	1	10.0	3	25.0
Overall	**10**	**100**	**12**	**100**

Half of the bat fatalities were found at T1; two bats were found at T5 and T8, and one bat was found at T9 (Figure 5.1-1). No bat casualties were found at the meteorological tower. Almost 60 percent of bat carcasses were found between 20 - 30 meters from the search turbine, and none were found beyond 60 meters (Figure 5.1-2; Appendices A, B). Only one bat carcass was found during spring searches (Table 5.1-2; Figure 5.1-3). Bat casualties were more common during the fall migration season, with a peak occurring between August 13 – 23, 2009, during which 55.5 percent (n = 5) of the total number of fall bat casualties were detected (Table 5.1-2; Figure 5.1-4).

5.2 LANDCOVER AND VISIBILITY CLASS

Bird and bat carcasses were plotted by landcover and visibility class (Table 5.2-1; Appendix B). Nineteen (10 bats and 9 birds) carcasses were documented during scheduled carcass searches. Due to the low sample size, bird and bat carcasses were pooled and visibility classes Moderate, Difficult and Very Difficult were pooled. Sixteen (84%) were found on turbine pads or roads – all areas classified as Easy and three were located in grasslands (Moderate). All grassland/moderate visibility detections occurred at T8, where grassland/moderate areas were most abundant relative to other search plots (Tables 1 and 2).

Table 5.2-1. Landcover and visibility classification for bird and bat fatalities combined from scheduled carcass searches at the Lempster Wind Power Project; April 15 – October 31, 2009.

	Landcover				Visibility Classification			
Search Plot	**Turbine Pad/Road**	**Grassland**	**Shrub**	**Rocky**	**Easy**	**Moderate**	**Difficult**	**Very Difficult**
T1	8	0	0	0	8	0	0	0
T5	5	0	0	0	5	0	0	0
T8	2	3	0	0	2	3	0	0
T9	1	0	0	0	1	0	0	0

[4] Identification of Myotis species were independently verified by the USFWS on February 9, 2010, and two preliminarily identified little brown bats were revised as big-brown bats, including the bat reported incorrectly as a little brown bat in the Spring 2009 Interim Report (Tidhar 2009).

Table 5.2-1. Landcover and visibility classification for bird and bat fatalities combined from scheduled carcass searches at the Lempster Wind Power Project; April 15 – October 31, 2009 (continued).

Met	0	0	0	0	0	0	0	0
Overall #	**16**	**3**	**0**	**0**	**16**	**3**	**0**	**0**
Overall % Composition	**0.84**	**0.16**	**0**	**0**	**0.84**	**0.16**	**0**	**0**

5.3 SEARCHER EFFICIENCY TRIALS

Searcher efficiency trials were conducted on 16 days over the duration of the study, during which a total of 191 carcasses (54 large birds, 129 small birds, and eight bats) were deployed (Tables 5.3-1, 5.3-2). On each day trials were conducted, an average of 11 carcasses were placed on search plots (range 4 - 24). Bird carcasses were placed throughout the two seasons to account for changes over time; however, due to the low number of non-*Myotis* bat carcasses available, these were all deployed in the fall season. Observer detection rates were highest for large birds (77.4 percent), and similar for small birds and bats (53.9 and 57.1 percent, respectively). In addition, detection rates for small and large birds were similar across seasons.

Table 5.3-1. Summary of searcher efficiency trials conducted within the Lempster Wind Power Project in 2009.

Season	Carcass Type	Number Placed	Number Available	Number Found	Percent Available	Percent Found
	Small bird	51	47	26	92.2	55.3
Spring	Large bird	18	18	14	100	77.8
	Bat	0	-	-	-	-
	Small bird	78	68	36	87.2	52.9
Fall	Large bird	36	35	27	97.2	77.1
	Bat	8	7	4	87.5	57.1
	Small bird	**129**	**115**	**62**	**89.1**	**53.9**
Overall	**Large bird**	**54**	**53**	**41**	**98.1**	**77.4**
	Bat	**8**	**7**	**4**	**87.5**	**57.1**

Table 5.3-2. Summary of searcher efficiency trials results at the LWPP during the spring (April 15-June 01) and fall (July 15-October 15) seasons.

Size	Date	Number Placed	Number Available	Number Found	Percent Found
	5/13/2009	5	5	4	80.0
	5/20/2009	8	8	6	75.0
	5/27/2009	5	5	4	80.0
	Total Spring	***18***	***18***	***14***	***77.8***
	7/23/2009	2	2	1	50.0
	7/27/2009	5	4	2	50.0
	8/3/2009	4	4	4	100
Large Birds	8/8/2009	3	3	1	33.3
	8/27/2009	5	5	5	100
	9/5/2009	5	5	5	100

Table 5.3-2. Summary of searcher efficiency trials results at the LWPP during the spring (April 15-June 01) and fall (July 15-October 15) seasons (continued).

	9/18/2009	3	3	2	66.7
	9/21/2009	2	2	2	100
	10/5/2009	4	4	3	75.0
	10/17/2009	3	3	2	66.7
	Total Fall	***36***	***35***	***27***	***77.1***
	Overall	**54**	**53**	**41**	**77.4**
Small Birds	4/27/2009	7	7	4	57.1
	5/1/2009	4	4	1	25.0
	5/7/2009	12	12	8	66.7
	5/13/2009	5	5	2	40.0
	5/20/2009	16	13	9	69.2
	5/27/2009	7	6	2	33.3
	Total Spring	*51*	*47*	*26*	*55.3*
	7/23/2009	7	7	3	42.9
	7/27/2009	8	7	2	28.6
	8/3/2009	8	4	2	50.0
	8/8/2009	7	6	3	50.0
	8/27/2009	6	5	3	60.0
	9/5/2009	7	7	4	57.1
	9/18/2009	6	6	2	33.3
	9/21/2009	9	8	5	62.5
	10/5/2009	5	5	4	80.0
	10/17/2009	7	6	4	66.7
	10/17/2009	*8*	*7*	*4*	*57.1*
	Total Fall	*78*	*68*	*36*	*52.9*
	Overall	**129**	**115**	**62**	**53.9**
Bats	10/17/2009	8	7	4	57.1

Searcher efficiency rates were further evaluated based on visibility class. The majority of small birds and bat carcasses were deployed in the E-class in both the spring and fall; while the majority of large birds were deployed in the M-class (Figure 5.3-1). Due to the small sample sizes of fatalities within a given visibility class (Appendix B), data from M-, D-, and VD-classes were pooled. In addition, small bird and bat data were pooled due to the low number of bat carcasses available for trials. Detection rates of large bird carcasses in each visibility class were similar between seasons (Table 5.3-3). All large birds in E-class were found and 64 percenand 65 percent of large birds in M/D/VD were found in the spring and fall seasons, respectively. The proportion of small bird/bat carcasses found in E-class was similar between seasons (67 and 78 percent in spring and fall, respectively); however, a higher proportion of carcasses placed in M/D/VD were found in the spring compared to the fall (43 and 15 percent, respectively).

Table 5.3-3. Results of searcher efficiency trials (proportion found) and carcass removal trials (number of days in the field) based on visibility class within the Lempster Wind Power Project.

	Searcher Efficiency		Carcass Removal	
Visibility Class	Small Birds/ Bats (± 90% CI)	Large Birds (± 90% CI)	Small Birds/ Bats (n)	Large Birds (n)
Spring				
Easy	0.67 ± 0.16	1.00	4.23 (34)	7.40 (17)
M/D/VD[1]	0.43 ± 0.17	0.64 ± 0.24	16.5 (6)	1.5 (1)
Fall				
Easy	0.78 ± 0.11	1.00	6.4 (37)	6.85 (16)
M/D/VD[1]	0.15 ± 0.11	0.65 ± 0.16	13.4 (17)	13.0 (8)

[1]Moderate/Difficult/Very Difficult visibility classes pooled due to low sample size

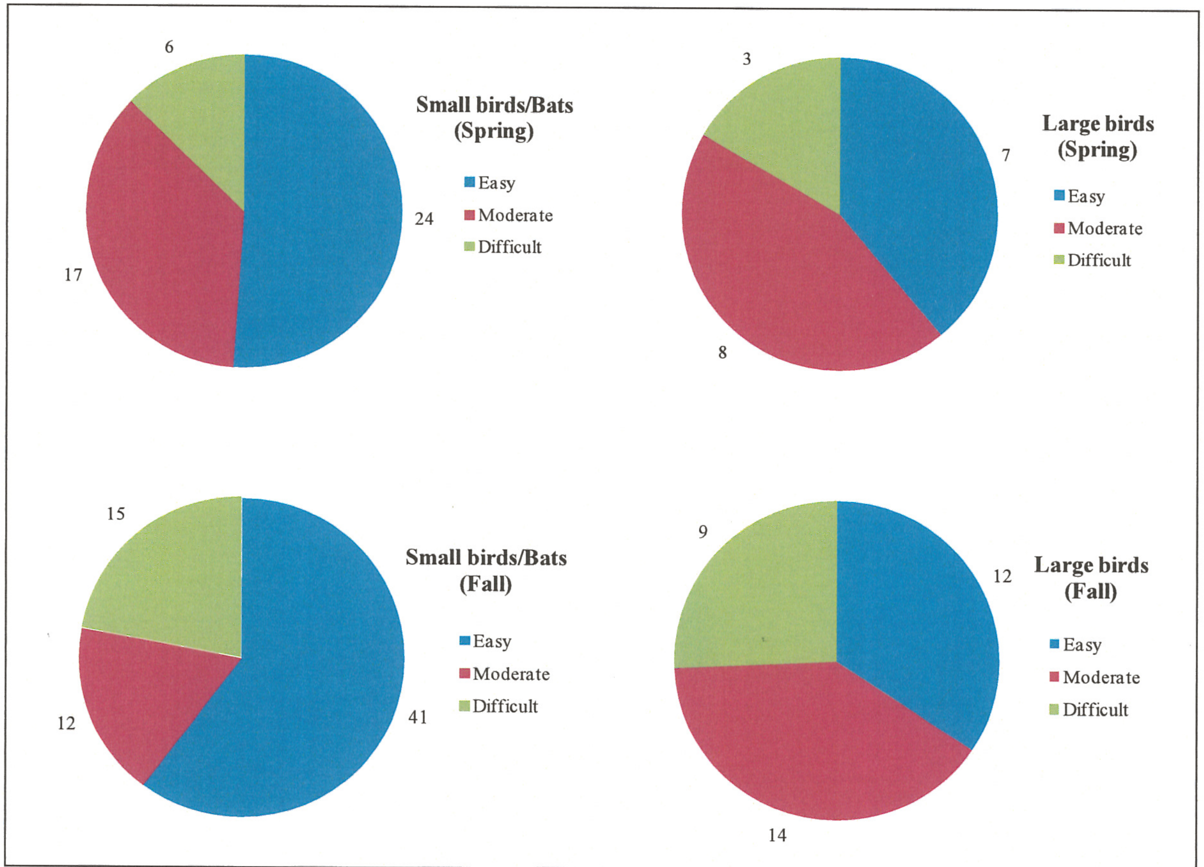
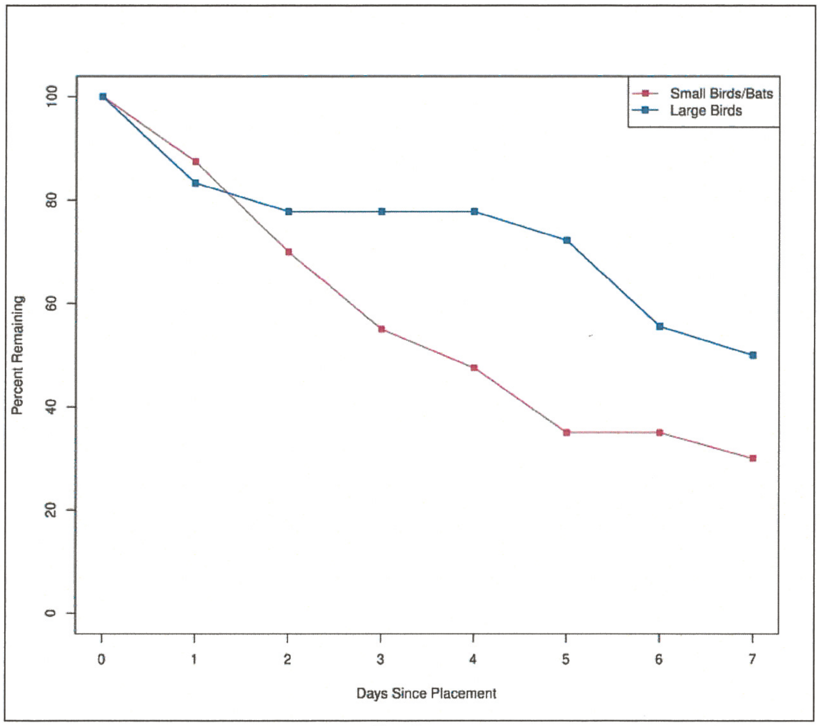


Figure 5.3-1. Searcher efficiency trial effort, by size class, for spring and fall surveys at the Lempster Wind Power Project during the 2009 study.

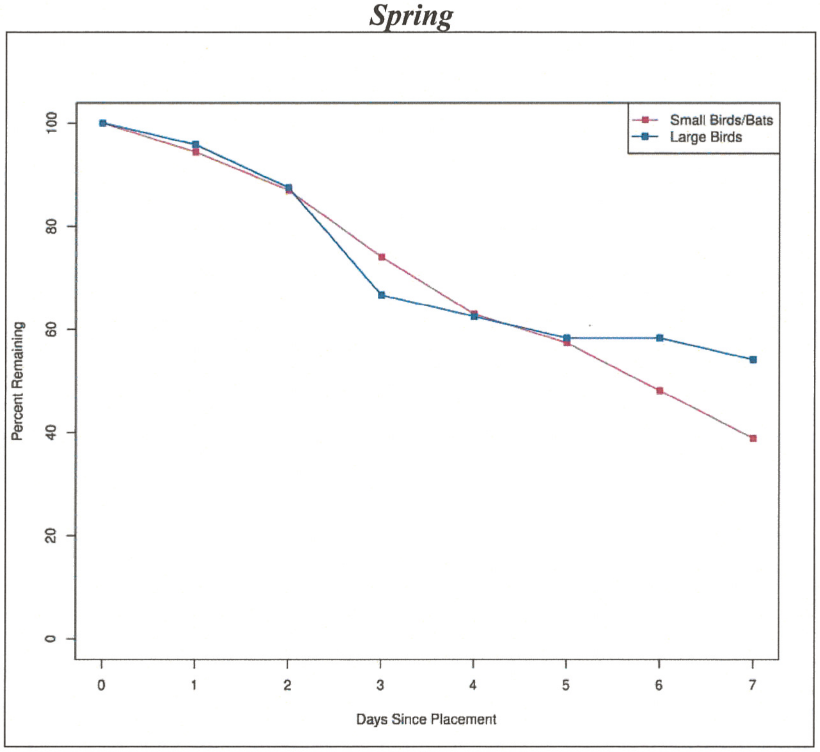
5.4 CARCASS REMOVAL TRIALS

A total of 136 carcasses were placed within study area throughout the duration of the monitoring period. This included 40 small birds and 18 large birds in the spring, and 54 small birds, six bats, and 24 large birds in the fall (Table 5.3-3). Carcasses were monitored for a maximum of seven days. Overall for both seasons, by day seven, approximately 70 percent of the bats, 60 percent of large birds, and almost 35 percent of small bird carcasses remained; however, seasonal differences in scavenging removal rates were apparent, particularly for large birds which were removed more rapidly during the fall compared with the spring (Figure 5.4-1).

Carcass removal rates were further evaluated based on visibility class. Again, due to sample size M/D/VD and small birds/bats were analyzed together. The majority of carcass removal carcasses were placed in the E-visibility class (Table 5.3-3). In both seasons, small bird/bat carcasses placed in E-class were scavenged 2 - 4 times faster than those placed in M/D/VD. This was similar to large bird carcasses in the fall. In the spring, only one large bird carcass was placed in M/D/VD and was scavenged after only 1.5 days.



Spring



Fall

Figure 5.4-1. Rate of removal of small bird, large bird, and bat carcasses during carcass removal trials at the Lempster Wind Power Project in 2009.

5.5 FATALITY ESTIMATES

Based on the results of standardized carcass searches, searcher efficiency, and carcass removal trials, and search plot area, fatality estimates were calculated for small birds and bats. No large bird carcasses were recorded during carcass searches; therefore, a fatality estimate for this group was not possible. Fatality estimates were much higher for the fall compared to the spring for both groups (Tables 5.5-1, 5.5-2). The seasonal fatality estimate for small birds was 0.80 birds/turbine (90% CI: 0, 2.29) in the spring and 5.95 birds/turbine (2.86, 8.66) in the fall; while for bats it was 0.66 bats/turbine (0, 1.90) in the spring and 5.55 bats/turbine (2.61, 8.72) in the fall.

Fatality estimates were adjusted for visibility class, however, there were very low sample sizes per visibility class. When adjusted for visibility class, fatality estimates were reduced slightly for small birds (0.70 birds/turbine (0, 1.97) in the spring and slightly increased (6.15 birds/turbine (2.7, 10.97)) in the fall. Estimates decreased slightly for bats (0.58 bats/turbine (0, 1.63) in the spring and 5.51 bats/turbine (1.96, 10.00) in the fall.

Combined seasonal fatality estimates were calculated using fatality estimates not adjusted for visibility class. The combined spring and fall fatality estimate was 6.75 small birds/turbine (3.75, 9.78) and 6.21bats/turbine (3.08, 9.84). Turbines within the LWPP have a 2.0 MW capacity, therefore the combined spring and fall estimate per MW at the site is 3.38 fatalities/MW for small birds and 3.08 fatalities/MW for bats. The combined seasonal estimate for all 12 2.0 megawatt turbines at the Lempster Wind Power Project based on these estimates is 81.12 bird and 73.92 bat fatalities.

An annual fatality estimate is not possible because of differences in mortality rates during the winter and the summer. Therefore, this estimate is only applicable for the study period.

5.6 WEATHER EVALUATION

Data used to determine the relationship between weather and bat mortality was restricted to the fall 2009 period, as only one bat casualty was found during the spring 2009 season. To ensure pairing of fatalities with the appropriate weather conditions, only carcasses categorized as fresh were used in the analysis. Of the 12 bat carcasses found, ten were classed as fresh, meaning that it was likely that mortality occurred on the preceding night.

Primarily due to small sample size in the fatality data, there were no significant correlations between weather (Table 4.6-1) and bat mortality. Correlations of each weather variable and mortality yielded a maximum adjusted R^2 value of 0.027, and a best Pearson's r value of -0.19. Attempts to account for extra zero values in the response variable (bat mortality), which are not explained by the weather variables, through use of zero-inflated poisson models did not yield better results. Based on the available data, there were no correlations between bat mortality and weather.

Table 5.5-1. Fatality estimates for small birds at the Lempster Wind Power Project for spring and fall seasons and both seasons combined.

	Parameter	Spring		Fall	
		Mean ± SE	90 % CI	Mean ± SE	90 % CI
P	Observer detection	0.55 ± 0.08	(0.43, 0.69)	0.53 ± 0.07	(0.43, 0.65)
$\hat{\pi}_i$	Average probability of carcass availability and detection	0.79 ± 0.05	(0.70, 0.85)	0.84 ± 0.03	(0.79, 0.89)
m_i	Adjusted fatality estimate (fatalities/turbine)	0.80 ± 0.70	(0, 2.29)	5.95 ± 1.79	(2.86, 8.66)
d_i	Daily fatality rate (fatalities/turbine/day)	0.02 ± 0.02	(0, 0.05)	0.06 ± 0.02	(0.03, 0.08)
m_i	Combined fatality estimate (fatalities/turbine)	6.75 ± 1.94	(3.75, 9.78)		
d_i	Combined daily fatality estimate (fatalities/turbine/day)	0.04 ± 0.01	(0.02, 0.06)		

Table 5.5-2. Fatality estimates for bats at the Lempster Wind Power Project for spring and fall seasons and both seasons combined.

	Parameter	Spring		Fall	
		Mean ± SE	90 % CI	Mean ± SE	90 % CI
P	Observer detection	0.55 ± 0.08	(0.43, 0.68)	0.53 ± 0.07	(0.43, 0.65)
$\hat{\pi}_i$	Average probability of carcass availability and detection	0.79 ± 0.05	(0.70, 0.85)	0.84 ± 0.03	(0.79, 0.89)
m_i	Adjusted fatality estimate (fatalities/turbine)	0.66 ± 0.58	(0, 1.90)	5.55 ± 1.98	(2.61, 8.72)
d_i	Daily fatality rate (fatalities/turbine/day)	0.01 ± 0.01	(0, 0.04)	0.05 ± 0.02	(0.02, 0.08)
m_i	Combined fatality estimate (fatalities/turbine)	6.21 ± 2.10	(3.08, 9.84)		
d_i	Combined daily fatality estimate (fatalities/turbine/day)	0.04 ± 0.01	(0.02, 0.06)		

6.0 DISCUSSION

The 2009 monitoring study represented the first year of a two-year study to estimate the overall annual rate of bird and bat fatalities at the project. The approach used for calculating adjusted fatality estimates is consistent with the approach outlined by Shoenfeld (2004) and Erickson (2006), and accounted for search interval, total area searched, proportion of area searched at specific distances from the turbine, searcher efficiency rates, and carcass removal rates. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate fatality rates. For this reason scavenging trials were conducted throughout the monitoring period. Searcher efficiency trials were also conducted throughout the study period to account for any biases associated with changes in conditions or searcher ability. The influence of carcass visibility and weather were also assessed, however, small sample sizes, due to the low number of fatalities, decreased the potential to detect whether visibility class or weather were significant factors.

The overall design of this study incorporates several assumptions or factors that affect the results of the fatality estimates. First, the study design incorporates all bird and bat casualties found within standardized search plots into the analysis, which would lead to a more conservative fatality estimate. Second, it was assumed that all fatalities recorded during the study were due to collision with wind turbines. In some cases fatalities may have resulted from other sources of mortality, such as maintenance vehicle traffic on access roads or predation. Distribution of carcasses within search plots were analyzed and adjustments to the mortality estimates were made to account for unsampled areas or areas within the plot that were not searched.

6.1 BIRD FATALITIES

The estimated fatality rate over both seasons was 3.38 small birds/MW/year. The range of overall bird fatality estimates at 46 wind-energy facilities across North America where post-construction data is available ranged from zero to 13.9 birds/MW/year (Figure 6.1-1). Likewise, the range of overall bird fatality estimates at 14 eastern and northeastern wind-energy facilities has ranged from zero to 13.93 (Figure 6.1-1). When compared with other regional and national monitoring studies, the overall fatality estimate for birds at LWPP falls within this range. Comparisons between projects on a per MW basis do not reflect differences in project size, study designs, and physiographic or landcover differences between projects. Species composition of bird fatalities during the 2009 LWPP study included common species and no state- or federally-listed species. Fatalities included Golden-crowned Kinglet and Red-eyed Vireo, which are two of the five most common bird species reported killed at eastern and northeastern wind projects from published monitoring studies (WEST, unpublished data).

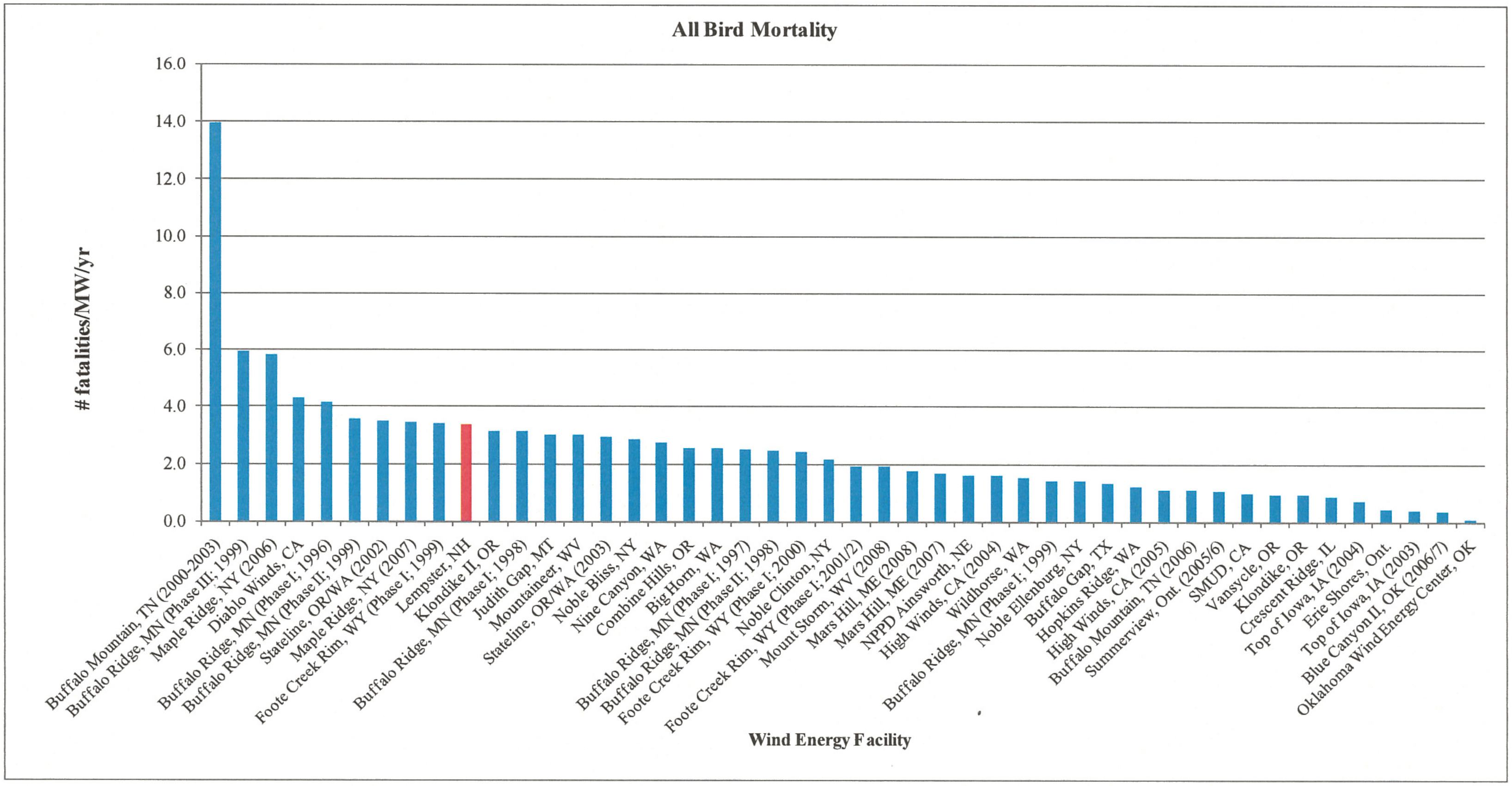


Figure 6.1-1. Annual bird fatality estimates (per megawatt) at wind-energy facilities across North America. The Lempster Wind Power Project is highlighted in red. Estimates are for small birds with spring and fall seasons combined.

6.2 BAT FATALITIES

The estimated bat fatality at LWPP during the 2009 study of 3.08 bats/MW/year was below average compared to reported bat fatality estimates at wind-energy facilities in the northeast (Figure 6.2-1). The range of overall bat fatality estimates from 45 other wind-energy facilities across North America ranged from zero to 39.70 fatalities/MW/year. At 13 other Eastern and Northeastern wind-energy facilities, bat fatality estimates ranged from 1.51 to 39.70 (Figure 6.2-1). The highest fatality estimates for bats have come from the eastern U.S., particularly the Appalachian region, where estimates have ranged from 20.8 to 69.6 bats per turbine (Arnett et al. 2008).

Landscape and habitat context have both been proposed as hypotheses to explain bat fatalities at wind-energy facilities. In the eastern U.S., clearings cut for wind turbines on forested ridges may contribute to relatively high numbers of bat fatalities at these sites, as clearings create potential foraging and commuting habitat. In addition, ridgelines may also serve as attractive linear features during foraging, commuting, or migration (Kunz et al. 2007). Given that the LWPP is located along a forested ridge top, it is likely that forested clearing during development increased bat activity at the site relative to pre-construction periods. The 2009 LWPP bat fatality estimate is similar to the 2007 Mars Hill, Maine (Stantec 2008) bat fatality estimate. Mars Hill is also located along a forested ridge top in the northeastern U.S. The bat fatality estimates derived from the LWPP and Mars Hill (2007 [Stantec 2008] and 2008 [Stantec 2009]) are low relative to other estimates derived at other forested ridge projects (e.g., Mountaineer, WV).

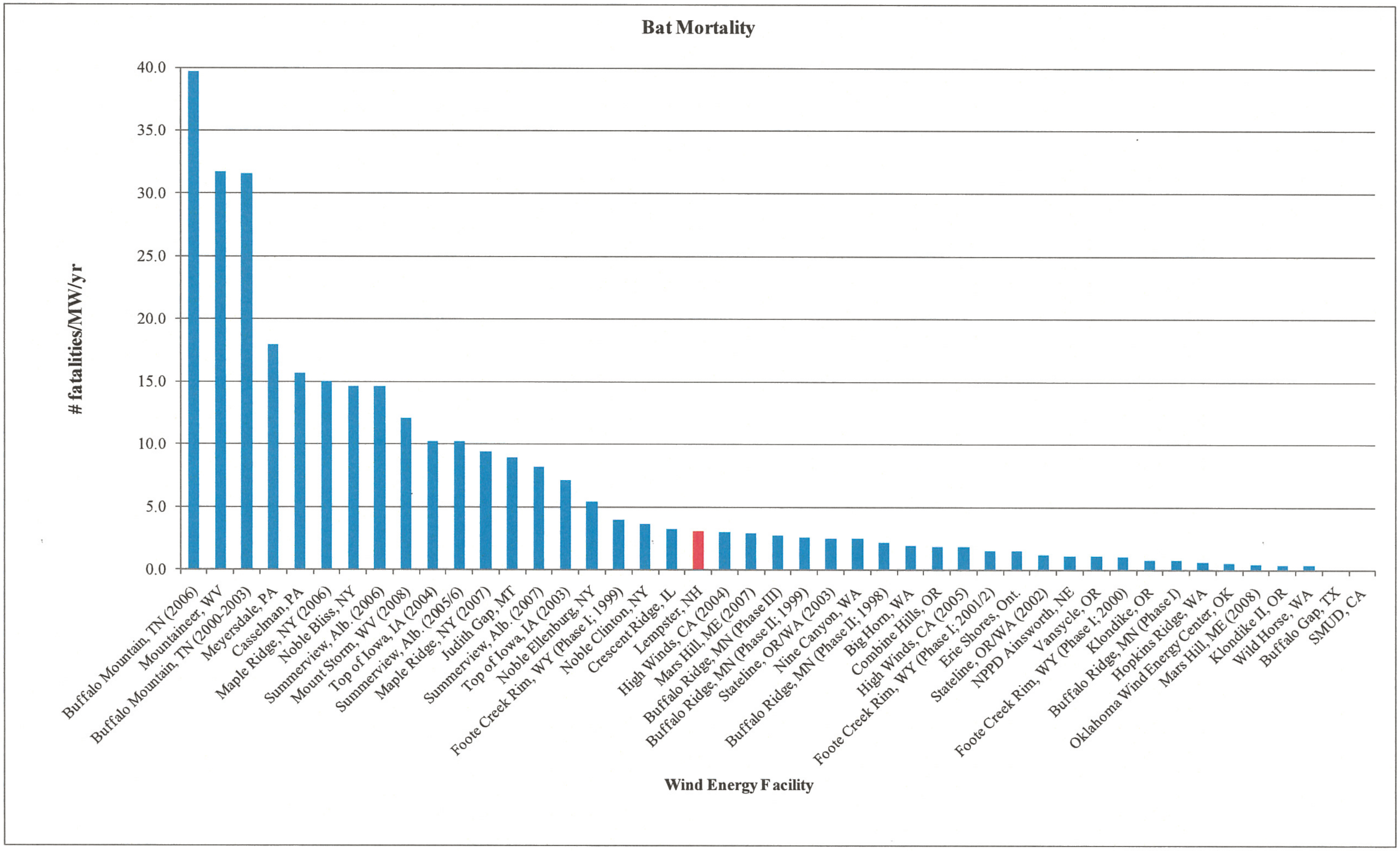


Figure 6.2-1. Bat fatality estimates (per megawatt) at wind-energy facilities across North America. The Lempster Wind Power Project is highlighted in red. Fatality estimates are for spring and fall seasons combined.

Species composition of bat fatalities at the LWPP was similar to that at other wind-energy facilities, with the majority of identified bat casualties comprising three long-distance migratory tree bats. Almost 95 percent of bat casualties at the LWPP were either hoary or silver-haired bats. These three species typically comprise over 75 percent of bat casualties at wind-energy facilities throughout North America (Johnson 2005; Arnett et al. 2008). Migratory tree bats are primarily solitary tree dwellers that do not hibernate; therefore, it is difficult to develop suitable field methods to estimate population size for these species. As a result, impacts on these bat species caused by wind-energy development cannot be put into perspective from a population impact standpoint. To help solve this problem, population genetic analyses of deoxyribonucleic acid (DNA) sequence and microsatellite data are being conducted to try and provide effective population size estimates, to determine if populations are growing or declining, and to see if these populations are comprised of one large population or several discrete subpopulations that use spatially segregated migration routes (Amy L. Russell, Assistant Professor, Grand Valley State University, Allendale, Michigan, pers. comm.). To date, initial analyses have been conducted on eastern red bats using mitochondrial DNA. Based on these analyses, it appears that this species fits a model of a single, very large population with a history of strong population growth (Vonhof and Russell in prep). The data do not suggest there are multiple populations separated by distinct migratory corridors. Although the point estimate for the eastern red bat population size in North America is 3.3 million, according to Dr. Russell (pers. comm.) the true population size is likely "millions to tens of millions" in size. Additional research will be required to determine what impact wind-energy facilities have on migratory tree bat populations. Specifically, population size estimates similar to those available for eastern red bat are needed for hoary bat and silver-haired bat. The LWPP study was not designed to address these research questions, and the fatality rates estimated for these species from the LWPP based on the results of 2009 monitoring do not suggest the potential for population level impacts from the project.

The 2009 LWPP monitoring study fulfilled the objective of producing an estimate of the annual fatality rate for birds and bats. The daily search rate interval used in the study is equal to the most intensive carcass search effort rate used among all published monitoring studies in the U.S. (Figures 6.1-1, 6.1-2).

The second year of study at the LWPP (scheduled for 2010) will provide an additional annual fatality estimate for birds and bats. Inter-annual variation in fatality rates have been shown at other regional studies (e.g., Mars Hill 2007 and 2008). The 2010 Final Report will include results from the 2010 monitoring season as well as an inter-year comparison.

7.0 LITERATURE CITED

Altringham, J.D. 1996. Bats: Biology and Behaviour. Oxford University Press.

Arnett, E.B., K. Brown, W.P. Erickson, J. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Kolford, C.P. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersley, Jr. 2008. Patterns of Fatality of Bats at Wind Energy Facilities in North America. Journal of Wildlife Management 72: 61-78.

Baerwald, E. 2006. Bat Fatalities in Southern Alberta. Presented at the Wildlife Research Meeting VI, San Antonio, Texas. National Wind Coordinating Collaborative. November 2006.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Post-Construction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, for the Nebraska Public Power District.

Erickson, W.P. 2006. Objectives, Uncertainties and Biases in Mortality Studies at Wind Facilities. Paper presented at the NWCC Research Meeting VI, November 2006. San Antonio, Texas. www.nationalwind.org

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report: July 2001 - December 2003. Technical report for and peer-reviewed by FPL Energy, Stateline Technical Advisory Committee, and the Oregon Energy Facility Siting Council, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Walla Walla, Washington, and Northwest Wildlife Consultants (NWC), Pendleton, Oregon. December 2004. http://www.west-inc.com

Gruver, J., M. Sonnenburg, K. Bay, and W. Erickson. 2010. Post-Construction Bat and Bird Fatality Study at the Blue Sky Green Field Wind Energy Center, Fond du Lac County, Wisconsin July 21, 2008 – October 31, 2008 and March 15, 2009 – June 4, 2009. Unpublished report prepared by WEST, Inc., Cheyenne, Wyoming.

Higgins, K.F., R.G. Osborn, C.D. Dieter, and R.E. Usgaard. 1996. Monitoring of Seasonal Bird Activity and Mortality at the Buffalo Ridge Wind Resource Area, Minnesota, 1994-1995. Completion Report for the Research Period May 1, 1994 - December 31, 1995. Unpublished report prepared for Kenetech Windpower, Inc. by the South Dakota Cooperative Fish and Wildlife Research Unit, Brookings, South Dakota. 84 pp.

Howe, R.W., W. Evans, and A.T. Wolf. 2002. Effects of Wind Turbines on Birds and Bats in Northeastern Wisconsin. Wisconsin Public Service Corporation, Madison, Wisconsin.

Jain, A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. M.S. Thesis. Iowa State University, Ames, Iowa. http://www.fws.gov/midwest/eco_serv/wind/references/Windfarmstudy.pdf

Johnson, G.D. 2005. A Review of Bat Mortality at Wind-Energy Developments in the United States. Bat Research News 46(2): 45-49.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, and D.A. Shepherd. 2000. Avian Monitoring Studies at the Buffalo Ridge Wind Resource Area, Minnesota: Results of a 4-Year Study. Final report prepared for Northern States Power Company, Minneapolis, Minnesota, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. September 22, 2000. 212 pp. http://www.west-inc.com

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision Mortality of Local and Migrant Birds at a Large-Scale Wind Power Development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Johnson, G.D., W.P. Erickson, and J. White. 2003a. Avian and Bat Mortality During the First Year of Operation at the Klondike LWPP I Wind Project, Sherman County, Oregon. March 2003. WEST, Inc.

_____. 2003b. Mortality of Bats at a Large-Scale Wind Power Development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150:332-342.

Johnson, G.D., M.K. Perlik, W.P. Erickson, and M.D. Strickland. 2004. Bat Activity, Composition and Collision Mortality at a Large Wind Plant in Minnesota. Wildlife Society Bulletin 32:1278-1288.

Johnson, G., D. Tidhar, and K. Bay. 2009. American Golden-Plover Study for the Fowler Ridge Wind Farm, Benton County, Indiana: Spring 2007 through Spring 2009. Unpublished report prepared by BP Wind Energy North America by WEST, Inc.

Kerlinger, P., R. Curry, A. Hasch, and J. Guarnaccia. 2007. Migratory Bird and Bat Monitoring Study at the Crescent Ridge Wind Power Project, Bureau County, Illinois: September 2005–August 2006. Curry and Kerlinger, Arlington, VA.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003. Technical report prepared by Curry and Kerlinger, LLC., for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee. Curry and Kerlinger, LLC. 39 pp. http://www.responsiblewind.org/docs/MountaineerFinalAvianRpt3-15-04PKJK.pdf

Kunz, T.H., Editor. 1982. Ecology of bats. Plenum Press, New York, NY, USA.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological Impacts of Wind Energy Development on Bats: Questions, Research Needs, and Hypotheses. Frontiers in Ecology and the Environment 5(6): 315-324.

Manly, B.F.J. 1997. Randomization, Bootstrap, and Monte Carlo Methods in Biology. Second edition. Chapman and Hall, New York. 399 pp.

Mumford, R.E. and J.O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press, Bloomington, IN. 537pp.

Neter, J., M.H. Kutner, C.J. Nachtsheim, and W. Wasserman. 1996. Applied Linear Regression Models. Third Edition. Irwin Book Team, Chicago, Illinois.

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

Shoenfeld, P. 2004. Suggestions Regarding Avian Mortality Extrapolation. Technical memo provided to FPL Energy. West Virginia Highlands Conservancy, HC70, Box 553, Davis, West Virginia, 26260.

Tidhar, D. 2009. Post-Construction Wildlife Monitoring Study; Study Plan and Spring 2009 Interim Report. Unpublished report prepared for Lempster Wind by WEST, Inc.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2006.

Soil Survey Geographic (SSURGO) database for Benton County, Indiana. U.S. Department of Agriculture, Natural Resources Conservation Service, Fort Worth, Texas.

Vonhof M.J. and A.L. Russell (in prep). Phylogeography of the Eastern Red Bat, *Lasiurus borealis* (Chiroptera: Vespertilionidae). Intended for Molecular Phylogenetics and Evolution.

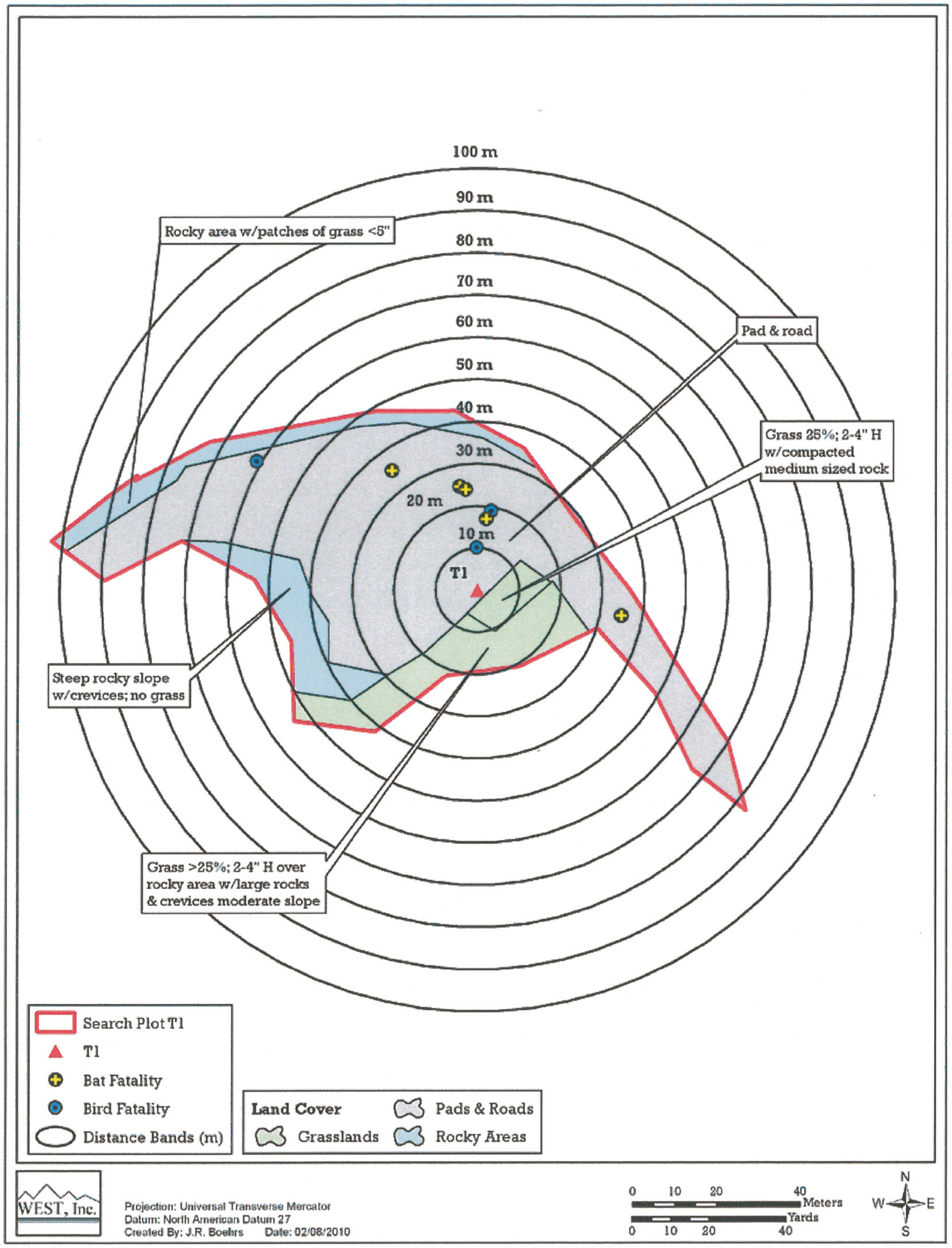
Vuong, Q.H. 1989. "Likelihood ratio tests for model selection and non-nested hypotheses." _Econometrica_. 57:307-333.

Young, D.P. Jr., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003. Avian and Bat Mortality Associated with the Initial Phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming, Final Report, November 1998 - June 2002. Prepared for PacifiCorp, Inc. Portland, Oregon, SeaWest Windpower Inc. San Diego, California, and Bureau of Land Management, Rawlins District Office, Rawlins, Wyoming.

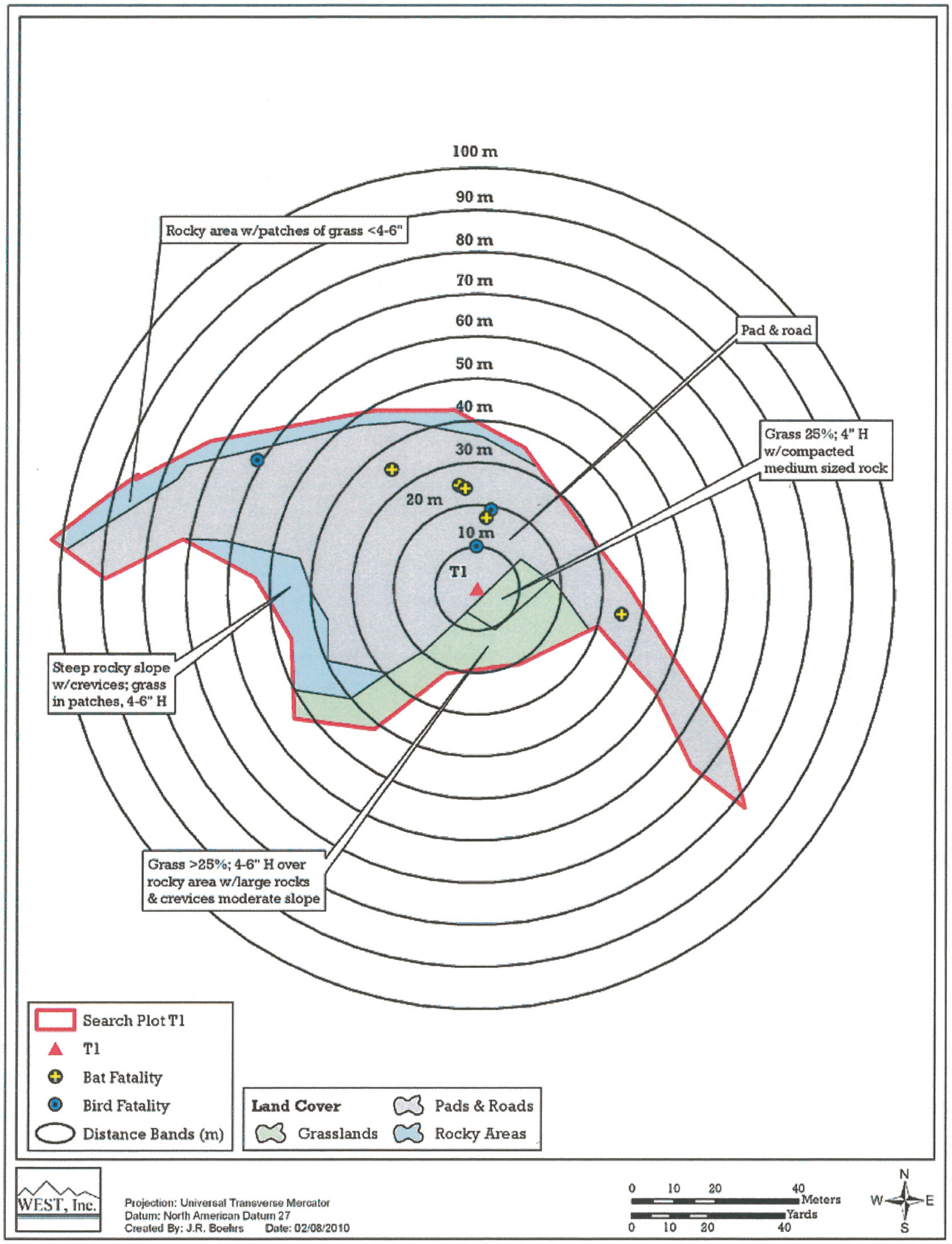
Young, D.P., Jr., W.P. Erickson, J.D. Jeffrey, K. Bay, and M. Bourassa. 2005. Eurus Combine Hills Turbine Ranch. Phase 1 Post Construction Wildlife Monitoring Final Report February 2004 February 2005. Technical report for Eurus Energy America Corporation and the Combine Hills Technical Advisory Committee, Umatilla County, Oregon. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon.

8.0 APPENDIX

Appendix 8.0-1. Landcover Maps of the 2009 Lempster Wind Power Project Search Plots



Search Plot T1 – April 2009



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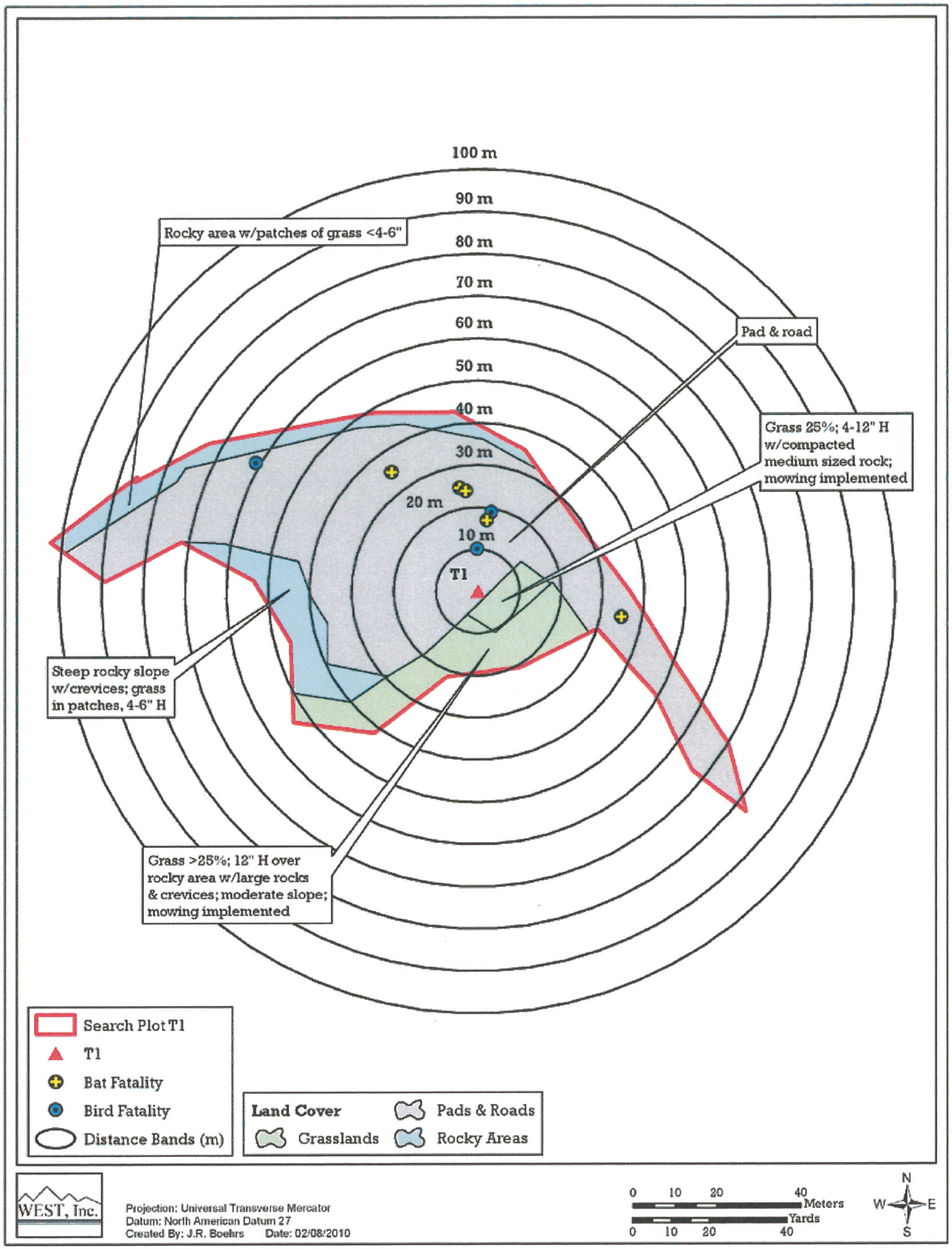

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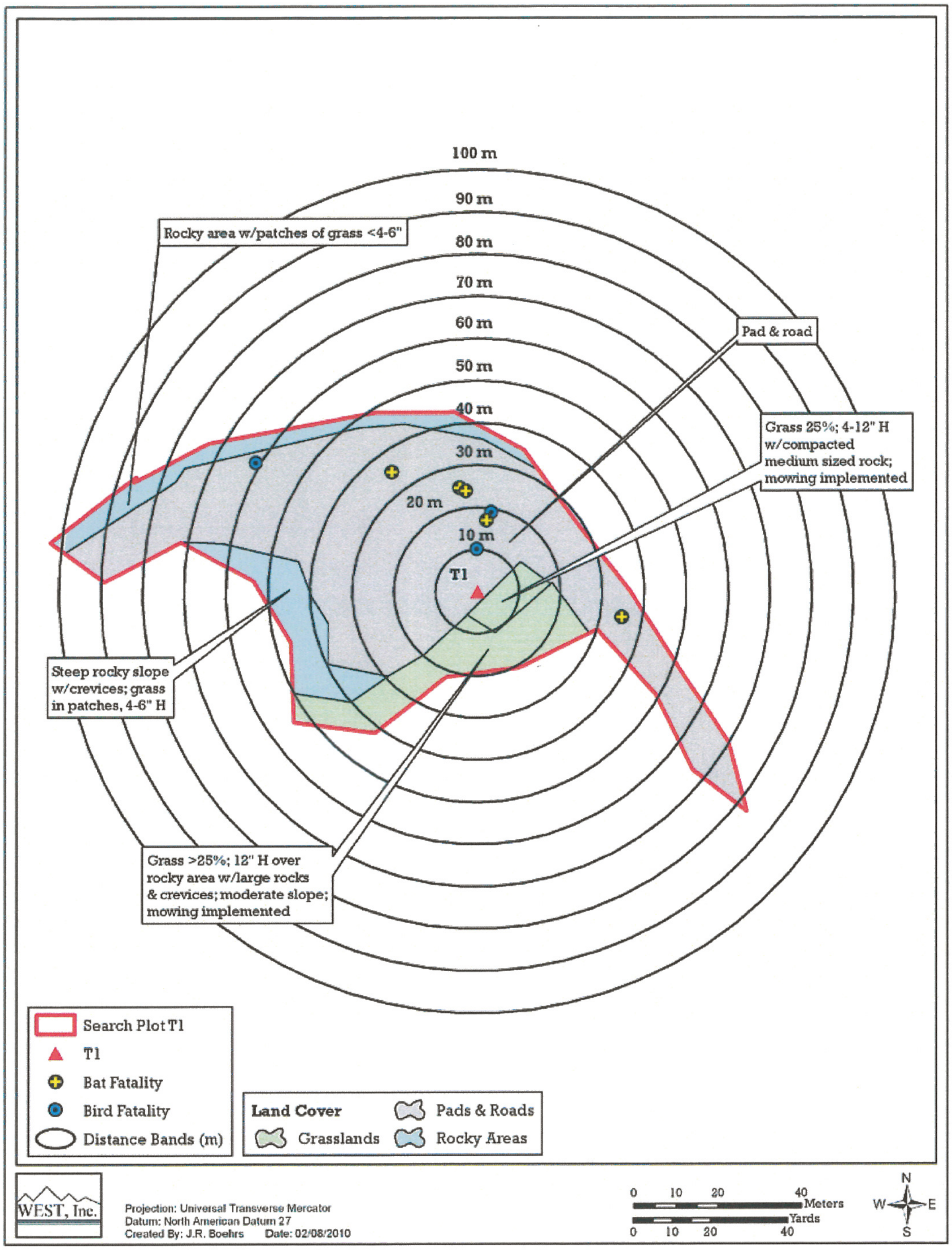
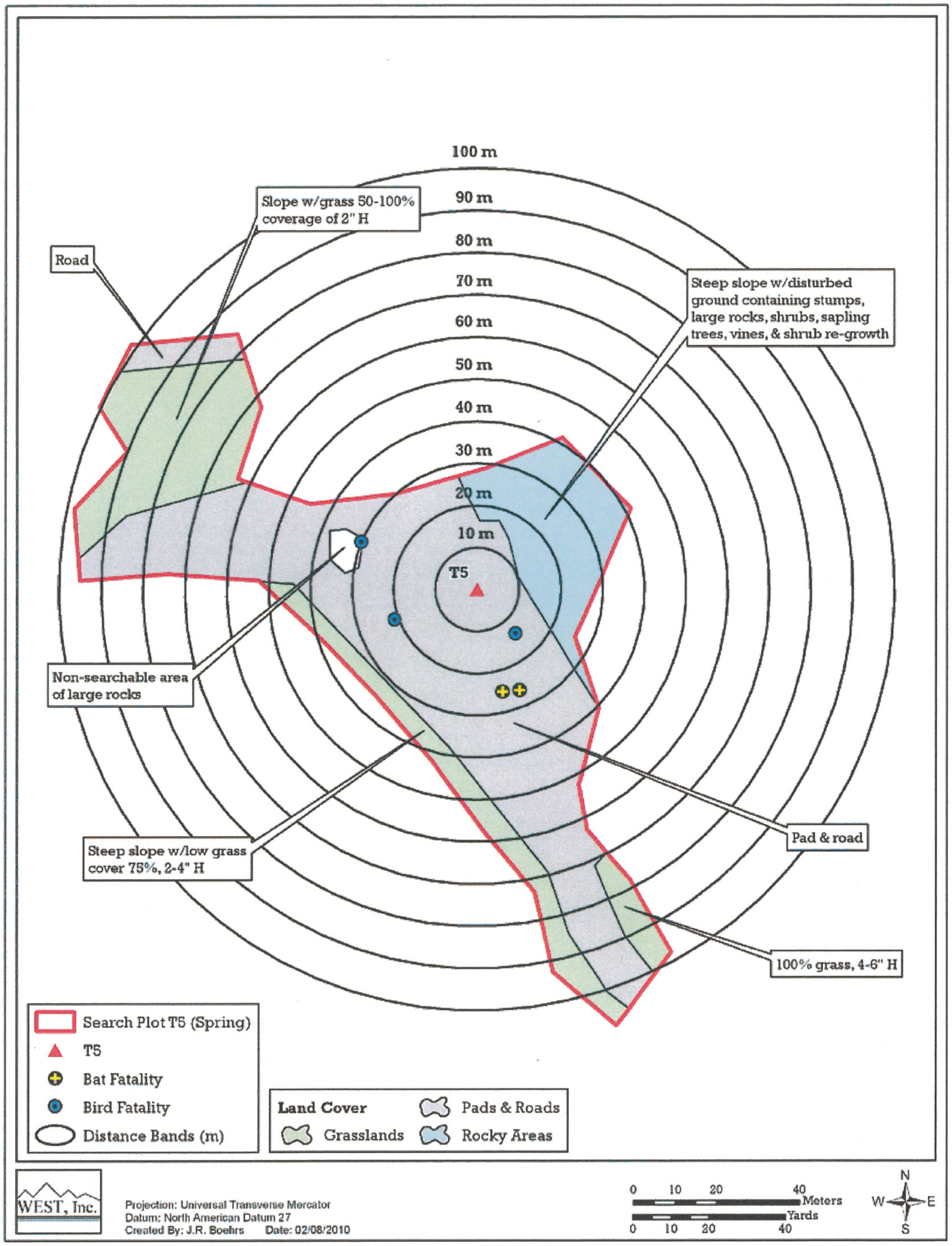
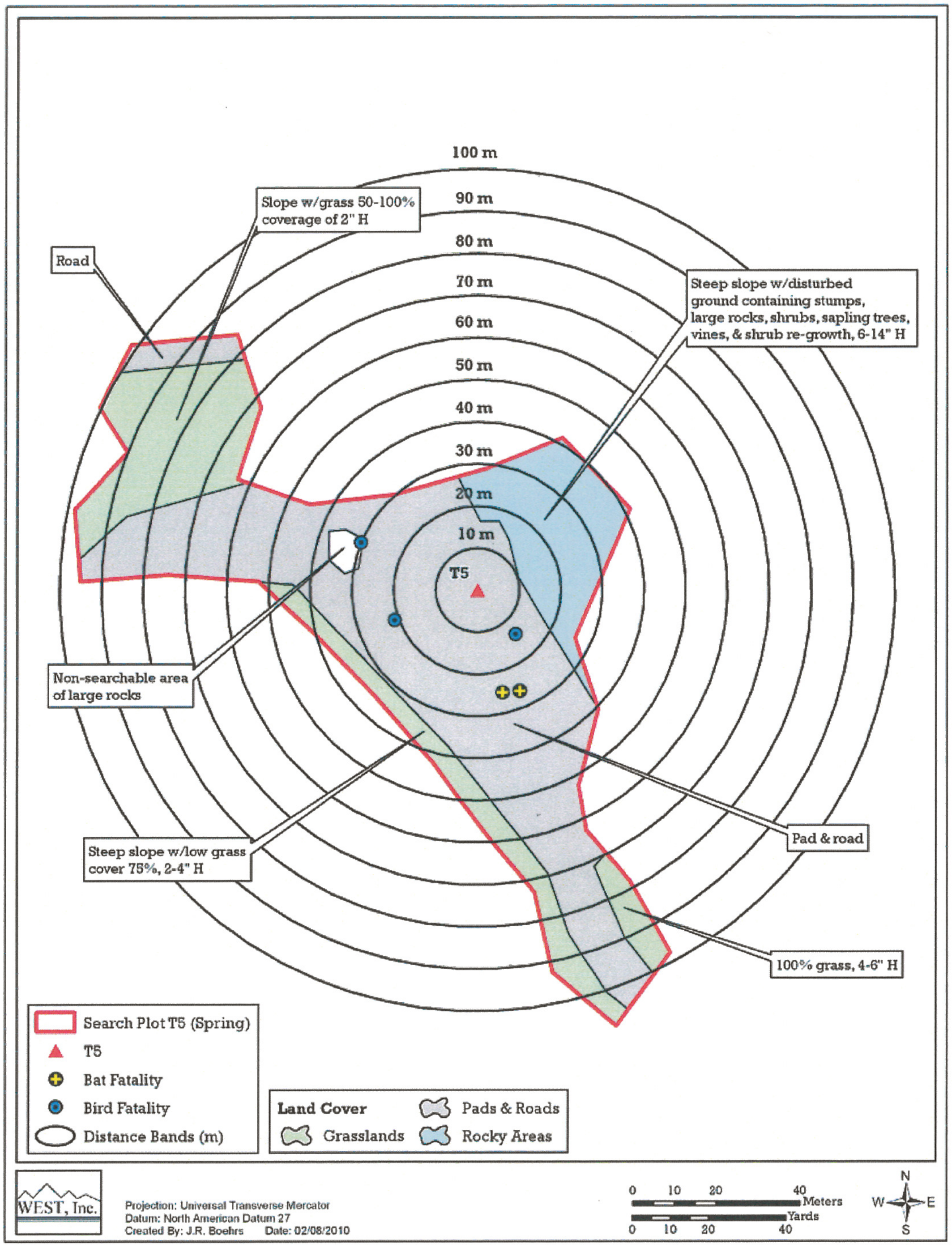


Search Plot T1 – October 2009



Search Plot T5 – April 2009



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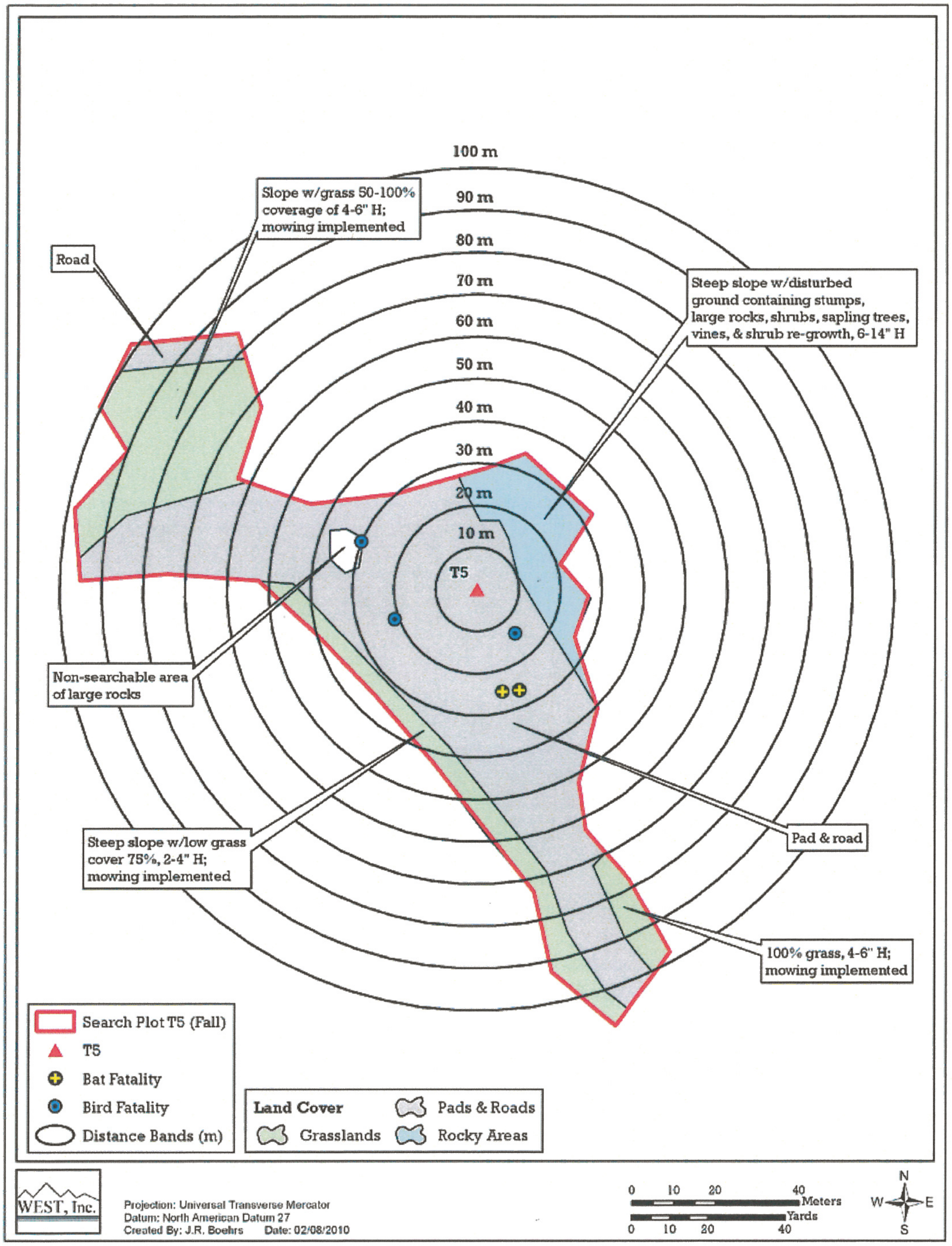

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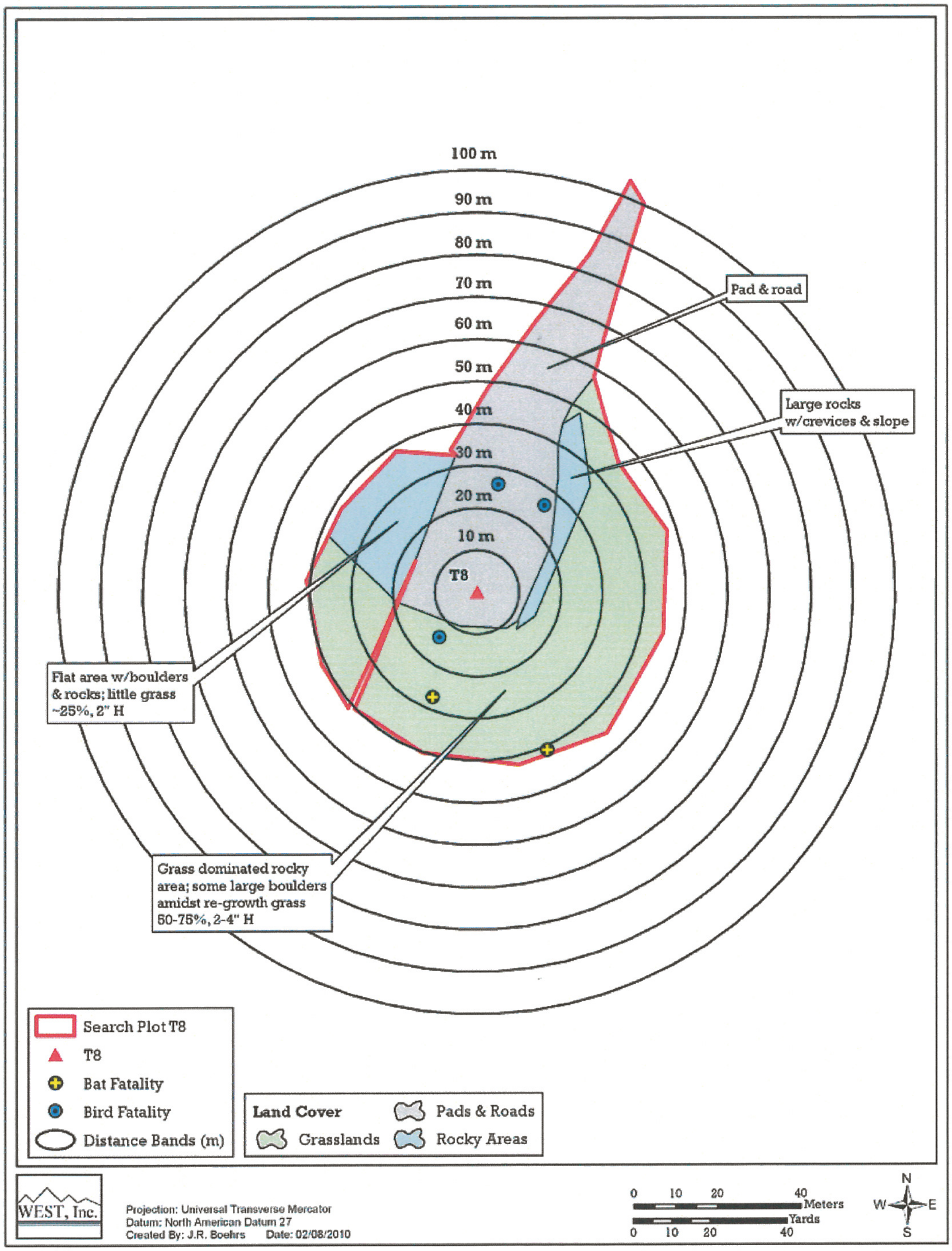
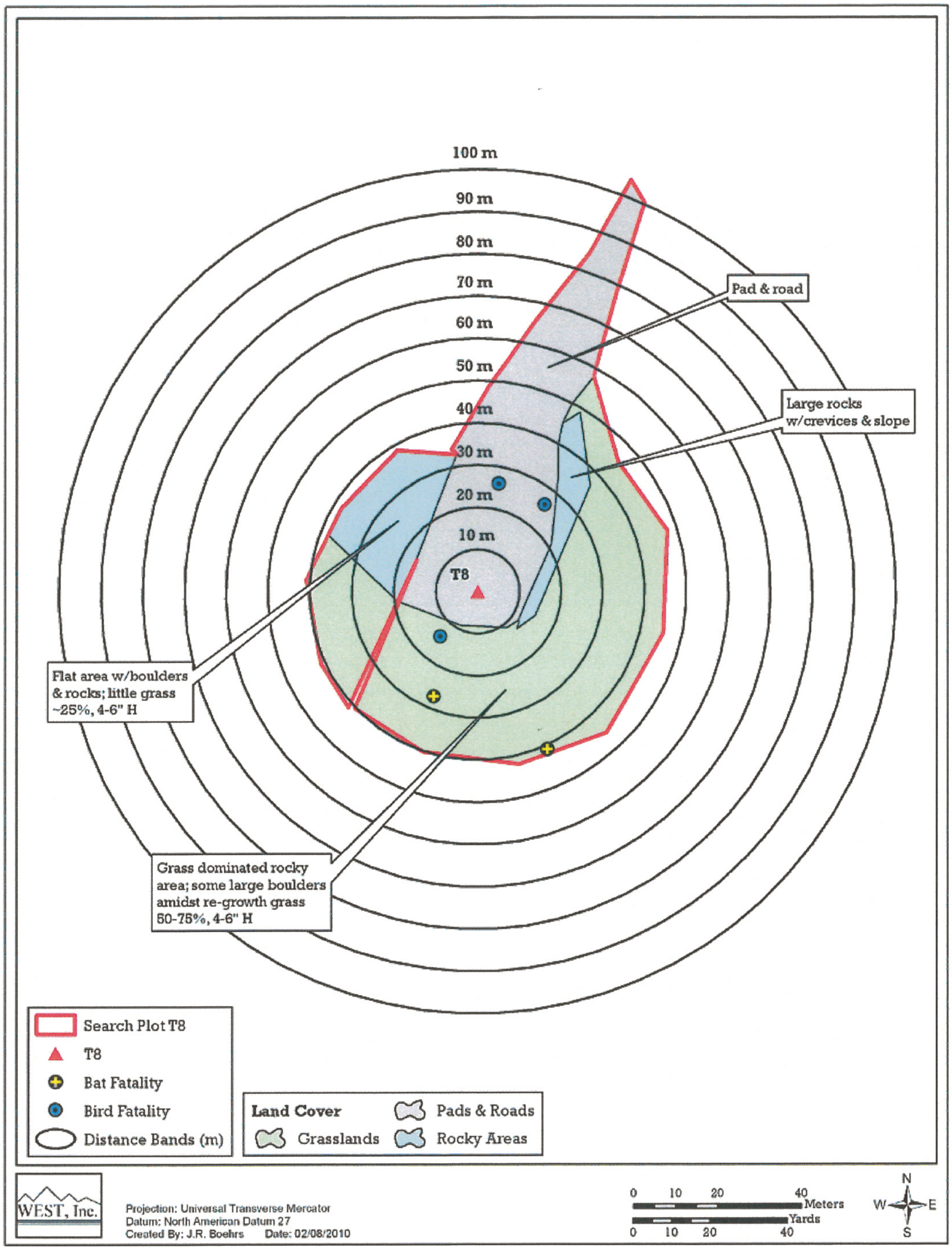


Search Plot T8 – April 2009



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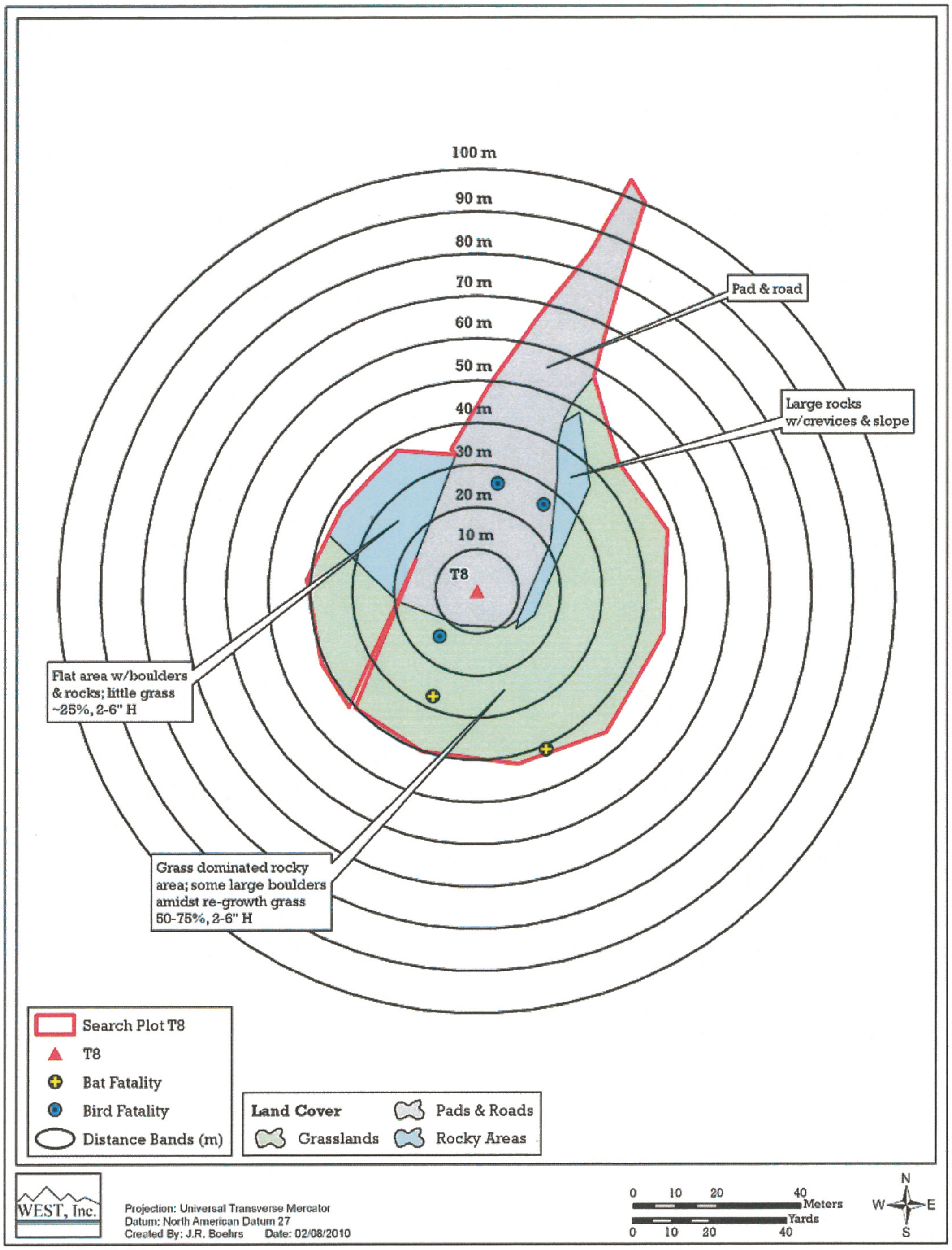

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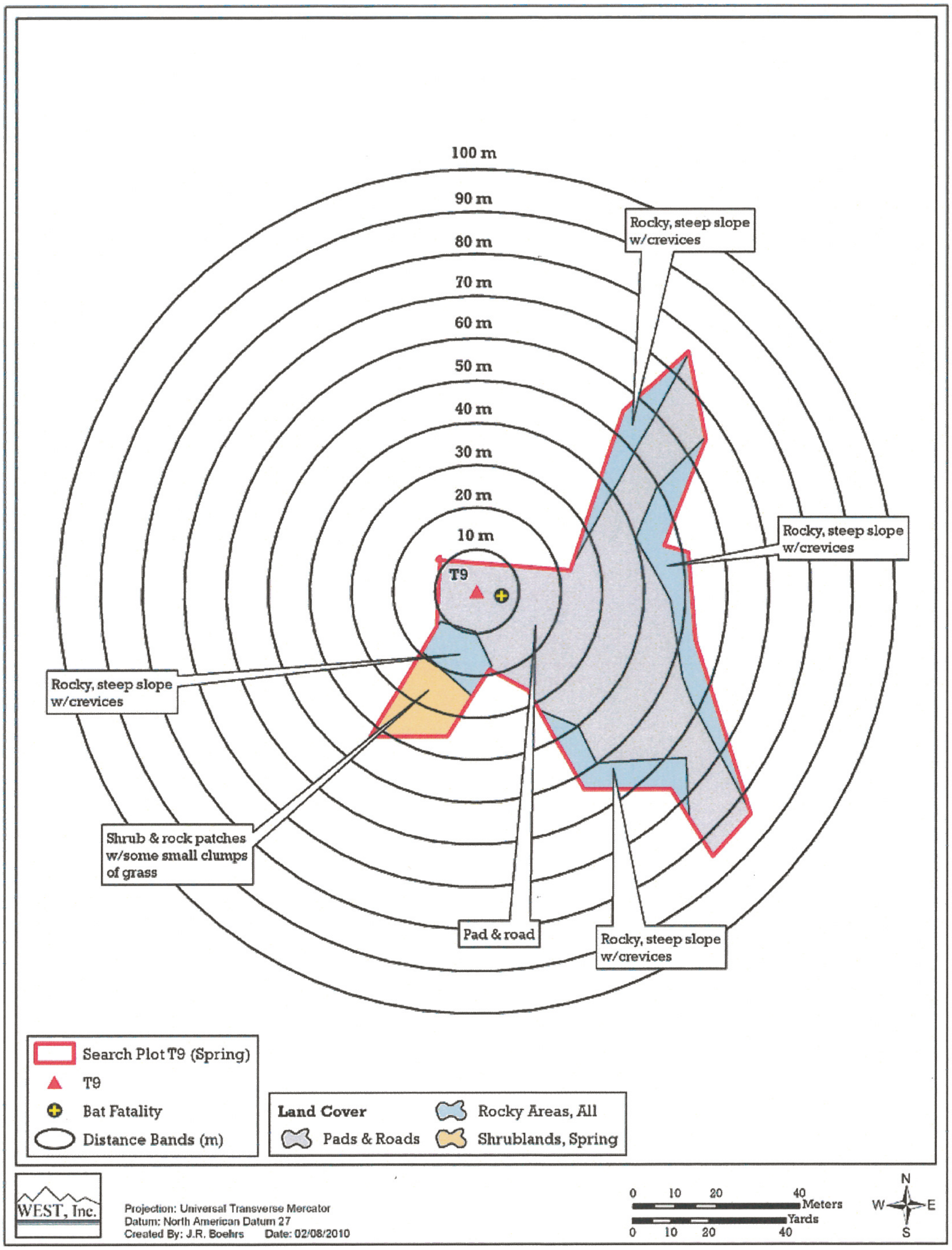
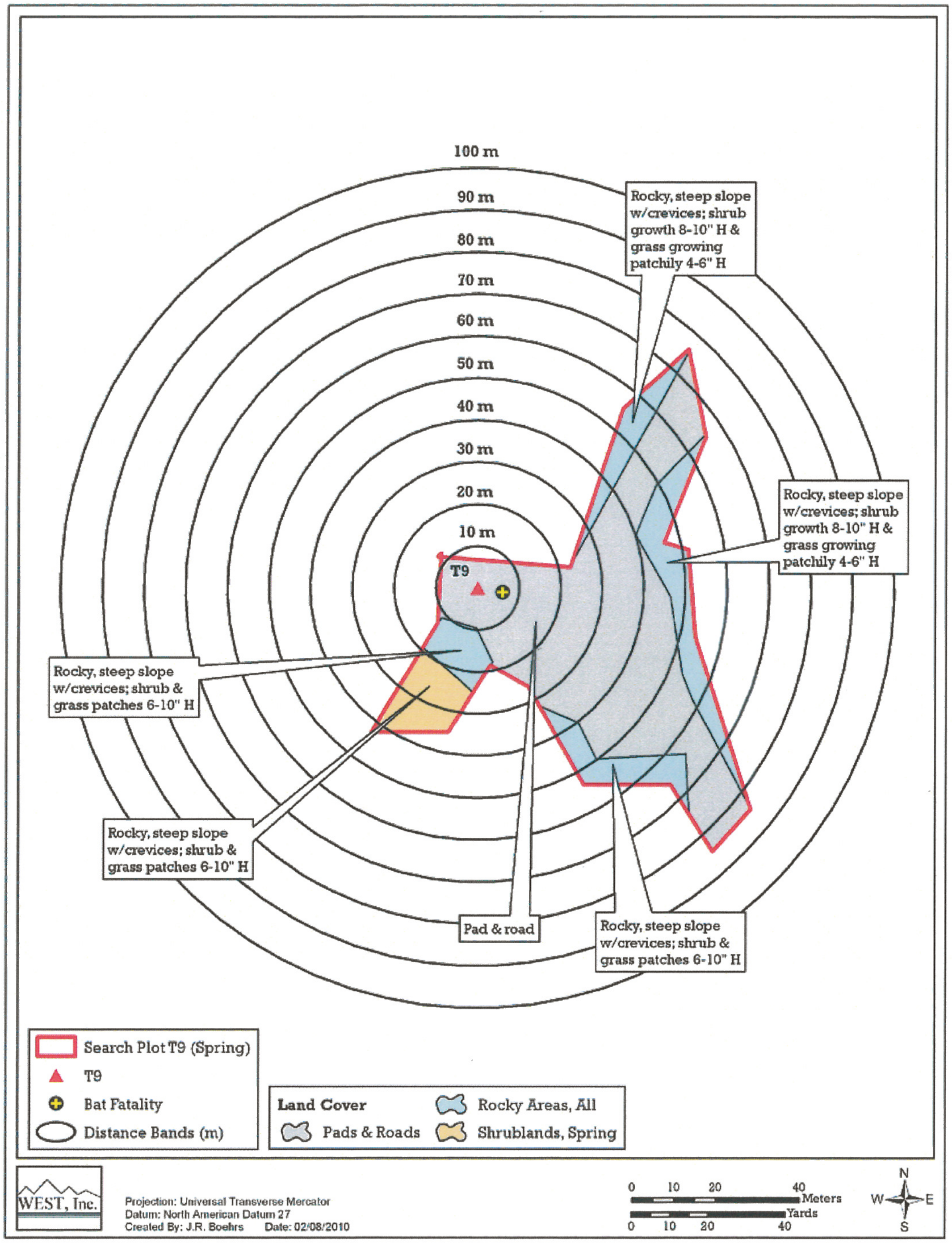


Search Plot T9 – April 2009



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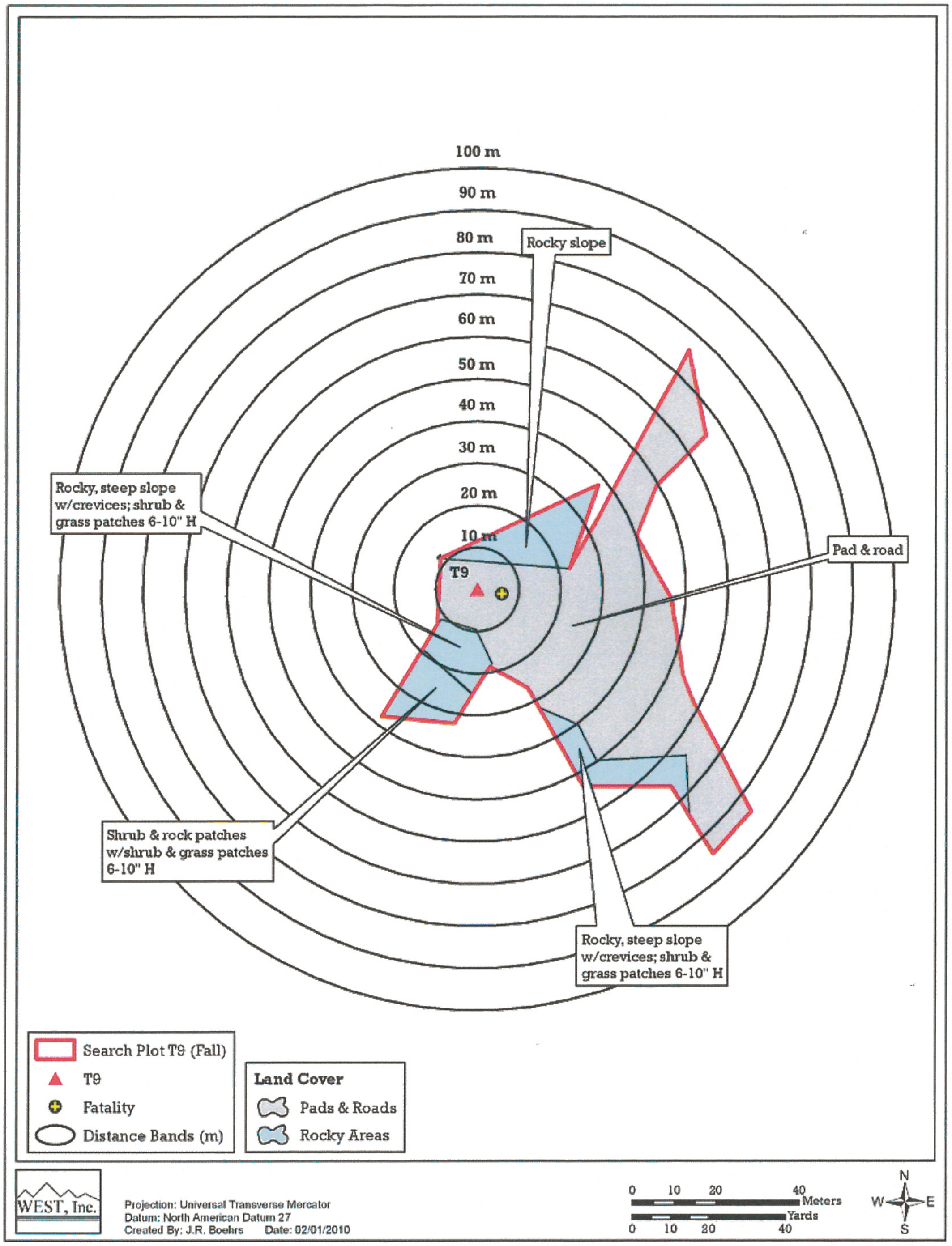

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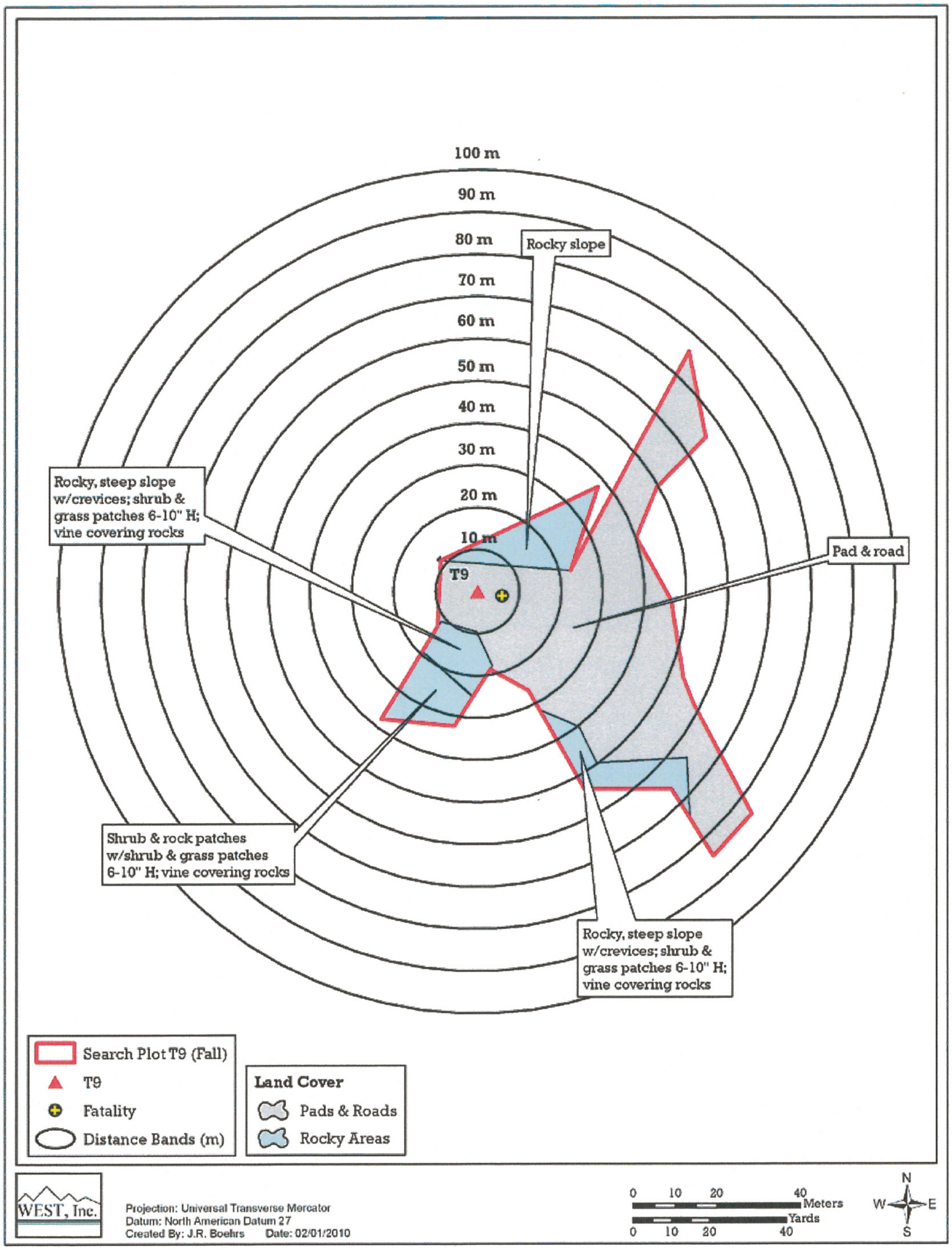

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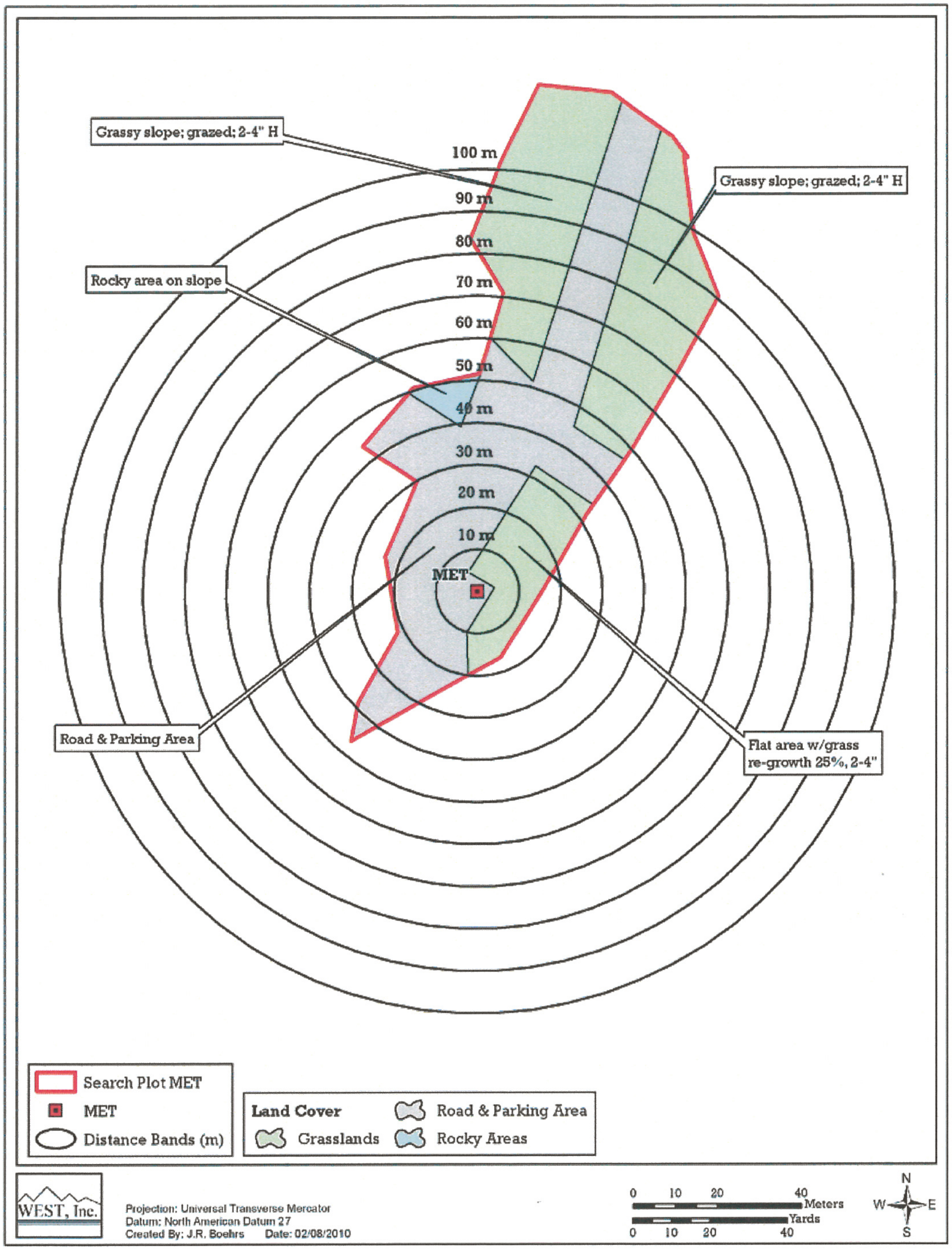
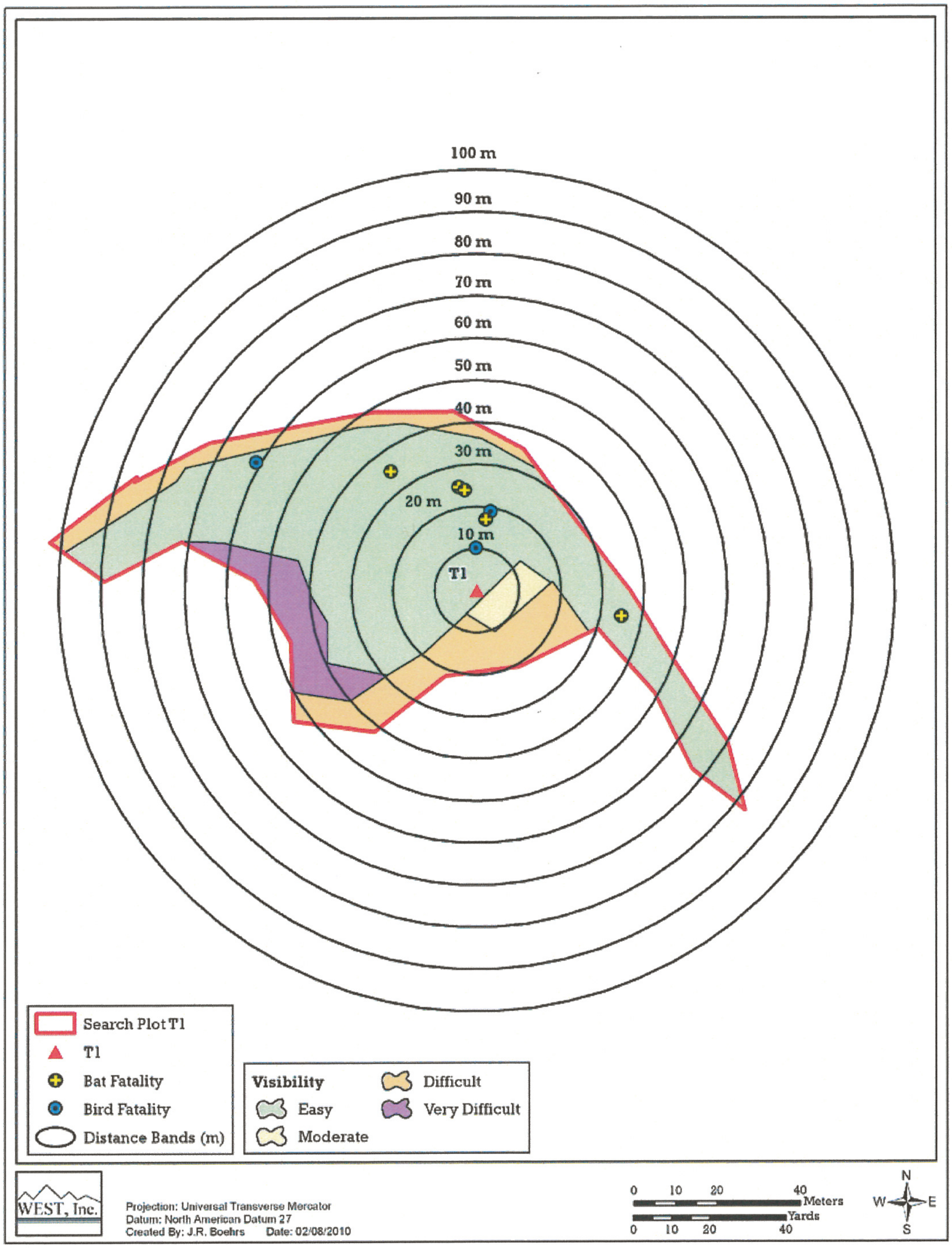
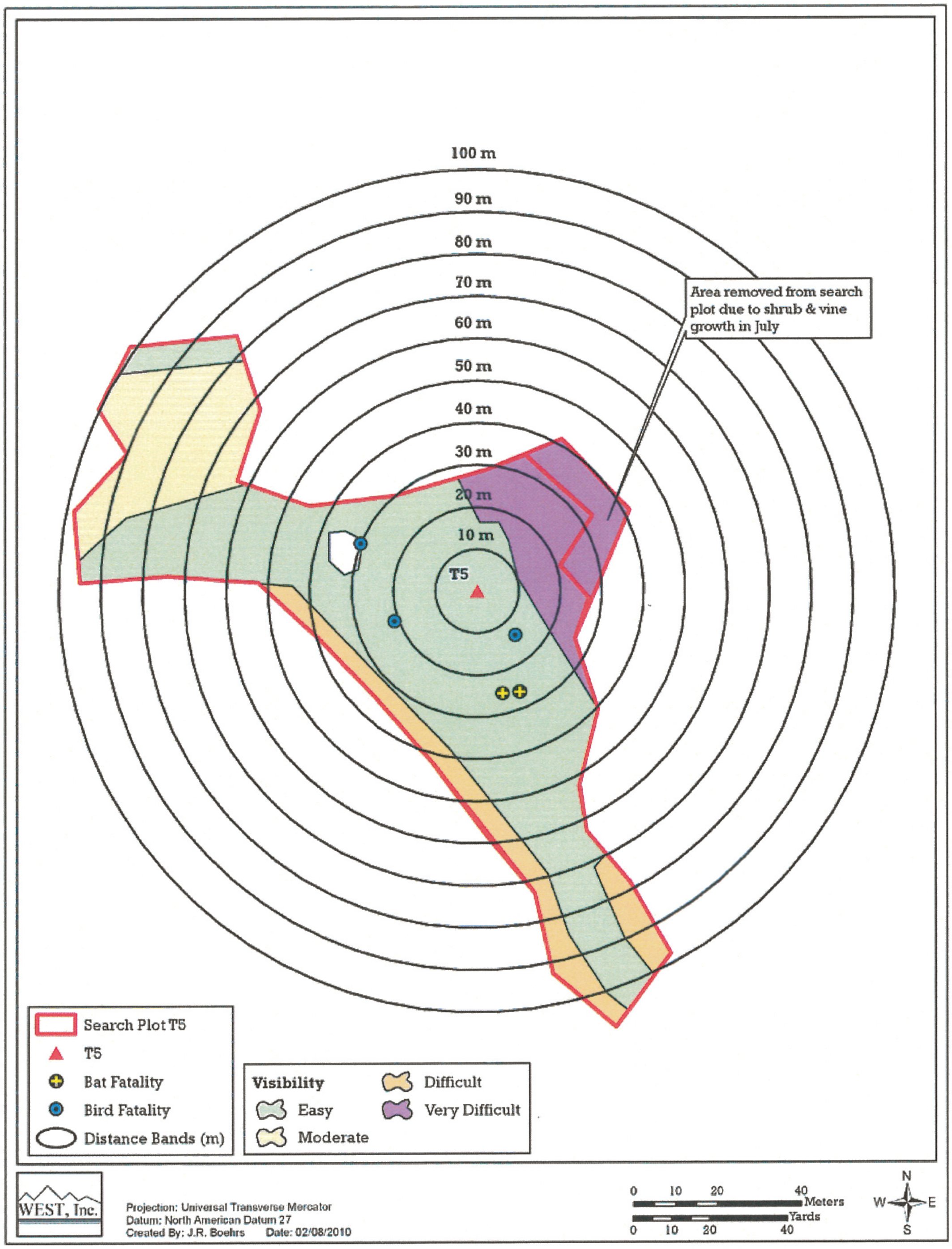
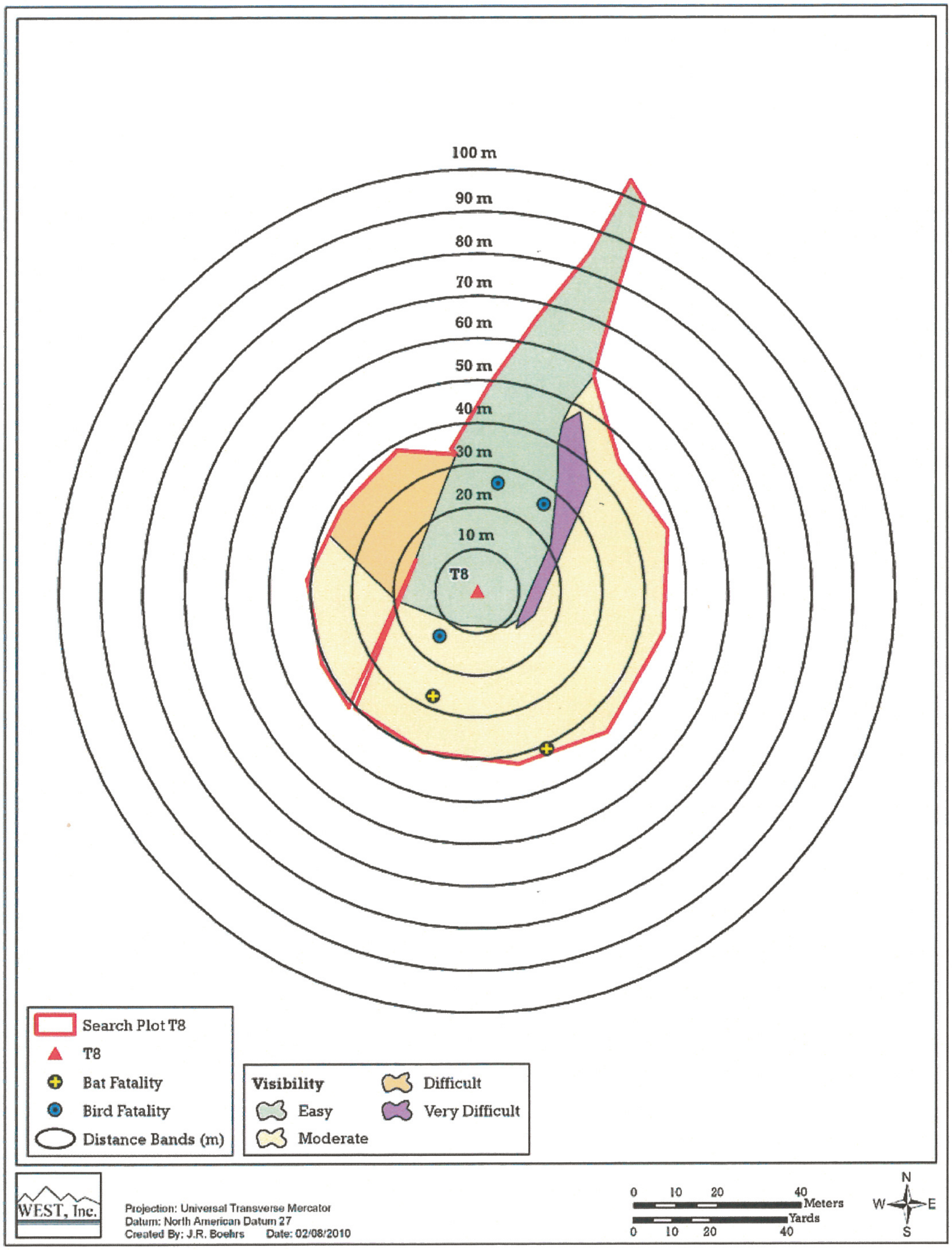


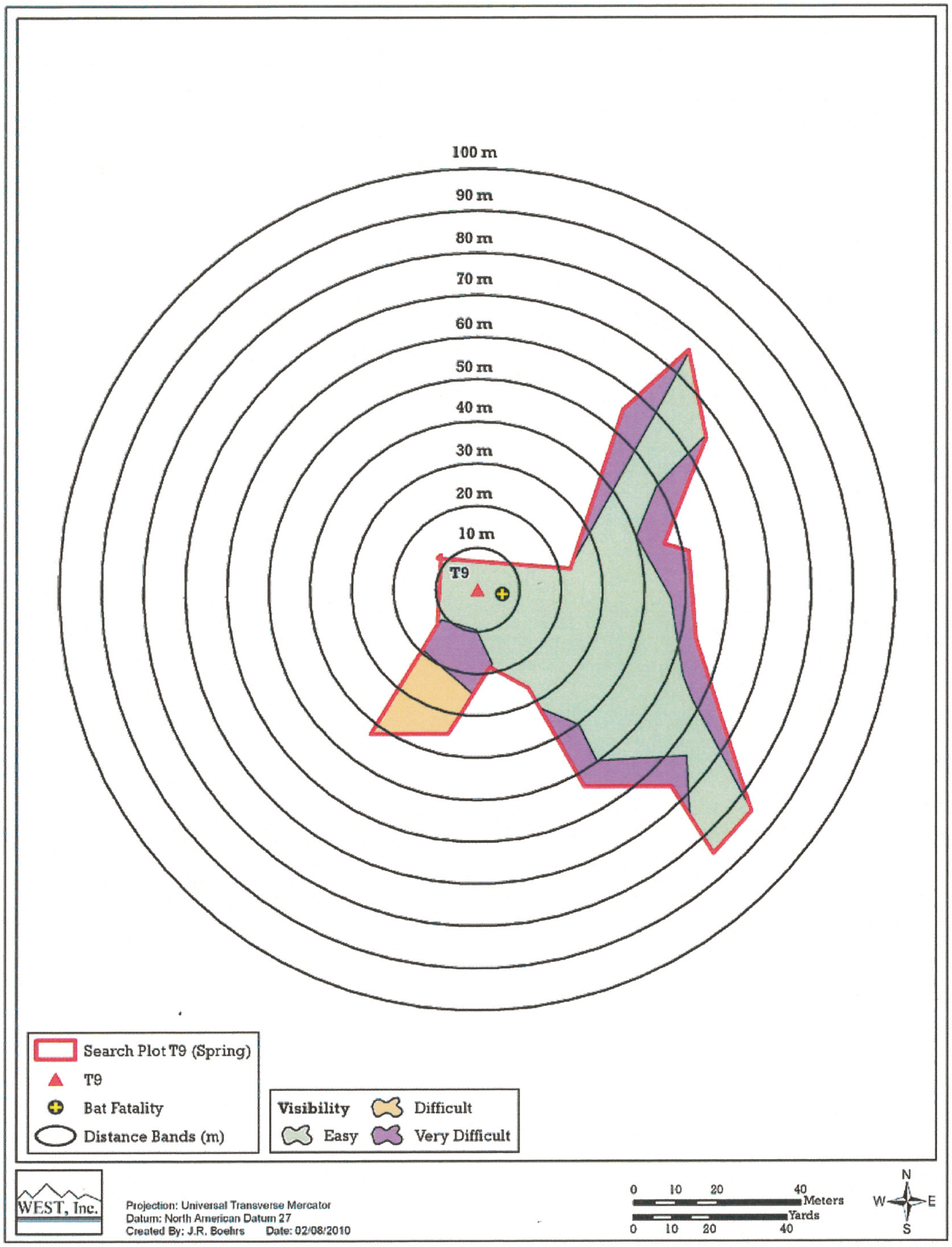
Seach Plot Met – Spring and Fall 2009

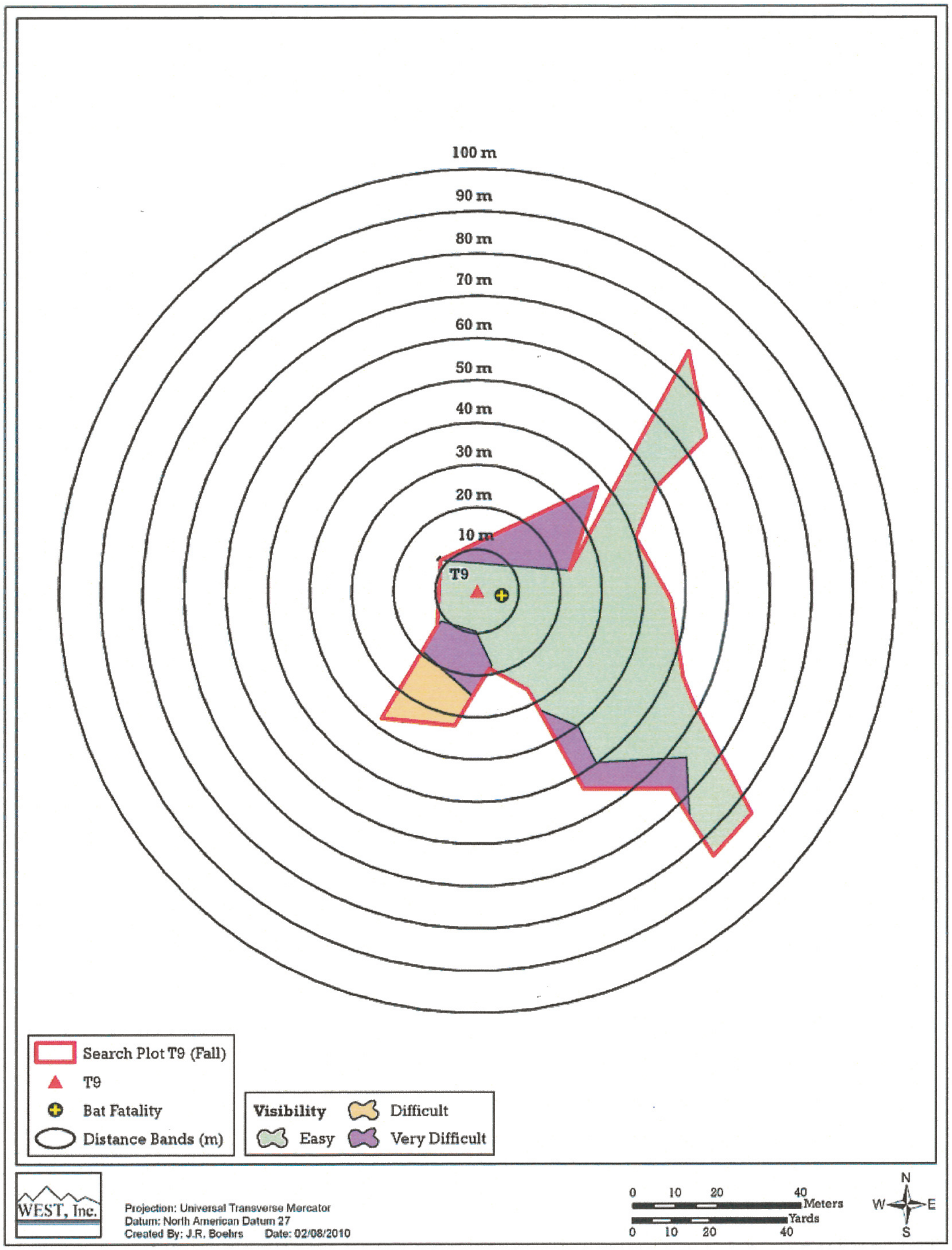
Appendix 8.0-2. Visibility Classification Maps of the 2009 Lempster Wind Power Project Search Plots

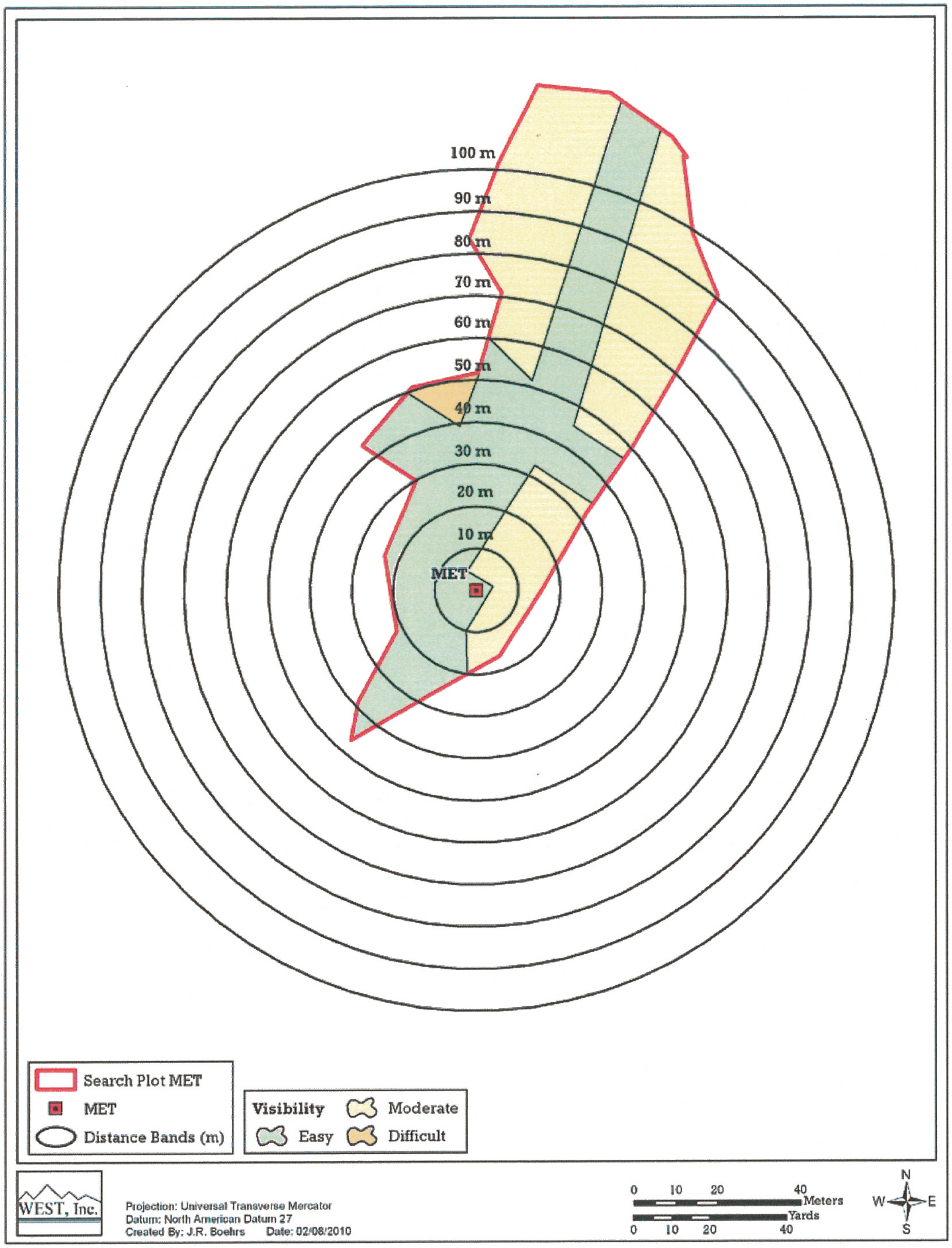

100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
T1
Search Plot T1
T1
Bat Fatality
Bird Fatality
Distance Bands (m)
Visibility
Easy
Moderate
Difficult
Very Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40 Meters
0 10 20 40 Yards
N
W
E
S


100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
T5
Area removed from search plot due to shrub & vine growth in July
Search Plot T5
T5
Bat Fatality
Bird Fatality
Distance Bands (m)
Visibility
Easy
Moderate
Difficult
Very Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40 Meters
0 10 20 40 Yards
N
W E
S


100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
T8
Search Plot T8
T8
Bat Fatality
Bird Fatality
Distance Bands (m)
Visibility
Easy
Moderate
Difficult
Very Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40 Meters
0 10 20 40 Yards
N
W
E
S


100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
T9
Search Plot T9 (Spring)
T9
Bat Fatality
Distance Bands (m)
Visibility
Difficult
Easy
Very Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40 Meters
0 10 20 40 Yards
N
W
E
S


100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
T9
Search Plot T9 (Fall)
T9
Bat Fatality
Distance Bands (m)
Visibility
Difficult
Easy
Very Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40 Meters
0 10 20 40 Yards
N
W
E
S


100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
MET
Search Plot MET
MET
Distance Bands (m)
Visibility
Easy
Moderate
Difficult
WEST, Inc.
Projection: Universal Transverse Mercator
Datum: North American Datum 27
Created By: J.R. Boehrs Date: 02/08/2010
0 10 20 40
Meters
Yards
0 10 20 40
N
W
E
S

YAHOO! LOCAL Maps

When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.

Ithaca College

1. Starting at **ITHACA COLLEGE** on **CASCADILLA ST** going toward **N MEADOW ST**
2. Turn (R) on **WASHINGTON ST** - go **0.2** mi
3. Turn (L) on **W BUFFALO ST** - go **0.9** mi
4. Turn (R) on **STEWART AVE** - go **0.2** mi
5. Turn (L) on **E STATE ST(RT-79)** - go **0.9** mi
6. Continue to follow **RT-79** - go **27.2** mi
7. Continue on **US-11** - go **2.2** mi
8. Turn (L) on **E MAIN ST(RT-26)** - go **0.5** mi
9. Continue on **RT-206** - go **27.0** mi
10. Bear (L) on **RT-206** - go **0.3** mi
11. Turn (L) to take ramp onto **I-88 E** (Portions toll) - go **88.1** mi
12. Take exit **#25-1/ALBANY** onto **I-90 E** (Toll applies) - go **11.2** mi
13. Take exit **#1N/ALBANY INT'L AIRPORT/MONTREAL** onto **I-87 N** (Toll applies) - go **6.6** mi
14. Take exit **#7/TROY/COHOES** onto **RT-7 E** - go **4.5** mi
15. Bear (R) on **RT-7** - go **24.6** mi

16. Continue on **BENNINGTON BYP** - go **1.2** mi
17. Continue on **VT-279** - go **3.7** mi
18. Take ramp onto **US-7 S** toward **BENNINGTON DOWNTOWN** - go **2.3** mi
19. Turn L on **VT-9** - go **39.0** mi
20. Turn L to take ramp onto **I-91 N** toward **U.S. 5 NORTH/VT. 9 EAST/PUTNEY. VT./KEENE. NH.** - go **2.7** mi
21. Take exit **#3/BRATTLEBORO (US-5)/KEENE N.H. (VT-9 E)** onto **CHESTERFIELD RD** - go **0.5** mi
22. Continue on **FRANKLIN PIERCE HWY(RT-9)** - go **14.4** mi
23. Turn L on **RT-10** - go **1.3** mi
24. Take ramp onto **FRANKLIN PIERCE HWY(RT-10)** toward **CONCORD/RT-9 E/NEWPORT** - go **2.7** mi
25. Continue on **RT-9** - go **25.0** mi
26. Continue on **US-202** - go **14.0** mi
27. Take ramp onto **I-89 S** - go **8.2** mi
28. Take exit **#1/BOW/LOGGING HILL RD.** - go **0.2** mi
29. Turn R on **LOGGING HILL RD** - go **0.8** mi
30. Turn R on **WHITE ROCK HILL RD** - go **0.5** mi
31. Turn L on **TIMMINS RD** - go **0.5** mi
32. Arrive at **20 TIMMINS RD, BOW,** on the R

B 20 Timmins Rd., Bown NH 03304

Total Distance: 311.35 mi, Total Travel Time: 6 hrs 32 mins

YAHOO! LOCAL Maps

When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.

Ithaca College

1. Starting at **ITHACA COLLEGE** on **CASCADILLA ST** going toward **N MEADOW ST**
2. Turn (R) on **WASHINGTON ST** - go **0.2** mi
3. Turn (L) on **W BUFFALO ST** - go **0.9** mi
4. Turn (R) on **STEWART AVE** - go **0.2** mi
5. Turn (L) on **E STATE ST(RT-79)** - go **0.9** mi
6. Continue to follow **RT-79** - go **27.2** mi
7. Continue on **US-11** - go **2.2** mi
8. Turn (L) on **E MAIN ST(RT-26)** - go **0.5** mi
9. Continue on **RT-206** - go **27.0** mi
10. Bear (L) on **RT-206** - go **0.3** mi
11. Turn (L) to take ramp onto **I-88 E** (Portions toll) - go **88.1** mi
12. Take exit **#25-1/ALBANY** onto **I-90 E** (Toll applies) - go **11.2** mi
13. Take exit **#1N/ALBANY INT'L AIRPORT/MONTREAL** onto **I-87 N** (Toll applies) - go **6.6** mi
14. Take exit **#7/TROY/COHOES** onto **RT-7 E** - go **4.5** mi
15. Bear (R) on **RT-7** - go **24.6** mi

16. Continue on **BENNINGTON BYP** - go **1.2** mi
17. Continue on **VT-279** - go **3.7** mi
18. Take ramp onto **US-7 S** toward **BENNINGTON DOWNTOWN** - go **2.3** mi
19. Turn (L) on **VT-9** - go **39.0** mi
20. Turn (L) to take ramp onto **I-91 N** toward **U.S. 5 NORTH/VT. 9 EAST/PUTNEY. VT./KEENE. NH.** - go **2.7** mi
21. Take exit **#3/BRATTLEBORO (US-5)/KEENE N.H. (VT-9 E)** onto **CHESTERFIELD RD** - go **0.5** mi
22. Continue on **FRANKLIN PIERCE HWY(RT-9)** - go **14.4** mi
23. Turn (L) on **RT-10** - go **1.3** mi
24. Take ramp onto **FRANKLIN PIERCE HWY(RT-10)** toward **CONCORD/RT-9 E/NEWPORT** - go **2.7** mi
25. Continue on **RT-9** - go **25.0** mi
26. Continue on **US-202** - go **14.0** mi
27. Take ramp onto **I-89 S** - go **8.2** mi
28. Take exit **#1/BOW/LOGGING HILL RD.** - go **0.2** mi
29. Turn (R) on **LOGGING HILL RD** - go **0.8** mi
30. Turn (R) on **WHITE ROCK HILL RD** - go **0.5** mi
31. Turn (L) on **TIMMINS RD** - go **0.5** mi
32. Arrive at **20 TIMMINS RD, BOW,** on the (R)

B 20 Timmins Rd., Bown NH 03304

Total Distance: 311.35 mi, Total Travel Time: 6 hrs 32 mins