Annual Report for the Maple Ridge Wind Power Project

Postconstruction Bird and Bat Fatality Study - 2006

Draft

February 23, 2007

Prepared for:

PPM Energy and Horizon Energy

and

Technical Advisory Committee (TAC) for the Maple Ridge Project.

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EXECUTIVE SUMMARY

The Maple Ridge Wind Power Project is situated on the Tug Hill Plateau of Lewis County, just west of Lowville, New York. The project consists of a total of 120 Vestas wind turbines constructed within the Phase I project area (2005). The remaining 75 (Phase IA and Phase II) turbines were erected in May-December 2006 and are outside the scope of the first year study. Each 1.65 MW turbine consists of an 80-meter-(262-foot)-tall tubular steel tower; a maximum 82-meter-(269-foot)-diameter rotor; and a nacelle which houses the generator, transformer, and power train. The towers have a base diameter of approximately 15 feet and a top diameter of 8 feet. The tower is topped by the nacelle, which is approximately 9 feet high and 25 feet long, and connects with the rotor hub. The rotor consists of three 134-foot-long composite blades. Approximately 30% (38 out of 120) of the nacelles are equipped with two FAA aviation obstruction beacons consisting of L-864 flashing red strobes (white during the day). With the rotor in the 12 o'clock position, each turbine has a maximum height of approximately 400 feet (122 meters). All components of the turbine are painted white.

During this first year pilot-project, carcass surveys were conducted at 50 out of 120 (41.7%) operational turbine sites, as well as the two meteorological towers. We completed 2,244 turbine searches over all 50 sites. Ten turbine sites were searched on a daily basis from June 17th to November 15th 2006 (127 complete rounds for a total of 1270 turbine tower searches). Ten turbine sites were searched every three days between June 29, 2006 and November 15th, 2006 (45 complete rounds for a total of 450 turbine searches). Finally, 30 turbine sites were searched weekly (7-day sites) between July 11, 2006 and November 13th, 2006, for a total of 524 total surveys (16 rounds). One meteorological tower was searched daily (97 total searches, from July 17th, 2006 to November 15th, 2006). The second meteorological tower was searched every 3 days (31 total searches, from July 17th, 2006 to November 14th, 2006).

A total of 123 avian incidents were recorded by searchers during standardized surveys, representing 28 species. Of the 28 species, there was one raptor fatality (American Kestrel), There were 106 identified songbird incidents involving 26 species found during this partial year study (June 17th 2006 to November 15th 2006). Night migrants accounted for 82.1% (N = 123) of fatalities during standardized surveys. The greatest number of bird incidents occurred during the fall migration period with 83 (65.87%; N = 123) bat carcasses found between September and October 2006. Although no waterbirds, shorebirds, or gamebirds were found during standardized surveys, incidental observations revealed two Wild Turkey (not deemed killed by turbines), one Ruffed Grouse, and two Canada Goose carcasses.

Remains of 326 bats were found by searchers during standardized surveys, representing five species (Hoary Bat, Silver-haired Bat, Eastern Red Bat, Little Brown Bat, and Big Brown Bat). The greatest number of bat incidents occurred during the fall migration period, with 228 (69.9%) bat carcasses found between July 1st and August 31st 2006.

Bat carcasses were located closer to turbine tower bases than were bird carcasses. About 80% of bird carcasses were found within 60 m of the turbine bases, whereas 98% of bat fatalities were found within this same distance from turbines. About 80% of bat carcasses were within 40 m of turbine bases. Bat fatalities appeared to be slightly greater at turbines close to wetland areas than at turbines located farther from wetlands, although there was considerable variation in these data. There did not appear to be a difference in bat fatalities with respect to distance of turbines from woodlands.

Carcass removal (scavenging) and searcher efficiency studies were conducted to estimate the proportion of carcasses missed by the searchers and the proportion removed by scavengers within the one, three and seven day search cycles. These rates, along with the proportion of towers searched were used to estimate the total number of fatalities likely to have occurred during the study period at all operational turbines at the Maple Ridge project. Carcass removal rates were modest. Both carcass removal and searcher efficiency rates were comparable to those found in most fatality studies conducted in the United States.

By dividing the estimated number of incidents by the number of turbines and by 1.65 MW per turbine searched in each year, a rate of incidents/turbine and incidents/Megawatt was calculated, allowing comparisons between wind farms of different sizes (different numbers of towers and different turbine sizes). Because we used three different search periods to calculate incidents/MW, we calculated three different estimates for birds and bats. The estimates for birds are: 5.75 incidents/Mw (9.48 incidents/turbine), 2.53 incidents/Mw (4.17 incidents/turbine) and 1.87 incidents/Mw (3.10 incidents/turbine) for 1 day, 3 day and 7 day sites respectively. For bats, the estimates are 12.31 incidents/Mw (20.31 incidents/turbine), 10.82 incidents/Mw (17.85 incidents/turbine) and 6.90/Mw (11.39 incidents/turbine) for one, three and seven day sites respectively.

For both bats and birds, there is no clear evidence that L-864 FAA obstruction lighting (flashing red strobes) attracted birds or bats to towers and that the presence of those lights cause large scale fatality events at wind turbines. There was no significant difference between the numbers of birds or bats killed at turbines with vs. without L-864 obstruction lights.

The rate of bird and bat fatalities were within the ranges of those found during other wind turbine fatality studies conducted in the United States. For birds, the fatality rates at Maple Ridge were similar to the rates at Appalachian Ridges in West Virginia and Tennessee. For bats the rate was much lower than rates reported from Appalachian Ridges and somewhat greater than rates reported from Midwestern wind power sites. However, the rates determined for Maple Ridge do not include the spring migration season, so annual rates will likely be slightly greater than rates reported herein.

The analyses described in this report will provide ample information for designing a fatality study protocol for the coming years. Carcass removal and scavenging rates, combined with other findings can be used to determine the optimal search interval and sample size of turbines need to be searched for the entire 195 turbines at the Maple Ridge Wind Power Project.

1.0 INTRODUCTION

The following report describes the research design, initiation and completion of the first year of postconstruction study of avian and bat collision fatalities at the 120 turbine Maple Ridge Wind Power Project in Lewis County, New York.

The work was conducted in accordance with the "Proposed Scope of Work for a Postconstruction Avian and Bat Fatality Study at the Maple Ridge Wind Power Project, Lewis County, New York" dated March 14, 2006, and agreed upon in mid-May 2006, after several revisions. People/agencies who reviewed the proposed scope of work included staffers from the U. S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (ACE), Environmental Design and Research (EDR), NYS DEC staffers, developers (PPM and Horizon), and others. Representatives from some or all of these groups have been included in a Technical Advisory Committee (TAC), which has the responsibility of reviewing and commenting on progress reports, annual reports, and other updates from this project.

TAC members:

Patrick Doyle, Horizon Wind Energy
William Moore, PPM Energy
Paul Kerlinger, Curry and Kerlinger
Aaftab Jain, Curry and Kerlinger
Al Hicks, NYSDEC
Brianna Gary, NYSDEC
Tim Sullivan, USFWS
Mark Watson, NYSERDA
Mike Berger, NYS Audubon
Diane Sullivan Enders, moderator (EDRPC)

The first year of postconstruction study, as outlined here, is a pilot study of methods to be used in subsequent years of postconstruction studies. It is anticipated that upon submission of this analysis of the results of the 2006 data collection effort, the protocol will be reviewed by members of the TAC and revised accordingly. Further, there is an ongoing analysis of the methods used in the first year, as well as the preliminary results, conducted by Dr. James Gibbs, Dept. of Statistics, Syracuse University. Upon completion of this study, the TAC will be able to review the efficacy of the different search methods detailed later in this report.

The objectives of the 2006 fatality study, the first year of postconstruction study, are to provide a quantitative estimate of the number of bird and bat fatalities that occur at the Maple Ridge wind plant during the study period. Specifically, estimates of numbers of fatalities will be determined for:

▪Birds (collective fatalities of all species),
▪Bats (collective fatalities of all species),

▪Bird species (species by species),
▪Bat species (species by species),
▪Raptors (all species collectively),
▪Waterfowl (all species collectively),
▪Songbirds (all species collectively), and
▪Night migrants (all species collectively and individual species).

The methods used include searches under turbines in concert with studies of carcass removal rates (scavenging) and searcher efficiency rates. The study is being conducted at a subset of turbines and will be done for a period of 3 years postconstruction following the completion of construction of the rest of the wind turbines (Phase II), almost concluded in 2006. This means that studies will be conducted in 2006, 2007, 2008, and 2011, a total of 4 years after the first 120 turbines are erected. If it is determined that modifications of the protocol and methods are required to this scope of work, revisions will be reviewed by the TAC.

The study was also designed as a means of determining the optimal design of research during the coming years of preconstruction research at Maple Ridge. The issues examined in this study include:

▪The number of turbines that need to be searched to accurately determine avian and bat fatalities at the Maple Ridge site.
▪Carcass removal and searcher efficiency rates.
▪The optimal duration of days between fatality searches at turbines.
▪Provide sample sizes with respect to numbers of towers searched so that confidence intervals could be estimated for bird and bat fatalities.
▪Provide data that will permit sample size determination for future studies at Maple Ridge with respect to build out of 195 turbines.

1.1 Project Description

The Maple Ridge Wind Power Project will ultimately consist of 195 wind turbines and three permanent meteorology towers on the Tug Hill Plateau of Lewis County, just west of Lowville, New York. In 2005, a total of 120 Vestas wind turbines were constructed within the Phase I project area. The remaining turbines are under construction (May to December 2006). Each 1.65 MW turbine consists of an 80-meter-(262-foot)-tall tubular steel tower; a maximum 82-meter-(269-foot)-diameter rotor; and a nacelle which houses the generator, transformer, and power train. The towers have a base diameter of approximately 15 feet and a top diameter of 8 feet. The tower is topped by the nacelle, which is approximately 9 feet high and 25 feet long, and connects with the rotor hub. The rotor consists of three 134-foot-long composite blades. Approximately 30% (38 out of 120) of the nacelles are equipped with L-864 FAA aviation obstruction beacons (lights) consisting of flashing strobes (red at night). With a rotor blade oriented in the 12 o'clock position, each turbine has a maximum height of approximately 400 feet (122 meters). All components of the turbine are painted white.

Two 262-foot-(80-meter)-tall meteorological towers were also constructed in 2005 to collect wind data and support performance testing of the project. The towers are free-standing galvanized lattice steel structures with FAA obstruction lighting. One additional meteorological tower of the same description will be constructed as a part of Phase II (2006 construction). Other project components include a series of buried electrical interconnect lines, a system of gravel service roads to each wind turbine, an approximately 4 mile aerial 34.5kV electrical distribution line, and a substation.

Figure 1. High Resolution Project map for the Northern section of the Maple Ridge WRA

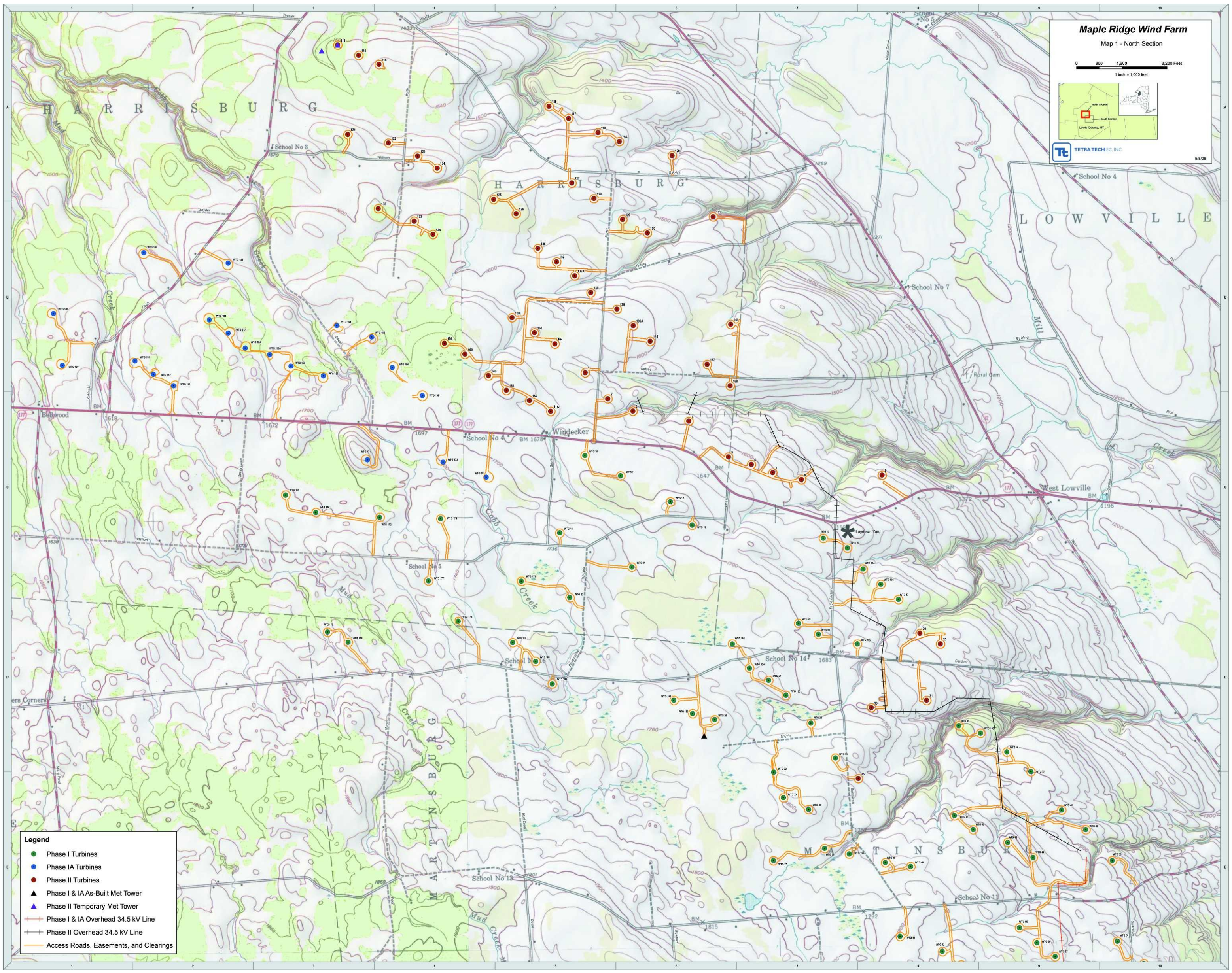
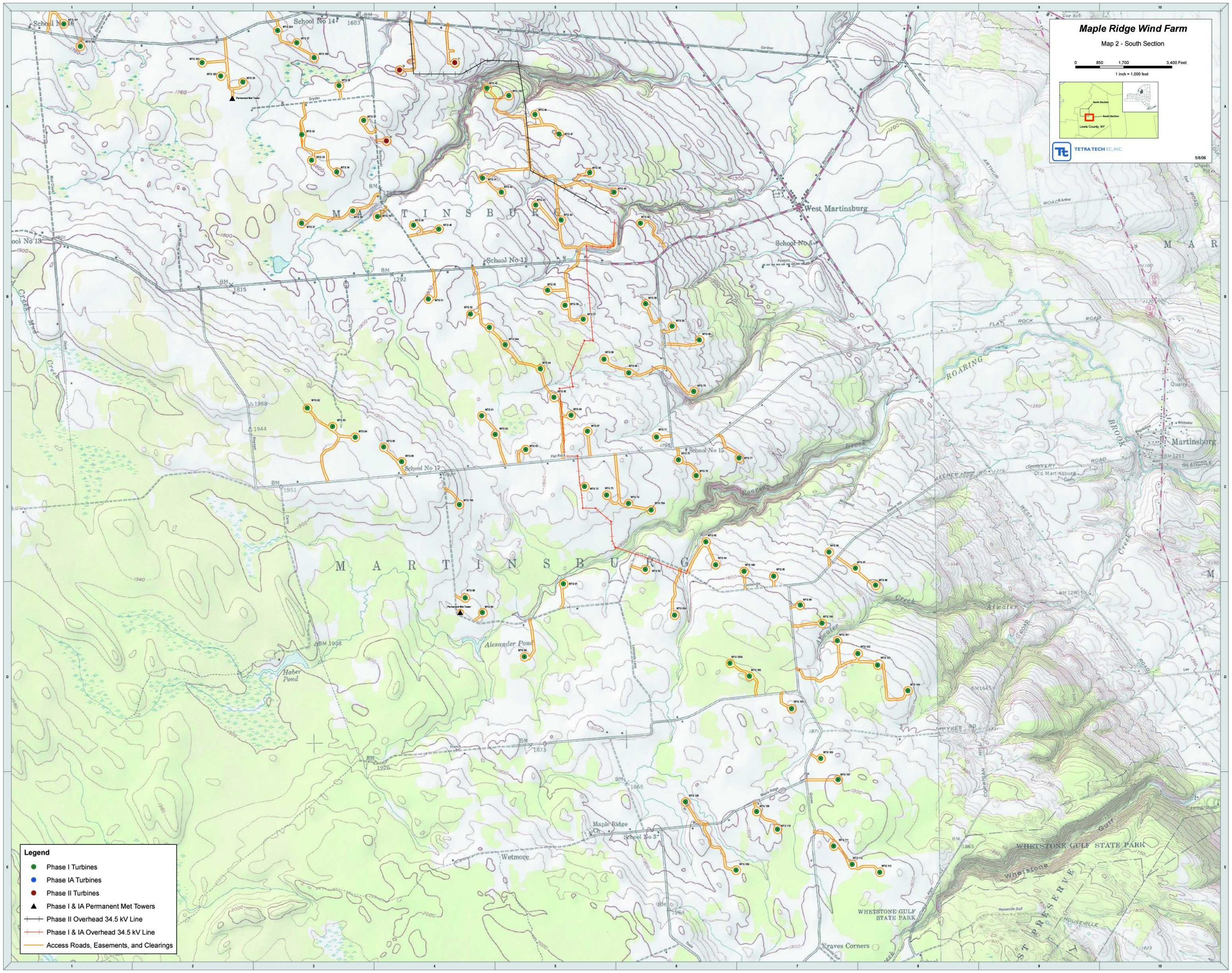


Figure 2: High Resolution Project map for the Southern section of the Maple Ridge WRA.



1.2 Study Area

The proposed project is located on the eastern edge of the Tug Hill Plateau in the Towns of Martinsburg, Harrisburg, and Lowville. The total project area totals approximately 21,100 acres. The project area lies approximately 1 mile west of NYS Route 12 (north of West Lowville) and County Route 29 (south of West Lowville).

Phase I includes approximately 15,570 acres of land (on 84 separate parcels) under lease from 58 different landowners in the Towns of Harrisburg, Martinsburg, and Lowville. This boundary has a north-northwest orientation, and extends from the intersection of Graves Road and Corrigan Hill Road in the south, to Cobb Road, Snyder Road, and State Highway 177 in the north. The first year (2006) of searches are within the Phase I study area.

Phase II includes approximately 5,575 acres of land (on 31 separate parcels) under lease from 17 different landowners in the Towns of Harrisburg and Lowville. This boundary has a north-northwest orientation, spanning from Cobb Road, Snyder Road, and State Highway 177 in the south to O'Brien Road in the north. As this area is currently under construction, searches were not conducted there, but will be conducted there in 2007.

The project site is located in a rural and agricultural area with elevations ranging from about 1,300 to 1,980 feet above mean sea level (asl). The majority of the area consists of open crop fields (primarily hay, alfalfa, and corn) and pastures, with forested areas generally confined to woodlots, wooded wetlands, and ravines/stream corridors. Larger areas of contiguous forest occur in the western portion of the project area. The site also includes successional old field, hedgerow, successional shrubland, yards, farms, streams, and ponds. Existing built features within the site boundaries include various communication towers, single-family homes, barns, silos, small industrial facilities, and other agricultural buildings. Roads on site include a two lane highway (Hwy 177) as well as several local paved and gravel roads present before the construction of the wind project. Narrower gravel access roads were created over farmland and through forested areas to service the towers.

2.0 METHODS:

2.1 Carcass Surveys

2.1.1 Site Selection

Fifty turbine sites were chosen to be searched in 2006. Site selection was through a process of randomization and stratification. All Phase I turbine locations were surveyed, and classified broadly as bare ground, agricultural (crop), agricultural (grassland), brush and wooded. Most sites belonged to two or more classes (e.g. agricultural crop field with woodlot and some brush). Sites were randomized from each of these groups, but some sites were excluded due to perceived difficulty in searching/ground clearing (heavy brush, severely sloped terrain, presence of debris and waste on site, etc.).

While 10 3 day and 30 7 day sites were initially chosen from each of these groups, all 10 1 day sites were randomly chosen from sites that had few wooded areas within the search plot. This was done to ensure that sites could be marked clearly and mowed completely to maximize efficiency in locating carcasses. (However, the Maple Ridge wind resource area occupies a heterogeneous mix of wooded and open land. Hence, these sites were located fairly close to woodlots and other wooded areas). Because of the small sample size of only 10 turbine sites to be searched daily, it was not possible to divide daily sites by ground cover classification. NYSDEC suggested additional sites to include heavily wooded areas and sites close to wetlands. These suggested sites were considered and, where feasible, added to the 3 day and 7 day search turbine list. Table 1 shows the ground cover at the various sites under which searches occurred.

Table 1. Primary ground cover at the 1-Day, 3-Day and 7-Day search sites.

Search Frequency	Turbine Number	Primary Ground Cover
1-Day	17	Grass/Wooded
1-Day	52	Grass
1-Day	56	Crop
1-Day	57	Grass/Crop
1-Day	75	Grass
1-Day	77	Grass/Crop/Brush
1-Day	89	Grass/Crop
1-Day	97	Grass/Crop
1-Day	98	Grass/Crop
1-Day	189	Grass
1-Day	Met Tower #2	Grass/Wooded
3-Day	45	Grass/Wooded
3-Day	76	Grass/Wooded
3-Day	82	Wooded
3-Day	83	Wooded
3-Day	86	Grass
3-Day	102	Grass/Wooded
3-Day	179	Grass/Wooded
3-Day	193	Wooded
3-Day	195	Grass/Wooded
3-Day	197	Grass/Wooded/Brush
3-Day	Met Tower #1	Grass/Wooded
7-Day	12	Grass
7-Day	16	Grass
7-Day	22a	Grass
7-Day	23	Grass
7-Day	24	Grass
7-Day	26	Grass
7-Day	27	Grass
7-Day	32	Grass/Wooded
7-Day	34	Grass/Wooded
7-Day	35	Grass

Search Frequency	Turbine Number	Primary Ground Cover
7-Day	37	Grass/Wooded
7-Day	39	Grass
7-Day	40	Grass
7-Day	50	Grass/Wooded
7-Day	53	Grass/Wooded
7-Day	54A	Grass/Wooded
7-Day	59	Crop
7-Day	64	Grass/Wooded
7-Day	90	Grass
7-Day	101	Grass/Wooded
7-Day	103	Grass/Wooded
7-Day	104	Grass/Wooded
7-Day	108	Grass
7-Day	109	Grass
7-Day	110	Grass
7-Day	180	Grass/Wooded
7-Day	181	Grass
7-Day	183	Wooded
7-Day	185	Wooded
7-Day	192	Grass/Wooded

Upon contract finalization and authorization to begin searches in mid-May, a field crew of 4 field technicians and one Field Biologist (Linda Slobodnik) was hired in the second week of June. However, on-site plant managers were not aware of the specifications of the protocol with respect to mowing the large areas under all 50 turbines that were to be searched. Developer management needed to get landowner permission and procure compensation for lost crops before mowing could commence. This matter was resolved by development management, and letters were mailed to landowners on August 11th.

In the absence of written landowner agreements, adjustments in the protocol were required to start collecting data. Sites that were currently searchable (low vegetation/cover) amongst the randomly chosen sites were selected as one and three day searches. Oral permissions to search the sites were obtained by Horizon Wind, and search areas were flagged and searches commenced. Two one-day sites were replaced when individual landowners contacted Horizon Wind to revoke oral permissions. Oral permission to do some mowing was also obtained by Robert Burke. Some mowing did occur, but Horizon Wind did not do extensive mowing that would have resulted in substantial crop loss until the landowner compensation letters were mailed. While this resulted in search difficulties, it was important to avoid causing discontent by removing farmers' crops/hay before compensation could be addressed.

As of June 17th, all 10 one-day sites were being surveyed. As of July 17th, all 10 three-day sites were being surveyed. The second meteorological tower was also added on July 17th. Given that a complete mowing schedule had not yet begun, searchable ground at the one-day and three-day sites varied from site to site, and changed over time as grass/crop/brush increased in height.

The 30 seven-day sites were plotted over the first two weeks of July. However, only the gravel areas at the base of the turbines and access roads were searched, pending landowner agreements. These sites had high grass and were not suitable to be searched (besides the gravel area immediately beneath the towers). Limited searching occurred on available bare ground. Some mowing occurred, prior to formal landowner agreement. By August 15th the setup phase was concluded and the regular search cycle and protocols were fully in place for all sites. By the end of August, mowing efforts had also been standardized and were operating regularly. For the complete list of searches completed, see Table 2.
Searches are conducted when weather and other conditions permitted. Work was not done during lightning but was conducted during light rain.

2.1.2 Carcass collection:

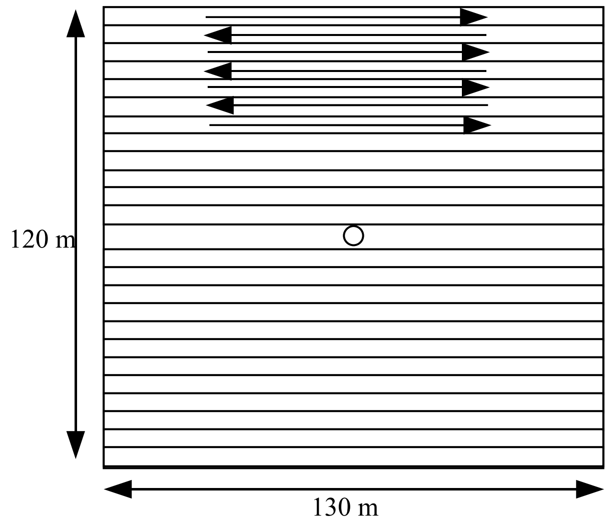
Prior to August 7th, carcasses were noted on the ground and tracked until scavenged. By August 7th, both state and federal permits were obtained and all remaining carcasses were retrieved. All fresh carcasses found were collected as well.

2.1.3 Standardized Surveys.

Carcass surveys were conducted every day at 10 sites and one meteorological tower, every 3 days at 10 sites and one meteorological tower, and every 7 days at 30 wind turbine tower. Searchers and search times were continuously switched over the course of the project to reduce the chance of towers being continually surveyed at the same time of day, or by the same searcher. Search teams were also switched on a daily basis.

The survey consisted of searchers walking in parallel transects within an overall search area of 130m by 120m, centered on the tower. While walking in each transect, the searcher used the unaided eye, alternately scanning an area that extended for 5m in either side of his/her track (Figure 1). The surveyors used range finders to initially establish and flag the beginning, midpoint and end of each transect. Site by site differences did remain. Towers that were constructed by clearing wooded areas had heavily wooded areas at approximately 35-45m from the tower base. Thus, wooded sites could only be cleared and searched out to the tree line. Non-wooded sites were searched out to the overall search area. Data recorded at the beginning of the surveys included meteorological data (cloud cover, temperature, wind velocity); ground cover information (crop type and height). In addition, the start and finish times were recorded for each tower searched (Appendix A). With respect to birds, any feathers or clumps of feathers with flesh attached were recorded as a fatality. Loose feathers were not considered fatalities unless there were several primary or tail feathers that would be more than could be lost during molting. When unattached single loose feathers were found their location was recorded and the feathers were removed and retained but not recorded as a fatality. Small feathers such as down feathers were also not recorded, since these most likely were lost as a result of normal preening. In any event, this type of remains were too scant to assign cause of death.

Figure 3. Representation of Carcass Survey Search Pattern centered on a wind tower turbine (not to scale)



When a carcass or injured bird or bat was found, the searchers performed a thorough investigation and documentation of the incident using the protocols listed in the 'Proposed Scope of Work for a Postconstruction Avian and Bat Fatality Study at the Maple Ridge Wind Power Project'. An incident report number was assigned and an incident report filled out for each find (Appendix B). A GPS was used to determine geographic coordinates, and a range finder and compass were used to determine distance and bearing from the tower. The carcass was photographed in the position in which it was found using a digital camera. After identifying the animal by species (including age and sex when possible), an examination was performed to determine the nature and extent of any injuries, and whether any scavenging or insect infestation had occurred. In case of dismemberment, the surveyors searched the vicinity to locate all body parts. In case of avian incidents, all loose feathers were collected in order to avoid identifying the feathers as an additional kill during the next survey of the tower. The carcass was then placed in a plastic bag labeled with date, species, tower number, and incident report number, and taken to a freezer to be stored in accordance with the U.S. Fish and Wildlife Service (FWS) permit requirements. When carcasses were found at times and locations outside of one of the standardized surveys conducted as part of this study, such as avian or prey surveys, the carcass was processed as above but it was classified as an "incidental" find. Brianna Gary and Ward Stone (NYSDEC) identified bird carcasses. Bat carcasses were identified by Al Hicks, also of the NYSDEC.

When an injured animal was found, the searchers recorded the same data collected for a carcass, noting however, that it was an injury and not a fatality. The searchers then captured and restrained the animal in a manner to avoid either further injury to the animal or injury to the survey crew. Once the animal was secured it was transported to a wildlife rehabilitator or veterinarian. Only one such avian incident occurred.

Rabies related precautions precluded the handling of injured bats in New York State. Only in those cases where the animal was in proximity to a specific turbine was a turbine number recorded as the location in the report. When no corroborating information that the injury was linked to a tower was available, the animal was simply recorded as having been found "Incidental". For instance, if a bird was found with a broken wing, it would not be associated with a specific wind turbine tower if it were observed to be mobile.

The protocol dictated that if the carcass or injured animal found was listed as a threatened or endangered species, or a species of concern, the Avian Respondent, listed in the WRRS, was to be notified immediately by telephone, and collection of the dead animal was to be delayed until specific direction for proceeding was received from the FWS.

2.1.4 Searcher Efficiency, Scavenger Removal, Proportion of Operational Towers searched:

It is recognized that the number of carcasses found under the towers is lower than the total number of birds and bats likely to have been killed. There are at least three factors that need to be accounted for. The first is the possibility that the searchers will miss carcasses due to the amount of ground cover or the size and coloration of the species making it difficult to spot them. A second possibility is that the carcasses are removed prior to the time the searchers arrive on location after the collision event occurred. Finally, the estimate of incidents must be adjusted by the ratio of the number of towers searched to the number of operational towers in the windfarm. Several scavenger removal and searcher efficiency studies conducted in late summer/early Fall 2006 estimated the proportion of carcasses missed by the searchers and the proportion removed by scavengers within the 1, 3 and 7 day search cycles.

We made the following adjustments to extrapolate the mortality counts to estimated mortality for the entire wind farm. We adjusted the number of carcasses found (*C*) for scavenger efficiency (*Sc*) and search efficiency (*Se*)

a) Proportion of test carcasses left by scavengers within the search period (*Sc*). Scavenge rate (*Sc*) was measured over 5 tests (6-Sep, 14-Sep, 26-Sep, 25-Oct, 7-Nov and 10-Nov 2006) by placing 55 bat carcasses and 16 small bird carcasses (e.g. European Starling) on mortality transects at various searched sites (1, 3 and 7 day sites) in the Maple Ridge Wind Resource Area (MRWRA). An additional 6 birds of medium (Mourning Dove) and Large (Seagull) were also used to test for scavenging. However, we were unable to update our New York state permits in time to carry out complete testing for medium and large birds. We monitored carcasses, daily for at least two weeks, and then once a week after most carcasses were either scavenged or extremely decomposed, for evidence of scavenging. The status of each carcass was reported as completely intact (CI), partially scavenged with carcass or large group of feathers remaining (PSC/PSF) or no remains (NR). Movement of carcasses was noted, although this could not always be distinguished from weather related events. The probability of a collision event is equally distributed over all days of the search cycle (1,3 or 7 days). Thus, the overall duration between carcass fall and discovery is approximately half the actual search cycle (0.5, 1.5 or 3.5 days respectively). For example, if a carcass was discovered at a 7-day search site, it had an equal probability of having hit the tower on each of the previous 7 nights. The average time between impact and discovery is (1 + 2 + 3 + 4 + 5 + 6)/6 = 3.5 days (rounded to 4 days). Thus, the scavenge rate was calculated for the number of test carcasses that were not visible (body of carcass removed/severely scavenged) after 1, 2 and 4 days, for the 1 day, 3 day and 7 day search sites, respectively.

b) Proportion of carcasses missed by observers in the search efficiency trials (*Se*). Search efficiency trials were conducted for each observer by having Aaftab Jain, the Project Coordinator, place bat carcasses and bird carcasses of three sizes, small, medium and large, under towers in the (MRWRA), without the knowledge of the searchers. The searchers recorded all carcasses that they discovered, including carcasses planted by the Project Coordinator. Planted evidence of collisions was later removed from the database and a mean search efficiency rate (*Se*) was calculated. The carcasses used to test for Search Efficiency were the same as the ones used to test for Scavenge Rate

c) Proportion of towers searched to the total number of operational towers in the windfarm (*Ps*).
Ps for the 10 1-day and 10 3-day sites was 10:120. *Ps* for the 30 7-day sites was 30:120.

Thus, $\dot{C} = \dfrac{C}{Sc \times Se \times Ps}$

Where $\dot{C}$ = Adjusted total number of kills estimated at the windfarm.

The variance of the number of kills found was first calculated per tower using standard methods. Then, we calculated the variance due to the correction factors *Sc* and Se, using the variance of a product formula (Goodman, 1960). The variance of the product of *Sc* and *Se* is:

$$\mathrm{Var}(\dot{C}) = \dot{C}^2 \times \left[\frac{\mathrm{var}\,\mathrm{C}}{\mathrm{C}^2} + \frac{\mathrm{var}(Sc \times Se)}{(Sc \times Se)^2} \right]$$

We used this procedure for the three different search frequencies (1 day, 3 day and 7 day) to get three different estimates of mortality for birds and bats.

3.0 RESULTS:

3.1 Search Effort

3.1.1 Summary of Search Effort:

Over the duration of the pilot project, we completed 2,244 individual turbine and meteorological tower searches over all 50 turbine and meteorological tower sites, during a period from June 17th to November 15th. All turbines were searched as frequently as the protocol described, although minor weather and human related disruptions occurred.

3.1.2 One-Day search sites (N = 10 turbines):

A total of 127 complete rounds of standardized searches were conducted between June 17, 2006 and November 15th, 2006 (Table 2), for a total of 1,270 turbine searches. The total search period was 152 days, out of which sites were not searched on 25 days due to inclement weather (heavy rain during the summer, inaccessible sites due to snow in the winter). The average number of days between successive searches for each tower was 1.16 days.

3.1.3 Three-Day search sites (N = 10 turbines):

A total of 45 complete rounds of standardized searches were conducted between June 29, 2006 and November 15th, 2006 (Table 2), for a total of 450 turbine searches. The total search period was 138 days. When sites could not be searched due to inclement weather (heavy rain during the summer, inaccessible sites due to snow in the winter), field technicians accessed the sites at the earliest available date before the next search round was due to occur. The average number of days between successive searches for each tower was 3.20 days.

3.1.4 Seven-Day search sites (N = 30 turbines):

A total of 16 complete rounds of standardized searches were conducted between July 11, 2006 and November 13th, 2006 (Table 2) (480 turbine searches). Two incomplete rounds, comprising 25 and 19 towers, were also done at the end of the study. Thus, the total number of turbine searches was 524. The total search period was 125 days. When sites could not be searched because to inclement weather (heavy rain during the summer, inaccessible sites due to snow in the winter), field technicians accessed the sites at the earliest available date before the next search round was due to occur. The average number of days between successive searches for each tower was 7.8 days.

Table 2. Total number of surveys completed at all 50 survey towers from June 17, 2006 to November 15, 2006.

10 Wind Turbines			**10 Wind Turbines**			**30 Wind Turbines**	
(1 Day Search Period)			**(3 Day Search Period)**			**(7 Day Search Period)**	
Carcass Surveys:	**Start Date**		**Start Date**	**End Date**		**Start Date**	**End Date**
Round 1	17-Jun		29-Jun	1-Jul		11-Jul	31-Jul
Round 2	18-Jun		2-Jul	4-Jul		18-Jul	7-Aug
Round 3	20-Jun		5-Jul	7-Jul		25-Jul	14-Aug
Round 4	21-Jun		8-Jul	10-Jul		1-Aug	21-Aug
Round 5	22-Jun		11-Jul	13-Jul		8-Aug	28-Aug
Round 6	23-Jun		14-Jul	16-Jul		15-Aug	11-Sep
Round 7	24-Jun		17-Jul	19-Jul		22-Aug	18-Sep
Round 8	25-Jun		20-Jul	23-Jul		29-Aug	25-Sep
Round 9	26-Jun		23-Jul	26-Jul		5-Sep	2-Oct
Round 10	27-Jun		26-Jul	31-Jul		12-Sep	9-Oct
Round 11	28-Jun		29-Jul	3-Aug		19-Sep	16-Oct
Round 12	29-Jun		1-Aug	6-Aug		26-Sep	25-Oct
Round 13	30-Jun		4-Aug	9-Aug		3-Oct	1-Nov
Round 14	1-Jul		7-Aug	12-Aug		10-Oct	7-Nov
Round 15	2-Jul		10-Aug	15-Aug		17-Oct	13-Nov
Round 16	3-Jul		13-Aug	18-Aug		24-Oct	13-Nov
Round 17	4-Jul		16-Aug	21-Aug		31-Oct	13-Nov
Round 18	5-Jul		19-Aug	24-Aug			
Round 19	6-Jul		22-Aug	27-Aug			
Round 20	7-Jul		25-Aug	30-Aug			
Round 21	8-Jul		28-Aug	2-Sep			
Round 22	9-Jul		31-Aug	5-Sep			
Round 23	10-Jul		2-Sep	8-Sep			
Round 24	11-Jul		6-Sep	14-Sep			
Round 25	12-Jul		9-Sep	17-Sep			
Round 26	13-Jul		12-Sep	20-Sep			
Round 27	14-Jul		15-Sep	26-Sep			
Round 28	15-Jul		18-Sep	30-Sep			
Round 29	16-Jul		21-Sep	2-Oct			
Round 30	17-Jul		25-Sep	5-Oct			
Round 31	18-Jul		27-Sep	8-Oct			
Round 32	19-Jul		30-Sep	14-Oct			
Round 33	20-Jul		3-Oct	18-Oct			
Round 34	21-Jul		6-Oct	22-Oct			
Round 35	22-Jul		9-Oct	24-Oct			
Round 36	23-Jul		13-Oct	26-Oct			
Round 37	24-Jul		16-Oct	1-Nov			
Round 38	25-Jul		19-Oct	7-Nov			
Round 39	26-Jul		22-Oct	10-Nov			
Round 40	27-Jul		25-Oct	13-Nov			
Round 41	29-Jul		1-Nov	13-Nov			
Round 42	30-Jul		7-Nov	14-Nov			
Round 43	31-Jul		9-Nov	14-Nov			

10 Wind Turbines			**10 Wind Turbines**			**30 Wind Turbines**	
(1 Day Search Period)			**(3 Day Search Period)**			**(7 Day Search Period)**	
Carcass Surveys:	**Start Date**		**Start Date**	**End Date**		**Start Date**	**End Date**
Round 44	1-Aug		13-Nov	13-Nov			
Round 45	2-Aug		15-Nov	15-Nov			
Round 46	3-Aug						
Round 47	4-Aug						
Round 48	5-Aug						
Round 49	6-Aug						
Round 50	7-Aug						
Round 51	8-Aug						
Round 52	9-Aug						
Round 53	10-Aug						
Round 54	11-Aug						
Round 55	12-Aug						
Round 56	13-Aug						
Round 57	14-Aug						
Round 58	15-Aug						
Round 59	16-Aug						
Round 60	17-Aug						
Round 61	18-Aug						
Round 62	19-Aug						
Round 63	20-Aug						
Round 64	21-Aug						
Round 65	22-Aug						
Round 66	23-Aug						
Round 67	24-Aug						
Round 68	25-Aug						
Round 69	26-Aug						
Round 70	28-Aug						
Round 71	29-Aug						
Round 72	30-Aug						
Round 73	31-Aug						
Round 74	1-Sep						
Round 75	2-Sep						
Round 76	3-Sep						
Round 77	4-Sep						
Round 78	5-Sep						
Round 79	6-Sep						
Round 80	7-Sep						
Round 81	8-Sep						
Round 82	9-Sep						
Round 83	10-Sep						
Round 84	11-Sep						
Round 85	12-Sep						
Round 86	15-Sep						
Round 87	16-Sep						
Round 88	17-Sep						
Round 89	18-Sep						

10 Wind Turbines			10 Wind Turbines			30 Wind Turbines	
(1 Day Search Period)			(3 Day Search Period)			(7 Day Search Period)	
Carcass Surveys:	Start Date		Start Date	End Date		Start Date	End Date
Round 90	19-Sep						
Round 91	20-Sep						
Round 92	21-Sep						
Round 93	22-Sep						
Round 94	25-Sep						
Round 95	26-Sep						
Round 96	27-Sep						
Round 97	28-Sep						
Round 98	29-Sep						
Round 99	30-Sep						
Round 100	2-Oct						
Round 101	3-Oct						
Round 102	4-Oct						
Round 103	5-Oct						
Round 104	6-Oct						
Round 105	7-Oct						
Round 106	8-Oct						
Round 107	9-Oct						
Round 108	10-Oct						
Round 109	13-Oct						
Round 110	14-Oct						
Round 111	16-Oct						
Round 112	18-Oct						
Round 113	19-Oct						
Round 114	22-Oct						
Round 115	24-Oct						
Round 116	25-Oct						
Round 117	26-Oct						
Round 118	27-Oct						
Round 119	31-Oct						
Round 120	1-Nov						
Round 121	2-Nov						
Round 122	7-Nov						
Round 123	8-Nov						
Round 124	9-Nov						
Round 125	10-Nov						
Round 126	13-Nov						
Round 127	15-Nov						

3.1.5 Meteorological towers:

One meteorological tower was searched daily, for a total of 97 searches, from July 17th, 2006 to November 15th, 2006. The average search interval for this tower was 1.25 days. The second meteorological tower was searched every 3 days (31 total searches, from July 17th, 2006 to November 14th, 2006). A total of 128 searches at meteorological towers were conducted. The average search interval for this tower was 3.87 days. See Table 3 below for a complete list of search dates.

Table 3: Total number of surveys completed at both meteorological towers from July 17, 2006 to November 15, 2006.

	Meteorological Tower #2	Meteorological Tower #1
	(1 Day Search Period)	(3 Day Search Period)
Carcass Surveys:	Date	Date
Round 1	17-Jul	17-Jul
Round 2	18-Jul	20-Jul
Round 3	19-Jul	23-Jul
Round 4	20-Jul	1-Aug
Round 5	21-Jul	4-Aug
Round 6	22-Jul	7-Aug
Round 7	23-Jul	10-Aug
Round 8	24-Jul	13-Aug
Round 9	25-Jul	16-Aug
Round 10	26-Jul	22-Aug
Round 11	27-Jul	25-Aug
Round 12	29-Jul	28-Aug
Round 13	30-Jul	31-Aug
Round 14	31-Jul	3-Sep
Round 15	1-Aug	6-Sep
Round 16	2-Aug	9-Sep
Round 17	3-Aug	12-Sep
Round 18	4-Aug	15-Sep
Round 19	5-Aug	18-Sep
Round 20	6-Aug	21-Sep
Round 21	7-Aug	24-Sep
Round 22	8-Aug	25-Sep
Round 23	9-Aug	27-Sep
Round 24	10-Aug	30-Sep
Round 25	11-Aug	3-Oct
Round 26	12-Aug	6-Oct
Round 27	13-Aug	9-Oct
Round 28	14-Aug	18-Oct
Round 29	15-Aug	22-Oct
Round 30	16-Aug	24-Oct
Round 31	17-Aug	27-Oct
Round 32	18-Aug	2-Nov
Round 33	19-Aug	8-Nov
Round 34	20-Aug	13-Nov
Round 35	21-Aug	14-Nov
Round 36	22-Aug	
Round 37	23-Aug	
Round 38	24-Aug	
Round 39	25-Aug	
Round 40	26-Aug	

	Meteorological Tower #2	**Meteorological Tower #1**
	(1 Day Search Period)	**(3 Day Search Period)**
Carcass Surveys:	**Date**	**Date**
Round 41	28-Aug	
Round 42	29-Aug	
Round 43	30-Aug	
Round 44	31-Aug	
Round 45	1-Sep	
Round 46	2-Sep	
Round 47	3-Sep	
Round 48	4-Sep	
Round 49	5-Sep	
Round 50	6-Sep	
Round 51	7-Sep	
Round 52	8-Sep	
Round 53	9-Sep	
Round 54	10-Sep	
Round 55	11-Sep	
Round 56	12-Sep	
Round 57	15-Sep	
Round 58	16-Sep	
Round 59	17-Sep	
Round 60	18-Sep	
Round 61	19-Sep	
Round 62	20-Sep	
Round 63	21-Sep	
Round 64	22-Sep	
Round 65	25-Sep	
Round 66	26-Sep	
Round 67	27-Sep	
Round 68	28-Sep	
Round 69	29-Sep	
Round 70	30-Sep	
Round 71	2-Oct	
Round 72	3-Oct	
Round 73	4-Oct	
Round 74	5-Oct	
Round 75	6-Oct	
Round 76	7-Oct	
Round 77	8-Oct	
Round 78	9-Oct	
Round 79	10-Oct	
Round 80	14-Oct	
Round 81	16-Oct	
Round 82	18-Oct	
Round 83	19-Oct	
Round 84	22-Oct	
Round 85	24-Oct	
Round 86	25-Oct	

	Meteorological Tower #2	Meteorological Tower #1
	(1 Day Search Period)	(3 Day Search Period)
Carcass Surveys:	Date	Date
Round 87	26-Oct	
Round 88	27-Oct	
Round 89	31-Oct	
Round 90	1-Nov	
Round 91	2-Nov	
Round 92	7-Nov	
Round 93	8-Nov	
Round 94	9-Nov	
Round 95	10-Nov	
Round 96	13-Nov	
Round 97	15-Nov	

3.2 Incidents Recorded During Surveys.

3.2.1 Birds:

During this study, of the total of 138 avian fatalities/injuries found during standardized searches and incidentally, in this study. Of these, 15 (10.9%) were found incidentally and of 384 total bat fatalities, 58 (15.1%) were found incidentally. In Table 3, the incidental finds are listed in a separate column by species but are not included in either the totals or calculations.

The term “incident” is used here to refer to either a fatality or injury of a bird or bat found within the wind project area and does not necessarily indicate that the cause of death or injury was wind turbine related. This term is not to be confused with the term defined earlier, “incidental find”, which refers to incidents found other than during standardized surveys and at sites outside the 50 searched towers.

A total of 123 avian incidents were recorded by searchers during standardized surveys, representing 29 species, which included 16 unidentified birds. Of these 16, one was identified only as a non-passerine species (Table 3) and 15 were not identifiable to a taxonomic group because they were scavenged and, or decayed prior to being found. Of the 29 species, only one was a raptor species (one American Kestrel). No waterfowl, game birds, or shore birds, or other waterbirds were found during the regular turbine searches. There were 106 incidents of identified passerines (songbirds) identified to 26 different species plus two birds identifiable as passerines (one warbler species and one vireo species). Golden-crowned Kinglets (n = 49; 39.8% of 123 avian incidents) and Red-eyed Vireos (n = 12; 9.8%) were the most common species found. All but one of the avian incidents found during this study were fatalities. One injured Blue-throated Black Warbler (9/25/06) was taken to a local rehabilitation clinic (Lowville, NY) and was successfully released the next day. This incident was used in the estimates of total incidents on site with the presumption that injured birds would have a low probability of survival in the absence of the rehabilitation process.

Night migrants accounted for 82.1% of the 123 avian incidents recorded during standardized surveys. Of all 106 identified songbirds, (excluding incidental finds) registered, 101 (95.3%) were night migrating birds. The term "incident" is used here to refer to either a fatality or injury of a bird or bat found within the wind project area and does not necessarily indicate that the cause of death or injury was wind turbine related.

An additional 19 fatalities/injuries representing eight species were found incidental to standardized surveys. These incidents account for 13.3% of the 143 avian fatalities/injuries found during the study period. These included three Wild Turkey carcass remnants, two of which were located > 80m from the nearest tower and one was located > 40m from the nearest tower. Due to the limited flight capabilities of Wild Turkeys and the great distances of the carcasses from turbines, they were not considered turbine related deaths. Other incidental finds included Black-throated Blue Warbler, Magnolia Warbler, American Crow, Ruffed Grouse, Red-eyed Vireo, Tree Swallow, Eastern Phoebe. Two more unidentified birds and two Canada Geese were reported by wind farm technicians from towers outside Phase I. These were either Phase II or Phase IA towers that are to be included in the study in 2007. This mix of taxa represent night migrants, daytime migrants, and residents (birds that do not migrate).

Only two (Table 4) avian fatalities were registered at the two guyed communication towers that were searched. These birds (a Rose-breasted Grosbeak and an unidentified Warbler) were both night migrants and both were found incidentally and not during standardized searches.

Table 4. Number of Avian Incidents at each Wind Turbine by Species Group found during standardized surveys and "incidentally" from June 17th to November 15th 2006..

Tower #	Search Frequency	Other	Raptor	Unidentified bird	Passerine	Total Standardized Survey Incidents.	Incidental
56	1 Day			1	8	9	
52	1 Day	1			6	7	
89	1 Day				7	7	
181	7 Day				6	6	
17	1 Day				5	5	
98	1 Day				5	5	
189	1 Day				5	5	
12	7 Day				4	4	
24	7 Day				4	4	
57	1 Day				4	4	
97	1 Day			2	2	4	
183	7 Day			1	3	4	
32	7 Day		1	1	1	3	1
75	1 Day			2	1	3	
83	3 Day				3	3	
86	3 Day				3	3	
108	7 Day			2	1	3	
193	3 Day				3	3	

Tower #	Search Frequency	Other	Raptor	Unidentified bird	Passerine	Total Standardized Survey Incidents.	Incidental
195	3 Day				3	3	
197	3 Day			2	1	3	
16	7 Day			1	1	2	
22A	7 Day				2	2	
26	7 Day				2	2	
27	7 Day			1	1	2	
34	7 Day				2	2	
45	3 Day				2	2	
53	7 Day				2	2	
76	3 Day				2	2	
82	3 Day				2	2	
101	7 Day			1	1	2	
185	7 Day				2	2	
39	7 Day				1	1	
50	7 Day				1	1	
54A	7 Day				1	1	
59	7 Day				1	1	
64	7 Day				1	1	
77	1 Day				1	1	
90	7 Day				1	1	
102	3 Day				1	1	1
103	7 Day				1	1	
104	7 Day				1	1	
109	7 Day			1	0	1	
110	7 Day				1	1	
179	3 Day				1	1	
23	7 Day				0	0	
35	7 Day				0	0	
37	7 Day				0	0	
40	7 Day				0	0	
71	1 Day				0	0	
99	1 Day				0	0	
180	7 Day				0	0	
192	7 Day				0	0	2
13	Incidental						1
38	Incidental						1
47	Incidental						1
68	Incidental						1
111	Incidental						1
135	Incidental						1
163	Incidental						1
175	Incidental						1
138A	Incidental						2
Met # 1	Incidental						2
	Totals	**1**	**1**	**15**	**106**	**123**	**16**
Sorted by total number of avian fatalities found during standardized surveys (descending order).							

Tower #	Search Frequency	Other	Raptor	Unidentified bird	Passerine	Total Standardized Survey Incidents.	Incidental
Includes incidents associated with wind turbines found during standardized surveys and "incidentally" from June 17th to November 15th 2006.							

Figure 4. Locations of Bat Incidents in 2006 at the Maple Ridge WRA found during Standardized Surveys in the High Winds Project Site, June 17th, 2006 through November 15, 2006, (1, 3 and 7-day sites, Phase I)

Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally

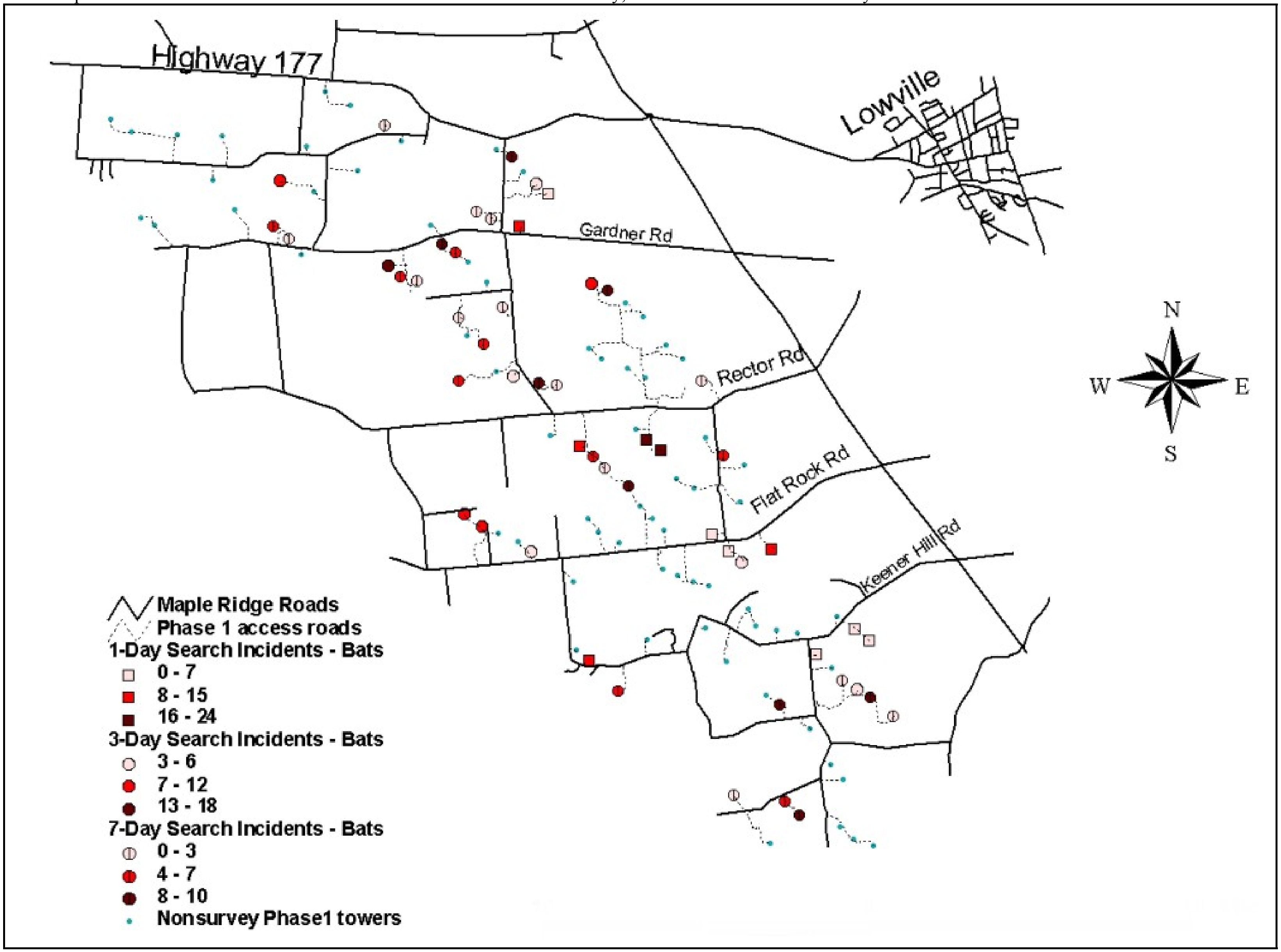
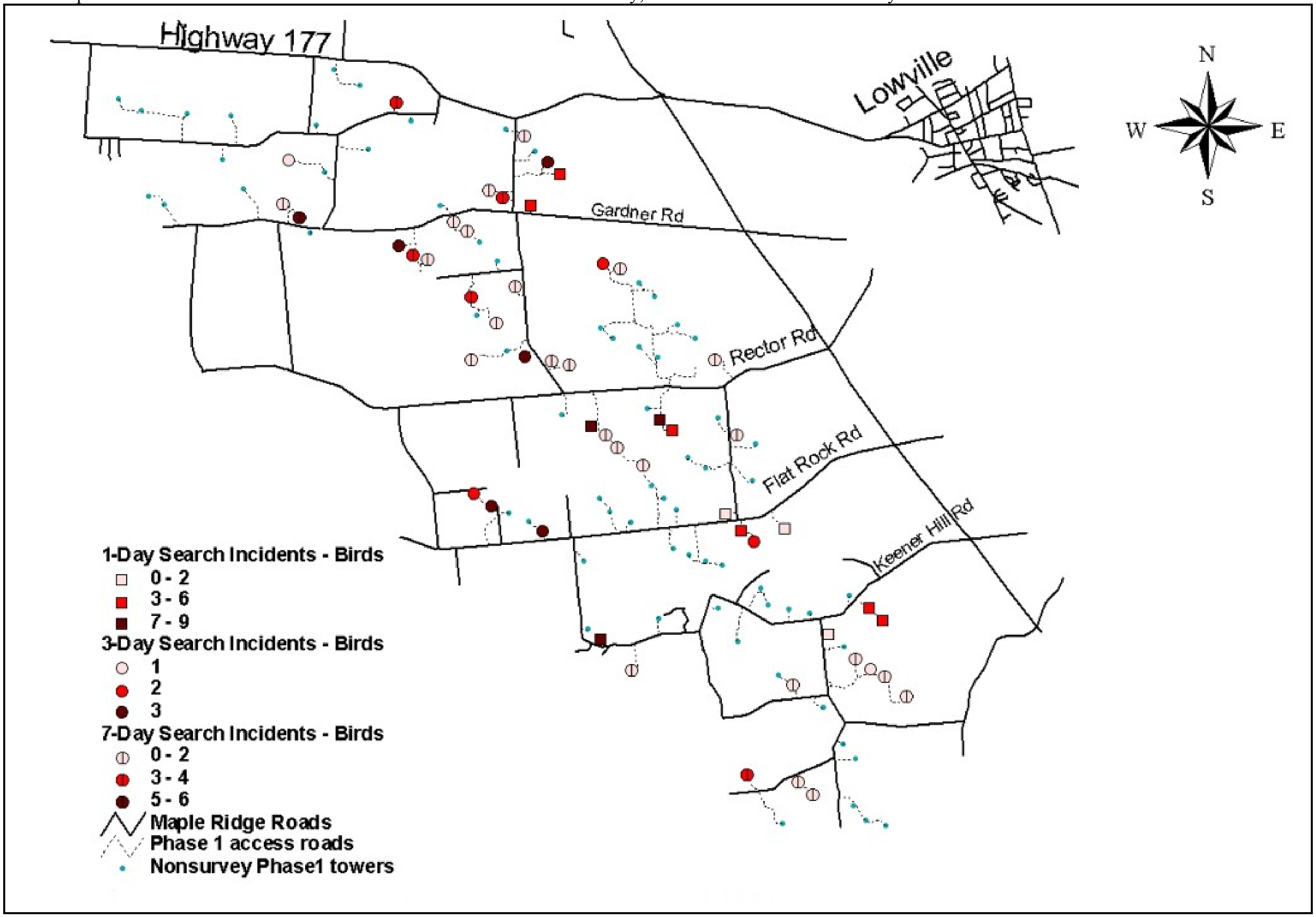


Figure 5. Locations of Avian Incidents in 2006 at the Maple Ridge WRA found during Standardized Surveys in the High Winds Project Site, June 17th, 2006 through November 15, 2006, (1, 3 and 7-day sites, Phase I)

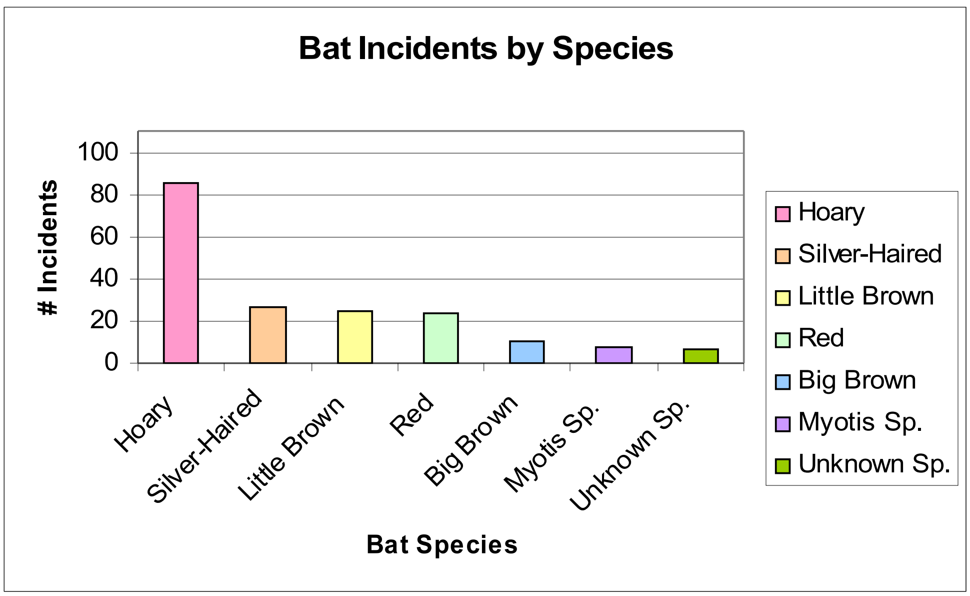
Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally.



3.2.2 Bats:

Remains of 384 bats were found by searchers during standardized surveys and via incidental finds. These fatalities represented at least 5 different species including Hoary Bat, Silver-Haired Bat, Red Bat, Little Brown Bat, and Big Brown Bat. Bat species identification by Al Hicks at the NYSDEC is ongoing. Currently, 220 out of 383 bat carcasses have been processed and assigned species identifications. Of these, 185 bats were from standardized surveys and 37 bats were from incidental finds. Out of the 185 bats found during standardized surveys, Hoary Bats comprised 45.95% (n = 85), Silver-Haired Bats comprised 14.59% (n = 27), Little Brown Bats comprised 13.51% (n = 25), Red Bats comprised 12.97% (n = 24), and Big Brown Bats comprised 5.41% (n = 10). A further 4.32% (n = 8) were identified as Myotis species (probably Little Brown Bats) and 3.24% (n = 6) (Figure 2) could not be identified because of the advanced state of decomposition (Figure 2). The proportions were similar when identifying the incidental finds.

Figure 6. Distribution of Bat Incidents by Species, from standardized surveys conducted from June 17th to November 15th 2006.*



* 185 out of 326 total bat carcasses processed to date.

Table 5, (below) shows the number of bat incidents associated with specific wind turbines found during standardized surveys as well as incidental finds. The data is from the 220 bat fatalities processed thus far out of the total of 383 bat fatalities submitted for species identification. It is sorted by the total number of incidents associated with each tower in descending order, separated by search frequency (1, 3 and 7 day). An in-depth analysis of the interaction between bat species and particular tower types must await the remaining significant number of bat fatalities to be assigned species.

Table 5. Wind Turbine Locations of Bat Incidents by Species

Tower #	Search frequency	Hoary	Silver-Haired	Red	Little Brown	Big Brown	Myotis Species	Unknown Species	Total
185	7 day	4			2	1	1		8
192	7 day	5	1			1			7
39	7 day	6							6
103	7 day	1	2	3					6
110	7 day	5			1				6
16	7 day	2		1	1	1			5
109	7 day	2	1		2				5
37	7 day	2		1			1		4
59	7 day	3		1					4
64	7 day	1	2	1					4
22A	7 day			1	3				4
50	7 day		1		2				3
90	7 day	1		1	1				3
12	7 day	1	1						2
24	7 day	1	1						2
32	7 day	1					1		2
34	7 day	2							2
53	7 day				2				2
108	7 day	1							1
23	7 day		1						1
26	7 day		1						1
35	7 day			1					1
40	7 day	1							1
104	7 day				1				1
180	7 day		1						1
54A	7 day						1		1
27	7 day								0
101	7 day								0
181	7 day								0
183	7 day								0
82	3 day	4	2	2			1	1	10
193	3 day	3	3	2	1	1			10
83	3 day	2	1	2	2		1		8
45	3 day	4	1	1					6
76	3 day	2	1	1	1				5
179	3 day	3			1	1			5
102	3 day			1		1		1	3
195	3 day	1	1	1					3
197	3 day	1		1					2
86	3 day		1						1
Met #1	3 day								0
56	1 day	3	1		1	2	1	2	10
57	1 day	5			1		1		7
17	1 day	3	1	2					6
89	1 day	6							6
97	1 day	2	1		1	1		1	6
189	1 day	3	1		1				5

Tower #	Search frequency	Hoary	Silver-Haired	Red	Little Brown	Big Brown	Myotis Species	Unknown Species	Total
98	1 day	2				1		1	4
52	1 day		1		1				2
75	1 day	1							1
77	1 day	1							1
71	1 day								0
99	1 day								0
Met #2	1 day								0
62A	Incidental	1	2						3
106	Incidental	1				1			2
170	Incidental	3							3
41	Incidental	1		1					2
42	Incidental	2							2
43	Incidental	1		1					2
68	Incidental	1			1				2
171	Incidental		1		1				2
172	Incidental			1	1				2
180	Incidental		1		1				2
44	Incidental		1						1
46	Incidental	1							1
48	Incidental	1							1
55	Incidental		1						1
60	Incidental		1						1
65	Incidental	1							1
72	Incidental	1							1
96	Incidental							1	1
186	Incidental	1							1
188	Incidental		1						1
191	Incidental			1					1
61a	Incidental			1					1
Fenner Rd.	Incidental		1						1
Phoenix Rd	Incidental	1							1
	Total (std.)	85	27	24	25	10	8	6	**184**
	Total (inc.)	16	9	6	4	1	0	1	**36**
	Total	**101**	**36**	**30**	**29**	**11**	**8**	**7**	**220**
	Data from 220 identified bat fatalities (184 during standardized surveys and 36 'incidental finds', June 17th to November 15th 2006.								
	Sorted by number of fatalities (descending order).								

3.2.3 Seasonal Distribution of Fatalities (Birds and Bats):

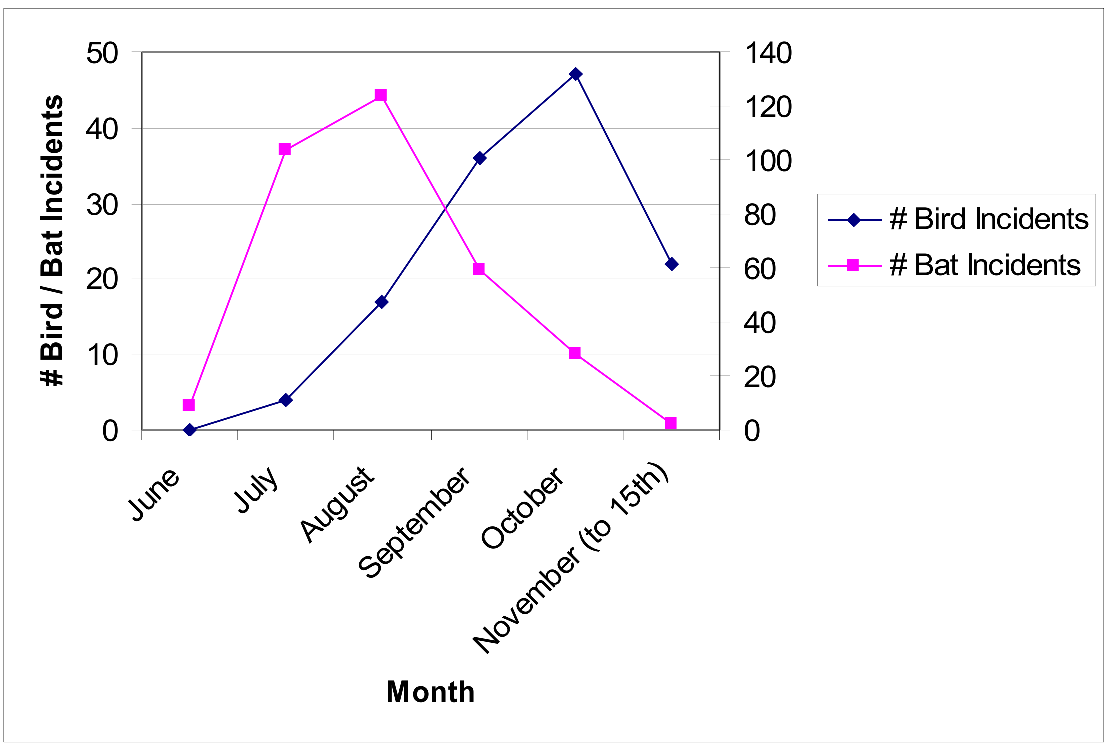
While the duration of this project only included summer, fall and early winter, we were able to discern patterns in seasonal mortalities that coincided largely with fall migration. Bat fatalities peaked in July and August (Figure 7, Table 6) and declined sharply in subsequent months, as fall migration concluded and temperatures became colder. Only two bat incidents were noted in the first half of November, although these incidents were remarkable as temperatures were generally well below freezing, and snowfall had begun to impede searches. Carcasses were relatively fresh, so these birds had been active in relatively cold, sometimes freezing temperatures. Bird incidents peaked later than bats, increasing in a linear fashion from July through September, and then declining noticeably in late October and into November. However, numbers for the first half of November remained relatively high (22 incidents in two weeks, Table 6) in spite of snow cover and inclement weather.

Table 6. Number of birds and bats found per month, from June 17th to November 15th. 2006

Species Group	JUN	JUL	AUG	SEP	OCT	NOV[1]	Total
Raptor	0	1	0	0	0	0	1
Passerine	0	2	15	29	42	19	107
Other Bird/Non-Identified Birds[2]	0	0	2	5	5	3	15
Bat	9	104	124	59	28	2	326
Total	7	106	141	93	75	24	449

[1]Searches were concluded on November 15th, and several snowy days in November precluded searching.
[2]'Other birds' comprised of one Woodpecker species in September. The rest of this category were Non-Identified Birds.

Figure 7. Number of birds and bats found per month, from June 17th to November 15th.



3.2.4 Distance from Turbine Bases. There were primarily two classes of animals involved with tower collisions: small birds and bats. The very small sample size of larger birds will not be considered in the following analyses because of the paucity of data available. While the weight and size of birds and bats are similar, there are behavioral differences in the flight pattern of these groups. Turbine incidents were divided into small bird and bat events to determine if surveying a 120m by 130m radius area is an effective method for finding the majority of carcasses for both size classes. The number of incidents of species (found during standardized surveys only) falling into each size group (Table 7) were then tabulated based on distance (range) from the base of wind turbines (Table 8). As wooded sites could not be searched beyond the tree line (approximately 45 m from the base of the tower) we used only non-wooded sites to estimate the range of distances that birds and bats fall from the towers. Also, we used data from the period after site setup and mowing was completely in place (September 1st – November 15) as our previous search efforts focused on the area close to the towers until adequate mowing occurred.

Table 7. Species Size Groupings used in Analyses.

Category	Description
Small Bird	≤ 8" length (most smaller passerines)
Bats	≤ 6" length (some bats may be as small as 2")

Distances were recorded for all 123 bird and 326 bat carcasses found during standardized surveys. However, after eliminating incidents from wooded sites, as well as incidents that were recorded before mowing was done completely, 69 bird incidents and 74 bat incidents remained to evaluate "fall" distance from tower. The number of bat incidents that we could analyze was more impacted by this elimination process as the peak in fall bat migration occurs earlier than the peak in fall bird migration.

Table 8. Number of Incidents per Size Grouping (Small Birds and Bats) versus Distance from Wind Turbine Tower, September 1, 2006 through November 15, 2006.

	Distance Range (m)																
Size Group	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	Total
Small Birds	2	0	3	5	5	1	5	9	4	10	6	5	6	4	2	2	69
Bat	14	10	2	6	4	9	6	8	4	4	4	1	0	0	1	1	74
Total	16	10	5	11	9	10	11	17	8	14	10	6	6	4	3	3	143

Of the 69 bird incidents found during standardized surveys, 80% were located within 60 meters of a wind turbine (Table 8). Of the 74 bat incidents found during standardized surveys, 80% were located within 40m of the tower and 98% were located within 60m of the tower. Thus, bat incidents were concentrated closer to the tower than birds. Beyond 60-65m, the transects covered an area in the 4 corners of the 120 by 130m square. Because distance from the turbines alone is not adequate to evaluate bird and bat carcass distances from the turbines we looked at bird and bat incident density in the following manner. For both birds and bats, we divided the recorded distances into concentric 5m rings. The number of carcasses per ring was divided by the area of the ring that fell within the 120m by 130m search area, to give the carcass density. As described above, smaller concentric rings lay entirely within the overall search area, whereas larger concentric rings (radius > 60m were only partially in the overall search area. These densities were plotted (Figures 4 and 5) along with a logarithmic trend line to forecast the distance at which density drops to zero, indicating no more incidents would be found at that distance. The R^2 (goodness-of-fit) value for both trend lines are shown on the figures (R^2= 1 indicates perfect fit). The R^2 for the bat incidents (Figure 5) is 0.59 while the R^2 = 0.39 for the bird incidents (Figure 6).

While this method of estimation indicates that densities of bat incidents approximate zero outside of 50m from the tower, densities of bird incidents are forecast to remain greater than zero beyond 100m. To accurately determine the extent of missed incidents which are located outside of the 75 meter search pattern radius, a new methodology incorporating greater search areas would need to be defined. However, given landowner constraints and limited search area, this would be difficult to implement at the MRWRA.

Figure 8. Density of bird incidents at non-wooded sites, from surveys conducted between September 1st 2006 and November 15 2006, in relation to distance from towers.
Trend line predicts distance at which density approximates zero (R^2 = 0.39) at approximately 110m.

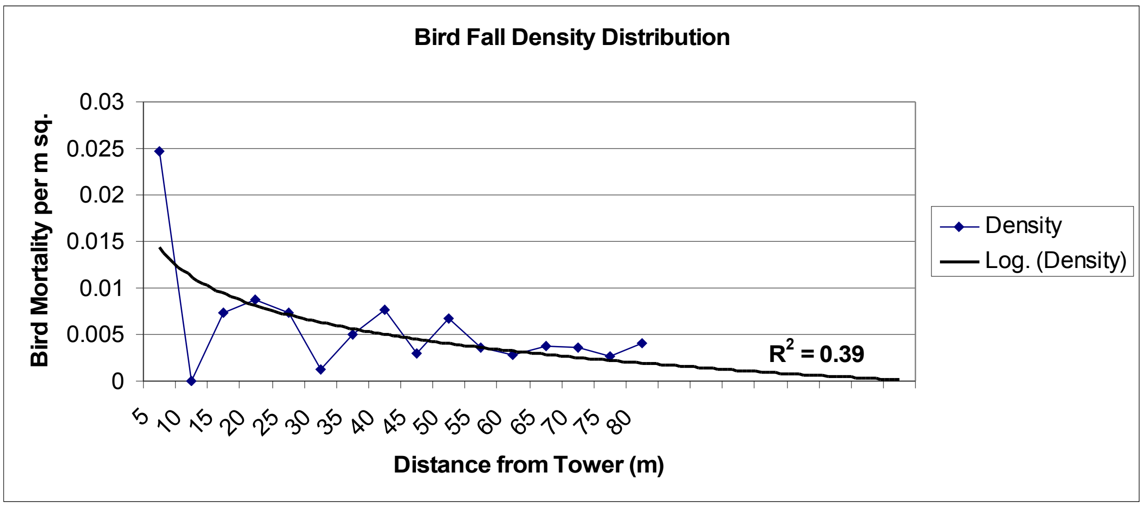
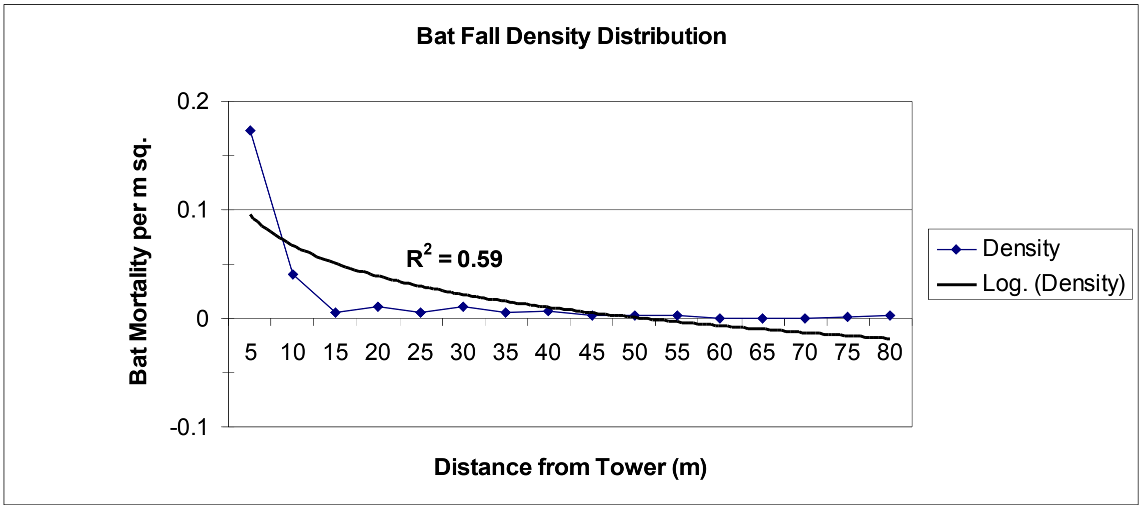


Figure 9. Density of bat incidents at non-wooded sites, from surveys conducted between September 1st 2006 and November 15 2006, in relation to distance from towers.
Trend line predicts distance at which density approximates zero ($R^2 = 0.59$) at approximately 45 m.



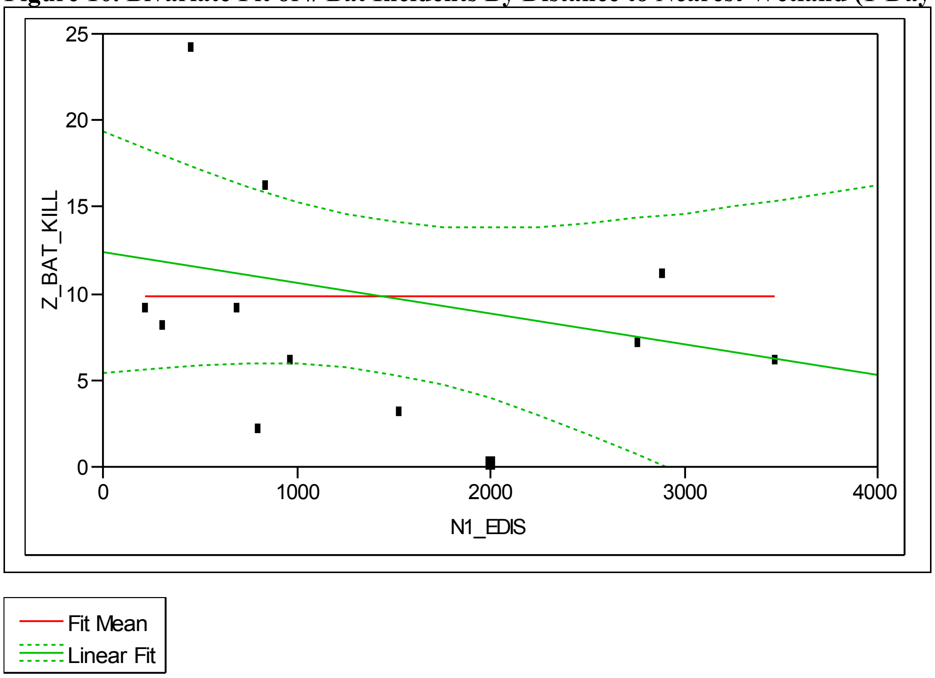
3.2.5 Distance to Nearest Wetland (Bats):

All of the 5 bat species found at the MRWRA are known to forage over water bodies to some extent (Erickson 2002, Furlonger *et al* 1987, Genter and Jurist 1995, Zinn and Baker 1979) as well as use wetlands for some of their daily water intake needs (Kurta 2000). As a result, we investigated the correlation between the number of bat incidents noted at turbine tower sites and the corresponding distance of that turbine tower to the nearest wetland. We performed F-tests for the one, three and seven-day sites although sample size was small (n = 10) for the 10 one-day and 10 three-day sites respectively. N = 30 for the seven day sites, resulting in a more robust analysis.

3.2.5.1 One-Day Sites:

There was no significant negative relationship between the number of bat incidents recorded at the 1-day sites and distance to the nearest wetland (F –Test Analysis of Variance, $F = 1.10$, $p = 0.32$, $df = 1, 8$). The relationship is represented in Figure 10.

Figure 10. Bivariate Fit of # Bat Incidents By Distance to Nearest Wetland (1-Day sites)

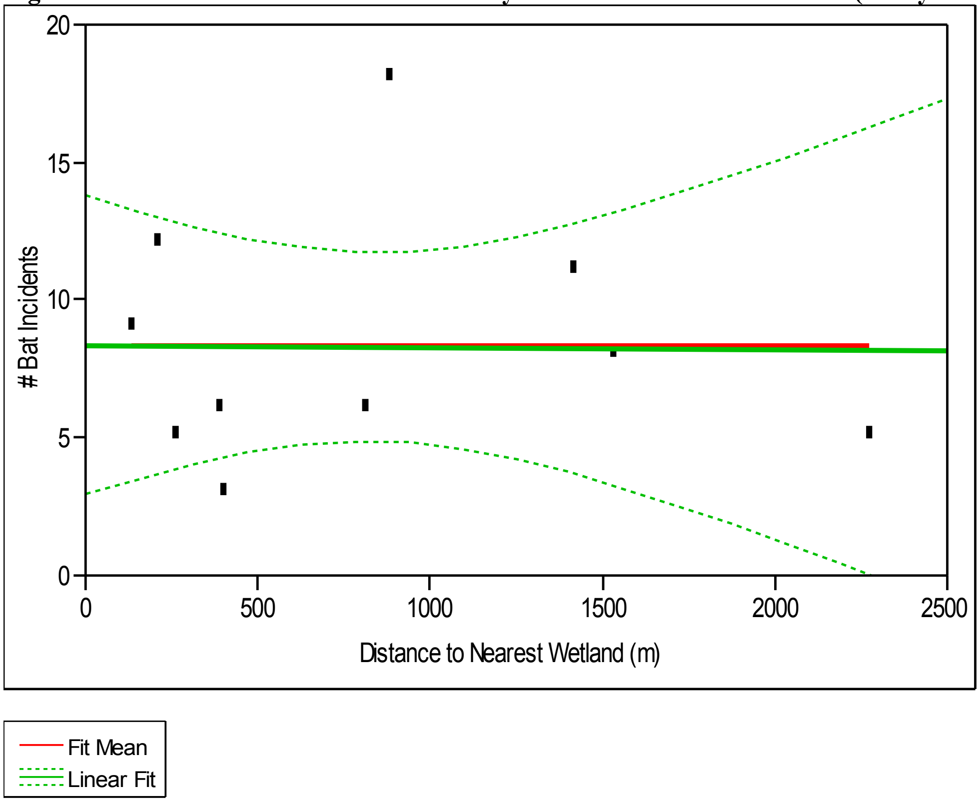


The broken green line in Figure 10 indicates 95% confidence intervals for the negative relationship. The unbroken red line indicates the mean # of bat incidents (Mean = 9.9).

<u>3.2.5.2 Three-Day Sites:</u>

There was no significant negative relationship between the number of bat incidents recorded at the 3-day sites and distance to the nearest wetland (F –Test Analysis of Variance, F = 0.002, p = 0.96, df = 1, 8). The relationship is represented in Figure 11.

Figure 11. Bivariate Fit of # Bat Incidents By Distance to Nearest Wetland (3-Day sites)

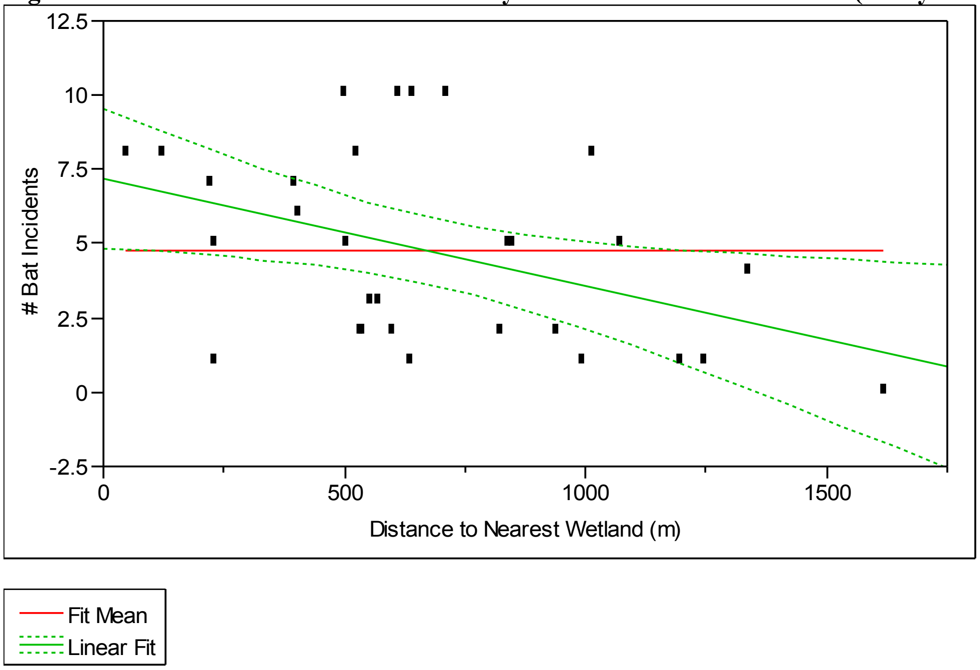


The broken green line in Figure 11 indicates 95% confidence intervals for the negative relationship. The unbroken red line indicates the mean # of bat incidents (Mean = 8.3).

3.2.5.3 Seven-Day Sites:

There was a significant negative relationship between the number of bat incidents recorded at the 7-day sites and distance to the nearest wetland (F –Test Analysis of Variance, $F = 5.93$, $p = 0.02$, $df = 1, 28$) The negative relationship is represented in Figure 12.

Figure 12. Bivariate Fit of # Bat Incidents By Distance to Nearest Wetland (7-Day sites)



The broken green line in Figure 12 indicates 95% confidence intervals for the negative relationship. The unbroken red line indicates the mean # of bat incidents (Mean = 4.73).

3.2.6 Wooded versus Non-wooded Turbine sites.

The area within the MRWRA wind farm is a mix of agricultural/grassland (non-wooded) and wooded land. Out of the 30 towers searched on a 7-day (weekly) basis, 14 were classified as wooded and 16 were classified as non-wooded sites. We performed non-parametric tests (chi-squared) to determine whether a disproportionate number of bird and bat incidents were found at wooded versus non-wooded sites. However, we had to adjust for the fact that wooded sites could only be searched out to approximately 40m from the tower base, whereas non-wooded sites were searched out to the full 120m by 130m search area. Thus, to insure equal search areas and detectability, we compared the number of incidents at both types of sites that fell within the 40m search area. A chi-square test (Table 9) revealed that there was not a significant deviation from the expected number of bat incidents within 40m of the turbine tower base at wooded as opposed to non-wooded turbine sites ($\chi^2 = 1.77$,*df* = 1, P>0.10, ns). Further, a chi-square test (Table 10) revealed that there was not a significant deviation from the expected number of bird incidents within 40m of the turbine tower base at wooded as opposed to non-wooded turbine sites ($\chi^2 = 0.09$,*df* = 1, P>0.10, ns)

Table 9. Contingency table showing the proportion of bat incidents noted within 40m from turbine tower base of the 30 7-day search sites, comparing wooded versus non-wooded sites.

	# 7-Day Turbines	# Bats (within 40m)	Sum
Non-wooded Towers	16	21	37
Wooded Towers	14	27	41
Sum	30	48	78

Table 10. Contingency table showing the proportion of bird incidents noted within 40m from turbine tower base of the 30 7-day search sites, comparing wooded versus non-wooded sites.

	# 7-Day Turbines	# Birds (within 40m)	Sum
Non-wooded Towers	16	10	26
Wooded Towers	14	10	24
Sum	30	20	50

3.2.7 Lit versus Un-Lit Turbine sites:

We examined the numbers of incidents of night migrating bird and bat fatalities at turbines with FAA lights vs. turbines without such lights. Chi-square tests were performed at the 10 1-day search sites and the 30 7-day search sites to test whether the actual proportion of incidents at lit versus unlit towers differed significantly from expected proportion, but no significant difference was seen. If the FAA lights did not attract birds/bats, the proportion of incidents should be the same as the proportion of lit to unlit towers. (We did not perform this test at the 10 3-day sites due to the lack of lit turbines in that sample).

There was no significant deviation (Table 11) from the expected number of bat incidents within 40m of the tower base at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 0.07$,*df* = 1, P>0.10, ns). There was no significant deviation (Table 12) from the expected number of bird incidents within 40m of the tower base at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 1.74$,*df* = 1, P>0.10, ns). There was no significant deviation (Table 13) from the expected number of bird incidents at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 0.08$,*df* = 1, P>0.10, ns), amongst the 10 towers searched on a daily basis (1-day sites). There was a marginally significant deviation (Table 14) from the expected number of bird incidents at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 3.58$, *df* = 1, $0.05 < p < 0.10$, ns), amongst the 10 towers searched on a daily basis (1-day sites).

Table 11. Contingency table showing the proportion of bat incidents noted within 40m from turbine tower bases of the 30 7-day search sites, comparing lit versus unlit sites.

	# 7-Day Turbines	# Bats (40m)	Sum
Lit Towers	7	12	19
Unlit Towers	23	36	59
Sum	30	48	78

Table 12. Contingency table showing the proportion of bird incidents noted within 40m from turbine tower bases of the 30 7-day search sites, comparing lit versus unlit sites.

	# 7-day Turbines	# Birds (40m)	Sum
Lit	7	2	9
Unlit	23	17	40
Sum	30	19	49

Table 13. Contingency table showing the proportion of bat incidents noted within the complete search area under turbine tower bases of the 10 3-day search sites, comparing lit versus unlit sites.

	# 1-day Turbines	# Bats	Sum
Lit	3	24	27
Unlit	7	60	67
Sum	10	84	94

Table 14. Contingency table showing the proportion of bird incidents noted within the complete search area under turbine tower bases of the 10 3-day search sites, comparing lit versus unlit sites.

	# 1-day Turbines	# Birds	Sum
Lit	3	24	9
Unlit	7	34	41
Sum	10	58	50

3.3 Adjusting Fatality Estimates

3.3.1 Estimates from One-day, Three-day and Seven-day Search Sites:

Our search protocols were designed to search a subset (N = 50) of the 120 turbines in phase I of the MRWRA. The three different search frequencies (one day, three days and seven days) provide an opportunity to assess different distributions of search effort and the resulting accuracy of mortality estimates. A statistical power analysis of these three search frequencies is now being conducted, per requests from members of the TAC. Results presented here include 95% confidence intervals for the three search frequencies so that each may be evaluated for level of confidence and so that the best or optimal methods may be used in the future.

Table 15 shows the results of the scavenger study as described in the Methods. As there were three different search frequencies, there were three different scavenging rates. The proportion of Small Birds not Scavenged (Sc) within one, two and four days was used to adjust the number of both Small and Medium size bird incidents that were discovered by our searchers. Due to a delay in receiving necessary permits, only one test (n = 16) was carried out for small birds. Further, the number of Medium and Large birds used to test for Sc was inadequate for the purposes of this study. However, only two medium and no large birds were found during standardized surveys in 2006. Scavenge tests for 2007 will have adequate testing for all size classes of birds and of bats. The proportion of bats not Scavenged (Sc) within one, two and four days was used to adjust the number of bat incidents that were discovered by our searchers.

Table 15. Maple Ridge Scavenger Removal Study Data.

	# of carcasses	# Scavenged.	Prop. not scavenged (Sc)	Prop. Scavenged
Small Birds – 1 day[1]	16	1	0.94	0.06
Small Birds – 3 day	16	1	0.94	0.06
Small Birds – 7 day	16	1	0.94	0.06
Bats – 1 day	71	10	0.86	0.14
Bats – 3 day	71	14	0.80	0.20
Bats – 7 day	71	20	0.72	0.28

[1]Sc for small birds was also used to estimate the proportion of medium sized birds scavenged.

Table 16 shows the results of the preliminary Search efficiency study as described in the Methods. The proportion of birds found (Se) was used to adjust the number of incidents that were discovered by our searchers, in each size class (Small, Medium, Large and Bats).

Table 16. Maple Ridge Searcher Efficiency Study Data.

	# carcasses	# not found	**Prop found (Se)**	Proportion not found
Small Birds[1,2]	16	7	0.44	0.56
Bats	57	24	0.42	0.58

[1]The search efficiency rate is unaffected by the three search periods therefore the same rate was applied to all three search frequencies.
[2]Se for small birds was also used to estimate the proportion of medium sized birds scavenged.

Tables 17, 18 and 19 show estimates of the number of bird and bat fatalities attributed to collisions with the wind turbines at the Maple Ridge project in the 2006 study period. They reflect search and scavenging rates as determined in tables 13 and 14, the number of birds/bats found during searches and the subsequent estimate adjustment made using the formula described in the Methods. The tables show the extrapolation for small birds and bats from data collected at the 10 One-day sites. The first row contains the number of incidents noted (# Found) and is adjusted by the correction factors Se, Sc and Ps to get the adjusted total. The 95% confidence intervals are calculated as mentioned in the Methods, and included here.

Table 17. First Year Estimates for Bird and Bat Collision Mortality under 120 Towers of the Maple Ridge Project, (without incidental finds) corrected for Searcher Efficiency, Scavenger Removal Rate and Proportion of Searched Towers, from 1-day Sites.

Correction Factors	**Birds**			**Bats**	**Total Carcasses**
	Small	Medium	Large	Bats	
# Found	49	0	0	101	150
Search Efficiency **(Se)**	44%	-	-	42%	
% Not Scavenged **(Sc)**	94%	-	-	86%	
Proportion of Towers Searched (Ps)	8.33%	-	-	8.33%	
Adjusted Total	**1115 (± 54 - 95% CI)**	**-**	**-**	**2437 (± 742 -95% CI)**	**3552**

Table 18. First Year Estimates for Bird and Bat Collision Mortality under 120 Towers of the Maple Ridge Project, (without incidental finds) corrected for Searcher Efficiency, Scavenger Removal Rate and Proportion of Searched, from 3-day sites.

Correction Factors	**Birds**			**Bats**	**Total Carcasses**
	Small	Medium	Large	Bats	
# Found	22	1	0	83	106
Search Efficiency **(Se)**	44%	44%[1]	-	42%	
% Not Scavenged **(Sc)**	94%	94%	-	80%	
Proportion of Towers Searched **(Ps)**	8.33%	8.33%	-	8.33%	
Adjusted Total	**500 (± 24 - 95% CI)**	**22 (± 2 - 95% CI)**	**-**	**2143 (± 677 -95% CI)**	**2665**

[1] **Se** for small birds was also used to estimate the proportion of medium sized birds scavenged.

Table 19. First Year Estimates for Bird and Bat Collision Mortality under 120 Towers of the Maple Ridge Project, (without incidental finds) corrected for Searcher Efficiency, Scavenger Removal Rate and Proportion of Searched Towers, from 7-day sites.

Correction Factors	**Birds**			**Bats**	**Total Carcasses**
	Small	Medium	Large	Bats	
# Found	50	1	0	142	193
Search Efficiency **(Se)**	44%	44%[1]	-	42%	
% Not Scavenged **(Sc)**	94%	94%	-	72%	
Proportion of Towers Searched **(Ps)**	25%	25%	-	25%	
Adjusted Total	**379 (± 18 - 95% CI)**	**8 (± 1 - 95% CI)**	**-**	**1366 (± 153 -95% CI)**	**1753**

[1] **Se** for small birds was also used to estimate the proportion of medium sized birds scavenged.

3.3.2 Estimated Fatalities by Species:

We adjusted the number of incidents of birds and bats per species in Table 20, by same extrapolation factors described in the methods: search efficiency (Se), scavenge rate (Sc) and the proportion of towers searched (Ps).We used the rates appropriate to the sites where the incidents were noted, i.e. one American Goldfinch was found at a 1-day site, and thus was adjusted by the small bird search efficiency, the small bird scavenge rate at daily searched sites and the proportion of 10 daily sites searched to 120 total turbines. The resulting estimate of 23 American Goldfinches killed does not have confidence intervals calculated and should serve only as an indicator of impact per species. The table rows are classified by bird size (medium and small) and by bats. The species within the rows are in alphabetical order. The first three numerical columns show the number of incidents recorded at the one, three and seven-day search sites. The next four columns show the number of incidents per megawatt calculated for that species, followed by the size class of the species. The next three columns show the estimated total incidents estimated for that species, for the entire Phase I (120 operational towers). Finally, the incidental species are also reported in the final column, but not used in any extrapolations.

Table 20. Number of Incidents per Species per Total Installed Megawatt Capacity at the *Maple Ridge WRA* , Fall 2006, found during both standardized surveys and incidentally.

	2006			Estimated # Incidents/Mw				Estimated Mortality (120 towers)			Incidental Finds
Species Name	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	**1-Day Sites**	**3-day Sites**	**7-Day Sites**	**Size Class**	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	
Birds (Medium)											
American Kestrel	0	0	1	0.00	0.00	0.04	Medium	0	0	8	.
Common Grackle	0	1	0	0.00	0.00	0.00	Medium	0	23	0	.
American Crow	0	0	0	0.00	0.11	0.00	Medium	0	0	0	1
Canada Goose	0	0	0	0.00	0.00	0.00	Medium	0	0	0	2
Ruffed Grouse	0	0	0	0.00	0.00	0.00	Medium	0	0	0	1
Total Medium Birds	**0**	**1**	**1**				**Total Estd. Medium**	**0**	**23**	**8**	**4**
Birds (Small)											.
American Goldfinch	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
American Redstart	1	0	1	0.11	0.00	0.04	Small	23	0	8	.
Blackburnian Warbler	0	1	1	0.00	0.11	0.04	Small	0	23	8	.
Blackpoll Warbler	0	1	0	0.00	0.11	0.00	Small	0	23	0	.
Black-throated Blue Warbler	3	2	1	0.34	0.23	0.04	Small	68	46	8	1
Black-throated Green Warbler	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Brown Creeper	3	0	0	0.34	0.00	0.00	Small	68	0	0	.
Cedar Waxwing	0	2	1	0.00	0.23	0.04	Small	0	46	8	.
Chestnut-sided Warbler	0	1	1	0.00	0.11	0.04	Small	0	23	8	.
Cliff Swallow	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Eastern Phoebe	1	0	0	0.11	0.00	0.00	Small	23	0	0	1
Golden-crowned Kinglet	22	7	20	2.53	0.80	0.77	Small	501	159	152	.
Hermit Thrush	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Magnolia Warbler	3	0	3	0.34	0.00	0.11	Small	68	0	23	1
Ovenbird	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Palm Warbler	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Philadelphia Vireo	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Pine Warbler	0	1	0	0.00	0.11	0.00	Small	0	23	0	.
Red-eyed Vireo	1	3	7	0.11	0.34	0.27	Small	23	68	53	3
Red-winged Blackbird	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Ruby-crowned Kinglet	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Scarlet Tanager	0	1	0	0.00	0.11	0.00	Small	0	23	0	.
Swainson's Thrush	1	1	0	0.11	0.11	0.00	Small	23	23	0	.
Tree Swallow	1	0	0	0.11	0.00	0.00	Small	23	0	0	1

	2006			Estimated # Incidents/Mw				Estimated Mortality (120 towers)			Incidental Finds
Species Name	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	**1-Day Sites**	**3-day Sites**	**7-Day Sites**	**Size Class**	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	
Yellow-bellied Sapsucker	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Yellow-throated Vireo	1	0	0	0.11	0.00	0.00	Small	23	0	0	.
Unidentified Bird	6	2	7	0.69	0.23	0.27	Small	137	46	53	4
Unidentified Non-Passerine.	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Unidentified Vireo Species	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Unidentified Warbler Species	0	0	1	0.00	0.00	0.04	Small	0	0	8	.
Total Birds	**50**	**24**	**50**	**5.75**	**2.53**	**1.84**	**Total Estd. Birds**	**1138**	**523**	**372**	**11**
Bats											
Hoary Bat	26	20	39	***	--	--	Bat	627	516	375	16
Eastern Red Bat	2	11	10	--	--	--	Bat	48	284	96	5
Silver-haired Bat	5	10	12	--	--	--	Bat	121	258	115	9
Little Brown Bat	5	5	15	--	--	--	Bat	121	129	144	4
Big Brown Bat	4	3	3	--	--	--	Bat	97	77	29	1
Myotis Species	2	2	4	--	--	--	Bat	48	52	38	0
Unknown Species	4	2	0	--	--	--	Bat	97	52	0	1
Unprocessed Species**	53	30	59	--	--	--	Bat	1279	775	567	22
Total Bats	**101**	**83**	**142**	**12.31**	**10.82**	**6.90**	**Total Bat**	**2437**	**2143**	**1366**	**58**
Total (Birds & Bats)	**201**	**131**	**242**				**Total Estd. (Birds & Bats)**	**6011**	**4809**	**3103**	**70**

***Number of individuals during standardized surveys - included in the Total for that species**

**Bat carcasses not currently identified/processed

***Bats/Mw only calculated for total bats, pending completion of species identification

4.0 DISCUSSION

4.1 Search Interval

Although the 2006 study at Maple Ridge did not include the entire active period for birds and bats, it appears to be the most thorough search effort to date of bird and bat fatalities at wind turbines. No other study has included the number of individual turbine searches within such a short period of time. Issues with respect to determining the protocols and access to various land tracts delayed the initiation of searches on site.

The protocols for conducting fatality searches compare favorably with practices employed elsewhere. Most surveys for evidence of collision mortality have been carried out with a 14 to 30 day search cycle (Erickson et al. 2001), although at sites in the Midwest (Jain 2005, Howe et al. 2002) and at sites in the east (Arnett et al. 2005, Nicholson 2002), intensity of searches was similar to our study. Those studies, however, either did not include the entire summer and fall period or did not include the variation in search frequency as the present study.

One of the goals of this study was to search groups of turbines at different frequencies (1, three and seven day frequencies) to determine the optimal search rate. Arnett et al. (2005) searched at one and seven day frequencies, although they only searched during August and part of September. Nicholson (2005) searched every day during spring and fall migration, but that project included only three turbines so every day searches were relatively easy to accomplish. The reader is cautioned that more intensive search efficiency and scavenging studies for birds and bats are required in subsequent years. The impact of this paucity of information for determining fatality rates for medium and large birds was minimal this year as only 3 medium and 0 large birds were found on site. However, more extensive small bird and bat scavenging and search efficiencies would be beneficial to the more accurate assessment of project results. Much was learned during 2006 regarding acquisition of bird and bat carcasses, and the conduct of searcher efficiency and carcass removal testing. Our findings and efforts in 2006 will provide a basis for designing the 2007 study.

4.2 Seasonal Distribution of Fatalities

Similar to other Midwestern and Eastern WRA sites, the greatest mortality for both birds and bats is expected to occur during the fall migration season. Although this pilot project did not extend through the entire year, a definite peak in mortalities over a two month period for both birds (August to September) and bats (July to August) indicated that temporal mortality patterns at Maple Ridge WRA were not unusual and mirrored findings at Mountaineer in West Virginia (Kerns and Kerlinger 2004, Arnett et al. 2005), as well as many studies in the Midwestern and western United States (Johnson 2003). Fall mortalities are hypothesized to be primarily due to migration activity, although migration related activity such as staging or pre-migration flocking and foraging may also play a role. However, bird mortality continued to be regularly noted on surveys in November, indicating that, had the search season been extended, a relatively small number of additional fatalities may have been recorded. However, the Maple Ridge WRA is largely unsearchable during the winter because of frequent heavy snow that makes sites inaccessible and covers search areas. However, a small winter sampling effort at select towers may provide useful information.

4.3 Night Migrant Fatalities

As with most turbine facilities across the United States, the numbers of fatalities of night migrants was fairly low at the Maple Ridge facility. The numbers were especially small in comparison with fatality rates of these birds at tall, guyed communication towers in the Midwestern and eastern United States where fatalities sometimes involve hundreds or even thousands of birds in a single night or migration season. Those towers have two types of Federal Aviation Administration lighting (steady burning red L-810 and flashing red incandescent beacons – L-864), multiple sets of guy wires, and are almost always in excess of 500 feet (152 m). We conducted tests of night migrant incidents found at lit and unlit towers for both the 30 seven-day search sites and the 10 one-day search sites (The 10 three-day search sites were not suitable for this analysis as they were not deployed with FAA obstruction beacons). If the red flashing beacons attracted birds to turbines, a disproportionately greater number of these fatalities would have been found at turbines with lights and, or large-scale, multiple fatality events would have been observed. We did not see a clear relationship between the numbers of night migrant fatalities and whether turbines possessed L-864 red flashing beacons. We did observe marginal evidence ($0.05 < p < 0.10$) of higher night migrant fatalities at the lit one-day sites but not at seven-day sites.

We also observed no significant evidence of a higher proportion of bat fatalities at FAA lit towers. For both bats and birds, there is no clear evidence that FAA lighting in the form of flashing red beacons attracted birds or bats to towers and that the presence of those lights cause large scale fatality events at wind turbines.

At Maple Ridge the numbers of night migrant fatalities may be slightly higher than at those studied in the Midwest and at other eastern sites in West Virginia (Kerns and Kerlinger 2004) as the turbines are somewhat taller than Night migrant fatality rates have ranged between about 1 and 7 birds per turbine per year (Kerlinger et al. in press). The estimates of bird incidents/turbine at Maple Ridge (largely night migrants) range from 3.10 to 9.48 incidents/turbine. The fact that the Maple Ridge turbines are about 397 feet (121 m) in height, do not have guy wires, and have only flashing red strobe-like lights may explain the smaller numbers of night migrant fatalities at those turbines as compared to fatalities at tall communication towers (>500 feet, 152 m). Kerlinger (2004a, 2004b) has recently demonstrated that flashing red, strobe-like lights (L-864) of the type recommended by FAA and used most often on wind turbines do not appear to attract night migrants like the combination of the same lights in combination with L-810 steady burning red lights. These results continue to suggest that wind turbines in the eastern United States, do not appear to kill large or significant numbers of night migrants. Determining the exact number of night migrants is difficult, however, as the birds involved may be resident breeders. However, Erickson 2001 attempts to summarize the range of night migrant incidents noted at several wind farm sites in the US.

None of the bird species found during standardized or incidental surveys are state or listed species. Table 19 describes the range and estimated North American population of these species. Those populations come from larger geographic ranges than the source area of birds migrating over Maple Ridge. Those birds are from a subset of the North American population located in far upstate New York, Quebec, and Ontario. It is also possible that some birds originate as far west as Manitoba or even Saskatchewan, but those would account for a small portion of the migrants that fly over Maple Ridge.

Most of the species listed are stable or increasing. While it is difficult to estimate the effect of local sources of mortality (such as wind tower collision) on entire populations, the estimated total number of incidents at the Maple Ridge WRA are very small compared to the overall population of the species involved. The eastern population of the Golden-crowned Kinglet, which was found most often during searches, is estimated to be increasing (Table 19). Given the overall population level (estimated 34 million birds), it is difficult to presume that tower mortality at the Maple Ridge WRA has a significant adverse effect on population levels.

Table 19. Population trends and geographical distribution of bird species found at the Maple Ridge WRA during standardized surveys and incidentally

Species	North America Population	Population Trends	Geographic Range
American Kestrel	5.8 million	Stable	North America (S of Tundra)
American Crow	31 million	Increasing	North America
Common Grackle	97 million	**Decreasing**	Temp. North America (E of Rockies)
Ruffed Grouse	8.3 million	Stable	N Temp. and Boreal Forests
Canada Goose	5 million	Increasing	North America
American Goldfinch	24 million	Stable	Temp. North America
American Redstart	25 million	**Decreasing**	E Temp. and North Temp. Forest
Blackburnian Warbler	5.9 million	Stable	N Temp. and Boreal Forest (E of Rockies)
Blackpoll Warbler	21 million	Stable	Boreal Forest
Black-throated Blue Warbler	2 million	Stable	E Boreal and North Temp. Forest
Black-throated Green Warbler	9.6 million	Stable	North Temp. and Boreal Forest East of Rockies
Brown Creeper	5.4 million	**Potentially Decreasing**	North Temp. Forest
Cedar Waxwing	15 million	Increasing	Temp. North America
Chestnut-sided Warbler	9.4 million	**Slightly Decreasing**	E North Temp. Forest (E of Rockies)
Cliff Swallow	89 million	Increasing	North America (S of Tundra)
Eastern Phoebe	16 million	Stable	Eastern North America
Golden-crowned Kinglet	34 million	Increasing in East	Boreal Forest North America
Hermit Thrush	56 million	Increasing	Boreal and North Temp. Forest North America
Magnolia Warbler	32 million	Increasing	Boreal and North Temp. Forest (Mostly E of Rockies)
Ovenbird	24 million	Stable	Temp. and Boreal Forest (E of Rockies)
Palm Warbler	23 million	Stable	Boreal and North Temp. Forest (E of Rockies)
Philadelphia Vireo	4.3 million	Stable	N Temp. and Boreal Forest (E of Rockies)
Pine Warbler	11 million	Increasing	Eastern Temp. Forest
Red-eyed Vireo	140 million	Increasing	Temp. and Boreal Forests
Red-winged Blackbird	210 million	Increasing	North America

Species	North America Population	Population Trends	Geographic Range
Ruby-crowned Kinglet	72 million	Maybe Decreasing	Boreal Forest North America
Scarlet Tanager	2.2 million	Maybe Increasing	E Temp. Forest
Swainson's Thrush	100 million	**Maybe Decreasing**	Boreal Forest
Tree Swallow	20 million	Increasing	North Temp. and Boreal North America
Yellow-bellied Sapsucker	9.2 million	Stable	Boreal and North Temp.. Forest
Yellow-throated Vireo	1.4 million	Increasing	E Temp. Forest

4.4 Bat Fatalities

There are few population estimates for bats in North America (mostly limited to cave dwelling bats that live in large colonies) due to the nocturnal habits of this group of mammals. Consequently, it is difficult to assess the impact of tower collision mortality on these species. All bat species found during searches at the Maple Ridge WRA are widespread, and not listed as state or federally endangered. However, bats are longer-lived and have low reproductive rates compared to birds. Thus, collision mortality has the potential for a more serious effect on bat populations.

While only the 30 seven-day sites showed a significant negative trend, the direction of the relationship between the number of bat incidents and distance to the nearest wetland was negative for all three site types. The sample size for the one and three day sites (N = 10 each) may have been inadequate to test for the relationship. However, the foraging and water needs of the bat species found at the MRWRA and the strong significant trend at the 30 day sites shows that this issue is potentially important in understanding causes of bat mortality. It is likely that if degrees of freedom from these three analyses were pooled, a significant difference would emerge supporting the contention that turbines nearer to wetlands are likely to be involved in greater numbers of collisions of bats than turbines farther from wetlands.

4.5 Significance of 2006 Findings:

Bird and bat fatalities found at the Maple Ridge turbines were within the range of fatalities found at wind turbines in the United States. With respect to avian fatalities, the rates were slightly greater than at most other turbine sites, although on a per megawatt basis they were lower than the rates found at turbines in Tennessee (Nicholson 2002) and similar to the rates at the Mountaineer turbine site in WV (Kerns and Kerlinger 2004). It is noteworthy that the turbines at Maple Ridge were more than about 100 (31 m) and 50 (16 m) feet taller than the turbines at either the Tennessee or West Virginia turbines and the Maple Ridge turbines had a larger rotor swept area than the other turbines. Most importantly, the species involved in the fatalities at Maple Ridge were primarily species that are relatively common and none are considered threatened or endangered. However, some of the species are thought to be declining. The biological significance of the fatalities at wind turbines needs to be investigated.

Comparing avian fatality rates at the Maple Ridge turbines with communication tower fatalities (Shire et al. 2000, Trapp 1998), it is obvious that turbines kill far fewer birds. Most importantly, turbines have not yet been involved in large-scale, multiple fatality incidents that occur in one night. This is likely a result of three factors: communication towers have more and different types of FAA obstruction lighting and those communication towers involved in large-scale events (dozens to more than 1,000 in one night at one tower) almost always have occurred at towers with guy wires in excess of about 500 feet (152 m) in height. Thus, those towers have steady burning L-810 lights (Kerlinger et al. in press), multiple guy wires, and are taller than wind turbines, including those at the Maple Ridge project site. More recently, Gehring and Kerlinger (2007) have completed a study at communication towers that show large differences in fatality rates between tall communication towers (>305 m) and mid-sized towers (116-146 m) range. The former towers experienced five times the fatality rates of mid-sized towers (both were guyed). Most importantly, Gehring and Kerlinger found that red, flashing L-864 obstruction beacons on towers experienced significantly fewer fatalities than towers of equal height with standard FAA lighting (which includes L-864 beacons and L-810, steady burning red lights). The latter finding is in agreement with both the Kerlinger et al. (in press) and Gehring and Kerlinger (2007) results that suggest red flashing FAA obstruction beacons do not attract night migrants.

With respect to bats, the fatality rates per megawatt found at Maple Ridge are much smaller than the rates at turbines studied on Appalachian ridges in Pennsylvania and West Virginia (Kerns an Kerlinger 2004, Arnett et al. 2005) and Tennessee (Nicholson 2002) and similar to the rates found at some Midwestern turbines. The rates at Maple Ridge also include a longer sampling period than the study by Arnett et al., which only considered the period August-September 15. What is most striking is the finding that the period during which the peak of fatalities occurred corresponds to the peak periods reported in studies in the eastern, Midwestern, and western United States, suggesting that some of the mechanics of these fatalities are independent of geography.

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APPENDIX A: MAPLE RIDGE WIND RESOURCE AREA (MRWRA) PROJECT SITE INFORMATION DATASHEET.

A similar log was kept for each site (1,3 and 7-day, as well as the two meteorological towers) detailing site conditions at each search and the number of incidents noted.

Date	Time Surveyed	Temp °F	% Cloud Cover	Survey Weather Conditions	Wind Direction	Wind	Prior Evening Conditions	Bird Carcasses	Bat Carcasses	Observer	C

APPENDIX B: MAPLE RIDGE WIND RESOURCE AREA PROJECT INCIDENT (MORTALITY) DATASHEET

Details for each incident (bird or bat) were recorded by observers in an individual row of this datasheet. Additional information such as presence of predator sign, evidence of mowing damage, additional carcass condition information was recorded in the last column.

Turbine #	Date	Time	Bird / Bat #	Habitat	Species/Age/Sex	Carcass Condition	Time on Ground	Dir-Dist Transect	Observer	Days i Surve

APPENDIX C: MAPLE RIDGE WIND RESOURCE AREA PROJECT INCIDENT LOCATION (GPS) DATASHEET

In addition to Incident (Mortality) sheet, observers noted GPS coordinates to the towers for future use in GIS analyses. However, Distance and Bearing to the turbine base were also recorded for increased accuracy.

Bird/Bat #	Location (Longitude)	Location (Latitude)	Elevation	Distance	Bearing