Annual Report for the Maple Ridge Wind Power Project

Postconstruction Bird and Bat Fatality Study - 2007

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Prepared for:

PPM Energy and Horizon Energy

and

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

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EXECUTIVE SUMMARY

The Maple Ridge Wind Power Project consists 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 75 turbines in Phase IA and II of the project were constructed in May to December 2006. Each 1.65 MW turbine consists of an 80m (262 feet) tall tubular steel tower; a maximum 82m (269 feet) diameter rotor; and a nacelle which houses the generator, transformer, and power train. The towers have a base diameter of approximately 4.5m (15 feet) and a top diameter of 2.5 m (8 feet). The tower is topped by the nacelle, which is approximately 2.8m (9 feet) high and 7.6m (25 feet) long, and connects with the rotor hub. The rotor consists of three 41m (134 feet) long composite blades. Approximately 30% (57 out of 195) of the nacelles are equipped with L-864 FAA aviation obstruction beacons (lights) consisting of flashing red strobes (for night) and no illumination during the day. With a rotor blade oriented in the 12 o'clock position, each turbine has a maximum height of approximately 122m (400 feet). All components of the turbine are painted white.

After a first year pilot-project (summer-fall 2006), April 30-November 14, 2007 was the first complete 3-season of study (Spring-Summer-Fall, winter studies precluded by heavy snowfall and limited site accessibility). Weekly carcass surveys were conducted at 64 out of 195 (32.8%) turbine sites. We completed 1736 individual turbine searches, equivalent to about 28 rounds of searches at the 64 turbines. Two out of the three meteorological towers were also searched weekly for a total of 56 searches, from May 1, 2007 to November 14, 2007 (28 rounds).

A total of 64 avian incidents (carcasses) were recorded by searchers during standardized surveys, representing 21 identified species (However, 23 incidents could not be identified to species). Of the 21 species, there were three raptor fatalities (Red-tailed Hawk), and one columbiform fatality (Rock Pigeon). Thirty-seven out of 64 incidents involved songbirds of 19 species. Night migrants accounted for 25 out of these 37 incidents (67.6%) during standardized surveys where species could be assigned. The greatest number of bird incidents occurred during the month of August. A total of 32 avian incidents were recorded while on site, but not during standardized surveys (incidental finds). Of these fatalities, four were game birds (Ruffed Grouse, Wild Turkey, American Woodcock), three were raptors (Red-tailed Hawk, Sharp-shinned Hawk), three were waterbirds (Mallard, Canada Goose), one was a woodpecker (Yellow-bellied Sapsucker) and two were fatalities described as "other" birds (Black-billed Cuckoo, Ruby-throated Hummingbird).

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 at times other than during standardized surveys and at sites outside the 64 searched towers.

Remains of 202 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 133 (65.8%) bat carcasses found between July 1, 2007 and August 31, 2007. A total of 81 bat incidents were recorded while on site, but not during standardized surveys. Of these fatalities, 43 were Hoary Bats, 14 were Eastern Red Bats, 12 were Silver-haired Bats, 10 were Little Brown Bats, one was a Big Brown Bat, and one was an unidentified species.

Bat carcasses were found closer to turbine tower bases than bird carcasses. There was evidence that bat fatalities were slightly greater at turbines close to wetland areas than at turbines located farther from wetlands. There was moderate evidence that bat fatalities but not bird fatalities were greater at wooded vs. non-wooded turbine sites. There was no significant difference in bat or bird fatalities between lit (FAA L-864 obstruction lights) and unlit turbine sites. Neither bird nor bat fatalities seemed to be significantly higher at the northwest-edge of the windfarm (hypothesized as the source of initial contact of bats with the windfarm during the fall).

The amount of area searchable under each tower and the numbers of towers searched per round during the project set-up stage were adjusted for when calculating the final fatality estimates. In addition, 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 7-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 195 turbines at the Maple Ridge Wind Resource Area (WRA).

Due to late season snowfall in March and April, turbine areas were not accessible or amenable to carcass searches prior to mid-April 2007. Between April 30, 2007 and May 15, 2007, 56 out of the total of 64 turbine sites (88%) were "set up" and searches immediately began on those towers. Six more turbine sites were added by May 25, 2007 and the last two sites were established and being searched by June 6, 2007. Also, search areas under meteorological towers 1 and 2 were established and searches began on May 1 and 2, 2007, respectively.

By dividing the estimated number of incidents by the number of turbines and by 1.65 MW per turbine searched in each period, a rate of incidents/turbine and incidents/Megawatt was calculated for the study duration. In addition, by dividing the number of incidents/turbine by the rotor swept area (m^2) and multiplying that figure by 2000, we are able to show the number of incidents/2000m^2 rotor swept area. A typical 1.65 MW wind turbine tower in New York State will produce approximately 4,400 MWh per year (William Moore, PPM-Atlantic Renewable, pers. comm.). The metric "incidents/MWh produced" is calculated for the duration of the project period.

It is presumed that some of the carcasses noticed during non-survey activities (site maintenance and scavenger checks, etc.) could have been discovered during regular

surveys. Contrary to standard practice, since a significant number of incidental findings occurred during these non-survey activities, we did an additional calculation of mortality rates using incidental finds that met the criteria mentioned above. The actual estimate of mortality is likely between the two estimates.
See Results for 95% CI.

The estimates for birds are:

- 7-Day standardized surveys (Total period 196 days): 755 incidents/period, 2.34 incidents/Mw/period, 3.87 incidents/turbine/period, 0.0015 incidents/MWh produced, and 1.46 birds per $2000m^2$ rotor swept area/period.

- 7-Day standardized surveys + added incidentals (Total period 196 days): 900 incidents/period, 2.80 incidents/Mw/period, 4.61 incidents/turbine/period, 0.0018 incidents/MWh produced, and 1.75 birds per $2000m^2$ rotor swept area/period.

The estimates for bats are:

- 7-Day standardized surveys (Total period 196 days): 2087 incidents/period, 6.49 incidents/Mw/period, 10.70 incidents/turbine/period, 0.0066 incidents/MWh produced and 5.88 bats per $2000m^2$ rotor swept area/period.

- 7-Day standardized surveys + added incidentals (Total period 196 days): 2705 incidents/period, 8.41 incidents/Mw/period, 13.87 incidents/turbine/period, 0.0055 incidents/MWh produced and 5.25 bats per $2000m^2$ rotor swept area/period.

The fatality rates and species composition of both birds and bats of the 2007 study compares in the following manner with other studies: the species composition and rates of bird fatalities at the Maple Ridge site were similar to those found at other eastern wind power project sites. Fatality rates for bird incidents/turbine/period were greater than reported from western and mid-western wind power sites. However, this was not always the case when comparing incident/MW/period. For bats, the species composition is similar to that found at other eastern and Midwestern sites. The numbers of bat fatalities per turbine or per megawatt of power generated are lower than those reported from studies at Appalachian ridges, but greater than those reported from Midwestern studies, in most cases. Comparisons are general, please see the relevant tables and publications for differences in study periods and methods.

1.0 INTRODUCTION:

The following report describes the research design, initiation and completion of the second year of post-construction study of avian and bat collision fatalities at the 195-turbine Maple Ridge Wind Power Project in Lewis County, New York (Figures 1, 2).

During the period June–November 2006, a postconstruction bird and bat fatality study was conducted at the Maple Ridge Wind Power Project in Lewis County, NY. That study was designated as a pilot study conducted to establish a protocol that could be used to conduct three additional years of study, commencing in 2007.

The current protocol is slightly different from that used in 2006 ("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). 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), New York State Department of Environmental Conservation, developers (PPM and Horizon), and others. Changes/additions were made for the 2007 study based upon results of the 2006 study, input from the TAC and upon a statistical analysis conducted by Dr. James Gibbs, Dept. of Environmental and Forest Biology, SUNY-ESF, Syracuse, NY. The study protocol remains in compliance with the Army Corps of Engineers (ACOE) permit for the Maple Ridge Wind Resource Area (MRWRA).

The Technical Advisory Committee (TAC), which has the responsibility of reviewing and commenting on progress reports, annual reports, and other updates from this project is comprised of representatives from some or all of these groups.

TAC members:

Patrick Doyle, Horizon Wind Energy
William Moore, PPM Energy
Paul Kerlinger, Curry and Kerlinger
Aaftab Jain, Curry and Kerlinger
Alan Hicks, NYSDEC
Brianna Gary, NYSDEC
Tim Sullivan, USFWS
Mark Watson, NYSERDA
Mike Burger, Audubon New York
Diane Sullivan Enders, moderator (EDR)

* Members of the TAC reviewed a prior version of this (2007) annual report and requested changes that are reflected in this revised version as well as the 2008 annual report. The 2008 report was presented to the TAC on February 24, 2009. However, due to other obligations, the USFWS, NYSDEC, NYSERDA and Audubon New York were unable to participate in the review of the 2008 report.

The objectives of the 2007 fatality study, the second year of postconstruction study, are to provide a quantitative estimate of the number of bird and bat fatalities that occur at the Maple Ridge WRA 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 was conducted at a subset of turbines and will be done for a period of 3 years postconstruction (2006, 2007, 2008, and 2011, a total of 4 years including the pilot study. If it is determined that modifications of the current protocol and methods are needed, revisions will be evaluated by the TAC.

1.1 Project Description

The Maple Ridge Wind Power Project consists 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 75 turbines in Phase IA and II of the project were constructed in 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 4.5-meter-(15 feet) and a top diameter of 2.5-meter-(8-feet). The tower is topped by the nacelle, which is approximately 2.8-meter-(9-feet) high and 7.6-meter-(25-feet) long, and connects with the rotor hub. The rotor consists of three 40.8-meter-(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) and with no beacon illumination during the day. With a rotor blade oriented in the 12 o'clock position, each turbine has a maximum height of approximately 122 meters (400 feet). All components of the turbine are painted white.

Two 80-meter-(262-foot) 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 was 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 6.44 km (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 Wind Resource Area.

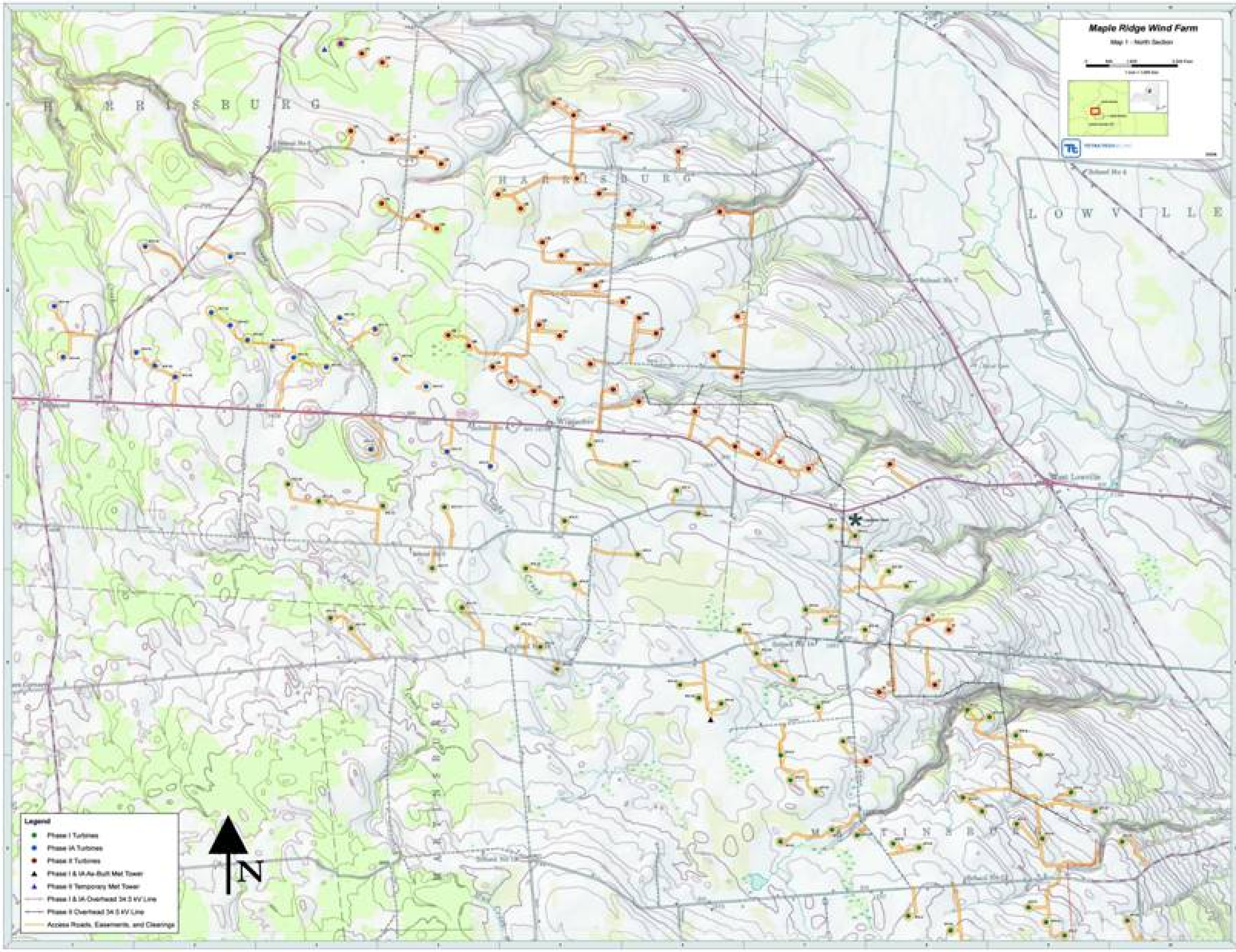
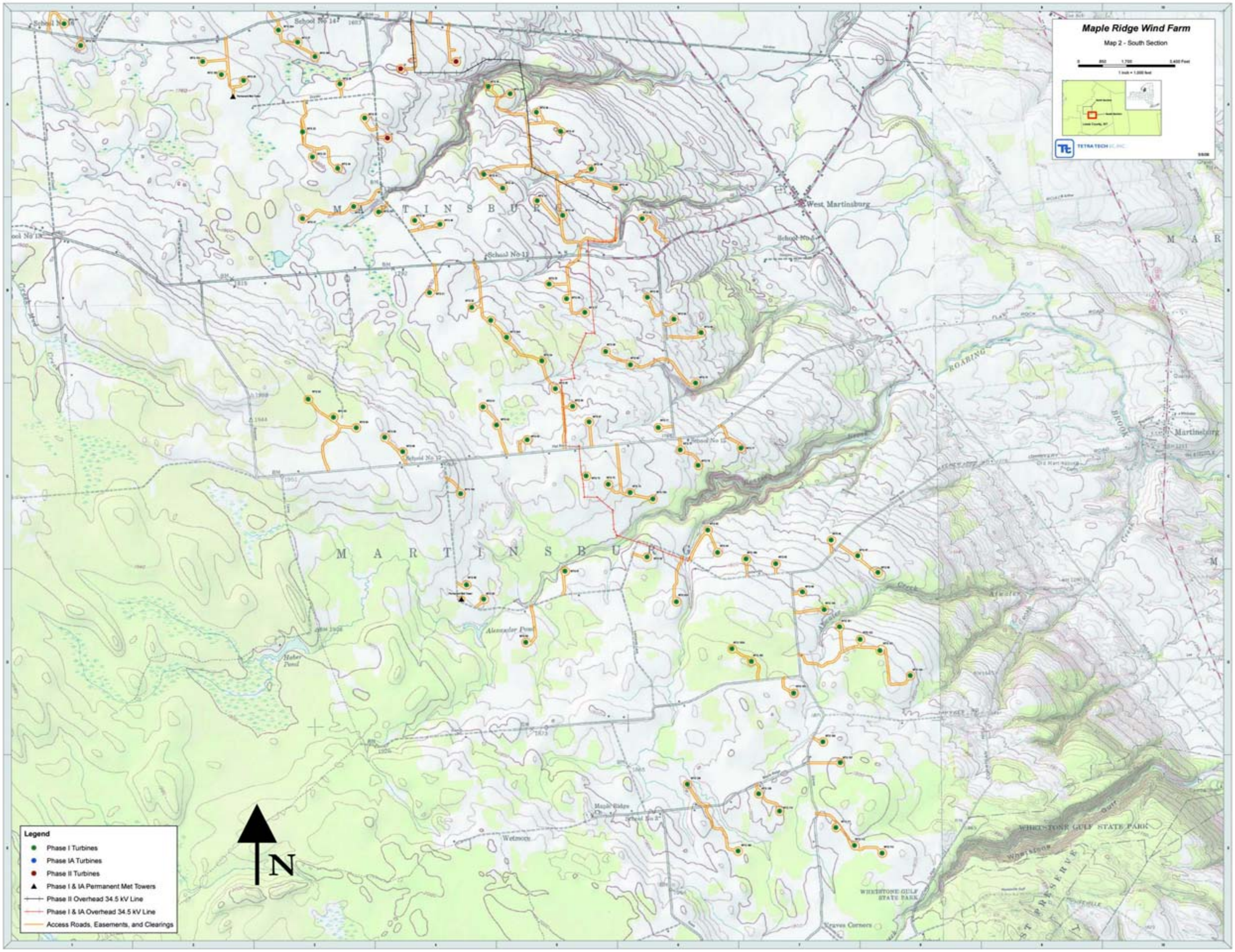


Figure 2. High Resolution Project map for the Southern section of the Maple Ridge Wind Resource Area.



1.2 Study Area

The 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 52 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.

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.

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. 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 (Figures 1, 2).

2.0 METHODS

2.1 Carcass Surveys

2.1.1 Site Selection

Sixty-four turbine sites were chosen to be searched in 2007. 2 meteorological towers were also searched (described below). Site selection was through a process of randomization and stratification. All 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). Tables 1 and 2 show the primary ground cover at the various sites under which searches occurred.

Due to late season snowfall in March and April, ground conditions were not amenable to search prior to mid-April, 2007. By April 25, 2007, the TAC determined that 64 turbines searched every

7 days was to be the search effort for 2007, commencing in the last week of April. Between April 30, 2007 and May 15, 2007, 56 out of the total of 64 turbine sites (88%) were "set up" and searches immediately began on those towers. Six more turbine sites were added by May 25, 2007 and the last two sites were set up and being searched by June 6, 2007. These last 8 sites were delayed as new landowners were introduced to the project and ultimately gave permission for the selected sites. In general, Phase I sites (for which we already had landowner agreements signed in 2006) were set up first, followed by Phase II and IA sites as agreements were signed. Also, meteorological towers 1 and 2 were set up and searches began by May 1 and 2, 2007, respectively.

We transitioned from searching 50 out of 120 (41.7%) Phase I turbine sites in 2006 (and two meteorological towers) to searching 64 out of 195 (32.8%) sites from Phases I, II and IA (and two meteorological towers) in 2007.

a) We chose ~33% of the turbines of each phase, in a randomized stratification process, as sixty-four turbine sites represented ~33% of the total 195 turbine sites at the Maple Ridge Wind Resource Area (MRWRA). Thus, we chose ~1/3 of the: 120 Phase I turbines (39 sites); 20 Phase IA turbines (7 sites); and 55 Phase II turbines (18 sites). Phase I sites were chosen through a randomized process in 2006. Sites that were eliminated from the Phase I sites included 2 turbine sites for which landowner permission was withdrawn. The remaining sites were eliminated if they had sites of similar ground cover in close proximity. This process retained adequate distribution of sites over Phase I.
   Both Phase IA and Phase II sites were chosen at random out of all suitable sites. Some sites were not considered due to electric fencing and presence of cattle. Also, 7 sites from the original randomization in Phase II were replaced by re-randomization, as Robert Burke (Horizon) indicated that landowner attitude and permission would not be positive at those sites.
b) Adequate coverage of the north-west region of the windfarm
   Phases IA and II are located in the North-West portion of the MRWRA. The North-west Edge hypothesis could be examined by comparing levels of fatalities between turbines near the North-west Edge (a subset of Phase Ia and II) versus the remaining turbines. North-West Edge turbines were defined as turbines within 1.25 km of an imaginary line (connecting turbines 120, 135, 114, 142, 149 and 150) on the Northern and Western boundaries of the MRWRA.
c) Adequate numbers of both sites surrounded by forest (wooded) vs. non-wooded sites will ensure statistical validity to account for the reduced search area in wooded sites. (Tables 1, 2) Also, while ground cover differs from year to year as a result of management practices, the large number of sites covered by the study ensures that the breadth of site types and conditions observed at the MRWRA were adequately represented (grass, crop, wooded and brush).
d) Sites searched daily in 2006 (Phase I) were included in the study, except for Sites 97 and 98, because the landowner withdrew access.

Table 1. Phase I site selection indicating 39 out of 50 sites retained from 2006.

Phase	Turbine Number	Wooded Ring[1]	Primary Ground Cover	Retained from 2006
Met	Met Tower #1	n/a	Grass/Wooded	Retained
Met	Met Tower #2	n/a	Grass/Wooded	Retained
1	12	No	Grass	Retained
1	16	No	Grass	Retained
1	17	Yes	Grass/Wooded	Retained
1	23	No	Grass	Retained
1	24	No	Grass	Retained
1	26	No	Grass	Retained
1	27	No	Grass	Retained
1	34	Yes	Grass/Wooded	Retained
1	37	Yes	Grass/Wooded	Retained
1	39	No	Grass	Retained
1	40	No	Grass	Retained
1	50	No	Grass/Wooded	Retained
1	52	No	Grass	Retained
1	53	Yes	Grass/Wooded	Retained
1	56	No	Crop	Retained
1	57	No	Grass/Crop	Retained
1	59	No	Crop	Retained
1	64	Yes	Grass/Wooded	Retained
1	75	No	Grass	Retained
1	76	No	Grass/Wooded	Retained
1	77	No	Grass/Crop/Brush	Retained
1	82	Yes	Wooded	Retained
1	83	Yes	Wooded	Retained
1	89	No	Grass/Crop	Retained
1	101	Yes	Grass/Wooded	Retained
1	102	Yes	Grass/Wooded	Retained
1	103	Yes	Grass/Wooded	Retained
1	104	No	Grass/Wooded	Retained
1	108	No	Grass	Retained
1	109	No	Grass	Retained
1	110	No	Grass	Retained
1	179	Yes	Grass/Wooded	Retained
1	180	No	Grass/Wooded	Retained
1	183	Yes	Wooded	Retained
1	189	No	Grass	Retained
1	195	No	Grass/Wooded	Retained
1	197	Yes	Grass/Wooded/Brush	Retained
1	22a	No	Grass	Retained
1	54A	Yes	Grass/Wooded	Retained
1	32	No	Grass/Wooded	Dropped
1	35	No	Grass	Dropped
1	45	Yes	Grass/Wooded	Dropped
1	86	No	Grass	Dropped

1	90	No	Grass	Dropped
1	97	No	Grass/Crop	Dropped
1	98	No	Grass/Crop	Dropped
1	181	No	Grass	Dropped
1	185	Yes	Wooded	Dropped
1	192	Yes	Grass/Wooded	Dropped
1	193	Yes	Wooded	Dropped

1. Wooded Ring indicates that turbine was constructed in a forest clearing with less area than the 120m by 130m search area.

Table 2. Phase II and IA site selection including proximity to Northwest edge of the MRWRA (NW-edge hypothesis).

Phase	Turbine Number	Wooded Ring	Primary Ground Cover	N-W Edge
2	36	No	Grass/Crop	No
2	79A	No	Crop	Yes
2	114	No	Grass/Crop	Yes
2	116	No	Grass/Crop/Wooded	Yes
2	118	No	Grass	Yes
2	121	No	Grass/Crop/Wooded	Yes
2	122	No	Grass/Crop	Yes
2	124	No	Grass/Crop	Yes
2	125	Yes	Grass/Wooded	Yes
2	126	Yes	Grass/Wooded	Yes
2	127	No	Grass/Crop	Yes
2	129	No	Grass/Crop	Yes
2	130	No	Grass/Crop	Yes
2	133	No	Crop	Yes
2	134	Yes	Grass/Wooded	Yes
2	136	Yes	Grass/Wooded	Yes
2	167	No	Grass	No
2	168	No	Grass	No
1A	61A	Yes	Grass/Wooded	Yes
1A	149	No	Grass	Yes
1A	153	No	Grass	No
1A	154	No	Grass	No
1A	184	Yes	Grass/Wooded	Yes
1A	187	Yes	Grass/Wooded	No
1A	198	Yes	Grass/Wooded	Yes

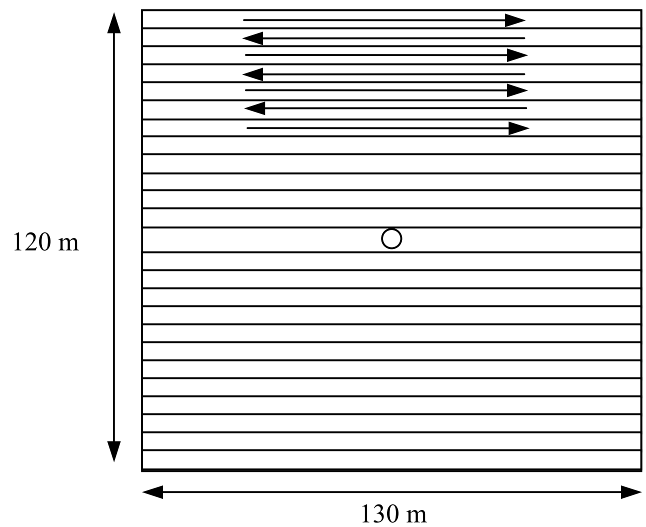
Searches were conducted when weather and other conditions permitted. Work was not done during lightning but was conducted during light rain.

2.1.2 Standardized Surveys

Carcass surveys were conducted every 7 days at 64 wind turbine towers. 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 5m wide transect, the searcher used the unaided eye, alternately scanning an area that extended for 2.5m (compares favorably to Johnson *et al*. 2003) on either side of his/her track (Figure 3). 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 approximately 35-45m from the tower base. These wooded sites could only be cleared and searched out to the tree line. Non-wooded sites were searched out to the overall search area, also subject to local site conditions (un-cleared brush, wetlands etc). Handheld GPS units were used to measure the searchable area under each turbine. Data recorded at the beginning of the surveys included meteorological data (cloud cover, temperature, wind velocity) and 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 indicating 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 was 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 Global Positioning System (GPS) was used to determine geographic coordinates, and a range finder and compass were used to determine distance and bearing from the tower. Distance of the carcass from the centerline of the transect (the line the searcher walked) was also measured. The carcass was photographed in the position in which it was found, using a digital camera, and a preliminary identification was made. 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 bird or bat 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, the carcass was processed as above but it was classified as an "incidental" find. With the approval of the NYSDEC, one of the project technicians (Lance Ebel) identified bird carcasses. Bat carcasses were identified by Alan Hicks (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 in 2006. Rabies related precautions precluded the handling and rehabilitation of injured bats in New York State. One injured bat (in 2007) was euthanized using cervical dislocation. A second bat was observed stunned but flew away. Both bats were not discounted from final mortality estimates. 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 an "incidental" find.

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 FWS was to be notified immediately by telephone, and collection of the dead/injured animal was to be delayed until specific direction for proceeding was received from the FWS.

As described in the protocol, the first carcass survey at each site was considered a "clean sweep" conducted at all newly installed and operational wind turbine towers. All carcass remains noted in the first search were removed and treated as incidental finds to increase the likelihood that all carcasses found during the subsequent surveys would be associated with incidents that occurred during the course of the standardized surveys. Clean sweeps were conducted using the same protocol as used in the standardized carcass surveys.

2.1.3 Adjustment Factors applied to Raw Data:

2.1.3.1 Project Set-up Period:

We began searches concurrently with site set-up. As a result, the first 5 rounds of searches (April 30 – 9 June) covered increasing proportions of all 64 sites (Table 3). We divided the numbers of birds and bats found during each search round by the proportion of the 64 sites searched in that round to obtain Set-up adjusted figures. See Section 3.3.1.1 for the adjustment factors for each search period during the set-up phase.

2.1.3.2 Area Adjustment Search Intensity (Search Sites Limited by Mowing Obstacles) (*Si*):

Because the areas searched under turbines in the Maple Ridge WRA were limited by habitat conditions such as trees, shrubs and wetlands that could not be cleared, we applied an area adjustment factor to the number of incidents found at partially searched sites. We used a sub-meter accuracy GPS Trimble XRS unit to measure the cleared search area within each search site. We analyzed the extent of searchable area within the 120m by 130m area with ESRI ArcGIS software. The total number of incidents (separately for all four size classes: small, medium and large birds and bats) was separated into 10m incremental annuli (0-10m, 10.1-20m, etc.) that fell within the 120m by 130m search area for all turbines (Table 13, Figure 12). Then, the fatality numbers for each annulus were divided by the percent area searched in that annulus. For example, if 20 bat fatalities were found in the 40.1-50 meter annulus (at all turbine sites) and if 50% of the available area in that annulus was searched (at all turbine sites), then 20 would be only half of the total number of bats in that annulus. Therefore, (20/0.50) = 40 area-adjusted bat fatalities for that annulus. We based our adjustment factor on prior work in Fiedler *et al*. (2008). Se, Sc and Ws adjustments were applied after this area adjustment process.

2.1.3.3 Searcher Efficiency, Scavenger Removal, Proportion of Operational Towers Searched

In addition to the Project Set-up adjustment and Area adjustment, it is generally 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 due to three additional adjustment factors. The first is the possibility that the searchers will miss carcasses due to the amount of ground cover or the size and camouflage of the species. 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. Applying these adjustment factors to the actual number of carcasses found during standardized surveys reduces underestimation of mortality due to these factors. Several scavenger removal and searcher efficiency studies conducted throughout the study duration in 2007 estimated the proportion of carcasses missed by the searchers and the proportion removed by scavengers within 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 incidents found, previously corrected for Project Set-up Period and Area Searched, (*C*), for Scavenger efficiency (*Sc*), Search efficiency (*Se*) and Proportion of towers searched to the total of 195 operational towers in the windfarm (*Ps*).

a) Proportion of test carcasses left by scavengers within the search period (*Sc*).
   Scavenge rate (*Sc*) was measured over 14 tests (8-Jun, 14-Jun, 26-Jun, 26-Jul, 4-Aug, 8-Aug, 20-Aug, 13-Sep, 14-Sep, 21-Sep, 30-Sep, 11-Oct, 22-Oct, 31-Oct) by placing 70 bat carcasses and 70 small bird (sparrow sized) carcasses, 16 medium bird (American Woodcock sized) carcasses and 23 large bird (gull sized) carcasses on mortality transects at various searched sites in the MRWRA. Carcasses were distributed among searched sites during the late afternoon-early evening before Day 1 of the test (Appendix D). Latex gloves and plastic bags were used to ensure that carcasses did not come into direct contact with the person placing them on site (Aaftab Jain, Project Coordinator). Placement bias prevention measures included dropping carcasses at varied distances to tower base, and at all types of searched ground cover (gravel, grass/hay and corn stubble). Also, carcasses were thrown over the Coordinator's shoulder to add a random element to the eventual location. Thus carcasses landed in locations independent to the center line of the transect in which it fell. Carcasses were dry and partially thawed when placed. Field technicians monitored carcasses daily for evidence of scavenging until all carcasses were scavenged or deemed too decomposed/picked clean by insects, typically from 10 days to 4 weeks. 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 (7 days). Thus, the overall duration between carcass fall and discovery is approximately half the actual search cycle (3.5 days). 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

remained visible (body of carcass removed/severely scavenged) after 4 days.

b) Proportion of carcasses not missed by observers in the search efficiency trials (*Se*).
The carcasses used to test for Search Efficiency were a subset of the ones used to test for Scavenge Rate (the carcasses that were not scavenged before the technicians arrived onsite). See Tables 12, 13. The dates of search efficiency trials coincided with the start dates of scavenging trials. 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. Carcasses were placed during the late afternoon-early evening before Day 1 of the test. The Project Coordinator did not walk directly from the gravel access area to the carcass location, and took care not to leave obvious tracks in grass/mud. The searchers recorded all carcasses that they discovered, including carcasses planted by the Project Coordinator (which were identifiable by a small tag attached to and hidden below the carcass). Planted evidence of collisions was later removed from the database and a mean search efficiency rate (*Se*) was calculated as the ratio of test carcasses found to test carcasses not scavenged. Carcasses that were missed were checked immediately after searches to ascertain whether they had already been scavenged.

c) Proportion of towers searched to the total of 195 operational towers in the windfarm (*Ps*).
Ps for the 64 7-day sites was 64:195.

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

Where $\widehat{C}$ = 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 (Ramsey and Schafer, 2002). Then, we calculated the variance due to the adjustment factors *Sc* and Se, using the variance of a product formula (Goodman, 1960). The variance of the product of *Sc* and *Se* is:

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

We used this procedure for the 7-day search frequencies to get an estimate of mortality for birds and bats.

3.0 RESULTS

3.1 Search Effort

3.1.1 Summary of Search Effort (64 Turbines, 7-Day search sites)

As described in the study protocol and methods, the first carcass survey at each site was considered a "clean sweep" conducted at all newly installed and operational wind turbine towers. All carcass remains noted in the first search were removed to increase the likelihood that all carcasses found during the subsequent surveys would be associated with incidents that occurred during the course of the standardized surveys. Clean sweeps were conducted using the same protocol as used in the standardized carcass surveys (see below). 6 birds and 3 bats were found during initial "clean sweeps," and designated as incidental finds.

30 rounds (1736 turbine searches) of standardized searching were conducted between April 30, 2007 and November 14, 2007 (Table 3). Of these, the first 5 rounds consisted of 42, 55, 61, 62 and 62 turbines each, as site access permissions wee received and more turbines were set up during the first days of the project. After the project set-up period, 23 complete rounds of standardized searches were conducted. Two incomplete rounds, comprising 44 and 9 turbines, were also done at the end of the study, when winter weather began to prevent regular search activities. The total search period was 196 days. Two out of the three meteorological towers were also searched weekly for a total of 56 searches, from May 1, 2007 to November 14, 2007 (28 rounds).

All turbines were searched as frequently as the protocol described, although minor weather and human related disruptions occurred. Field technicians accessed the sites at the earliest available date before the next search round was due to occur. While weather, and tower maintenance work did cause search postponements, by the end of the season, 62 out of 64 towers were searched at an average number of days between successive searches of between 6.5 days and 7.5 days. The remaining two towers were searched at an average number of days between successive searches of between 7.5 days and 7.8 days. The average number of days between searches for all 64 turbines was 6.86 and the median was 6.82. Appendix E has greater details on number of searches and search frequency per tower.

3.1.1.1 Extraordinary Maintenance activities:

During the 2007 project year, MRWRA turbines were shut down to make major repairs and refitting, for significant amounts of time (Appendix F).

We received information on turbine maintenance activity and downtime from the developer and attempted to explore the possible effect on fatalities at the MRWRA (Section 3.2.6). However, data available were inadequate to test for a relationship in this unforeseen circumstance. An experimental study with searches designed to coincide with tower downtime would have been better suited to explore this relationship.

Besides the maintenance activities described above, searches had to be modified in the month of August, 2007, as the wind developer instructed technicians to avoid a 15m (~50 foot) radius around the transformer at the base of the Phase I towers. See section 3.2.6 for an explanation of the effect of this unforeseen change to protocol.

Table 3. Number of surveys completed at all 64 survey towers from April 30 to November 14, 2007.

64 Wind Turbine Towers	(7-Day Search Period)	
Carcass Surveys:	**Start Date**	**End Date**
Round 1[1] (42 Turbines)	30-Apr	8-May
Round 2[1] (55 Turbines)	7-May	15-May
Round 3[1] (61 Turbines)	14-May	25-May
Round 4[1] (62 Turbines)	21-May	1-Jun
Round 5[1] (62 Turbines)	27-May	9-Jun
Round 6 (64 Turbines)	3-Jun	16-Jun
Round 7	10-Jun	23-Jun
Round 8	15-Jun	30-Jun
Round 9	24-Jun	7-Jul
Round 10	1-Jul	13-Jul
Round 11	4-Jul	22-Jul
Round 12	11-Jul	29-Jul
Round 13	18-Jul	5-Aug
Round 14[2]	25-Jul	12-Aug
Round 15[2]	1-Aug	19-Aug
Round 16[2]	8-Aug	27-Aug
Round 17[2]	15-Aug	2-Sep
Round 18[2]	22-Aug	10-Sep
Round 19	29-Aug	18-Sep
Round 20	5-Sep	25-Sep
Round 21	13-Sep	5-Oct
Round 22	19-Sep	9-Oct
Round 23	26-Sep	16-Oct
Round 24	3-Oct	23-Oct
Round 25	10-Oct	31-Oct
Round 26	17-Oct	13-Nov
Round 27	24-Oct	13-Nov
Round 28	31-Oct	12-Nov
Round 29[3]	6-Nov	14-Nov
Round 30[3]	12-Nov	14-Nov

1. Indicates project setup period.
2. Indicates Phase I searches could not enter 15m radius around transformer base.
3. Indicates incomplete 7-Day survey due to winter weather.

3.1.2 Meteorological Towers

Both meteorological towers were searched weekly, for a total of 56 searches, from May 1, 2007 to November 14, 2007. The total search period was 197 days. Meteorological towers 1 and 2 were searched at an average number of days between successive searches of 6.75 and 7 days respectively. See Table 4 for a complete list of search dates.

Table 4. Number of surveys completed at both meteorological towers from May 1 to November 14, 2007.

	Meteorological Tower 1	Meteorological Tower 2
	Date	**Date**
Round 1	1-May	2-May
Round 2	8-May	9-May
Round 3	17-May	17-May
Round 4	22-May	23-May
Round 5	29-May	30-May
Round 6	5-Jun	6-Jun
Round 7	12-Jun	16-Jun
Round 8	19-Jun	20-Jun
Round 9	26-Jun	27-Jun
Round 10	3-Jul	4-Jul
Round 11	10-Jul	11-Jul
Round 12	17-Jul	18-Jul
Round 13	24-Jul	25-Jul
Round 14	31-Jul	1-Aug
Round 15	7-Aug	8-Aug
Round 16	14-Aug	15-Aug
Round 17	21-Aug	22-Aug
Round 18	28-Aug	29-Aug
Round 19	4-Sep	5-Sep
Round 20	11-Sep	12-Sep
Round 21	18-Sep	19-Sep
Round 22	25-Sep	26-Sep
Round 23	2-Oct	3-Oct
Round 24	9-Oct	10-Oct
Round 25	16-Oct	17-Oct
Round 26	23-Oct	24-Oct
Round 27	30-Oct	31-Oct
Round 28	6-Nov	14-Nov

3.2 Incidents Recorded During Standardized Surveys and Incidentally

During this study, a total of 96 avian fatalities/injuries (incidents) and 283 bat fatalities/injuries (incidents) were recorded during standardized surveys at turbine towers and meteorological towers as well as incidentally reported. Incidentally reported carcasses included finds by wind developer employees at any of the 195 turbine sites and finds by field technicians not in standardized search plots or not during standardized searches. Of these 96 bird carcasses, 32 (33.33%) were found incidentally and of the 283 total bat carcasses, 81 (28.62%) were found incidentally.

Normally, incidental finds are not included in any extrapolation of total incidents/tower, as they are outside the study design framework. However, a number of incidents were noted, at survey sites, by field technicians visiting survey sites for scavenge tests and maintenance. Site maintenance techniques required frequent visits to sites before and after mowing activity to remove/replace boundary and transect markers. Further, some sites required daily checking during scavenger tests. We deemed it possible that field technicians could have noted some of these incidents during standardized searches if they had not already noticed them. We classified these incidental findings as “added incidentals.” We performed an additional calculation to estimate mortality using both incidents from standardized searches and “added incidentals” (See Section 3.3.) The number of “added incidentals” for birds was 12 (~13%). The number of “added incidentals” for bats was 63 (~22%).

3.2.1 Birds:

A total of 64 avian incidents were recorded by searchers during standardized surveys under wind turbines, representing 41 incidents identified to 21 species and 23 incidents that could not be identified to a taxonomic group because they were partially scavenged or decayed prior to being found (Table 5). Of the 41 identified incidents, there were 19 songbird species, one raptor species (3 Red-tailed Hawk incidents), and one columbiform species (one Rock Pigeon incident). 25 out of the 41 (60.98%) incidents identified to species were night migrants. Of all 37 identified songbirds, (excluding incidental finds), 25 (67.57%) were night migrants. While these birds are classified as ‘night migrants’ we could not ascertain that they were in the process of migration at the time of collision.

European Starlings (n = 7; 10.94% of 64 avian incidents), Cedar Waxwings (n = 6; 9.38% of 64 avian incidents) and Golden-crowned Kinglets (n = 4; 6.25% of 64 avian incidents) were the most common species found. The greatest number of bird incidents occurred during the month of August.

In Table 5, the incidental finds are listed in a separate column by species but are not included in either the totals or calculations.

One Black-throated Blue Warbler (Night-migrating songbird) was found at Meteorological Tower 1.

3.2.1.1 Incidental Finds:

A total of 32 avian incidents were recorded by searchers or reported by WRA employees at times or locations other than during standardized surveys on weekly searched sites (Table 5). As explained previously, some of these were classified as “added incidentals.” There were 12 added incidentals, 6 songbird species (one incident each of the following: Golden-crowned Kinglet, Winter Wren, Indigo Bunting, Eastern Kingbird, Scarlet Tanager, Hermit Thrush), one game bird species (one Ruffed Grouse), two species classified as “Other” (One Yellow-bellied Sapsucker and one Ruby-throated Hummingbird). There were also three unidentified bird incidents.

Of the remaining 20 birds that were not added incidentals, there were 3 raptor species (One sharp-shinned Hawk, 2 Red-tailed Hawks), 5 songbird species (Two Ruby-crowned Kinglets, one Golden-crowned Kinglet, one Brown Creeper, one Eastern Kingbird, one Song Sparrow), three game birds (one Woodcock, one Wild Turkey and one Ruffed Grouse), two waterbird species (two Mallards, one Canada Goose), one species classified as "Other" (one Black-billed Cuckoo). There were also four unidentified bird incidents.

This mix of taxa represent night migrants, daytime migrants, and non-migrant residents.

Table 5. Number of avian incidents at each wind turbine by species group found during standardized surveys and "incidentally" from April 30 to November 14, 2007.

Tower #	Search Frequency	Number of Bird Incidents					
		Other	Raptor	Unidentified bird	Passerine	Total Std.	Incidental
198	7 Day	0	0	0	6	**6**	0
56	7 Day	0	0	2	2	**4**	1
110	7 Day	0	0	1	3	**4**	0
197	7 Day	0	0	2	2	**4**	2
114	7 Day	0	0	3	0	**3**	1
129	7 Day	0	0	2	1	**3**	0
183	7 Day	0	0	1	2	**3**	0
22a	7 Day	0	0	0	2	**2**	1
24	7 Day	0	0	1	1	**2**	0
59	7 Day	0	0	1	1	**2**	0
103	7 Day	0	0	2	0	**2**	1
108	7 Day	0	0	2	0	**2**	0
134	7 Day	0	0	1	1	**2**	0
136	7 Day	0	1	0	1	**2**	1
180	7 Day	0	0	2	0	**2**	0
27	7 Day	0	0	0	1	**1**	1
57	7 Day	0	0	0	1	**1**	1
195	7 Day	0	0	0	1	**1**	1
16	7 Day	0	0	0	1	**1**	3
23	7 Day	0	0	0	1	**1**	0
40	7 Day	0	0	0	1	**1**	0
53	7 Day	0	0	0	1	**1**	1
61A	7 Day	0	0	0	1	**1**	0
64	7 Day	0	0	1	0	**1**	0
79A	7 Day	0	0	0	1	**1**	1
82	7 Day	0	0	0	1	**1**	0
102	7 Day	0	1	0	0	**1**	0
109	7 Day	0	0	0	1	**1**	0
116	7 Day	0	0	1	0	**1**	1
118	7 Day	0	0	0	1	**1**	0
121	7 Day	0	0	0	1	**1**	0
126	7 Day	0	0	0	1	**1**	0
130	7 Day	0	1	0	0	**1**	0
133	7 Day	1	0	0	0	**1**	0
149	7 Day	0	0	1	0	**1**	0
187	7 Day	0	0	0	1	**1**	0
34	7 Day	0	0	0	0	**0**	2
12	7 Day	0	0	0	0	**0**	2
17	7 Day	0	0	0	0	**0**	0

Tower #	**Search Frequency**	**Number of Bird Incidents**					
		Other	**Raptor**	**Unidentified bird**	**Passerine**	**Total Std.**	**Incidental**
26	7 Day	0	0	0	0	**0**	0
36	7 Day	0	0	0	0	**0**	0
37	7 Day	0	0	0	0	**0**	0
39	7 Day	0	0	0	0	**0**	0
50	7 Day	0	0	0	0	**0**	2
52	7 Day	0	0	0	0	**0**	0
54A	7 Day	0	0	0	0	**0**	0
75	7 Day	0	0	0	0	**0**	1
76	7 Day	0	0	0	0	**0**	0
77	7 Day	0	0	0	0	**0**	0
83	7 Day	0	0	0	0	**0**	0
89	7 Day	0	0	0	0	**0**	0
101	7 Day	0	0	0	0	**0**	0
104	7 Day	0	0	0	0	**0**	0
122	7 Day	0	0	0	0	**0**	0
124	7 Day	0	0	0	0	**0**	0
125	7 Day	0	0	0	0	**0**	1
127	7 Day	0	0	0	0	**0**	0
153	7 Day	0	0	0	0	**0**	0
154	7 Day	0	0	0	0	**0**	0
167	7 Day	0	0	0	0	**0**	0
168	7 Day	0	0	0	0	**0**	1
179	7 Day	0	0	0	0	**0**	0
184	7 Day	0	0	0	0	**0**	0
189	7 Day	0	0	0	0	**0**	0
MET 1	7 Day	0	0	0	1	**1**	0
MET 2	7 Day	0	0	0	0	**0**	0
25	Non-Survey	0	0	0	0	**0**	1
32	Non-Survey	0	0	0	0	**0**	3
72	Non-Survey	0	0	0	0	**0**	1
185	Non-Survey	0	0	0	0	**0**	1
62A	Non-Survey	0	0	0	0	**0**	1
	Totals	**1**	**3**	**23**	**37**	**64**	**32**
Sorted by grand total number of avian fatalities (Total Std.).							
Includes incidents associated with wind turbines found during standardized surveys and "incidentally" (April 30, 2007 to November 14, 2007).							

Figure 4. Locations of bird incidents at the Maple Ridge WRA found during standardized surveys, (April 30 to November 14, 2007).
Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally.

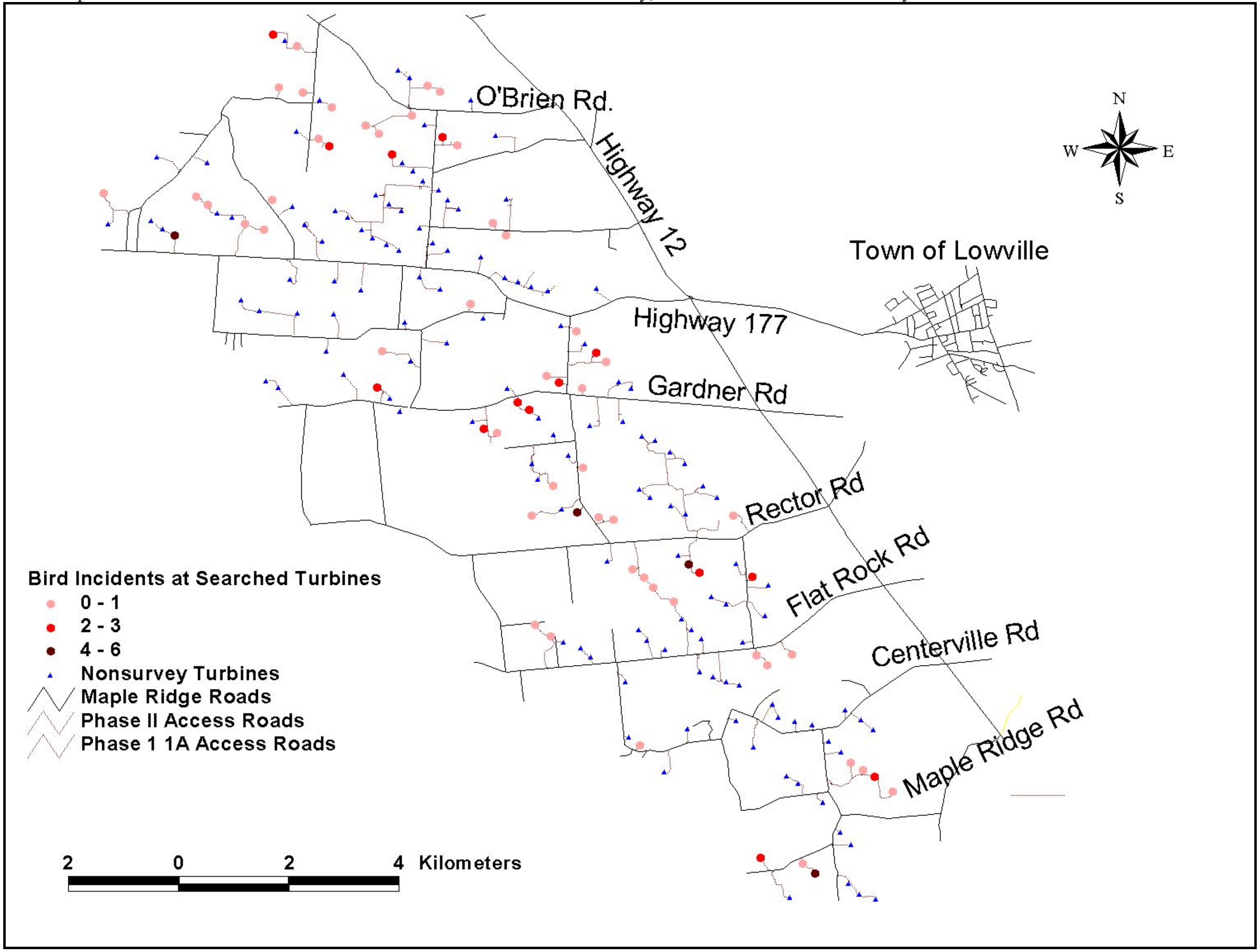
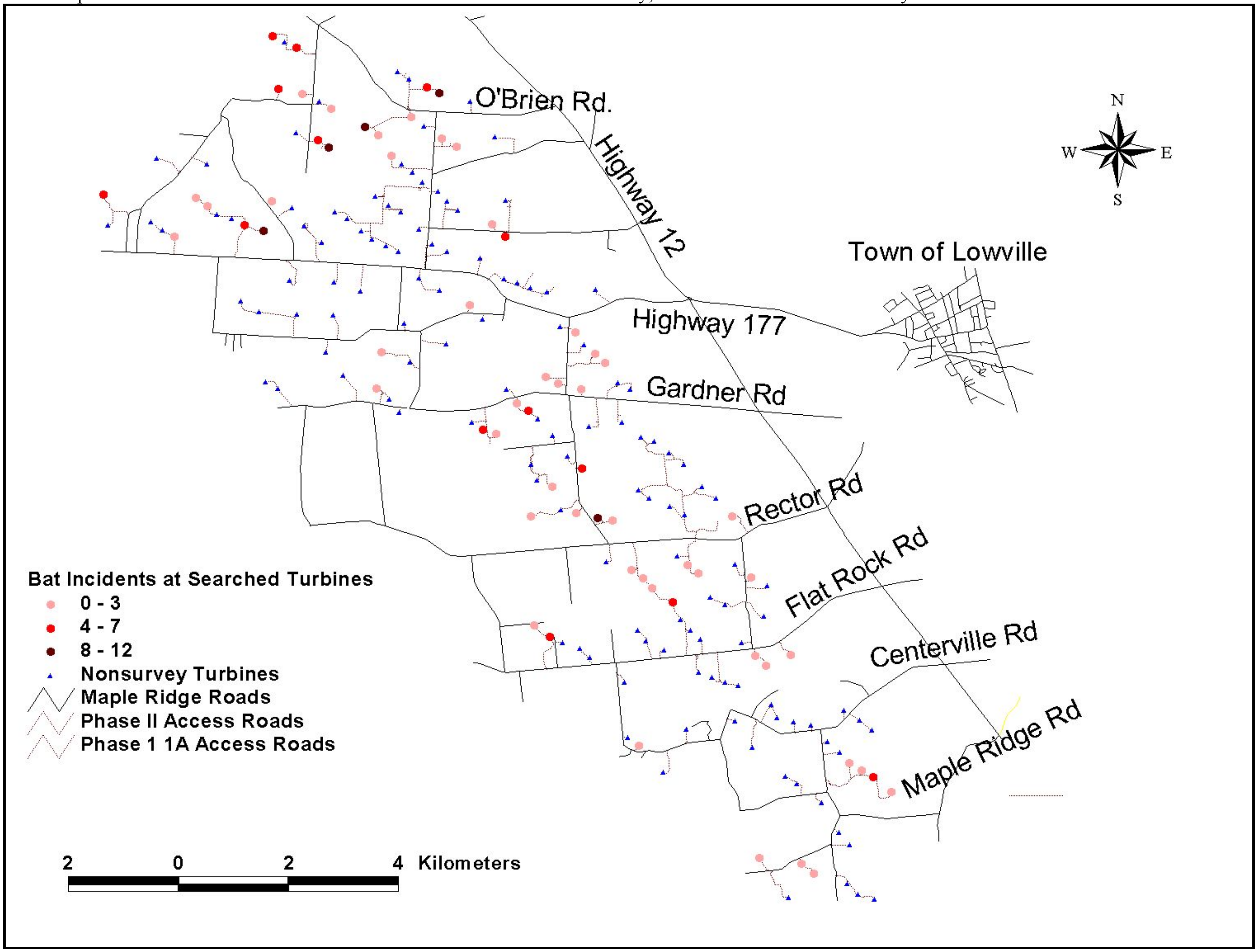


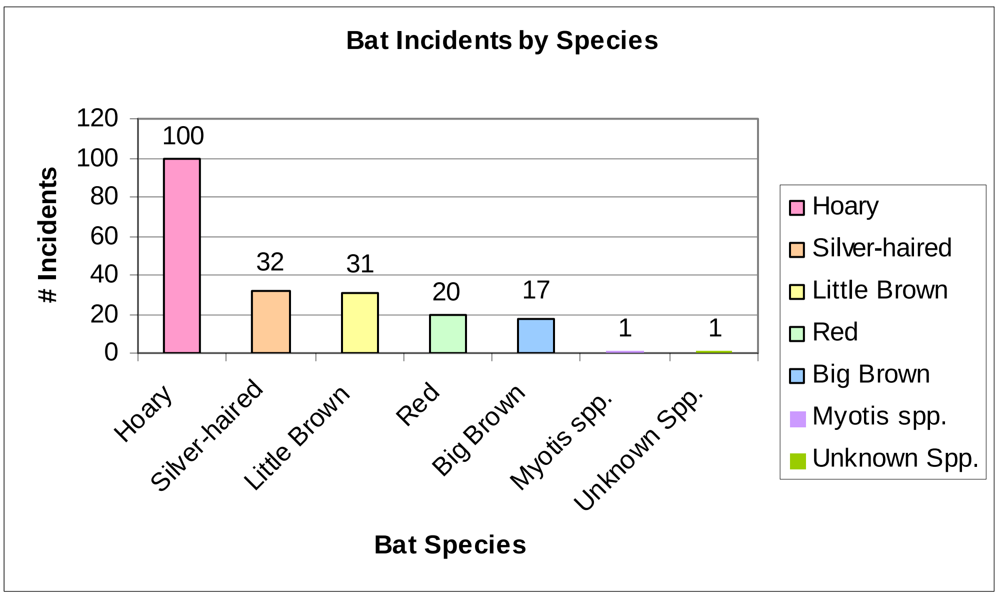
Figure 5. **Locations of bat incidents at the Maple Ridge WRA found during standardized surveys, (April 30 to November 14, 2007).**
Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally



3.2.2 Bats

Remains of 202 bats were found by searchers during standardized surveys (April 30, 2007 to November 14, 2007), representing five species (Hoary Bat, Silver-haired Bat, Eastern Red Bat, Little Brown Bat, and Big Brown Bat). Out of the 202 bats found during standardized surveys, Hoary Bats comprised 49.5% (n = 100), Silver-Haired Bats comprised 15.8% (n = 32), Little Brown Bats comprised 15.3% (n = 31), Red Bats comprised 9.9% (n = 20), and Big Brown Bats comprised 8.4% (n = 17). Further, 0.5% (n = 1) was identified as Myotis species (probably Little Brown Bat) and 0.5% (n = 1) could not be identified because of the advanced state of decomposition (Figure 6).

Figure 6. Distribution of bat incidents by species, from standardized surveys conducted from (April 30 to November 14, 2007).



3.2.2.1 Incidental Finds:

A total of 81 bat incidents were recorded by searchers or reported by WRA employees at times or locations other than during standardized surveys on weekly searched sites. As explained previously, some of these were classified as "added incidentals." There were 63 added incidentals, (37 Hoary Bats, 10 Eastern Red Bats, 9 Silver-Haired Bats and 7 Little Brown Bats).

Of the remaining 18 bats that were not added incidentals, there were six Hoary Bats, four Eastern Red Bats, three Silver-Haired Bats, three Little Brown Bats and one Big Brown Bat. There was also one unidentified bat incident.

Table 6 shows the number of bat incidents associated with specific wind turbines found during standardized surveys as well as incidental finds.

Table 6. Wind turbine locations of bat incidents by species.

Turbine #	Hoary	Silver	Little Brown	Red	Big Brown	Myotis spp.	Unknown Spp.	Total	Incidental
134	5	1	1	4	1	0	0	**12**	2
187	3	2	1	0	4	0	0	**10**	4
125	5	0	1	3	0	0	0	**9**	1
39	3	3	0	1	0	0	1	**8**	0
79A	7	0	0	0	1	0	0	**8**	6
133	7	0	0	0	0	0	0	**7**	1
27	4	0	1	1	0	0	0	**6**	0
83	0	0	5	0	1	0	0	**6**	1
103	3	2	0	0	1	0	0	**6**	1
116	3	0	1	0	2	0	0	**6**	1
153	3	0	1	1	1	0	0	**6**	1
168	3	0	0	1	2	0	0	**6**	0
36	2	2	0	1	0	0	0	**5**	0
114	4	0	0	1	0	0	0	**5**	3
183	3	1	1	0	0	0	0	**5**	5
64	3	1	0	0	0	0	0	**4**	1
118	3	1	0	0	0	0	0	**4**	2
121	1	1	1	0	0	0	0	**3**	2
149	1	1	0	1	0	0	0	**3**	4
22a	0	2	0	1	0	0	0	**3**	1
23	2	0	1	0	0	0	0	**3**	0
24	0	0	3	0	0	0	0	**3**	0
53	2	1	0	0	0	0	0	**3**	0
56	2	0	0	0	1	0	0	**3**	2
57	2	0	1	0	0	0	0	**3**	1
61A	1	1	1	0	0	0	0	**3**	0
104	3	0	0	0	0	0	0	**3**	2
122	1	1	0	1	0	0	0	**3**	4
126	2	0	1	0	0	0	0	**3**	1
127	2	0	0	1	0	0	0	**3**	1
130	2	0	1	0	0	0	0	**3**	0
189	2	0	0	0	0	0	0	**2**	1
26	1	1	0	0	0	0	0	**2**	0
34	1	0	1	0	0	0	0	**2**	1
37	1	1	0	0	0	0	0	**2**	1
40	1	0	0	1	0	0	0	**2**	1
50	0	0	1	1	0	0	0	**2**	0
75	1	0	1	0	0	0	0	**2**	0
77	1	0	1	0	0	0	0	**2**	1
82	0	1	1	0	0	0	0	**2**	1
102	0	2	0	0	0	0	0	**2**	0
108	1	1	0	0	0	0	0	**2**	0

Turbine #	Hoary	Silver	Little Brown	Red	Big Brown	Myotis spp.	Unknown Spp.	Total	Incidental
110	1	0	1	0	0	0	0	**2**	0
124	1	0	0	0	1	0	0	**2**	0
129	1	0	0	0	0	1	0	**2**	0
136	1	0	1	0	0	0	0	**2**	1
167	0	1	0	0	1	0	0	**2**	1
180	1	0	0	1	0	0	0	**2**	1
198	0	1	1	0	0	0	0	**2**	1
12	0	1	0	0	0	0	0	**1**	1
16	1	0	0	0	0	0	0	**1**	2
17	0	1	0	0	0	0	0	**1**	0
52	0	0	0	0	1	0	0	**1**	1
59	0	1	0	0	0	0	0	**1**	1
76	0	0	1	0	0	0	0	**1**	0
89	1	0	0	0	0	0	0	**1**	3
101	0	1	0	0	0	0	0	**1**	0
179	0	0	1	0	0	0	0	**1**	2
195	1	0	0	0	0	0	0	**1**	2
197	1	0	0	0	0	0	0	**1**	1
54A	0	0	0	0	0	0	0	**0**	1
109	0	0	0	0	0	0	0	**0**	1
154	0	0	0	0	0	0	0	**0**	0
184	0	0	0	0	0	0	0	**0**	0
1	…..	…..	…..	…..	…..	…..	…..	**…..**	1
9	…..	…..	…..	…..	…..	…..	…..	**…..**	2
18	…..	…..	…..	…..	…..	…..	…..	**…..**	1
25	…..	…..	…..	…..	…..	…..	…..	**…..**	1
73	…..	…..	…..	…..	…..	…..	…..	**…..**	1
132	…..	…..	…..	…..	…..	…..	…..	**…..**	1
190	…..	…..	…..	…..	…..	…..	…..	**…..**	1
Unknown Locn.*	…..	…..	…..	…..	…..	…..	…..	**…..**	1
Totals	100	32	31	20	17	1	1	**202**	81

Sorted by number of fatalities (descending order).

* Left by field technician's vehicle

3.2.3 Seasonal Distribution of Fatalities (Birds and Bats)

The duration of this project extended across 3 seasons (from 2 weeks after snow cleared in the mid-April) until snow once again made searching impossible in mid-November). As a result, we are able to discern patterns in seasonal mortalities. The greatest number of bat incidents occurred during the fall migration period, with 133 (65.8%) bat carcasses found between July 1, 2007 and August 31, 2007. (Figures 8 and 9) The number of incidents declined sharply in subsequent months, as fall migration concluded and temperatures became colder. Only one bat incident was noted in the first half of November, although this incident was remarkable as temperatures were generally below freezing, and snowfall had begun to impede searches.

The greatest number of bird incidents occurred during August. While only three raptor fatalities were noted, these occurred in August and September. (Table 7, Figures 7 and 9).

Table 7. Number of birds and bats found per month, from May to November, 2007.

Species Group	May[1]	June	July	August	September	October	November[1]
Raptor	0	0	0	1	2	0	0
Passerine	9	4	6	9	4	4	1
Other Bird	0	0	0	0	1	0	0
Unknown	3	8	4	4	2	2	0
Total Birds	**12**	**12**	**10**	**14**	**9**	**6**	**1**
Bats	11	24	49	84	27	6	1

[1]Searches began on April 30, 2007 and were concluded on November 14, 2007. A number of snowy days in November further reduced actual search days.
[2]'Other Bird' comprised of one Rock Pigeon.

Figure 7. Number of birds found per month from April 30 to November 14, 2007.

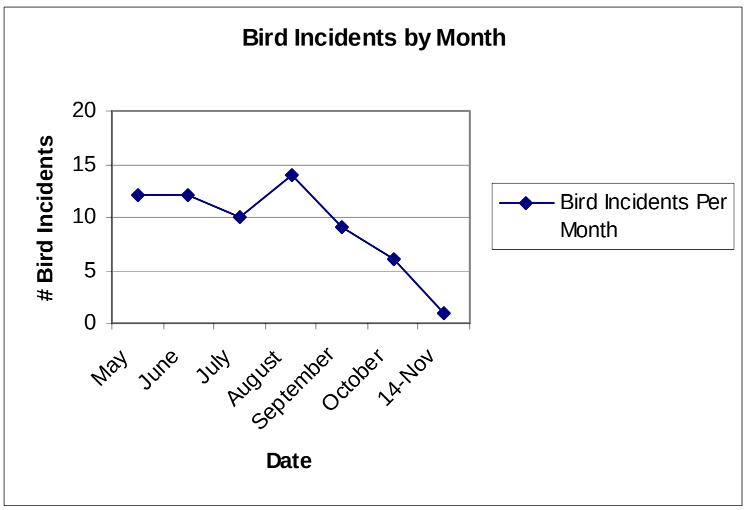


Figure 8. Number of bats found per month from April 30 to November 14, 2007.

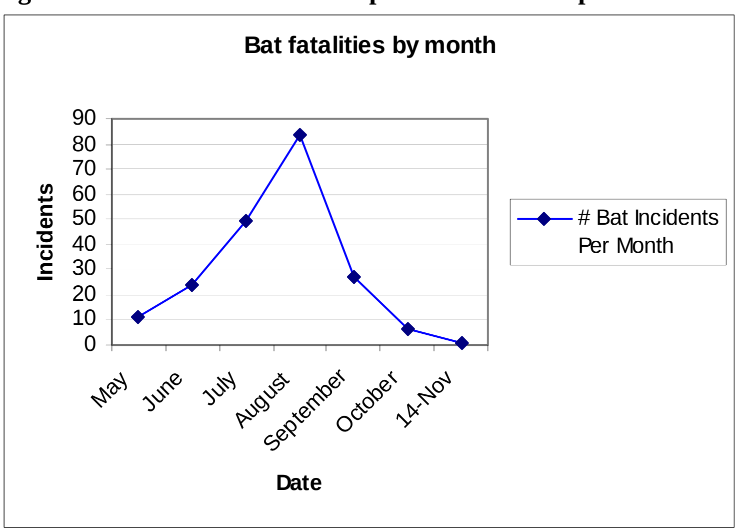
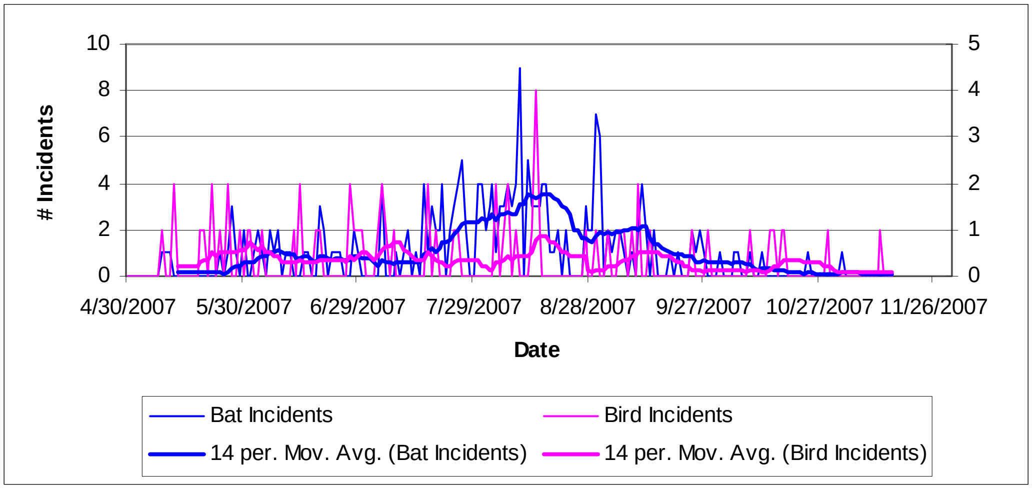


Figure 9. Number of birds and bats found per day from April 30 to November 14, 2007.
Note: Trend lines indicating a 14 day moving average.



3.2.4 Distance from Turbine Bases

There were primarily two classes of animals involved with tower collisions: small birds and bats. These two unrelated groups of species are similar in size and general shape. The small sample size of larger birds was not considered in the following analyses because of the paucity of data available. We included unidentified birds along with small birds for the purposes of this analysis. 202 bat incidents and 56 bird incidents were used to evaluate "fall" distance from tower base. While the weight and size of small birds and bats can be similar, there are differences in the flight speed of these groups (in general, bats tend to be more maneuverable in small areas and birds tend to be stronger, swifter fliers). Turbine incidents were divided into small bird and bat events to determine if surveying a 120m by 130m 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 8) were then tabulated based on distance (range) from the base of wind turbines (Tables 9, 10). Of the 56 small bird incidents found during standardized surveys, the mean distance to the turbine tower base was 33.54m ± 5.79 (95% CI) and the median distance was 38m. Of the 202 bat incidents found during standardized surveys, the mean distance to the turbine tower base was 26.8m ± 2.14 95% CI and the median distance was 24.5m. Thus, bat incidents were concentrated closer to the tower than birds.

Table 8. Species size groupings used in analyses.

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

The annuli (Tables 9, 10) with a radius greater than 60m were only partially within the 4 sides of the 120m by 130m search area. Thus distance from the turbines alone was not adequate to evaluate the spread of bird and bat carcasses at searched sites. Instead, we looked at bird and bat incident density in the following manner.

As searchable area varied between sites, we used data from GPS Trimble XRS measurements and analysis in ArcView GIS 3.3 to calculate the area searched per 10m concentric annulus around each of the 64 searched turbines. Distances were recorded for all bird and bat carcasses found during standardized surveys. We divided the number of birds and bats found within each 10m annulus (at 64 annulus) by the total searched area that fell within that annulus (at 64 turbines) to arrive at an incident density.

Table 9. Number of incidents (Birds) versus total area searched per 10m distance annulus at 64 searched sites, April 30 to November 14, 2007.

Buffer	Area Searched	Bird Incidents	Bird Incident Density
0-10	20004	9	0.00045
10-20	60010	9	0.00015
20-30	98736	5	0.00005
30-40	132303	6	0.00005
40-50	144686	10	0.00007
50-60	153565	6	0.00004
60-70	123132	4	0.00003
70-80	52701	2	0.00004
80-90	5771	0	0.00000

Table 10. Number of incidents (Bats) versus total area searched per 10m distance annulus at 64 searched sites, April 30 to November 14, 2007.

Buffer	Area Searched	Bat Incidents	Bat Incident Density
0-10	20004	18	0.00090
10-20	60010	55	0.00092
20-30	98736	45	0.00046
30-40	132303	43	0.00033
40-50	144686	23	0.00016
50-60	153565	13	0.00008
60-70	123132	4	0.00003
70-80	52701	1	0.00002
80-90	5771	0	0.00000

These densities were plotted (Figures 10, 11) along with the best fitting trend line (The most appropriately shaped trend-line with the highest R^2 value) to approximate 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 (R^2= 1 indicates perfect fit). The R^2 for bird incidents was 0.95 and the R^2 for bat incidents was 0.92.

The trend-line derived from that data was in accordance with our expectation that bird incidents approximate zero at a point farther out than bat incidents (densities of bat incidents approximate zero at ~75m from the turbine base and bird incidents approximate zero at ~90m from the turbine base. The current available data indicate that the current maximum search area of 120m by 130m was adequate to detect most bird and bat collision fatalities, but a small number of bat fatalities and a potentially higher number of bird fatalities may be missed.

Figure 10. Density of bird incidents at 64 searched sites, from surveys conducted between April 30 to November 14, 2007, in relation to distance from towers.
Note: Polynomial trend line approximates distance at which density crosses zero.

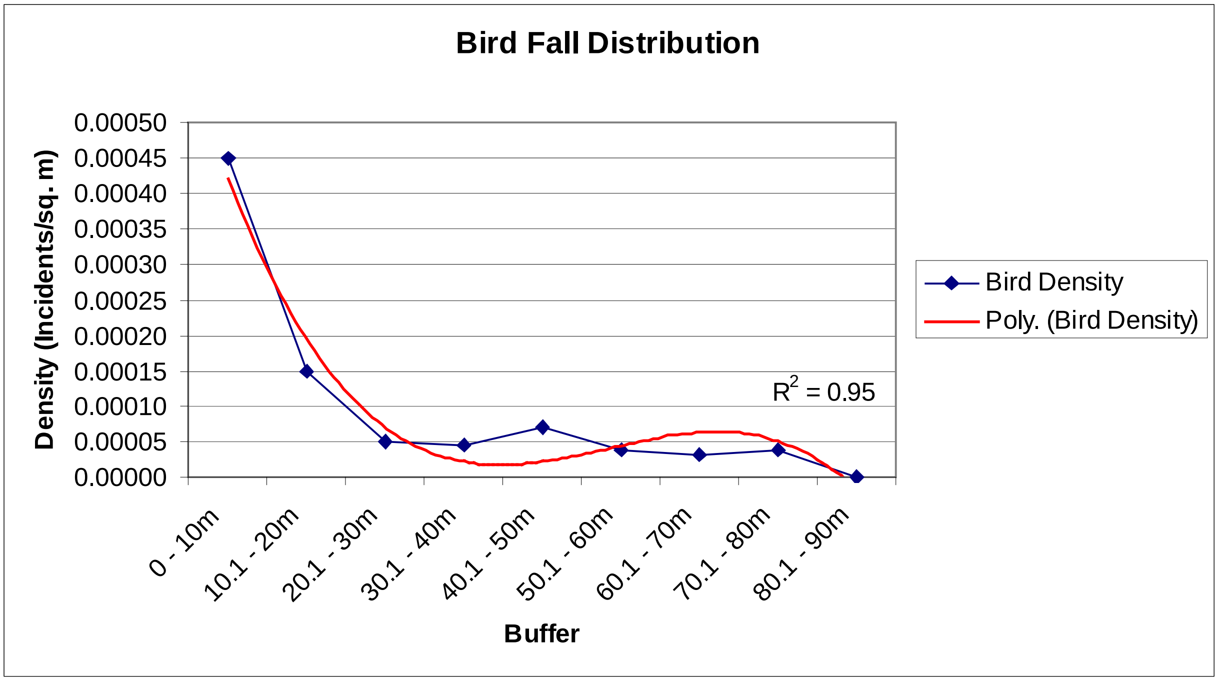
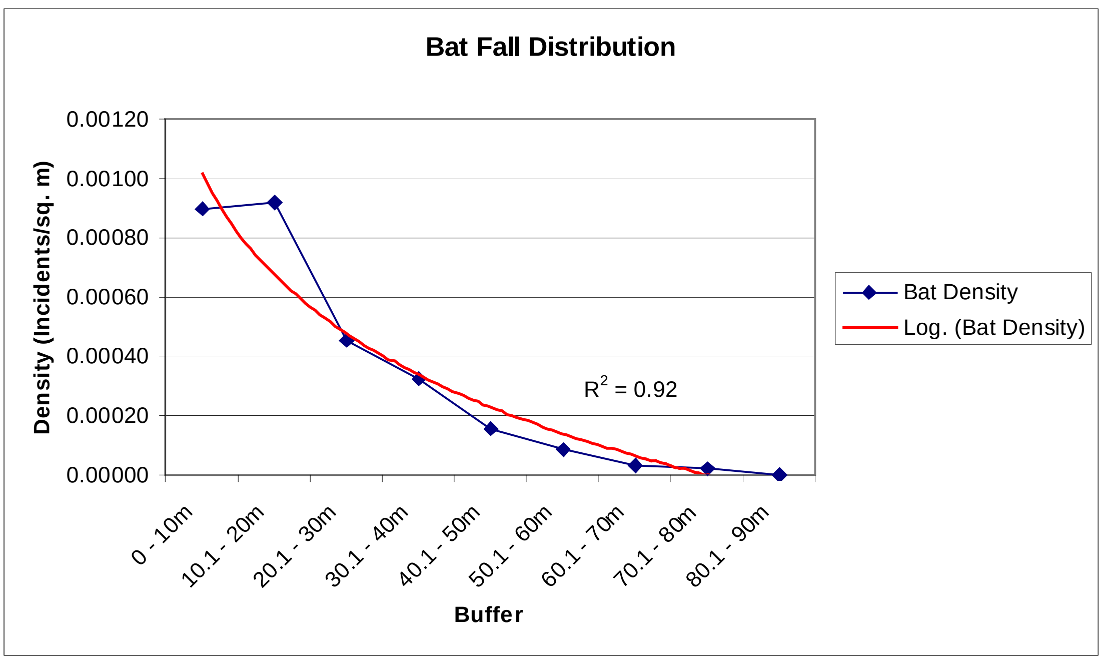


Figure 11. Density of bat incidents at 64 searched sites, from surveys conducted between April 30 to November 14, 2007, in relation to distance from towers.
Note: Logarithmic trend line approximates distance at which density crosses zero.



3.2.5 Multiple Regression Model

We collected data on several site conditions (factors) at turbines in order to determine their correlation with bird and bat fatalities. Factors included the presence of wooded areas on sites (Wooded), sites that were on the North-West Edge vs. the remaining sites (N-W_Edge), and, for bats only, the distance to nearest wetland (Dist_Wetland).

N-W-Edge: Models testing the N-W_Edge factor only used data from the fall, as TAC members hypothesized that if fall migrating birds and bats encounter the turbines at the Northwest boundary of the MRWRA before encountering the remaining turbines, the number of fatalities may be significantly higher at the former. Out of 64 towers searched on a 7-day basis, 18 were classified as N-W_Edge and 46 were classified as non-N-W_Edge sites.

Wooded: The area within the MRWRA wind farm includes a mix of agricultural/grassland (non-wooded) and wooded land. Out of the 64 towers searched, 29 were classified as wooded and 35 were classified as non-wooded sites.

Dist_wetland: 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) and to use wetlands for some of their daily water intake needs (Kurta 2000). We determined the distance of each searched turbine site to the nearest wetland, using wetland delineation by Environmental Research and Design (EDR). Dist_Wetland was not a factor in bird models.

We weighted the number of incidents per site by the square of the total area searched under each site (**Area_searched_sqd**) as this varied between sites. (Where necessary, we transformed data to achieve normal distributions). Numbers of bat incidents noted were sufficiently high to use a standard linear regression for both bat models. However, numbers of bird incidents were low, so we used a generalized linear regression with a Poisson distribution for both bird models.

We ran four regression models in total, including two models each, for birds and bats (Table 11).

Table 11. Results from bird and bat regression models, from surveys conducted between April 30 to November 14, 2007.

	Model Factors			Response Variable	Weight Variable
Model Name	**Wooded**	**N-W_Edge**	**Dist_Wetland**		
Bird 1	ns[1]	---[2]	---	# Bird Incidents	Area Searched
Bird 2 (Fall)	ns	ns	---	# Fall Bird Incidents	Area Searched
Bat 1	Significant (t=-1.92, p = 0.06)	---	Significant (t = -1.70, p = 0.09)	# Bat Incidents	Area Searched
Bat 2 (Fall)	ns	ns	Significant (t = -1.86, p = 0.07)	# Fall Bat Incidents	Area Searched

1. ns: Not Significant,
2. ---: Factor not used in model

Model Bird 1:

There was no evidence that the number of bird incidents differed between Wooded and Non-wooded sites (Chi-Squared Test, $\chi = 1.04$, $p = 0.31$, df = 1, 62).

Model Bird 2 (Fall):

There was no evidence that the number of bird incidents differed between Wooded and Non-wooded sites (Chi-Squared Test, $\chi = 0.27$, $p = 0.61$, df = 1, 61).

There was no evidence that the number of bird incidents differed between N-W-Edge and non-N-W-Edge sites (Chi-Squared Test, $\chi = 0.78$, $p = 0.38$, df = 1, 61).

Model Bat 1:

There was moderate evidence that the number of bat incidents was higher at Wooded compared to Non-wooded sites (T-test, $t = -1.92$, $p = 0.06$, df = 1, 61).

There was moderate evidence that the number of bat incidents decreased with the greater distance to the nearest wetland (T-test, $t = -1.70$, $p = 0.09$, df = 1, 61).

Model Bat 2 (Fall):

There was no evidence that sites on the N-W edge had greater bat incidents than non-N-W_Edge sites (T-test, $t = 0.40$, $p = 0.69$, df = 1, 60).

There was no evidence that the number of bat incidents differed between Wooded and Non-wooded sites (T-test, $t = -1.13$, $p = 0.26$, df = 1, 60).

There was moderate evidence that the number of bat incidents decreased with the greater distance to the nearest wetland (T-test, $t = -1.86$, $p = 0.07$, df = 1, 60)

<u>3.2.6 Extraordinary Maintenance Activities:</u>

During the 2007 project year, the MRWRA experienced unusually high levels of turbine maintenance. Turbines were made inactive for major repairs and refitting, for significant amounts of time. The 64 searched turbines were collectively down for a total of 60,131 turbine-hours. This is approximately 20% of the total number of hours in the study period (64 turbines*196 days*24 hours = 301,056 turbine-hours). While we hypothesized that inactive turbines may be correlated with a decrease in fatalities, we had no way of coordinating searches with inactive turbines, as maintenance work was not according to a regular schedule. In addition, downtime occurred for differing periods of the day (and night) at individual towers. An experimental study with searches designed to coincide with tower downtime would be better suited to explore this relationship.

Besides the maintenance activities described above, during August 2007 all technicians were instructed by the wind developer, to immediately avoid a 15 m (50 foot) radius, (~4.5% of a fully searched site) around the transformer at the base of the Phase I towers (39 out of the 64 searched towers, Table 3). Most of this area constituted the gravel pad at the base of the turbine, and every effort was made to continue to search these areas to the best of our ability. Searchers modified their survey pattern by carefully scanning these areas from outside the 15m circle, noting any evidence of bird or bat incidents. However, some incidents may have been missed due to increased distance. Further, the part of this circle that required mowing was difficult to scan after 2 weeks, when mowing could not occur. It is likely that some incidents fell into this zone but could not be detected. However, these areas were immediately cleared and searched upon removal of the safety warning. Some previously missed incidents may have been detected during these searches, somewhat mitigating the effect on the impact of reduction of search effort close to the turbines.

3.2.7 Lit versus Un-Lit Turbine Sites

We examined the numbers of night migrating bird and bat fatalities at turbines with FAA lights vs. turbines without such lights. Chi-square tests were performed contrasting the number of incidents noted at lit vs. unlit turbine sites to test whether the actual proportion of incidents at lit versus unlit towers differed significantly from the expected proportion. No significant differences were found. 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.

As the mean searched area at lit ($\bar{x}$ = 11160 m^2) versus unlit turbines ($\bar{x}$ = 11693m^2) did not differ significantly, (T-test, t = 0.58. p = 0.56, df = 62) we were able to use data from all 64 sites. There was no significant deviation (Table 12) from the expected number of night-migrant bird incidents at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 0$, $df = 1$, P = 1, ns). Further, there was no significant deviation (Table 13) from the expected number of bat incidents at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 0.14$, $df = 1$, P = 0.71, ns).

Table 12. Contingency table showing the proportion of night migrant birds comparing lit vs. unlit 7-day search sites

	# 7-Day Turbines	# Night Migrant Birds	Sum
Lit	18	7	25
Unlit	46	18	64
Sum	64	25	89

Table 13. Contingency table showing the proportion of bats comparing lit vs. unlit 7-day search sites

	# 7-Day Turbines	# Bats	Sum
Lit	18	52	70
Unlit	46	150	196
Sum	64	202	266

3.3 Adjusting Fatality Estimates

3.3.1 Estimates from 7-day Search Sites

Our search protocols were designed to search a subset (n = 64) of the 195 turbines in all three phases (I, II and IA) of the MRWRA. Results presented here include 95% confidence intervals.

3.3.1.1 Project Set-up Adjustment

We divided the numbers of birds and bats found during each search round by the proportion of the 64 sites searched in that round to obtain Set-up adjusted figures (Table 14).

E.g. By the second round of searches, 55 out of 64 (86%) turbines sites were set-up and searched. The 3 bird incidents and 3 bat incidents found during that 2nd round were considered to be 86% of the actual number of incidents noted, had we searched all 64 sites.

Table 14. Project Set-up Adjustment factors for first 5 search rounds of the Maple Ridge standardized surveys, 2007

Search Round	Turbines Searched	Proportion of Total 64 Towers Searched	Bird Incidents	Bat Incidents	Adj. Bird Incidents	Adj. Bat Incidents
Round 1	42	0.66	0	0	0	0
Round 2	55	0.86	3	3	3.49	3.49
Round 3	61	0.95	5	1	5.25	1.05
Round 4	62	0.97	5	7	5.16	7.23
Round 5	62	0.97	2	9	2.06	9.29
		Total	15	20	**16**	**21**

Thus, one bird incident and one bat incident may have been found, had we been able to set-up and search all 64 towers on the first day on site. The raw figures of bird and bat incidents found were adjusted to include the addition of one unidentified bird and bat species.

3.3.1.2 Area Searched (Search Sites Limited by Mowing Obstacles)

After dividing the area searched under the 64 turbines into 8 concentric buffers (annuli) of 10m increments in size (i.e. 0–10m, 10.1m–20m etc.) (Table 15, Figure 12), we examined the fall distribution of the 140 bat incidents and 74 bird incidents in these annuli. The total number of incidents (separately for all four size classes: small, medium and large birds and bats) in each 10m increment search annulus and the percent area searched in that annulus are reported below (Table 15).

Figure 12. Examples of searched towers showing searchable area divided into concentric annuli.

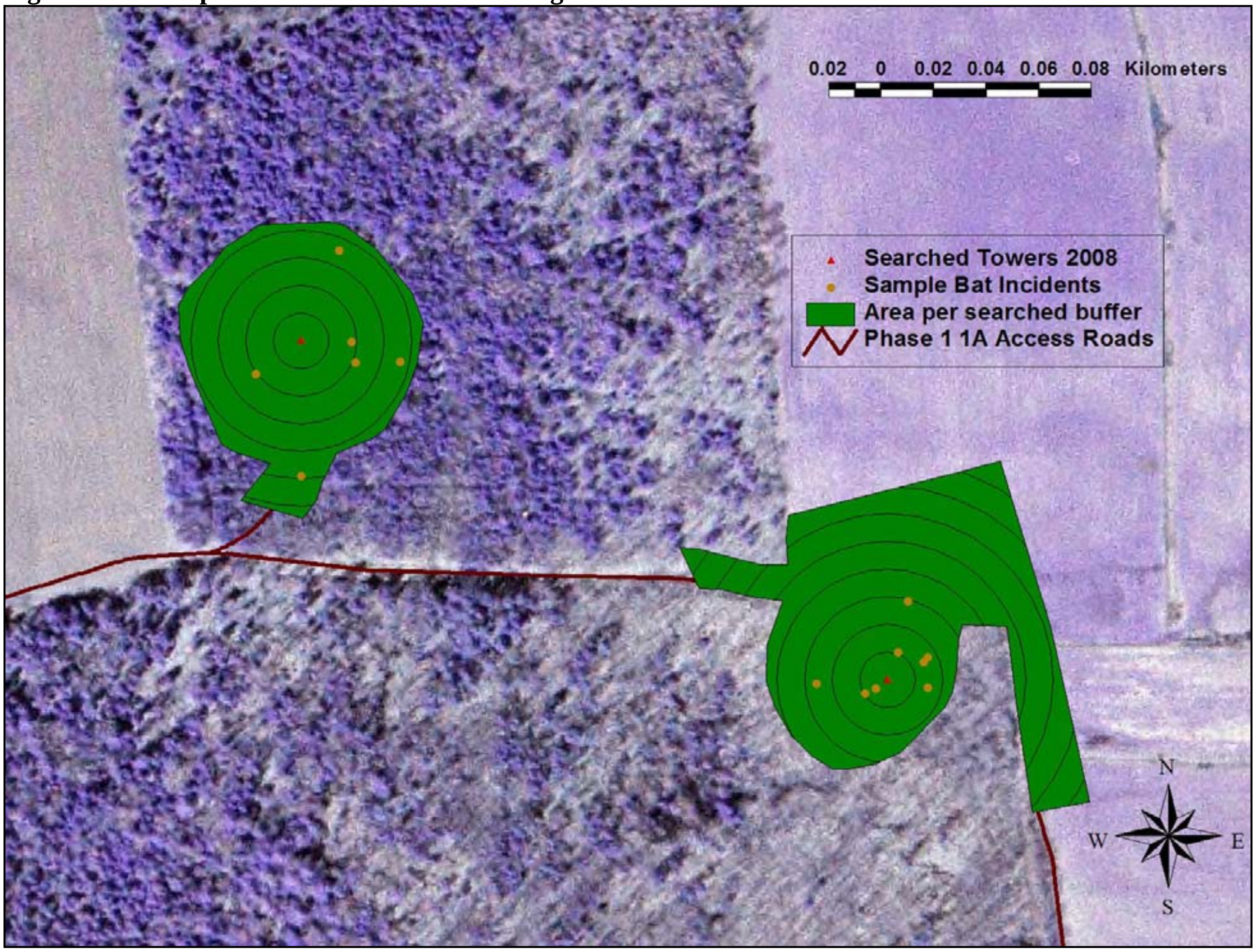


Table 15. Area Adjustment Factor (bird and bat incidents from standardized surveys conducted from April 30 to November 15, 2007 (not including 'added incidentals').

				Pre-Area Adjusted					Area Adjusted				
Annulus	Total Area Searched at 64 towers	Total Searchable area/ annulus	Search Intensity (Prop.) of annulus searched (*Si*)	Small birds	Med. birds	Large birds	Unid. birds	Bats	Small birds	Med. birds	Large birds	Unid. birds[2]	Bats
0-10	20004	20108.8	0.99	9	1	0	0	18	9.05	1.01	0.00	0.00	18.09
10-20	60010	60326.4	0.99	9	1	0	0	55	9.05	1.01	0.00	0.00	55.29
20-30	98736	100544	0.98	5	0	2	0	45	5.09	0.00	2.04	0.00	45.82
30-40	132303	140761.6	0.94	6	2	1	0	43	6.38	2.13	1.06	0.00	45.75
40-50	144686	180979.2	0.80	10	2	0	0	23	12.51	2.50	0.00	0.00	28.77
50-60	153565	221196.8	0.69	6	3	0	0	13	8.64	4.32	0.00	0.00	18.73
60-70	123132	176119.173	0.70	4	1	0	0	4	5.72	1.43	0.00	0.00	5.72
70-80	52701	80289.623	0.66	2	0	0	0	1	3.05	0.00	0.00	0.00	1.52
			Totals	51	10	3	0	202	59.49	12.39	3.10	0.00	219.70

As evident from the column entitled "Search intensity…", the innermost annuli required negligible adjustment as they were generally fully searched (out to 40m from the tower base). Incidents found in outer annuli (lower in number) were adjusted more robustly. Thus, the number of bat incidents found from standardized surveys (202) was adjusted for area to 219.70. The number of birds found (64) has been corrected for area to 74.98.

3.3.1.3 Scavenger Removal and Search Efficiency.

Table 16 provides the results of the scavenger study as described in the Methods section. The proportion of small, medium and large birds not scavenged (Sc) within four days was used to adjust the number of small, medium and large size bird incidents, respectively, that were discovered by our searchers during standardized surveys. Similarly, the proportion of bats not scavenged (Sc) within four days was used to adjust the number of bat incidents that were discovered by our searchers.

Table 16. Maple Ridge scavenger removal study data (2007).

Size Class	# Carcasses	# Scavenged.	Prop. not scavenged1 (Sc)
Small Birds	70	38	0.46
Medium Birds	16	7	0.56
Large Birds	23	8	0.65
Bats	70	31	0.55

1. Over 4 days, see methods.

Table 17 shows the results of the search efficiency study as described in the Methods. The proportion of carcasses 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 17. Maple Ridge searcher efficiency study data (2007).

	# Carcasses	# Carcasses not found	Prop found (Se)
Small Birds	61	23	0.62
Medium Birds	16	2	0.88
Large Birds	15	1	0.93
Bats	61	25	0.59

Table 18 shows estimates of the number of bird and bat fatalities attributed to collisions with the wind turbines at the Maple Ridge project in the 2007 study period. The table reflects search and scavenging rates as determined in tables 16 and 17, the number of birds/bats found during standardized searches, the number of birds/bats, and the subsequent estimate adjustment made using the formula described in the Methods. The tables show the extrapolation for small, medium and large birds as well as bats from data collected at the 64 7-day sites. The first row contains the number of incidents noted (# Found). The second row contains those numbers after correcting for Project Set-up and Area Searched (mowing obstacles) as described in Section 3.3.1.1 and 3.3.1.2. Finally, the numbers are adjusted by the adjustment 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 18. First full season estimates (April 30 to November 14, 2007) for bird and bat collision mortality under 195 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate, proportion of searched towers, project set-up and area adjustment, from 64 7-day Sites.

Adjustment Factors	Birds			Bats	Total Carcasses
	Small	Medium	Large	Bats	
# Found	51	10	3	202	
# After Area & Set-up Adjustment[1]	60.5	12.4	3.1	220.7	296.68
% Not Scavenged **(Sc)**	46%	56%	65%	56%	
Search Efficiency **(Se)**	62%	88%	93%	59%	
Proportion of Towers Searched (**Ps**)	32.82%	32.82%	32.82%	32.82%	
Adjusted Total	**660**	**78**	**16**	**2087**	**2841**
95% CI (±)	68	12	2	198	
Per Tower	3.39	0.40	0.08	10.70	
Per MW	2.05	0.24	0.05	6.49	
Per MWh Produced	0.0012	0.0001	0.00003	0.0043	
Per 2000 m^2 Rotor Swept Area	1.28	0.15	0.03	4.05	

1. Includes 1 small bird and 1 bat added due to Set-up Period Adjustment

As stated in the methods, incidental finds are not normally included in any extrapolation of total incidents/tower, as they are outside the regular study design framework. We deemed it possible that field technicians could have noted some incidents during standardized searches if they had not already noticed them during frequent maintenance and scavenge test visits. We classified these incidental findings as “added incidentals.” The number of “added incidentals” for birds was 12. The number of “added incidentals” for bats was 63. If all added incidentals were treated as survey finds, the final fatality tally would have included an additional 139 small birds, 6 medium birds, and 618 bat fatalities, bringing total numbers to 799 small birds, 85 medium birds, 16 large birds and 2705 bats (see Executive Summary for fatality estimates per tower, MW, MWh and 2000m^2 rotor swept area.).

3.3.2 Estimated Fatalities by Species

We adjusted the number of incidents of birds and bats per species, in Table 19, by the same extrapolation factors described in the methods. Estimate of total mortality includes adjustment for Search Efficiency, Scavenge Rate, Proportion of Towers Searched, Area Searched, and Project Start-up Adjustment. The resulting estimate of 13 American Goldfinch fatalities 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 (large, medium and small) and by bats. The species within the rows are in alphabetical order. The first numerical column shows the number of incidents recorded at the 64 7-day search sites. The next three columns show the number of incidents per megawatt, number of incidents per turbine and the estimate of mortality over the entire 195 turbines of the MWRWA calculated for that species. Finally, the incidental species are also reported in the final column, but not used in any extrapolations.

Table 19. Incidents per species found during both standardized surveys and incidentally, April 30 to November 14, 2007. Estimate of total mortality is an approximation with adjustments for search efficiency, scavenge rate, proportion of towers Searched, area searched, and project start-up adjustment. Results are reported in incidents per turbine and per total installed megawatt capacity at the Maple Ridge WRA.

	2007	**Estimated #**			**Estimate of mortality (195 towers)**	Incidental Finds
Species Name	64 7-Day Sites	Inc/Mw	Inc/Turbine		7-Day Sites	
Birds (Large)						
Canada Goose	0	0.00	0.00		0	1
Red-tailed Hawk	3	0.06	0.10		16	2
Wild Turkey	0	0.00	0.00		0	1
Unidentified Species	0	0.00	0.00		0	1
Total Large	**3**	**0.06**	**0.10**	**Total Estd. Large**	**16**	**5**
Birds (Medium)						
American Crow	1	0.03	0.05		8	.
American Robin	2	0.06	0.09		16	.
Mallard	0	0.00	0.00		0	2
Rock Pigeon	1	0.03	0.05		8	.
Ruffed Grouse	0	0.00	0.00		0	2
Sharp-shinned Hawk	0	0.00	0.00		0	1
Woodcock	0	0.00	0.00		0	1
Unidentified Species	6	0.17	0.27		47	.
Total Medium	**10**	0.28	0.45	**Total Estd. Medium**	**78**	**6**
Birds (Small)						
Alder Flycatcher	1	0.05	0.08		13	.
American Goldfinch	1	0.05	0.08		13	.
Bay-breasted Warbler	1	0.05	0.08		13	.
Black-billed Cuckoo	0	0.00	0.00		0	1
Black-polled Warbler	1	0.05	0.08		13	.
Bobolink	2	0.10	0.16		26	.
Brown Creeper	1	0.05	0.08		13	1
Cedar Waxwing	6	0.30	0.49		78	.
Cliff Swallow	1	0.05	0.08		13	.
Eastern Kingbird	0	0.00	0.00		0	2
European Starling	7	0.35	0.57		91	.
Golden-crowned Kinglet	4	0.20	0.33		52	2
Hermit Thrush	0	0.00	0.00		0	1
Indigo Bunting	0	0.00	0.00		0	1
Magnolia Warbler	1	0.05	0.08		13	.
Ovenbird	1	0.05	0.08		13	.
Prairie Warbler	1	0.05	0.08		13	.
Purple Finch	1	0.05	0.08		13	.
Red-eyed Vireo	2	0.10	0.16		26	.
Ruby-crowned Kinglet	0	0.00	0.00		0	2
Ruby-throated Hummingbird	0	0.00	0.00		0	1

Savannah Sparrow	1	0.05	0.08		13	.
Scarlet Tanager	0	0.00	0.00		0	1
Song Sparrow	0	0.00	0.00		0	1
Tree Swallow	2	0.10	0.16		26	.
Winter Wren	0	0.00	0.00		0	1
Yellow-bellied Sapsucker	0	0.00	0.00		0	1
Unidentified Bird[1]	17	0.84	1.39		220	6
Total Small Birds	**51**	2.52	4.16	**Total Estd. Small Birds**	**660**	**21**
Total Birds	**64**	**2.86**	**4.71**	**Total Estd. Birds**	**754**	**32**
Bats						
Hoary Bat	99	3.46	5.71		1023	43
Eastern Red Bat	20	0.70	1.15		207	14
Silver-haired Bat	32	1.12	1.85		331	12
Little Brown Bat	32	1.12	1.85		331	10
Big Brown Bat	17	0.59	0.98		176	1
Myotis Species	1	0.03	0.06		10	.
Unknown Species[1]	1	0.03	0.06		10	1
Total Bats	**202**	**7.06**	**11.65**	**Total Estd. Bats**	**2087**	**81**
Total (Birds & Bats)	**266**			**Total Estd. (Birds & Bats)**	**2841**	**111**

1. Includes 1 bird and 1 bat added as project set-up adjustment. (See Section 3.3.1.1)

4.0 DISCUSSION

4.1 Project Duration and Search Interval

The 2007 study at the Maple Ridge WRA included the entire period in which conditions were adequate for regular site maintenance and searches. Within two weeks of site accessibility after winter, the TAC agreed upon the number of turbines to be searched (N = 64) and the 7-day search interval. Site setup began immediately and was largely in place within two weeks. The large number of sites cleared for searching appears to constitute the most thorough search effort to date of bird and bat fatalities at wind turbines.

The protocols for conducting fatality searches were similar to practices employed elsewhere (Kerns and Kerlinger 2004), if not more intensive than at other sites. Most fatality studies at wind turbines have used a 14 to 30 day search cycle (Erickson *et al*. 2001), although at sites in the Midwest (Howe *et al*. 2002, Jain 2005,) and at sites in the east (Arnett *et al*. 2005, Nicholson 2002 search intensity was similar or more frequent than our study. Those studies, however, were conducted during limited periods during spring, summer and fall, and did not include as large a sample size of turbines searched.

Arnett *et al*. (2005) searched at one and 7-day frequencies, although they only searched during August and part of September to cover the primary season of bat mortality. Nicholson (2005) searched every day during spring and fall because he was primarily interested in migrating birds, but that study included only three turbines so daily searches were relatively easy to accomplish. Jain (2005) searched every two days, from late spring to early winter over a two year period, but cleared less area under each tower as compared to this study.

The 2006 Annual report called for various changes in research protocols in 2007. Those changes were: We took care to insure that we did not over estimate search efficiency. Tests were scheduled without the knowledge of the searchers, using appropriately sized carcasses. Small birds were primarily kinglets, sparrows and juncos, ranging from ~ 3.5 inches, (10 cm) to ~ 6.5 inches (17 cm) in length. For bats, we used Little Brown Bats which are smaller and less conspicuous than the majority of bat specimens found during the study. We conducted more extensive search efficiency and scavenge rate testing than in 2006 and used small, medium and large birds. Large and medium birds remained difficult to procure. However, we were able to conduct tests using 23 large birds and 16 medium sized birds over 4 different test dates, covering the full duration of the project. We also used GPS to measure the actual searchable area at each turbine site, to weight the number of incidents found at a site with the proportion of searchable area. This allowed for comparisons between site types (e.g. wooded vs. non-wooded sites, N-W edge vs. non-N-W edge sites, etc) via a multiple regression model, as well as adjustment for unsearched areas. As explained in section 3.2.6, we adjusted our search efforts to the best of our ability, in order to deal with the unforeseen tower maintenance issues experienced by the wind developer. However, our searches were somewhat affected in the month of August, when we were unable to adequately search a small portion of the area under Phase I towers. While not easily quantifiable, some incidents will have been missed in this area.

4.2 Seasonal Distribution of Fatalities

Similar to other Midwestern and eastern WRA sites, the greatest mortality for both birds and bats was expected to occur during the migration season. An increase in fatalities (Figure 7) over a two month period for bats (July to August) indicated that temporal mortality patterns at Maple Ridge WRA were not unusual, and mirrored findings at Mountaineer in West Virginia (Arnett *et al*. 2005, Kerns and Kerlinger 2004), as well as studies in the Midwestern and western United States (Jain 2005, Johnson 2003). Fall bat mortalities are hypothesized to be primarily due to migration activity, although migration related activity such as staging or pre-migration flocking/foraging may also play a role.

Both bird and bat fatalities declined to very low levels by November (2007), indicating that, had the search season been extended, few additional incidents would likely have been noted. This contrasts with the end of season results in 2006, where a number of additional bird fatalities may have been recorded, as bird fatalities continued into November. However, the Maple Ridge WRA is largely unsearchable during the winter because of frequent heavy snowfall that makes sites inaccessible and covers search areas. Winter sampling efforts may provide useful information.

4.3 Species Composition and Fatality Rates at Maple Ridge and Other Wind Power Facilities in the U.S.

In an effort to determine whether fatalities at the Maple Ridge WRA are similar, both in numbers and species composition to other wind power facilities in the United States, we refer to results presented by the National Research Council (NRC 2007) recent review (Table 20). For the most part, the types of fatalities at wind plants reviewed by NRC as being thorough studies, suggests that night migrating songbirds are the species most often killed at wind plants in the eastern United States. The studies also agree that there are very few waterbirds or shorebirds killed and that raptors are also rare among the fatality lists. There appears to be a slightly greater proportion of night migrant fatalities in the Midwest and east as opposed to the west. Overall, there appear to be fewer fatalities at western facilities than at eastern facilities. The numbers of birds killed per turbine and per megawatt, at the Maple Ridge WRA, fall within the range of studies listed in Table 20. While the methods differ on a study-by-study basis and the reader is cautioned to keep these differences in mind, results presented by these studies reflect the best data collected to date on fatalities at North American WRA's.

Table 20. Bird mortality reported at U.S. wind-energy projects (from NRC 2007)*

					All Bird Mortality		
Wind Project	**Study Period**	**# Turbines**	**Turbine MW**	**Project MW**	**Turbine per period**	**MW per period**	**Reference**
Pacific Northwest							
Stateline, OR/WA[1]	July 2001 – Dec 2003	454	0.66	300	1.93	2.92	Erickson et al. 2004
Vansycle, OR[1]	Jan 1999 – Dec 1999	38	0.66	25	0.63	0.95	Erickson et al. 2004
Combine Hills, OR[1]	Not Available	41	1.00	41	2.56	2.56	Young et al. 2005

					All Bird Mortality		
Wind Project	**Study Period**	**# Turbines**	**Turbine MW**	**Project MW**	**Turbine per period**	**MW per period**	**Reference**
Klondike, OR[1]	Feb 2002 – Feb 2003	16	1.50	24	1.42	0.95	Johnson et al. 2003
Nine Canyon, WA[1]	Sep 2002 – August 2003	37	1.30	62	3.59	2.76	Erickson et al. 2003
Rocky Mountain							
Foote Creek Rim, WY, Phase I[2]	Nov 1998 – Dec 2000	72	0.60	43	1.50	2.50	Young et al. 2001
Foote Creek Rim, WY, Phase II[2]	June 2001 – June 2002	33	0.75	25	1.49	1.99	Young et al. 2003
Upper Midwest							
Wisconsin[3]	Late July 1999 –May 2001	31	0.66	20	1.30	1.97	Howe et al. 2002
Buffalo Ridge, MN, Phase I[3]	Apr 1994–Dec 1995; 15 Mar–15 Nov 1996–1999	73	0.30	33	0.98	3.27	Johnson et al. 2002
Buffalo Ridge, MN, Phase I[3]	15 Mar 1998 – 15 Nov 1999; 15 Jun 2001– 15 Sep 2002	143	0.75	107	2.27	3.03	Johnson et al. 2002
Buffalo Ridge, MN, Phase II[3]	15 Mar 1999 – 15 Sep 1999; 15 Jun 2001 – 15 Sep 2002	139	0.75	104	4.45	5.93	Johnson et al. 2002
Top of Iowa[3]	15 Mar 2003 – 15 Dec 2004	89	0.90	80	1.29	1.44	Koford et al. 2005
East							
Buffalo Mountain, TN[4]	1 Sep 2000 – 30 Sep 2003	3	0.66	2	7.70	11.67	Nicholson 2001, 2002
Mountaineer, WV[4]	4 Apr 2003 – 22 Nov 2003	44	1.50	66	4.04	2.69	Kerns and Kerlinger 2004
Maple Ridge, NY[3,4]	30 Apr 2007 - 14 Nov 2007	195	1.65	322	3.87-4.61	2.34-2.80	Jain et al. – this study
[1] Agricultural/grassland/Conservation Reserve Program (CRP) lands							
[2] Short-grass prairie							
[3] Agricultural							
[4] Forest							

* Note: Where studies include more than one year, final estimates were reported on a per year basis.

4.4 Night Migrant Fatalities

Determining the exact number of night migrants amongst the bird mortalities at the MRWRA is difficult, as some of the birds involved may be resident breeders or individuals dispersing during the post-breeding season. It should be noted that a species that typically migrates at night may also breed on site, and could collide with a turbine during the breeding season, perhaps during daylight hours. However, two years of monitoring daytime flight patterns at the Top of Iowa windfarm showed that only 0.043% of observed daytime flight occurred at rotor height in proximity to the rotors (Jain 2005).

The numbers of fatalities of night migrating birds were 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 turbines for the 64 7-day search sites. We found no relationship between the numbers of night migrant fatalities and the presence of L-864 red flashing beacons on turbines. These results correspond to results from 2006 at Maple Ridge and results from all other wind power sites where such tests could be conducted (Kerlinger et al. 2006). The results also corroborate results at tests conducted at communication towers (Gehring and Kerlinger 2007) which did not indicate that red flashing L-864 beacons attract night migrating birds.

We also observed no significant evidence of a higher proportion of bat fatalities at FAA lit turbines in 2007, as was the case in 2006. Thus, there is no evidence for bats or birds that FAA lighting in the form of flashing red beacons attracts or disorients these animals resulting in greater numbers of fatalities than at unlit turbines. 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 also help to explain the smaller numbers of night migrant fatalities at those turbines as compared to fatalities at tall communication towers (>500 feet, 152 m).

4.5 Bird Population Trends and Significance of Fatalities at Maple Ridge

Seven European Starlings and one Rock Pigeon were amongst the incidents noted during standardized surveys in 2007, accounting for 11.4% of fatalities found. These birds are alien, invasive species that are not protected by the Migratory Bird Treaty Act (MBTA). They are often considered pests and targeted for population reduction. While the estimates of birds/MW and birds/turbine include extrapolations from these incidents, when considering the significance of the annual mortality at the MRWRA, it should be noted that 14% of small birds found and 10% of medium birds found are derived from non-MBTA species. In terms of extrapolated figures, approximately 100 out of 754 (~13%) estimated birds were non-MBTA species. By including European Starlings and Rock Pigeons in our calculations, we have been conservative regarding estimating the significance of bird deaths at Maple Ridge turbines.

None of the bird carcasses, that were found and identified during standardized or incidental surveys, are state or federally listed species. Virtually all birds killed by the turbines are relatively common species whose populations are not likely to be impacted by wind turbine impacts like those that occurred at Maple Ridge. One incident involving a Sharp-shinned Hawk was noted (August 3, 2007). That species is considered a species of special concern.

Table 21 describes the geographic range (source area) and estimated North American population of the species identified. Those populations come from large geographic ranges to the north of Maple Ridge, including far upstate New York, Quebec, and Ontario, as well as the Northwest Territories. 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 (Table 21) are stable or increasing as described by the North American Breeding Bird Survey (BBS) trends from 1966-2005 (Sauer *et al*. 2005). While it is difficult to estimate the effect of local sources of mortality (such as wind turbine collision) on entire populations, the estimated total number of incidents at the Maple Ridge WRA are very small compared to the overall populations of the species involved. The population of the most common find (Cedar Waxwing, n = 6, extrapolated to 78 incidents in 2007, Table 19) is listed as increasing, with an estimated overall population level of about 15 million. The eastern population of the Golden-crowned Kinglet, which was also found more often than other species during searches in both 2006 and 2007 (n = 4, extrapolated to 52 incidents in 2007), is estimated to be decreasing across the US but stable or increasing in the Eastern US. (Table 21). Given the overall population level of this species (estimated 34 million birds), it is difficult to fathom how the level of collision mortality at the Maple Ridge WRA (Table 18) could have a significant adverse effect on population levels, even with respect to cumulative impacts of fatalities from many wind plants. While approximately a fourth of all species found in 2007 were listed as decreasing, very few incidents were noted for these species. It is important here to note that regulated harvests of declining waterfowl and shorebird species occur on an annual basis, without significant negative impacts to populations. For example, about 400,000 American Woodcock – ~8-10% of the North American population are harvested annually by hunters in the eastern United States and Canada. A single woodcock fatality was found incidentally at the Maple Ridge site.

Table 21. BBS population trends and geographical distribution of bird species found at the Maple Ridge WRA during standardized surveys and incidentally (April 30 to November 14, 2007) Sauer *et al*. 2005

Species	North America Population	Population Trends	Geographic Range
Alder Flycatcher	49 million	Decreasing	Alaska, Canada, Great Lakes Region
American Crow	31 million	Increasing	North America
American Goldfinch	24 million	Non-Sig. Decrease	Temp. North America
American Robin	320 million	Increasing	North America
Bay-breasted Warbler	3.1 million	Decreasing	North East, Canada, North Great Lakes region
Black-billed Cuckoo	1.1 million	Decreasing	North Temp. Forest
Blackpoll Warbler	21 million	Non-Sig. Decrease	Boreal Forest
Bobolink	11 million	Decreasing	Central and Eastern North America
Brown Creeper	5.4 million	Non-Sig. Decrease	North Temp. Forest
Canada Goose	Millions	Increasing	North America
Cedar Waxwing	15 million	Increasing	Temp. North America
Cliff Swallow	89 million	Stable	North America (S of Tundra)
Eastern Kingbird	13 million	Decreasing	Central and Eastern North America
European Starling	Non-MBTA species	----	----
Golden-crowned Kinglet	34 million	East: Increasing Across US: Sig. Decrease	Boreal Forest North America
Hermit Thrush	56 million	Increasing	Boreal and North Temp. Forest North America
Indigo Bunting	28 million	Decreasing	Eastern North America
Magnolia Warbler	32 million	Increasing	Boreal and North Temp. Forest (Mostly E of Rockies)
Mallard	8.6 million	Stable	North America
Ovenbird	24 million	Increasing	Temp. and Boreal Forest (E of Rockies)
Prairie Warbler	1.4 million	Decreasing	Eastern United States
Purple Finch	3 million	Decreasing	Canada. Winters in Central and Eastern United States
Red-eyed Vireo	140 million	Increasing	Temp. and Boreal Forests
Red-tailed Hawk	2.2 million	Increasing	North America
Rock Pigeon	Non-MBTA species	----	----

Species	North America Population	Population Trends	Geographic Range
Ruby-crowned Kinglet	72 million	Stable	Boreal Forest North America
Ruby-throated Hummingbird	7.3 million	Increasing	Southern Canada to Gulf Coast (Eastern United States)
Ruffed Grouse	8.3 million	Decreasing	N Temp. and Boreal Forests
Savannah Sparrow	82 million	Decreasing	North America
Scarlet Tanager	2.2 million	Stable	E Temp. Forest
Sharp-shinned Hawk	1.1 million	Stable	North America
Song Sparrow	54 million	Decreasing	North America
Tree Swallow	20 million	Stable	North Temp. and Boreal North America
Wild Turkey	1.3 million	Increasing	Temp. Forests (E North America)
Winter Wren	36 million	Stable	Alaska, Canada, Great Lakes Region
American Woodcock	5 million	Stable-Decreasing	Eastern North America
Yellow-bellied Sapsucker	9.2 million	Stable	Boreal and North Temp. Forest

4.6 Bat Fatalities

The few population estimates for bats in North America are limited mostly to cave-dwelling bat species that live in large colonies. Due to the nocturnal habits of this group of mammals, it is extremely difficult to study populations and geographic distribution. Consequently, it is even more difficult to assess the impact of collision mortality on the populations of these species (Arnett et al 2008). All bat species found during searches at the Maple Ridge WRA are widely distributed, and while possibly uncommon in New York State, are not listed as state or federally endangered. However, Kunz et al. 2007 stated that the eastern red bat (*Lasiurus borealis*) may be in decline throughout much of its range, making it more susceptible to cumulative fatality rates associated with projected wind energy development.

Recent reviews of bat fatalities at wind resource areas (Arnett et al. 2008, Johnson 2005, Kunz et al 2007) have stated that the potential for significant cumulative population impacts, especially for migrating, tree-roosting bat species is an important concern, while acknowledging that the dearth of information of baseline population estimates and demographics remains a key challenge. O'Shea and Bogan 2003 speculates that changes in forest management (i.e. roost availability) may be a limiting factor for some species of tree-roosting bat species (hoary and red bats) in the U.S. A recent collapse in numbers of cave-dwelling little brown and big brown bats (Alan Hicks, personal communication) has been connected to a fungal infection of the respiratory system (though the cause of this collapse is unknown.) Thus, while the significance of bat fatalities at the Maple Ridge WRA cannot be determined, bat fatalities should remain a source of concern.

The period during which the peak of fatalities occurred, in the 2006 pilot season and in 2007, corresponds to the peak periods reported in studies in the eastern, Midwestern, and western United States (Gruver 2002, Jain 2005, Johnson *et al.* 2003a, Young *et al*. 2003), suggesting that some of the mechanics of these fatalities are independent of geography. Also similar to 2006, there is some evidence to support the idea that bat fatalities may increase in proximity to wetlands. Moderate evidence pointing towards increased fatalities in the presence of wooded sites was also noted in 2007. Multiple full year analyses should continue to test for and more fully understand the relationship between bat fatalities, proximity to wetlands and wooded areas.

Table 22. Population trends and geographical distribution of bat species found at the Maple Ridge WRA during standardized surveys and incidentally (April 30 to November 14, 2007).

Species	Tree-Roosting	Population Trends	Geographic Range
Hoary Bat	Yes	Unknown	North America
Eastern Red Bat	Yes	Poss. Decreasing	Central and Eastern North America
Silver-Haired Bat	Yes	Unknown	North America (Except Mexico)
Little Brown Bat	No	Poss. Increasing in North America. Possibly Decreasing in NY.	North America
Big Brown Bat	No	Poss. Increasing in North America. Possibly Decreasing in NY.	North America

Tables 23 and 24 show the comparison of the fatalities per turbine, per MW and per 2000m^2 rotor Swept Area at the MRWRA and other WRA's in the Eastern and Midwestern U.S. Bat fatality rates at Maple Ridge are higher than or comparable to those reported in the western and Midwestern U.S., and generally lower than those rates reported from the Appalachian mountains in the eastern U.S.

Table 23. Estimates of bat fatalities per turbine and per megawatt at different wind facilities in Eastern and Midwestern U.S. modified from Arnett et al. (2008).

Study Area Location	Study Period	Est. Mean Fatality/ Turbine	Estimated Mean Fatality/MW	Estimated Mean Fatality/ 2000m^2 rotor Swept Area	Reference
Eastern U.S.					
Buffalo Mountain, TN (phase 1) [a]	1 Sep 2000–30 Sep 2003	20.8	31.5	24.0	Nicholson 2001, 2002
Buffalo Mountain, TN (phase 2) [a]	1 Apr–31 Dec 2005	35.2	53.3	40.6	Nicholson 2001, 2002
Buffalo Mountain, TN (phase 2) [b]	1 Apr–31 Dec 2005	69.6	38.7	27.7	Nicholson 2001, 2002
Meyersdale, PA [c]	2 Aug–13 Sep 2004	23	15.3	11.3	Arnett et al. 2008
Mountaineer, WV (2003)1	4 Apr–11 Nov 2003	48	32	23.6	Arnett et al. 2008
Mountaineer, WV (2004) [c]	31 Jul–11 Sep 2004	38	25.3	18.7	Arnett et al. 2008
MRNY (This study)	30 Apr-14 Nov 2007	10.70-13.87	6.49-8.41	5.88-7.02	This Study
Midwestern U.S.					
Buffalo Ridge, MN 1 [d]	Apr - Dec 1994–1995; 15 Mar–15 Nov 1996–1999	0.1	0.2	0.2	Johnson et al. 2002
Buffalo Ridge, MN 2 [e]	15 Mar–15 Nov 1998–1999; 15 Jun–15 Sep 2001–2002	2.0	2.7	2.4	Johnson et al. 2002
Buffalo Ridge, MN 3 [f]	15 Mar–15 Sep 1999; 15 Jun–15 Sep 2001–2002	2.1	2.7	2.3	Johnson et al. 2002
Lincoln, WI	Jul 1999–Jul 2001	4.3	6.5	5.0	Howe et al. 2002
Top of Iowa, IA	15 Mar–15 Dec 2003, 2004	7.8	8.7	7.4	Koford et al. 2005

a - Estimated bats killed by 3 Vestas V47 0.66 megawatt turbines.
b - Estimated bats killed by 15 Vestas V80, 1.8 megawatt turbines.
c - Estimated bats killed from daily searches conducted at these facilities.
d - Estimated bats killed by 73 Kenetech 33 0.33 megawatt turbines based on 4 years of data.
e - Estimated bats killed by 143 Zond 0.75 megawatt turbines based on 4 years of data.
f - Estimated bats killed by 138 Zond 0.75 megawatt turbines based on 3 years of data.

Table 24. Percent species composition of bat fatalities at wind facilities in Eastern and Midwestern U.S. (modified from Arnett et al. 2008).

STUDY LOCATION	EPFU[a]	LABO	LACI	LANO	MYLU	MYSE	PISU	Other	Total No. Bats Found
Eastern U.S.									
Buffalo Mountain, TN (phase 1)	0.9	60.5	9.6	1.8	-	-	25.4	1.8[b]	114
Buffalo Mountain, TN (phase 2)	0.4	60.9	13.0	7.6	-	-	17.2	0.8[b]	238
Meyersdale, PA	6.9	27.5	45.4	5.7	2.7	0.7	8.0	0.5	262
Mountaineer, WV (2003)	0.4	42.1	18.5	5.9	12.6	1.3	18.3	0.8	475
Mountaineer, WV (2004)	2.5	24.1	33.7	4.8	9.8	-	24.6	0.5	398
MRNY	8.4	9.9	49.5	15.84	15.3	-	-	1.0	202
Midwestern U.S.									
Buffalo Ridge, MN 1-3	3.6	17.4	65.0	4.8	1.9	-	1.7	5.7	420
Lincoln, WI	1.4	38.9	34.7	16.7	-	-	-	8.3	72
Top of Iowa, IA	10.7	24.0	28.0	12.0	24.0	-	1.3	-	75

a - EPFU = big brown bat; LABO = eastern red bat; LACI = hoary bat; LANO = silver-haired bat; MYLU = little brown bat; MYSE = northern long-eared bat; PISU = eastern pipistrelle; b - Unidentified species

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APPENDICES

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

A similar log was kept for each site 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	Habitat Conditions and Site Repairs Needed

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 etc. 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 in Survey	Additional Information

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

APPENDIX D: Distribution of carcasses for scavenge rate test (Sc)

Tower #	# Tests (Bird)	# Tests (Bat)
12	0	0
16	5	2
17	0	0
22a	2	0
23	2	0
24	0	0
26	0	0
27	2	0
34	2	2
36	3	0
37	3	0
39	2	3
40	2	2
50	0	0
52	0	3
53	0	0
54A	3	0
56	5	2
57	0	0
59	0	0
61A	1	3
64	0	0
75	0	0
76	1	1
77	2	0
79A	2	3
82	3	3
83	0	0
89	1	2
101	1	4
102	0	0
103	0	0
104	5	2
108	0	0
109	0	0
110	0	4
114	3	0
116	6	4
118	1	1
121	4	1
122	8	2
124	2	2
125	3	2

Tower #	# Tests (Bird)	# Tests (Bat)
126	0	0
127	3	3
129	2	0
130	0	0
133	0	0
134	1	2
136	3	0
149	2	0
153	0	0
154	0	0
167	3	4
168	4	4
179	0	0
180	2	1
183	2	1
184	0	0
187	10	4
189	0	0
195	0	0
197	1	2
198	2	0
Met 1	0	0
Met 2	0	1

APPENDIX E: Number of 7-Day searches completed per site by November 14, 2007

Turbine Number	Phase	First Search	Most Recent Search	# Searches	# Days Since First Search	Average Search Period
12	1	5/3/07	11/12/07	28	193	6.89
16	1	5/3/07	11/12/07	28	193	6.89
17	1	5/6/07	11/12/07	28	190	6.79
23	1	5/4/07	11/12/07	27	192	7.11
22A	1	5/1/07	11/6/07	28	189	6.75
24	1	5/5/07	11/14/07	29	193	6.66
26	1	5/4/07	11/14/07	28	194	6.93
27	1	5/1/07	11/14/07	29	197	6.79
34	1	5/4/07	11/9/07	28	189	6.75
37	1	5/3/07	11/9/07	28	190	6.79
39	1	4/30/07	11/5/07	28	189	6.75
40	1	4/30/07	11/5/07	28	189	6.75
50	1	5/1/07	11/12/07	29	195	6.72
52	1	5/4/07	11/4/07	27	184	6.81
53	1	5/6/07	11/4/07	27	182	6.74
54A	1	5/5/07	11/3/07	28	182	6.50
56	1	4/30/07	11/6/07	28	190	6.79
57	1	5/1/07	11/6/07	28	189	6.75
59	1	5/2/07	11/4/07	27	186	6.89
64	1	4/30/07	11/5/07	28	189	6.75
75	1	5/2/07	11/6/07	28	188	6.71
76	1	5/4/07	11/2/07	26	182	7.00
77	1	5/4/07	11/2/07	26	182	7.00
82	1	5/6/07	11/2/07	26	180	6.92
83	1	5/5/07	11/6/07	27	185	6.85
89	1	5/3/07	11/2/07	27	183	6.78
101	1	5/2/07	11/9/07	28	191	6.82
102	1	5/6/07	11/4/07	27	182	6.74
103	1	5/14/07	11/5/07	26	175	6.73
104	1	5/3/07	11/9/07	28	190	6.79
108	1	5/6/07	11/4/07	27	182	6.74
109	1	4/30/07	11/5/07	28	189	6.75
110	1	5/2/07	11/9/07	28	191	6.82
179	1	5/12/07	11/14/07	27	186	6.89
180	1	5/2/07	11/14/07	28	196	7.00
183	1	5/10/07	11/14/07	27	188	6.96
189	1	5/1/07	11/12/07	30	195	6.50
195	1	5/5/07	11/12/07	27	191	7.07
197	1	5/3/07	11/4/07	27	185	6.85
36	2	6/5/07	11/12/07	24	160	6.67
79A	2	5/4/07	11/2/07	27	182	6.74
114	2	6/5/07	11/13/07	21	161	7.67
116	2	5/25/07	11/13/07	25	172	6.88
118	2	5/20/07	11/12/07	26	176	6.77

Turbine Number	Phase	First Search	Most Recent Search	# Searches	# Days Since First Search	Average Search Period
121	2	5/11/07	11/13/07	27	186	6.89
122	2	5/17/07	11/13/07	26	180	6.92
124	2	5/7/07	11/13/07	28	190	6.79
125	2	5/6/07	11/13/07	28	191	6.82
126	2	5/8/07	11/13/07	29	189	6.52
127	2	5/21/07	11/13/07	25	176	7.04
129	2	5/5/07	11/13/07	28	192	6.86
130	2	5/9/07	11/13/07	27	188	6.96
133	2	5/9/07	11/13/07	27	188	6.96
134	2	5/10/07	11/13/07	26	187	7.19
136	2	5/5/07	11/13/07	28	192	6.86
167	2	5/21/07	11/14/07	26	177	6.81
168	2	5/11/07	11/14/07	24	187	7.79
61A	1A	5/9/07	11/12/07	27	187	6.93
149	1A	5/12/07	11/13/07	27	185	6.85
153	1A	5/9/07	11/12/07	28	187	6.68
154	1A	5/13/07	11/13/07	26	184	7.08
184	1A	5/14/07	11/12/07	27	182	6.74
187	1A	5/17/07	11/12/07	27	179	6.63
198	1A	5/15/07	11/13/07	25	182	7.28
Met 1	Met	5/1/07	11/6/07	28	189	6.75
Met 2	Met	5/2/07	11/14/07	28	196	7.00

APPENDIX F: Total maintenance downtime hours for the 64 turbines searched between April 30, 2007 and November 14, 2007.

Turbine Number	Total Downtime (Hrs:Min:Sec)
12	2838:55:26
16	352:10:30
17	2481:39:09
22a	656:50:26
23	700:03:12
24	565:41:54
26	1048:23:32
27	478:36:39
34	1211:19:01
36	1084:19:07
37	646:31:42
39	1571:30:24
40	964:41:42
50	929:42:32
52	398:24:17
53	934:52:50
54A	5033:53:13
56	468:23:24
57	193:38:08
59	651:03:37
61A	0:00:00
64	0:00:00
75	616:27:59
76	1031:45:56
77	660:39:43
79A	295:37:46
82	1037:12:52
83	2640:05:53
89	2188:02:55
101	717:45:16
102	874:18:50
103	2440:52:25
104	698:17:32
108	668:01:25
109	530:15:00
110	699:08:37
114	2116:53:00
116	757:42:25
118	1657:18:07
121	620:51:24
122	623:35:19
124	727:03:55

Turbine Number	Total Downtime (Hrs:Min:Sec)
125	694:05:25
126	684:57:37
127	561:44:05
129	493:44:47
130	446:00:09
133	437:49:11
134	461:32:02
136	509:08:05
149	949:58:56
153	862:17:49
154	779:31:35
167	531:36:42
168	852:56:02
179	1182:02:51
180	736:25:21
183	480:02:05
184	860:02:31
187	245:41:37
189	475:18:14
195	740:41:32
197	850:50:40
198	1482:02:54

APPENDIX G: Distribution of bird and bat incidents in concentric rings around 15 fully searched sites, searched between April 30, 2007 and November 14, 2007.

Radius	Bat Incidents/ ring	Area (m^2) of ring sampled within 120 by 130m square	Incident Density
5	1	81	0.012355
10	4	243	0.016474
15	3	405	0.007413
20	3	567	0.005295
25	5	688	0.007268
30	4	850	0.004707
35	6	1012	0.005931
40	4	1174	0.003408
45	2	1335	0.001498
50	5	1497	0.003339
55	3	1659	0.001808
60	2	1781	0.001123
65*	2	1619	0.001236
70*	1	1133	0.000883
75*	0	769	0
80*	0	486	0

Radius	Bird Incidents/ ring	Area (m^2) of ring sampled within 120 by 130m square	Incident Density
20	2	1295	0.001544
40	5	3723	0.001343
60	5	6273	0.000797
80*	2	4006	0.000499

* Area searched in rings with radius>60m (rings partially limited by 120m by 130m predefined search area)
** Area for all rings was estimated using ArcView 3.2. Some areas estimated differed very slightly from algebraic calculations of area based on radius (πr^2), and caused no significant change to results.