Annual Report for the Maple Ridge Wind Power Project

Postconstruction Bird and Bat Fatality Study - 2006

May 31, 2007

Prepared for:

PPM Energy and Horizon Energy

and

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

Prepared by:

Aaftab Jain
Paul Kerlinger
Richard Curry
Linda Slobodnik

Curry and Kerlinger, LLC

Aaftab Jain
174 Fayette Blvd.
Syracuse, NY 13224
Office: 315-445-0111
Cell: 315-560-8650
aaftabj@hotmail.com

ACKNOWLEDGEMENTS

Members of the TAC provided valuable oversight and comments on this manuscript. USDA APHIS, New York City Audubon and the Wadsworth Rabies Laboratory in Albany, NY provided technical assistance. We are grateful to Robert Burke and William Burke who were responsible for mowing and site maintenance, as well as to all Vestas employees who notified us of incidental findings of birds/bats. We are grateful to landowners for their continued cooperation in granting us site access/crop clearing rights. Finally, we would like to thank the field crew for their hard work, motivation and attention to detail, without which this study would not have been possible.

TABLE OF CONTENTS

Executive Summary **1**

1.0 Introduction **3**
1.1 Project Description 5
1.2 Study Area 8

2.0 Methods **8**
2.1 Carcass Surveys 8
2.1.1 Site Selection 8
2.1.2 Carcass Collection 11
2.1.3 Standardized Surveys 11
2.1.4 Searcher Efficiency, Scavenger Removal, Proportion of Towers 13

3.0 Results **16**
3.1 Search Effort 16
3.1.1 Summary of Search Effort 16
3.1.2 1-Day Search Sites 16
3.1.3 3-Day Search Sites 16
3.1.4 7-Day Search Sites 16
3.1.5 Meteorological Towers 20
3.2 Incidents Recorded During Surveys 22
3.2.1 Birds 22
3.2.2 Bats 28
3.2.3 Seasonal Distribution of Fatalities 30
3.2.4 Distance from Turbine Bases 31
3.2.5 Distance to Nearest Wetland (Bats) 34
3.2.6 Wooded vs. Non-wooded Turbine sites 37
3.2.7 Lit vs. Un-lit Turbine sites 38
3.3 Adjusting Fatality Estimates 39
3.3.1 Estimates from 1-day, 3-day and 7-day Search Sites 39
3.3.2 Estimated Fatalities by Species 42

4.0 Discussion **45**
4.1 Search interval 45
4.2 Seasonal Distribution of Fatalities 46
4.3 Night Migrant Fatalities 46
4.4 Bird Population Trends 47
4.5 Bat Fatalities 49
4.6 Significance of 2006 Findings 49

5.0 References **51**

APPENDICES

Appendix A Maple Ridge Wind Resource Area (WRA) project site information datasheet

Appendix B Maple Ridge Wind Resource Area project incident (mortality) datasheet

Appendix C Maple Ridge Wind Resource Area project incident location (GPS) datasheet

Appendix D Distribution of carcasses for scavenge rate test (Sc)

Appendix E List of missed dates (1-Day sites)

Appendix F Model for assessment of tradeoff in precision for sampling frequency and number of searched sites

LIST OF TABLES

Table 1.	Primary ground cover at the 1-Day, 3-Day and 7-Day search sites.	9
Table 2.	Total number of surveys completed at all 50 survey towers from June 17, 2006 to November 15, 2006.	17
Table 3.	Total number of surveys completed at both meteorological towers from July 17, 2006 to November 15, 2006.	20
Table 4.	Number of avian incidents at each wind turbine by species group found during standardized surveys and "incidentally" from June 17, 2006 to November 15, 2006	23
Table 5.	Wind turbine locations of bat incidents by species	29
Table 6.	Number of birds and bats found per month, from June 17, 2006 to November 15, 2006.	31
Table 7.	Species size groupings used in analyses.	32
Table 8.	Number of incidents per size grouping (small birds and bats) versus distance from wind turbine tower, September 1, 2006 through November 15, 2006.	32
Table 9.	Contingency table showing the proportion of bat incidents noted within 40m from turbine tower base of the 30 7-day search sites, comparing wooded versus non-wooded sites.	38
Table 10.	Contingency table showing the proportion of bird incidents noted within 40m from turbine tower base of the 30 7-day search sites, comparing wooded versus non-wooded sites.	38
Table 11.	Contingency table showing the proportion of bat incidents noted within 40m from turbine tower bases of the 30 7-day search sites, comparing lit versus unlit sites.	39
Table 12.	Contingency table showing the proportion of bird incidents noted within 40m from turbine tower bases of the 30 7-day search sites, comparing lit versus unlit sites.	39
Table 13.	Contingency table showing the proportion of bat incidents noted within the complete search area under turbine tower bases of the 10 3-day search sites, comparing lit versus unlit sites.	39
Table 14.	Contingency table showing the proportion of bird incidents noted within the complete search area under turbine tower bases of the 10 3-day search sites, comparing lit versus unlit sites.	39
Table 15.	Maple Ridge scavenger removal study data	40
Table 16.	Search efficiency study data.	40

Table 17.	First year estimates for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched towers, from 1-day sites.	41
Table 18.	First year estimates for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched towers, from 3-day sites.	41
Table 19.	First year estimates for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched towers, from 7-day sites.	42
Table 20.	Number of incidents per species per total installed megawatt capacity at the Maple Ridge WRA, Fall 2006, found during both standardized surveys and incidentally.	43
Table 21.	BBS Population trends and geographical distribution of bird species found at the Maple Ridge WRA during standardized surveys and incidentally	48
Table 22.	Results from recent bat mortality studies at WRA's in the Eastern, Midwestern and Western United States.	50

LIST OF FIGURES

Figure 1.	High resolution project map for the Northern section of the Maple Ridge WRA.	7
Figure 2.	High resolution project map for the Southern section of the Maple Ridge WRA.	8
Figure 3.	Representation of carcass survey search pattern centered on a wind tower turbine (not to scale).	12
Figure 4.	Locations of bat incidents at the Maple Ridge WRA found during standardized surveys, June 17 through November 15, 2006 (1, 3 and 7-day sites, Phase I).	26
Figure 5.	Locations of avian incidents at the Maple Ridge WRA found during standardized surveys, June 17 through November 15, 2006 (1, 3 and 7-day sites, Phase I).	27
Figure 6.	Distribution of bat incidents by species, from standardized surveys conducted from June 17 to November 15, 2006.	28
Figure 7.	Number of birds and bats found per day from June 17 to November 15, 2006.	31
Figure 8.	Density of bird incidents at non-wooded sites, from surveys conducted between September 1, 2006 and November 15, 2006, in relation to distance from towers.	33
Figure 9.	Density of bat incidents at non-wooded sites, from surveys conducted between September 1, 2006 and November 15, 2006, in relation to distance from towers.	34
Figure 10.	Bivariate fit of number of bat incidents by distance to nearest wetland (1-day sites).	35
Figure 11.	Bivariate fit of number of bat incidents by distance to nearest wetland (3-day sites).	37
Figure 12.	Bivariate fit of number of bat incidents by distance to nearest wetland (7-day sites).	37

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 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 4.5m (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 41-m(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 400 feet (122 meters). All components of the turbine are painted white.

During this first year pilot-project, carcass surveys were conducted at 50 out of 120 (41.7%) operational turbine sites, as well as the two meteorological towers. We completed 2,244 turbine searches over all 50 sites. Ten turbine sites were searched on a daily basis from June 17, 2006 to November 15, 2006 (127 complete rounds for a total of 1270 turbine tower searches). Ten turbine sites were searched every 3-days between June 29, 2006 and November 15, 2006 (45 complete rounds for a total of 450 turbine searches). Finally, 30 turbine sites were searched weekly (7-day sites) between July 11, 2006 and November 13, 2006, for a total of 524 total surveys (16 rounds). One meteorological tower was searched daily (97 total searches, from July 17, 2006 to November 15, 2006). The second meteorological tower was searched every 3 days (34 total searches, from July 17, 2006 to November 14, 2006).

A total of 125 avian incidents were recorded by searchers during standardized surveys, representing 30 species. Of the 30 species, there was one raptor fatality (American Kestrel), one woodpecker (Yellow-bellied Sapsucker) and three game bird fatalities (Wild Turkey). There were 104 identified incidents, involving 26 songbirds species, found during this partial year study (June 17, 2006 to November 15, 2006). Night migrants accounted for 80.0% of incidents during standardized surveys. The greatest number of bird incidents occurred during the fall migration period with 81 (64.8%; N = 125) bird carcasses found between September and October 2006. Although no waterbirds or shorebirds were found during standardized surveys, incidental findings revealed one Ruffed Grouse (game bird), and two Canada Goose carcasses (water bird). The term "incident" is used here to refer to either a fatality or injury of a bird or bat found within the wind project area and does not necessarily indicate that the cause of death or injury was wind turbine related. This term is not to be confused with the term defined earlier, "incidental find", which refers to incidents found other than during standardized surveys and at sites outside the 50 searched towers.

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

Bat carcasses appeared to fall closer to turbine tower bases than bird carcasses. Bat fatalities appeared to be slightly greater at turbines close to wetland areas than at turbines located farther from wetlands, although there was variation in these data. There did not appear to be a difference in bat or bird fatalities between wooded and non-wooded turbine sites.

Carcass removal (scavenging) and searcher efficiency studies were conducted to estimate the proportion of carcasses missed by the searchers and the proportion removed by scavengers within the one, three and 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 120 Phase I turbines at the Maple Ridge Wind Resource Area (WRA). Carcass removal rates were modest. While carcass removal and searcher efficiency rates calculated for bats were comparable to those found in most fatality studies conducted in the United States, more effort is required for such tests in the future.

As the TAC completed authorization to proceed with searches and contract finalization in mid-May, this pilot year of the project started later than originally planned. Project setup was completed by end-August 2006, due to reasons described in the Methods. As a result, final results included below necessarily include biases including: 1-day, 3-day and 7-day sites set up in that order of priority, i.e. differing search study durations, and initial site search was affected by presence of vegetation to a greater extent at 7-day and 3-day sites. While the area searched under each tower was more than adequate to discover a majority of bat carcasses, it is likely that a number of birds fell outside the search area. Changes to the study design for subsequent years will correct for these biases, but they should be kept in mind when considering the results of the pilot year (2006).

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. Because we used three different search periods to calculate incidents/MW, we calculated three different fatality estimates for birds and bats. A typical 1.65 MW wind turbine tower in New York State will produce approx 4,400 MWh per year (William Moore, PPM-Atlantic Renewable, pers. comm.). The metric “incidents/MWh produced” is calculated for the different durations of the project period for 1, 3 and 7-Day sites. See Results for 95% CI.

The estimates for birds are:
1-Day (Total season 152 days): 1151 incidents/season, 5.81 incidents/Mw/season, 9.59 incidents/turbine/season and 0.0053 incidents/MWh/season (Megawatt-hour) produced.

3-Day (Total season 138 days): 536 incidents/season, 2.71 incidents/Mw, 4.47 incidents/turbine, and 0.0027 incidents/MWh produced.
7-Day (Total season 125 days): 376 incidents/season, 1.90 incidents/Mw, 3.13 incidents/turbine and 0.0020 incidents/MWh produced.

The estimates for bats are:
1-Day (Total season 152 days): 2943 incidents/season, 14.87 incidents/Mw, 24.53 incidents/turbine and 0.0134 incidents/MWh produced.
3-Day (Total season 138 days): 2680 incidents/season, 13.54 incidents/Mw, 22.34 incidents/turbine and 0.0133 incidents/MWh produced.
7-Day (Total season 125 days): 1824 incidents/season, 9.21 incidents/Mw, 15.20 incidents/turbine and 0.0099 incidents/MWh produced.

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

As this is the pilot year of the project, comparison between initial study results and other study sites is difficult. While rates of bird and bat fatalities were within the ranges of those found during other wind turbine fatality studies conducted in the United States, differences exist in study protocols and especially, project duration, startup difficulties and scavenge and search efficiency calculations. Seasonal patterns of mortality have a strong effect on annual results and comparisons should preferably be made with projects that occurred during the same time of year. The analyses described in this report will provide ample information for designing a fatality study protocol for the coming years. Carcass removal and scavenging rates, combined with other findings, can be used to determine the optimal search interval and sample size of turbines needed to be searched for the entire 195 turbines at the Maple Ridge Wind Power Project.

1.0 INTRODUCTION

The following report describes the research design, initiation and completion of the first year of postconstruction study of avian and bat collision fatalities at the 120-turbine Maple Ridge Wind Power Project in Lewis County, New York (Figures 1, 2).

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

Advisory Committee (TAC), which has the responsibility of reviewing and commenting on progress reports, annual reports, and other updates from this project.

<u>TAC members:</u>

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)

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

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

- Birds (collective fatalities of all species),
- Bats (collective fatalities of all species),
- Bird species (species by species),
- Bat species (species by species),
- Raptors (all species collectively),
- Waterfowl (all species collectively),
- Songbirds (all species collectively), and
- Night migrants (all species collectively and individual species).

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

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

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

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; and 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

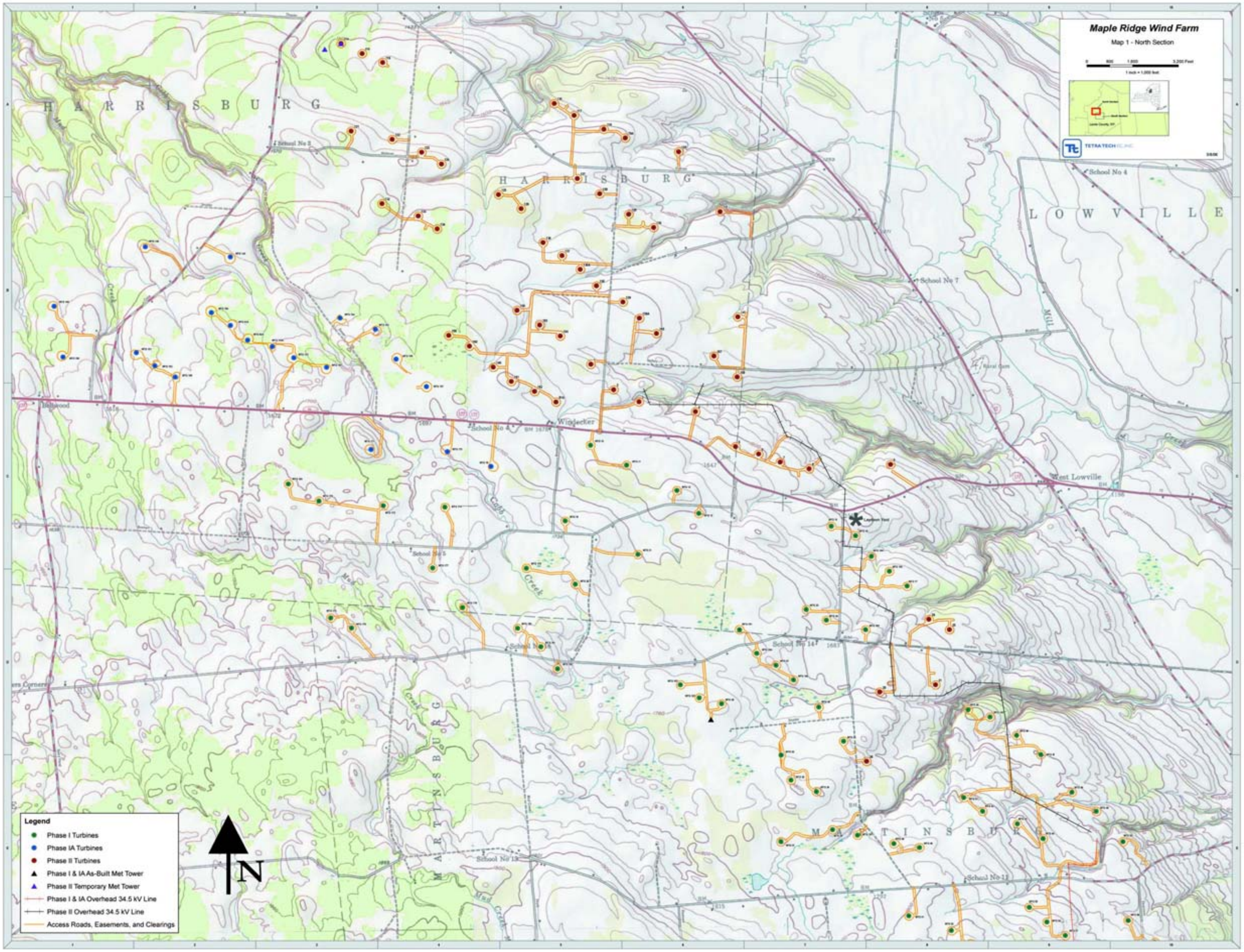
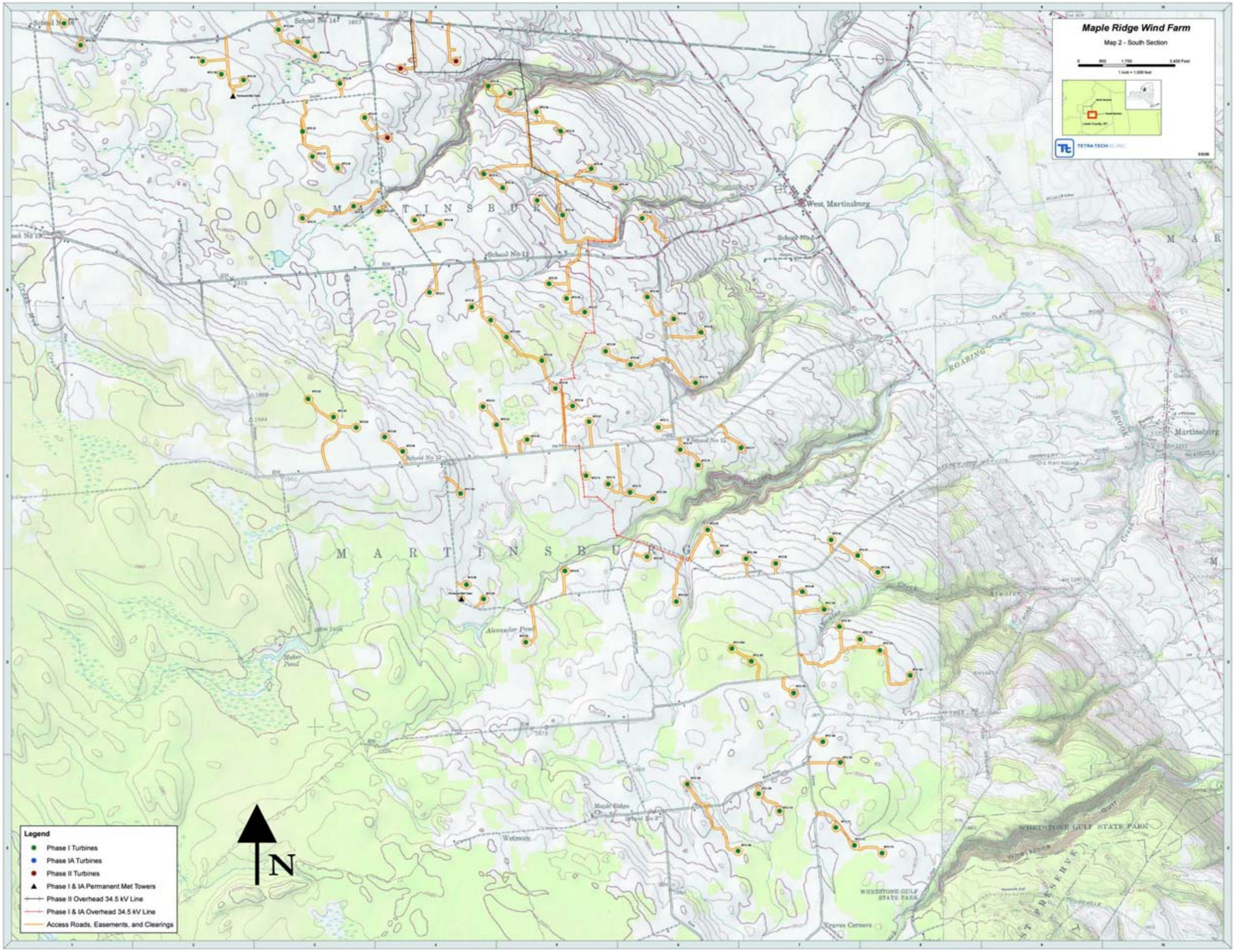


Figure 2: High Resolution Project map for the Southern section of the Maple Ridge



1.2 Study Area

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

Phase I includes approximately 15,570 acres of land (on 84 separate parcels) under lease from 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. The first year (2006) of searches are within the Phase I study area.

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

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

2.0 METHODS

2.1 Carcass Surveys

2.1.1 Site Selection

Fifty turbine sites were chosen to be searched in 2006. 2 meteorological towers were also searched (described below). Site selection was through a process of randomization and stratification. All Phase I turbine locations were surveyed, and classified broadly as bare ground, agricultural (crop), agricultural (grassland), brush and wooded. Most sites belonged to two or more classes (e.g. agricultural crop field with woodlot and some brush). Sites were randomized from each of these groups, but some sites were excluded due to perceived difficulty in searching/ground-clearing (heavy brush, severely sloped terrain, presence of debris and waste on site, etc.).

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

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

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

Search Frequency	Turbine Number	Primary Ground Cover
7-Day	32	Grass/Wooded
7-Day	34	Grass/Wooded
7-Day	35	Grass
7-Day	37	Grass/Wooded
7-Day	39	Grass
7-Day	40	Grass
7-Day	50	Grass/Wooded
7-Day	53	Grass/Wooded
7-Day	54A	Grass/Wooded
7-Day	59	Crop
7-Day	64	Grass/Wooded
7-Day	90	Grass
7-Day	101	Grass/Wooded
7-Day	103	Grass/Wooded
7-Day	104	Grass/Wooded
7-Day	108	Grass
7-Day	109	Grass
7-Day	110	Grass
7-Day	180	Grass/Wooded
7-Day	181	Grass
7-Day	183	Wooded
7-Day	185	Wooded
7-Day	192	Grass/Wooded

Upon contract finalization and authorization to begin searches in mid-May, a field crew of 4 field technicians and one Field Biologist (Linda Slobodnik) was hired in the second week of June. However, on-site plant managers were not aware of the specifications of the protocol with respect to mowing the large areas under all 50 turbines that were to be searched. Developer management needed to get landowner permission and procure compensation for lost crops before mowing could commence. This matter was resolved by developer management, and agreement letters were mailed to landowners on August 11, 2006.

In the absence of written landowner agreements, adjustments in the protocol were required to start collecting data. Starting mid-June, sites that were currently searchable (low vegetation/cover) amongst the randomly chosen sites were selected as one and 3-day searches. Oral permissions to search the sites were obtained by Horizon Wind, and search areas were flagged and searches commenced. Two 1-day sites were replaced when individual landowners contacted Horizon Wind to revoke oral permissions. Oral permission to do some mowing was also obtained by Robert Burke (Horizon Wind on-site manager). Some mowing did occur, but Horizon Wind did not do extensive mowing that would have resulted in substantial crop loss until the landowner compensation letters were mailed. While this resulted in search difficulties, it was important to avoid causing discontent by removing farmers' crops/hay before compensation could be addressed.

As of June 17, 2006, all 10 1-day sites were being surveyed. As of July 17, 2006 all 10 3-day sites were being surveyed. The second meteorological tower was also added on July 17, 2006. Given that a complete mowing schedule had not yet begun, searchable ground at the 1-day and 3-day sites varied from site to site, and changed over time as grass/crop/brush increased in height.

The 30 7-day sites were plotted over the first two weeks of July. However, only the gravel areas at the base of the turbines and access roads were searched, pending landowner agreements. These sites had high grass which was not suitable to be searched. Limited searching occurred on available bare ground. Some mowing occurred, prior to formal landowner agreement. By August 15, 2006 the setup phase was concluded and the regular search cycle and protocols were fully in place for all sites. By the end of August, mowing efforts had also been standardized and were operating regularly. For the list of searches completed, see Table 2.

Searches were conducted when weather and other conditions permitted. Work was not done during lightning but was conducted during light rain. By definition, 1-day sites, if missed, could not be made up. Barring further inclement weather, 3-day sites were made up within 1-2 days. All missed 7-day sites were made up within 1-5 days.

2.1.2 Carcass collection

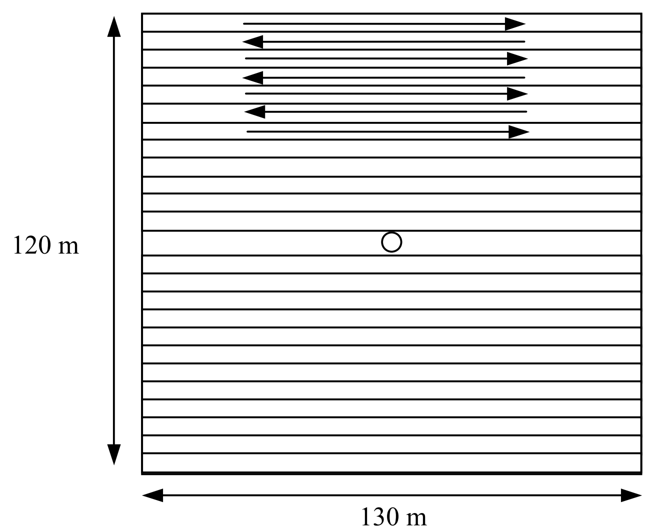
Prior to August 7, 2006, carcasses were noted on the ground and tracked until scavenged. By August 7, both state and federal permits were obtained and all remaining carcasses were retrieved. All fresh carcasses found were collected as well.

2.1.3 Standardized Surveys

Carcass surveys were conducted every day at 10 sites and one meteorological tower, every 3 days at 10 sites and one meteorological tower, and every 7 days at 30 wind turbine 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. 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 that would be more than could be lost during molting. When unattached single loose feathers were found their location was recorded and the feathers were removed and retained but not recorded as a fatality. Small feathers such as down feathers were also not recorded, since these most likely were lost as a result of normal preening. In any event, this type of remains 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. 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 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. Brianna Gary and Ward Stone (NYSDEC) identified bird carcasses. Bat carcasses were identified by Alan Hicks, also of the NYSDEC.

When an injured animal was found, the searchers recorded the same data collected for a carcass, noting however, that it was an injury and not a fatality. The searchers then captured and restrained the animal in a manner to avoid either further injury to the animal or injury to the survey crew. Once the animal was secured it was transported to a wildlife rehabilitator or veterinarian. Only one such avian incident occurred.
Rabies related precautions precluded the handling of injured bats in New York State. Only in those cases where the animal was in proximity to a specific turbine was a turbine number recorded as the location in the report. When no corroborating information that the injury was linked to a tower was available, the animal was simply recorded as an "incidental" find. For instance, if a bird was found with a broken wing, it would not be associated with a specific wind turbine tower if it were observed to be mobile.

The protocol dictated that if the carcass or injured animal found was listed as a threatened or endangered species, or a species of concern, the 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.

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

It is recognized that the number of carcasses found under the towers is lower than the total number of birds and bats likely to have been killed. There are at least three correction factors that need to be accounted for. The first is the possibility that the searchers will miss carcasses due to the amount of ground cover or the size and 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 correction factors to the actual number of carcasses found during standardized surveys prevents underestimation of mortality. Several scavenger removal and searcher efficiency studies conducted in late summer/early fall 2006 estimated the proportion of carcasses missed by the searchers and the proportion removed by scavengers within the 1, 3 and 7-day search cycles.

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

a) Proportion of test carcasses left by scavengers within the search period (Sc). Scavenge rate (Sc) was measured over 5 tests (14-Sep, 26-Sep, 25-Oct, 7-Nov and 10-Nov 2006) by placing 51 bat carcasses and 16 small bird carcasses (European Starlings) on mortality transects at various searched sites (1, 3 and 7-day sites) in the Maple Ridge Wind Resource Area (MRWRA). An additional 4 birds of medium size

(Mourning Dove) and 4 birds of large size (Seagull) were also used to test for scavenging. However, we were unable to update our New York state permits in time to carry out complete testing for medium and large birds. Carcasses were distributed among searched sites (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 different cleared 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. Field technicians monitored carcasses daily for at least two weeks, and then once a week after most carcasses were either scavenged or extremely decomposed, for evidence of scavenging. The status of each carcass was reported as completely intact (CI), partially scavenged with carcass or large group of feathers remaining (PSC/PSF) or no remains (NR). Movement of carcasses was noted, although this could not always be distinguished from weather related events.
The probability of a collision event is equally distributed over all days of the search cycle (1, 3 or 7 days). Thus, the overall duration between carcass fall and discovery is approximately half the actual search cycle (0.5, 1.5 or 3.5 days respectively). For example, if a carcass was discovered at a 7-day search site, it had an equal probability of having hit the tower on each of the previous 7 nights. The average time between impact and discovery is (1 + 2 + 3 + 4 + 5 + 6)/6 = 3.5 days (rounded to 4 days). Thus, the scavenge rate was calculated for the number of test carcasses that were not visible (body of carcass removed/severely scavenged) after 1, 2 and 4 days, for the 1 day, 3 day and 7 day search sites, respectively.

b) Proportion of carcasses missed by observers in the search efficiency trials (*Se*).
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). 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 the night before the searches. 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. Planted evidence of collisions was later removed from the database and a mean search efficiency rate (*Se*) was calculated as the ratio of birds found to (birds placed – birds scavenged overnight).

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

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

Where $\hat{C}$ = 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 correction factors *Sc* and Se, using the variance of a product formula (Goodman, 1960). The variance of the product of *Sc* and *Se* is:

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

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

3.0 RESULTS

3.1 Search Effort

3.1.1 Summary of Search Effort

Over the duration of the pilot project, we completed 2,244 individual turbine and meteorological tower searches for all 50 turbine and two meteorological tower sites, during a period from June 17, 2006 to November 15, 2006. All turbines were searched as frequently as the protocol described, although minor weather and human related disruptions occurred.

3.1.2 1-Day search sites (N = 10 turbines)

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

3.1.3 3-Day search sites (N = 10 turbines)

A total of 45 complete rounds of standardized searches were conducted between June 29, 2006 and November 15, 2006 (Table 2), for a total of 450 turbine searches. The total search period was 138 days. When sites could not be searched due to inclement weather (heavy rain during the summer, inaccessible sites due to snow in the winter), field technicians accessed the sites at the earliest available date before the next search round was due to occur. 8 days had more than 5 out of 10 3-day sites missed, out of which sites were made up for 6 of those days. The average number of days between successive searches for each tower was 3.20 days.

3.1.4 7-Day search sites (N = 30 turbines)

A total of 16 complete rounds of standardized searches were conducted between July 11, 2006 and November 13, 2006 (Table 2) (480 turbine searches). Two incomplete rounds, comprising 25 and 11 towers, were also done at the end of the study. Thus, the total number of turbine searches was 524. The total search period was 125 days. When sites could not be searched due to inclement weather (heavy rain during the summer, inaccessible sites due to snow in the winter), field technicians accessed the sites at the earliest available date before the next search round was due to occur. There were 20 days when 1 or more 7-day sites were missed. However, there were only 6 days when we could not search more than 5 sites out of 30, and all missed sites were made up before the next search cycle, except for the project end period from November 10, 2006 until November 15, 2006. The average number of days between successive searches for each tower was 7.8 days.

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

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

10 Wind Turbines			**10 Wind Turbines**			**30 Wind Turbines**	
(1 Day Search Period)			**(3 Day Search Period)**			**(7 Day Search Period)**	
Carcass Surveys:	**Start Date**		**Start Date**	**End Date**		**Start Date**	**End Date**
Round 41	29-Jul		1-Nov	13-Nov			
Round 42	30-Jul		7-Nov	14-Nov			
Round 43	31-Jul		9-Nov	14-Nov			
Round 44	1-Aug		13-Nov	13-Nov			
Round 45	2-Aug		15-Nov	15-Nov			
Round 46	3-Aug						
Round 47	4-Aug						
Round 48	5-Aug						
Round 49	6-Aug						
Round 50	7-Aug						
Round 51	8-Aug						
Round 52	9-Aug						
Round 53	10-Aug						
Round 54	11-Aug						
Round 55	12-Aug						
Round 56	13-Aug						
Round 57	14-Aug						
Round 58	15-Aug						
Round 59	16-Aug						
Round 60	17-Aug						
Round 61	18-Aug						
Round 62	19-Aug						
Round 63	20-Aug						
Round 64	21-Aug						
Round 65	22-Aug						
Round 66	23-Aug						
Round 67	24-Aug						
Round 68	25-Aug						
Round 69	26-Aug						
Round 70	28-Aug						
Round 71	29-Aug						
Round 72	30-Aug						
Round 73	31-Aug						
Round 74	1-Sep						
Round 75	2-Sep						
Round 76	3-Sep						
Round 77	4-Sep						
Round 78	5-Sep						
Round 79	6-Sep						
Round 80	7-Sep						
Round 81	8-Sep						
Round 82	9-Sep						
Round 83	10-Sep						
Round 84	11-Sep						

10 Wind Turbines			**10 Wind Turbines**			**30 Wind Turbines**	
(1 Day Search Period)			**(3 Day Search Period)**			**(7 Day Search Period)**	
Carcass Surveys:	**Start Date**		**Start Date**	**End Date**		**Start Date**	**End Date**
Round 85	12-Sep						
Round 86	15-Sep						
Round 87	16-Sep						
Round 88	17-Sep						
Round 89	18-Sep						
Round 90	19-Sep						
Round 91	20-Sep						
Round 92	21-Sep						
Round 93	22-Sep						
Round 94	25-Sep						
Round 95	26-Sep						
Round 96	27-Sep						
Round 97	28-Sep						
Round 98	29-Sep						
Round 99	30-Sep						
Round 100	2-Oct						
Round 101	3-Oct						
Round 102	4-Oct						
Round 103	5-Oct						
Round 104	6-Oct						
Round 105	7-Oct						
Round 106	8-Oct						
Round 107	9-Oct						
Round 108	10-Oct						
Round 109	13-Oct						
Round 110	14-Oct						
Round 111	16-Oct						
Round 112	18-Oct						
Round 113	19-Oct						
Round 114	22-Oct						
Round 115	24-Oct						
Round 116	25-Oct						
Round 117	26-Oct						
Round 118	27-Oct						
Round 119	31-Oct						
Round 120	1-Nov						
Round 121	2-Nov						
Round 122	7-Nov						
Round 123	8-Nov						
Round 124	9-Nov						
Round 125	10-Nov						
Round 126	13-Nov						
Round 127	15-Nov						

* Indicates incomplete 7-Day survey.

3.1.5 Meteorological Towers

One meteorological tower was searched daily, for a total of 97 searches, from July 17, 2006 to November 15, 2006. The total search period was 121 days. The average search interval for this tower was 1.25 days. The second meteorological tower was searched every 3 days (34 total searches, from July 17, 2006 to November 14, 2006, total search period, 120 days). The average search interval for this tower was 3.87 days. See Table 3 for a complete list of search dates. A total of 131 searches at meteorological towers were conducted.

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

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

	Meteorological Tower #2	Meteorological Tower #1
	(1 Day Search Period)	(3 Day Search Period)
Carcass Surveys:	Date	Date
Round 34	20-Aug	14-Nov
Round 35	21-Aug	
Round 36	22-Aug	
Round 37	23-Aug	
Round 38	24-Aug	
Round 39	25-Aug	
Round 40	26-Aug	
Round 41	28-Aug	
Round 42	29-Aug	
Round 43	30-Aug	
Round 44	31-Aug	
Round 45	1-Sep	
Round 46	2-Sep	
Round 47	3-Sep	
Round 48	4-Sep	
Round 49	5-Sep	
Round 50	6-Sep	
Round 51	7-Sep	
Round 52	8-Sep	
Round 53	9-Sep	
Round 54	10-Sep	
Round 55	11-Sep	
Round 56	12-Sep	
Round 57	15-Sep	
Round 58	16-Sep	
Round 59	17-Sep	
Round 60	18-Sep	
Round 61	19-Sep	
Round 62	20-Sep	
Round 63	21-Sep	
Round 64	22-Sep	
Round 65	25-Sep	
Round 66	26-Sep	
Round 67	27-Sep	
Round 68	28-Sep	
Round 69	29-Sep	
Round 70	30-Sep	
Round 71	2-Oct	
Round 72	3-Oct	
Round 73	4-Oct	
Round 74	5-Oct	
Round 75	6-Oct	
Round 76	7-Oct	
Round 77	8-Oct	
Round 78	9-Oct	

	Meteorological Tower #2	Meteorological Tower #1
	(1 Day Search Period)	(3 Day Search Period)
Carcass Surveys:	Date	Date
Round 79	10-Oct	
Round 80	14-Oct	
Round 81	16-Oct	
Round 82	18-Oct	
Round 83	19-Oct	
Round 84	22-Oct	
Round 85	24-Oct	
Round 86	25-Oct	
Round 87	26-Oct	
Round 88	27-Oct	
Round 89	31-Oct	
Round 90	1-Nov	
Round 91	2-Nov	
Round 92	7-Nov	
Round 93	8-Nov	
Round 94	9-Nov	
Round 95	10-Nov	
Round 96	13-Nov	
Round 97	15-Nov	

3.2 Incidents Recorded During Surveys

During this study, a total of 142 avian fatalities/injuries and 383 bat fatalities/injuries were recorded during standardized surveys at Phase I turbine towers and meteorological towers as well as incidentally reported. Incidentally reported carcasses included finds by wind developer employees at any tower sites both in and out of Phase I and finds by field technicians outside of standardized search plots. Of these 142 bird carcasses, 17 (12.0%) were found incidentally and of the 383 total bat carcasses, 57 (14.9%) were found incidentally.

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

3.2.1 Birds

In Table 4, the incidental finds are listed in a separate column by species but are not included in either the totals or calculations.

A total of 125 avian incidents were recorded by searchers during standardized surveys, representing 30 species, which included 18 unidentified birds. Of these 18, one was identified only as a non-passerine species, one as a vireo and one as a warbler (Table 4) and 15 were not identifiable to a taxonomic group because they were scavenged or decayed prior to being found. Of the 30 species, only one was a raptor species (one American Kestrel). Three were game birds (Wild Turkeys) that typically are not strong fliers but have been known to attain blade height (pers. comm., Mike Burger.) One was a woodpecker (Yellow-bellied Sapsucker). No waterfowl, shore birds, or other waterbirds were found during the regular turbine searches. There were 104 incidents of identified passerines (songbirds) identified to 26 different species plus two birds identifiable as passerines (one warbler species and one vireo species). Golden-crowned Kinglets (n = 49; 39.2% of 125 avian incidents) and Red-eyed Vireos (n = 12; 9.6% of 125 avian incidents) were the most common species found. All but one of the avian incidents found during this study were fatalities. One injured Black-throated Blue Warbler (September 25, 2006) was taken to a local rehabilitation clinic (Lowville, NY) and was successfully released the next day. This incident was used in the estimates of total incidents on site with the presumption that injured birds would have a low probability of survival in the absence of the rehabilitation process.

Night migrants (n = 100) accounted for 80.0% of the 125 avian incidents recorded during standardized surveys. Of all 104 identified songbirds, (excluding incidental finds), 99 (95.2%) were night migrants. The 100th night migrant was the Yellow-bellied Sapsucker, mentioned above. 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.

An additional 11 fatalities representing seven species were found incidental to standardized surveys, as well as 4 fatalities reported from towers outside the Phase I study area and 2 fatalities reported by wind developer employees at Meteorological Tower #1, for a total of 17 incidental finds. These account for 12.0% of the 142 avian fatalities/injuries found during the study period. Incidental finds included Black-throated Blue Warbler, Magnolia Warbler, American Crow, Ruffed Grouse, Red-eyed Vireo, Tree Swallow, and Eastern Phoebe. The four fatalities from towers outside Phase I included two unidentified birds and two Canada Geese. These were at towers from Phases IA and II, phases that are to be included in the study in 2007. This mix of taxa represent night migrants, daytime migrants, and non-migrant residents.

The two (Table 4) avian fatalities that were registered at one of the two meteorological towers were a Rose-breasted Grosbeak and an unidentified warbler and were both night migrants. Both were found incidentally and not during standardized searches.

Table 4. Number of avian incidents at each wind turbine by species group found during standardized surveys and “incidentally” from June 17, 2006 to November 15 2006.

Tower #	Search Frequency	Number of Bird Incidents					
		Other	Raptor	Unidentified bird	Passerine	Total Std.	Incidental
56	1 Day			1	8	9	
52	1 Day	1			6	7	
89	1 Day				7	7	
181	7 Day				6	6	
17	1 Day				5	5	

Tower #	Search Frequency	Number of Bird Incidents					
		Other	Raptor	Unidentified bird	Passerine	Total Std.	Incidental
98	1 Day				5	5	
189	1 Day				5	5	
57	1 Day				4	4	
97	1 Day			3	1	4	
197	3 Day	1		2	1	4	
12	7 Day				4	4	
24	7 Day				4	4	
183	7 Day			1	3	4	
75	1 Day			2	1	3	
83	3 Day				3	3	
86	3 Day				3	3	
193	3 Day				3	3	
195	3 Day				3	3	
32	7 Day		1	1	1	3	1
108	7 Day			2	1	3	
77	1 Day	1			1	2	
45	3 Day				2	2	
76	3 Day				2	2	
82	3 Day				2	2	
16	7 Day			1	1	2	
26	7 Day				2	2	
27	7 Day			1	1	2	
34	7 Day				2	2	
53	7 Day				2	2	
101	7 Day			1	1	2	
185	7 Day				2	2	
22A	7 Day				2	2	
102	3 Day				1	1	1
179	3 Day				1	1	
39	7 Day				1	1	
40	7 Day	1			0	1	
50	7 Day				1	1	
59	7 Day				1	1	
64	7 Day				1	1	
90	7 Day				1	1	
103	7 Day				1	1	
104	7 Day				1	1	
109	7 Day			1	0	1	
54A	7 Day				1	1	
71	1 Day				0	0	
99	1 Day				0	0	
23	7 Day				0	0	
35	7 Day				0	0	
37	7 Day				0	0	
110	7 Day					0	1
180	7 Day				0	0	

Tower #	Search Frequency	Number of Bird Incidents					
		Other	Raptor	Unidentified bird	Passerine	Total Std.	Incidental
192	7 Day				0	0	2
13	Incidental					0	1
38	Incidental					0	1
47	Incidental					0	1
68	Incidental					0	1
111	Incidental					0	1
135	Incidental					0	1
163	Incidental					0	1
175	Incidental					0	1
138A	Incidental					0	2
Met # 1	Incidental					0	2
	Totals	**4**	**1**	**16**	**104**	**125**	**17**
Sorted by grand total number of avian fatalities (descending order).							
Includes incidents associated with wind turbines found during standardized surveys and “incidentally” (June 17, 2006 to November 15, 2006).							

Figure 4. Locations of bat incidents at the Maple Ridge WRA found during standardized surveys, June 17, 2006 through November 15, 2006 (1, 3 and 7-day sites, Phase I)
Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally

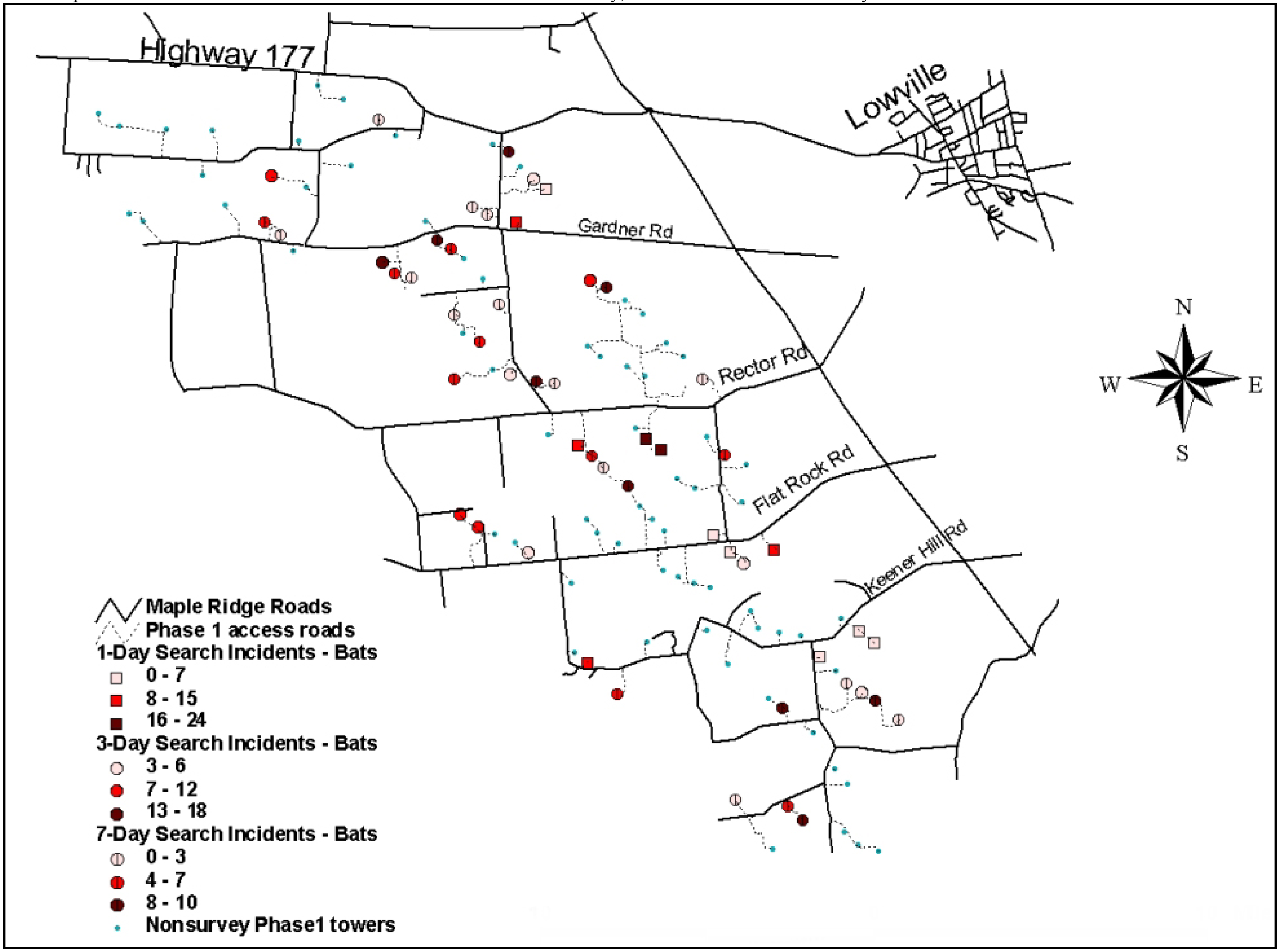
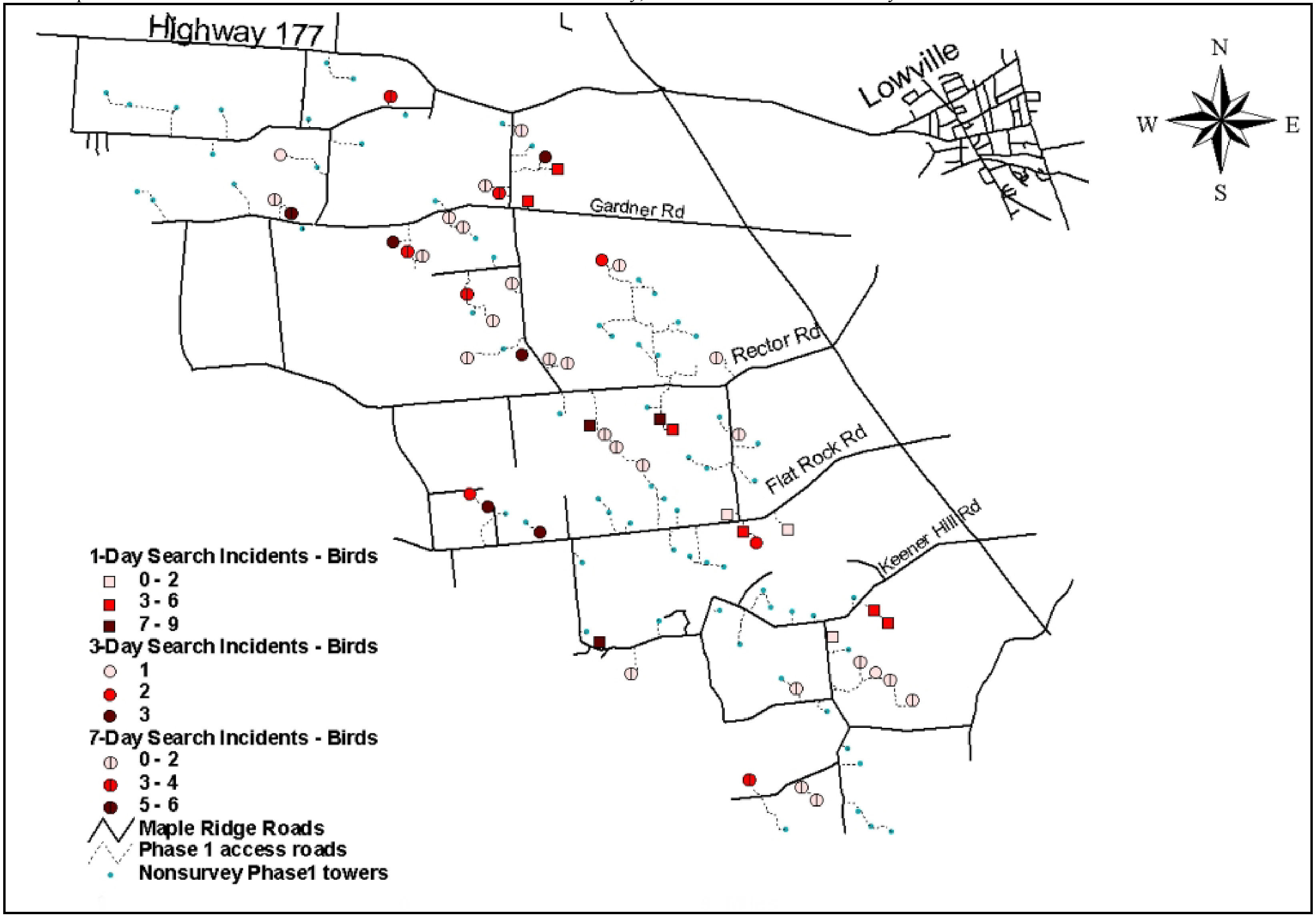


Figure 5. Locations of avian incidents at the Maple Ridge WRA found during standardized surveys, June 17, 2006 through November 15, 2006 (1, 3 and 7-day sites, Phase I)

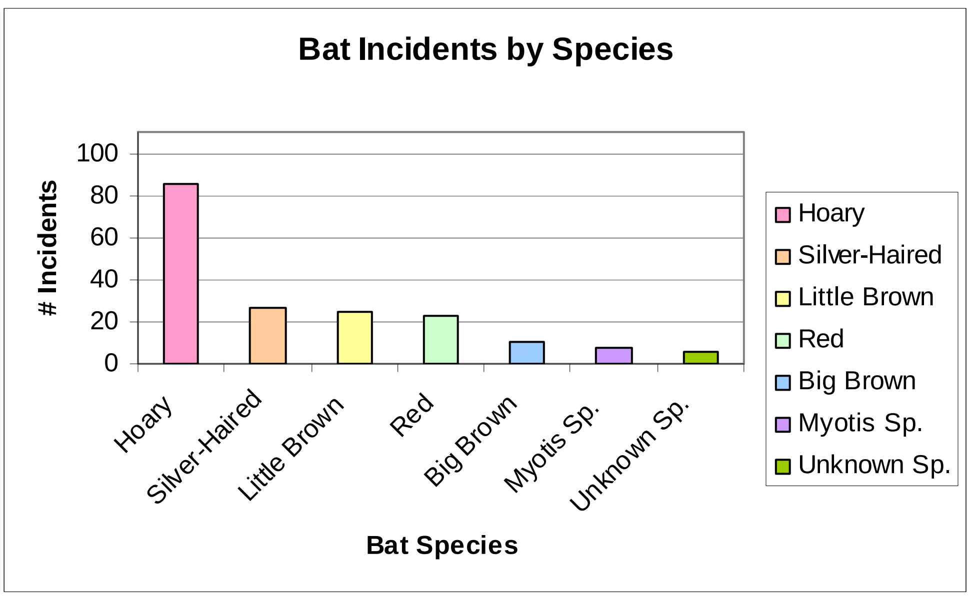
Note: Maps include incidents considered to be associated with a wind turbine only, and not those found incidentally.



3.2.2 Bats

Remains of 383 bats were found by searchers during standardized surveys and incidental finds. These fatalities represented at least 5 different species including Hoary Bat, Silver-Haired Bat, Red Bat, Little Brown Bat, and Big Brown Bat. Bat species identification by Alan Hicks at the NYSDEC is ongoing. Currently, 220 out of 383 bat carcasses have been processed and assigned species identifications. Of these, 184 bats were from standardized surveys and 36 bats were from incidental finds. Out of the 184 bats found during standardized surveys, Hoary Bats comprised 46.2% (n = 85), Silver-Haired Bats comprised 14.7% (n = 27), Little Brown Bats comprised 13.6% (n = 25), Red Bats comprised 12.5% (n = 23), and Big Brown Bats comprised 5.4% (n = 10). Further, 4.4% (n = 8) were identified as Myotis species (probably Little Brown Bats) and 3.3% (n = 6) could not be identified because of the advanced state of decomposition (Figure 6). The proportions were similar when identifying the incidental finds.

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



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

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

Table 5. Wind Turbine Locations of Bat Incidents by Species

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

Tower #	Search frequency	Hoary	Silver-Haired	Red	Little Brown	Big Brown	Myotis Species	Unknown Species	Total
97	1 day	2	1		1	1		1	6
189	1 day	3	1		1				5
98	1 day	2				1		1	4
52	1 day		1		1				2
75	1 day	1							1
77	1 day	1							1
71	1 day								0
99	1 day								0
Met #2	1 day								0
62A	Incidental	1	2						3
106	Incidental	1				1			2
170	Incidental	3							3
41	Incidental	1		1					2
42	Incidental	2							2
43	Incidental	1		1					2
68	Incidental	1			1				2
171	Incidental		1		1				2
172	Incidental			1	1				2
180	Incidental		1		1				2
44	Incidental		1						1
46	Incidental	1							1
48	Incidental	1							1
55	Incidental		1						1
60	Incidental		1						1
65	Incidental	1							1
72	Incidental	1							1
96	Incidental							1	1
186	Incidental	1							1
188	Incidental		1						1
191	Incidental			1					1
61a	Incidental			1					1
Fenner Rd.	Incidental		1						1
Phoenix Rd	Incidental	1							1
	Total (std.)	85	27	24	25	10	8	6	**184**
	Total (inc.)	16	9	6	4	1	0	1	**36**
	Total	**101**	**36**	**30**	**29**	**11**	**8**	**7**	**220**
	Data from 220 identified bat fatalities (184 during standardized surveys and 36 'incidental finds', June 17, 2006 to November 15, 2006.								
	Sorted by number of fatalities (descending order).								

3.2.3 Seasonal Distribution of Fatalities (Birds and Bats)

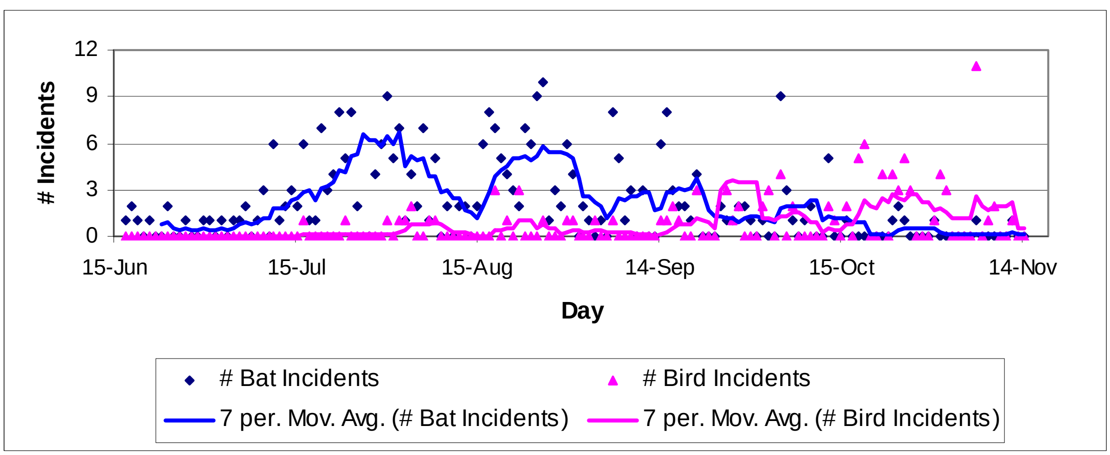
While the duration of this project only included later summer, fall and early winter, we were able to discern patterns in seasonal mortalities that coincided largely with fall migration. Bat fatalities peaked in July and August (Figure 7, Table 6) and declined sharply in subsequent months, as fall migration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

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

Species Group	JUN[1]	JUL	AUG	SEP	OCT	NOV[1]	Total
Raptor	0	1	0	0	0	0	1
Passerine	0	2	14	29	42	19	104
Other Bird/Non-Identified Birds[2]	0	3	2	5	5	3	20
Bat	9	104	124	59	28	2	326
Total	9	110	140	93	75	24	451

[1]Searches began on June 17, 2006 and were concluded on November 15, 2006. A number of snowy days in November further reduced actual search days.
[2]'Other Bird' comprised of one Woodpecker species and three Wild Turkeys. The rest of this category were Non-Identified Birds.

Figure 7. Number of birds and bats found per day from June 17 to November 15, 2006.
Note: Trend lines indicating a 7 day moving average.[1, 2]



[1] One bat data point (16 bat incidents on July 27, 2006) and one bird incident (18 bird incidents on September 25, 2006) were not shown for graphical scaling clarity. These two data points are reflected in the 7-day moving average.
[2] 10 1-day sites were set up by June 17, 2006. 10 3-day sites were set up by June 29, 2006. 30 7-day sites were set up by July 11, 2006. Adequate mowing was in place by end August. Raw data is shown in graph and does not represent the number of incidents per survey or weighting by site searchability.

3.2.4 Distance from Turbine Bases

There were primarily two classes of animals involved with tower collisions: small birds and bats. The very small sample size of larger birds was not considered in the following analyses because of the paucity of data available. 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. Further, bird feathers may cause a different fall pattern when compared with bats. 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 7) were then tabulated based on distance (range) from the base of wind turbines (Table 8). As wooded sites could not be searched beyond the tree line (approximately 40 m from the base of the tower) we used only non-wooded sites to estimate the range of distances that birds and bats fall from the towers. Using data from wooded sites would have resulted in a bias towards the area within 40m of the tower base. Also, we used data from the period after site setup and mowing was completely in place (September 1 – November 15, 2006) as our previous search efforts focused on the area close to the towers until adequate mowing occurred.

Table 7. Species Size Groupings used in Analyses.

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

Distances were recorded for all 125 bird and 326 bat carcasses found during standardized surveys. However, after eliminating incidents from wooded sites, as well as incidents that were recorded before mowing was done completely, 69 bird incidents and 74 bat incidents remained to evaluate "fall" distance from tower. The number of bat incidents that we could analyze was more impacted by this elimination process as fall bat migration occurs earlier than the peak in fall bird migration.

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

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

Of the 69 bird incidents found during standardized surveys, the mean distance to the turbine tower base was 43.7m and the median distance was 46m. Of the 74 bat incidents found during standardized surveys, the mean distance to the turbine tower base was 25m and the median distance was 26m. Thus, bat incidents were concentrated closer to the tower than birds. The Distance Ranges (Table 8) with a radius greater than 60m lay partially within the 4 corners of the 120 by 130m square. 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. For both birds and bats, we divided the recorded distances into concentric 5m rings. The number of incidents per ring was divided by the area of the ring that fell within the 120m by

130m search area, to give the incident density. As described above, smaller concentric rings lay entirely within the overall search area, whereas larger concentric rings (radius > 60m) were only partially in the overall search area. These densities were plotted (Figures 8 and 9) along with a logarithmic trend line to forecast the distance at which density drops to zero, indicating no more incidents would be found at that distance. The R^2 (goodness-of-fit) value for both trend lines are shown on the figures (R^2= 1 indicates perfect fit). The R^2 for the bat incidents (Figure 8) is 0.59 while the R^2 = 0.39 for the bird incidents (Figure 9).

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

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

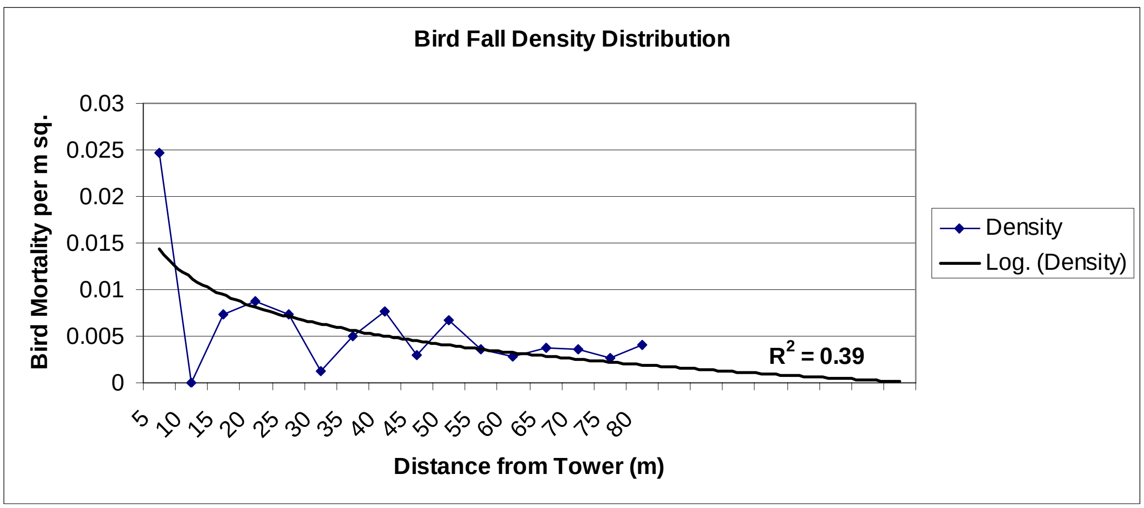
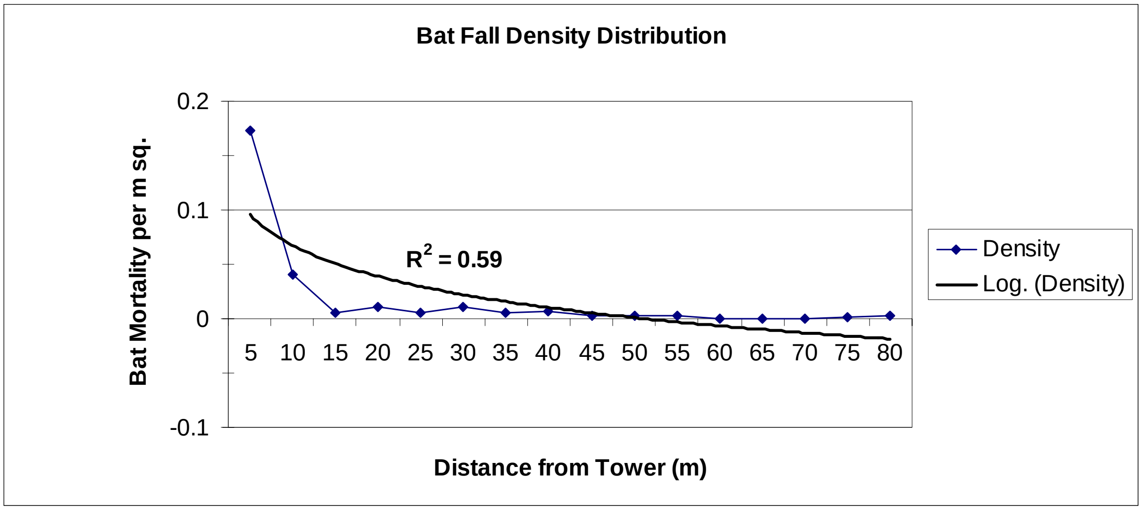


Figure 9. Density of bat incidents at non-wooded sites, from surveys conducted between September 1, 2006 and November 15, 2006, in relation to distance from towers.
Note: Trend line predicts distance at which density approximates zero (R^2 = 0.59) at approximately 45 m.



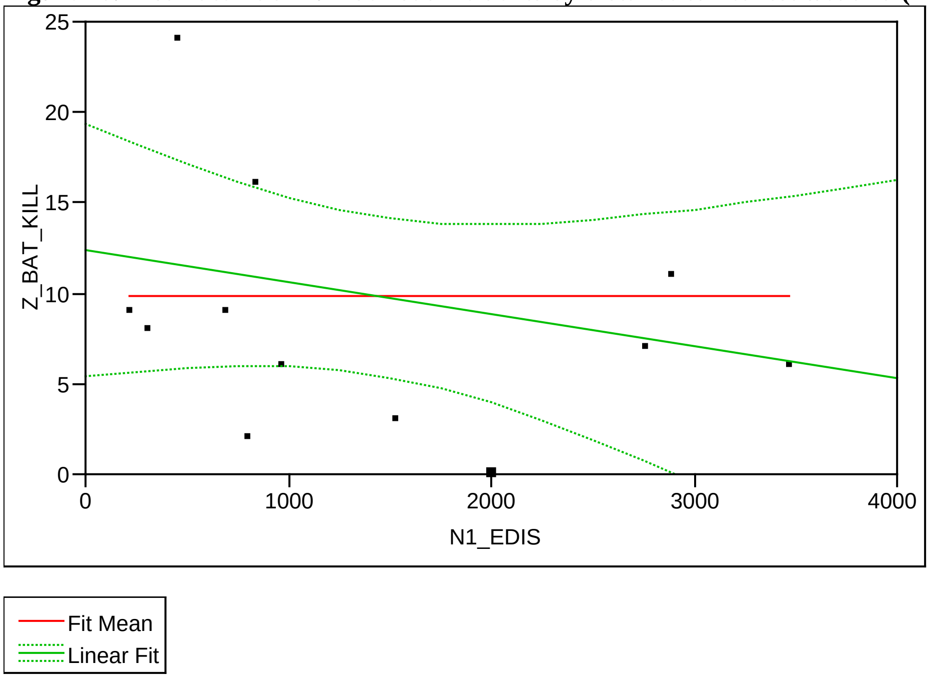
3.2.5 Distance to Nearest Wetland (Bats)

All of the 5 bat species found at the MRWRA are known to forage over water bodies to some extent (Erickson 2002, Furlonger *et al.* 1987, Genter and Jurist 1995, Zinn and Baker 1979) and to use wetlands for some of their daily water intake needs (Kurta 2000). As a result, we investigated the correlation between the number of bat incidents noted at turbine tower sites and the corresponding distance of that turbine tower to the nearest wetland, using wetland delineation by Environmental Research and Design (EDR). We performed F-tests for the 1, 3 and 7-day sites although sample size was small (n = 10) for the 1-day and 3-day sites respectively. N = 30 for the 7-day sites, resulting in a more robust analysis.

3.2.5.a 1-Day Sites

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

Figure 10. Bivariate fit of number bat incidents by distance to nearest wetland (1-Day sites)

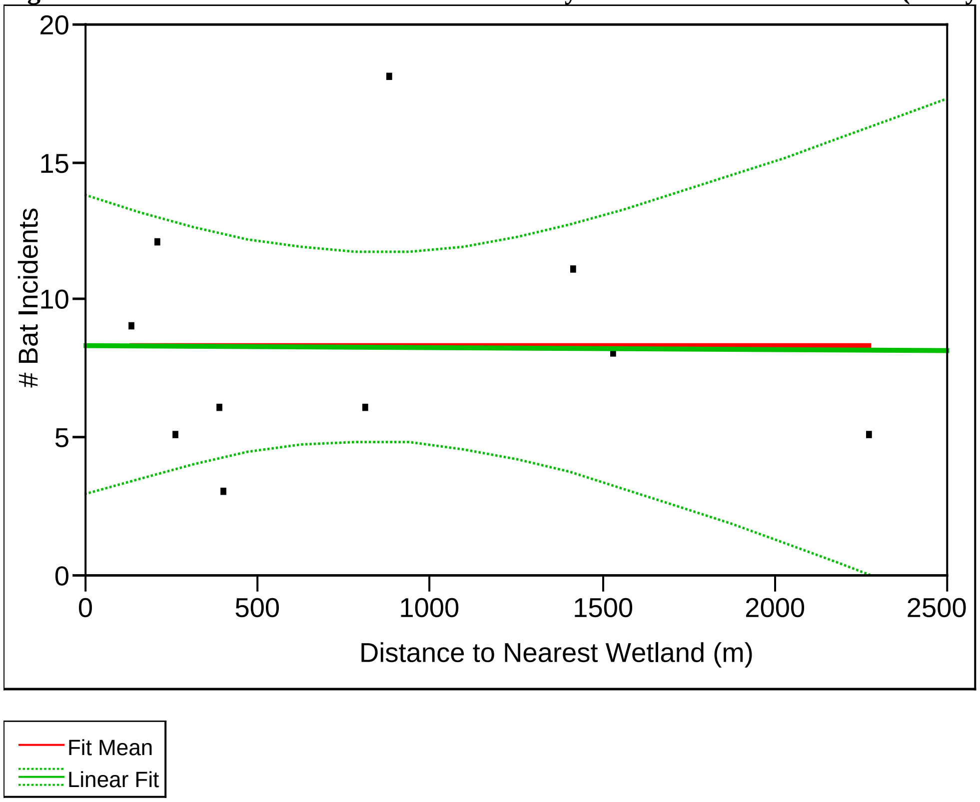


The broken green line in Figure 10 indicates 95% confidence intervals for the negative relationship. The unbroken red line indicates the mean number of bat incidents (Mean = 9.9).

3.2.5.b 3-Day Sites

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

Figure 11. Bivariate fit of number bat incidents by distance to nearest wetland (3-Day sites)

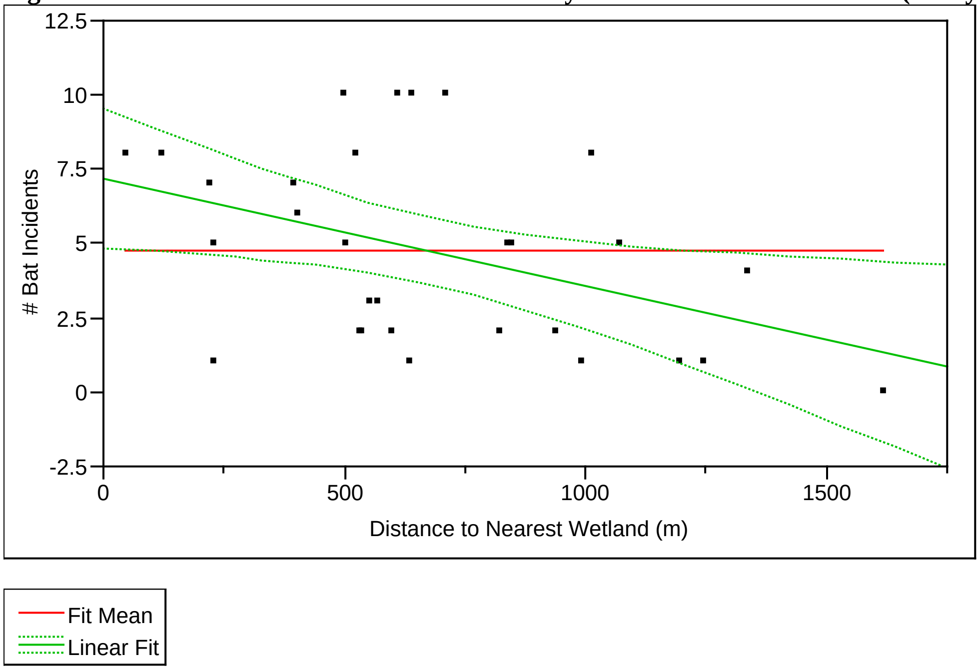


The broken green line in Figure 11 indicates 95% confidence intervals for the negative relationship. The unbroken red line indicates the mean number of bat incidents (Mean = 8.3).

3.2.5.c 7-Day Sites

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

Figure 12. Bivariate fit of number bat incidents by distance to nearest wetland (7-Day sites)



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

3.2.6 Wooded versus Non-wooded Turbine Sites

The area within the MRWRA wind farm includes a mix of agricultural/grassland (non-wooded) and wooded land. Out of the 30 towers searched on a 7-day basis, 14 were classified as wooded and 16 were classified as non-wooded sites. We performed non-parametric chi-squared tests to determine whether a disproportionate number of bird and bat incidents were found at wooded versus non-wooded sites. However, we had to adjust for the fact that wooded sites could only be searched out to approximately 40m from the tower base, whereas non-wooded sites were searched out to the full 120m by 130m search area. Thus, to insure equal search areas and detectability, we compared the number of incidents at both types of sites that fell within the 40m search area. A chi-square test (Table 9) revealed that there was not a significant deviation from the expected number of bat incidents within 40m of the turbine tower base at wooded as opposed to non-wooded turbine sites ($\chi^2 = 1.77$, $df = 1$, $P>0.10$, ns). Further, a chi-square test (Table 10) revealed that there was not a significant deviation from the expected number of bird incidents within 40m of the turbine tower base at wooded as opposed to non-wooded turbine sites ($\chi^2 = 0.09$, $df = 1$, $P>0.10$, ns). There was not an adequate distribution of wooded versus non-wooded sites amongst the 10 1-day and 10 3-day sites, thus we were not able to perform similar tests for those two groups.

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

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

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

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

3.2.7 Lit versus Un-Lit Turbine Sites

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

There was no significant deviation (Table 11) from the expected number of bat incidents within 40m of the tower base at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 0.07$, $df = 1$, P>0.10, ns). There was no significant deviation (Table 12) from the expected number of bird incidents within 40m of the tower base at turbines with L-864 red flashing FAA beacons as opposed to non-lit turbines (Chi-Squared Test, $\chi^2 = 1.99$, $df = 1$, P>0.10, ns) amongst the 30 towers searched on a weekly basis (7-day sites). (We only used data of incidents only within 40m from tower base so that wooded sites, generally only searchable to 40m from the tower base, would not bias the results.)

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

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

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

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

	# 7-day Turbines	# Birds (40m)	Sum
Lit Towers	7	2	9
Unlit Towers	23	18	41
Sum	30	20	50

Table 13. Contingency table showing the proportion of bat incidents noted within the complete search area under turbine tower bases of the 10 1-day search sites, comparing lit versus unlit sites.

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

Table 14. Contingency table showing the proportion of bird incidents noted within the complete search area under turbine tower bases of the 10 1-day search sites, comparing lit versus unlit sites.

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

3.3 Adjusting Fatality Estimates

3.3.1 Estimates from 1-day, 3-day and 7-day Search Sites

Our search protocols were designed to search a subset (n = 50) of the 120 turbines in phase I of the MRWRA. The three different search frequencies (1-day, 3-days and 7-days) provide an opportunity to assess different distributions of search effort and the resulting accuracy of mortality estimates. A statistical power analysis of these three search frequencies has been conducted by Dr. Gibbs, SUNY-ESF, per requests from members of the TAC (Appendix F). Results presented here include 95% confidence intervals for the three search frequencies so that each may be evaluated for level of confidence and so that the best or optimal methods may be used in the future, keeping in mind the issues previously discussed regarding the setup of the project.

Table 15 shows the results of the scavenger study as described in the Methods section. As there were three different search frequencies, there were three different scavenging rates. The proportion of small birds not scavenged (Sc) within one, two and four days was used to adjust the number of both small and medium size bird incidents that were discovered by our searchers. Due to a delay in receiving necessary permits, only one test (n = 16) was carried out for small birds. Further, the number of medium and large birds used to test for Sc was inadequate for the purposes of this study. However, only two medium and three large birds were found during standardized surveys in 2006. Scavenge tests for 2007 will have adequate testing for all size classes of birds and of bats. The proportion of bats not scavenged (Sc) within one, two and four days was used to adjust the number of bat incidents that were discovered by our searchers.

Table 15. Maple Ridge Scavenger Removal Study Data.

	# Carcasses	# Scavenged	Prop. not Scavenged (Sc)
Small Birds – 1 day[1]	16	1	0.94
Small Birds – 3 day	16	1	0.94
Small Birds – 7 day	16	1	0.94
Bats – 1 day	51	10	0.80
Bats – 3 day	51	14	0.73
Bats – 7 day	51	20	0.61

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

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

Table 16. Maple Ridge Searcher Efficiency Study Data.

	# Carcasses	# Carcasses not found	Prop found (Se)
Small Birds[1,2]	16	7	0.56
Medium Birds	16	7	0.56
Large Birds[3]	4	0	1.00
Bats	41	20	0.51

[1]The search efficiency rate is unaffected by the three search periods therefore the same rate was applied to all three search frequencies.
[2]Se for small birds was also used to estimate Se for medium sized birds
[3]Only 4 carcasses were used to test for Se for large sized bird. However, large bird carcasses were very prominent at mowed sites, giving us confidence in this statistic.

Tables 17, 18 and 19 show estimates of the number of bird and bat fatalities attributed to collisions with the wind turbines at the Maple Ridge project in the 2006 study period. They reflect search and scavenging rates as determined in tables 13 and 14, the number of birds/bats found during searches and the subsequent estimate adjustment made using the formula described in the Methods. The tables show the extrapolation for small birds and bats from data collected at the 10 1-day sites. The first row contains the number of incidents noted (# Found) and is adjusted by the correction factors Se, Sc and Ps to get the adjusted total. The 95% confidence intervals are calculated as mentioned in the Methods, and included here.

Table 17. First year estimates (June 17, 2006 to November 15, 2006) for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched towers, from 1-day Sites.

Correction Factors	**Birds**			**Bats**	**Total Carcasses**
	Small	Medium	Large	Bats	
# Found	50	0	1	101	152
% Not Scavenged **(Sc)**	94%	-	94%	80%	
Search Efficiency **(Se)**	56%	-	100.%	51%	
Proportion of Towers Searched (**Ps**)	8.33%	-	8.33%	8.33%	
Adjusted Total	**1138**	**-**	**13**	**2943**	**4094**
95% CI (±)	55	-	1	1222	

Table 18. First year estimates (June 29, 2006 to November 15, 2006) for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched, from 3-day sites.

Correction Factors	**Birds**			**Bats**	**Total Carcasses**
	Small	Medium	Large	Bats	
# Found	22	1	1	83	107
% Not Scavenged (**Sc**)	94%	94%	94%	80%	
Search Efficiency (**Se**)[1]	56%	56%	100%	51%	
Proportion of Towers Searched **(Ps)**	8.33%	8.33%	8.33%	8.33%	
Adjusted Total	**501**	**23**	**13**	**2680**	**3217**
95% CI (±)	24	2	1	1164	

[1] **Se** for small birds was also used for medium sized birds.

Table 19. First year estimates (July 11, 2006 to November 15, 2006) for bird and bat collision mortality under 120 towers of the Maple Ridge WRA, (without incidental finds) corrected for searcher efficiency, scavenger removal rate and proportion of searched towers, from 7-day sites.

Correction Factors	Birds			Bats	Total Carcasses
	Small	Medium	Large	Bats	
# Found	48	1	1	142	192
% Not Scavenged **(Sc)**	94%	94%	94%	61%	
Search Efficiency **(Se)**[1]	56%	56%	100%	51%	
Proportion of Towers Searched **(Ps)**	25%	25%	25%	25%	
Adjusted Total	**364**	**8**	**4**	**1824**	**2200**
95% CI (±)	17	0	0	286	

[1] **Se** for small birds was also used for medium sized birds.

3.3.2 Estimated Fatalities by Species

We adjusted the number of incidents of birds and bats per species, in Table 20, by the same extrapolation factors described in the methods: search efficiency (Se), scavenge rate (Sc) and the proportion of towers searched (Ps). We used the rates appropriate to the sites where the incidents were noted, e.g. one American Goldfinch was found at a 1-day site, and thus was adjusted by the small bird search efficiency, the small bird scavenge rate at daily searched sites and the proportion of 10 daily sites searched to 120 total turbines. The resulting estimate of 23 American Goldfinches killed does not have confidence intervals calculated and should serve only as an indicator of impact per species. The table rows are classified by bird size (large, medium and small) and by bats. The species within the rows are in alphabetical order. The first three numerical columns show the number of incidents recorded at the 1, 3 and 7-day search sites. The next four columns show the number of incidents per megawatt calculated for that species, followed by the size class of the species. The next three columns show the estimated total incidents estimated for that species, for the entire Phase I (120 operational towers). Finally, the incidental species are also reported in the final column, but not used in any extrapolations.

Table 20. Number of incidents per species per total installed megawatt capacity at the Maple Ridge WRA, Fall 2006, found during both standardized surveys and incidentally.

	2006			Estimated # Incidents/Mw				Estimate of mortality (120 towers)			Incidental Finds
Species Name	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	**1-Day Sites**	**3-day Sites**	**7-Day Sites**		**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	
Birds (Large)											
Canada Goose	0	0	0	0.00	0.00	0.00		0	0	0	2
Ruffed Grouse	0	0	0	0.00	0.00	0.00		0	0	0	1
Wild Turkey	1	1	1	0.06	0.06	0.02		13	13	4	0
Total Large	**1**	**1**	**1**	**0.06**	**0.06**	**0.02**	**Total Estd. Large**	**13**	**13**	**4**	**0**
Birds (Medium)											
American Kestrel	0	0	1	0.00	0.00	0.04		0	0	8	.
American Crow	0	0	0	0.00	0.00	0.00		0	0	0	1
Common Grackle	0	1	0	0.00	0.06	0.00		0	23	0	.
Total Medium	**0**	**1**	**1**	**0.00**	**0.06**	**0.04**	**Total Estd. Medium**	**0**	**23**	**8**	**4**
Birds (Small)											.
American Goldfinch	1	0	0	0.11	0.00	0.00		23	0	0	.
American Redstart	1	0	1	0.11	0.00	0.04		23	0	8	.
Blackburnian Warbler	0	1	1	0.00	0.11	0.04		0	23	8	.
Blackpoll Warbler	0	1	0	0.00	0.11	0.00		0	23	0	.
Black-throated Blue Warbler	3	2	1	0.34	0.23	0.04		68	46	8	1
Black-throated Green Warbler	1	0	0	0.11	0.00	0.00		23	0	0	.
Brown Creeper	3	0	0	0.34	0.00	0.00		68	0	0	.
Cedar Waxwing	0	2	1	0.00	0.23	0.04		0	46	8	.
Chestnut-sided Warbler	0	1	1	0.00	0.11	0.04		0	23	8	.
Cliff Swallow	1	0	0	0.11	0.00	0.00		23	0	0	.
Eastern Phoebe	1	0	0	0.11	0.00	0.00		23	0	0	1
Golden-crowned Kinglet	22	7	20	2.53	0.80	0.77		501	159	152	.
Hermit Thrush	1	0	0	0.11	0.00	0.00		23	0	0	.
Magnolia Warbler	3	0	3	0.34	0.00	0.11		68	0	23	1
Ovenbird	1	0	0	0.11	0.00	0.00		23	0	0	.
Palm Warbler	0	0	1	0.00	0.00	0.04		0	0	8	.
Philadelphia Vireo	0	0	1	0.00	0.00	0.04		0	0	8	.
Pine Warbler	0	1	0	0.00	0.11	0.00		0	23	0	.

	2006			Estimated # Incidents/Mw				Estimate of mortality (120 towers)			Incidental Finds
Species Name	**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	**1-Day Sites**	**3-day Sites**	**7-Day Sites**		**10 1-Day Sites**	**10 3-day Sites**	**30 7-Day Sites**	
Red-eyed Vireo	1	3	7	0.11	0.34	0.27		23	68	53	3
Red-winged Blackbird	0	0	1	0.00	0.00	0.04		0	0	8	.
Rose-breasted Grosbeak	0	0	0	0.00	0.00	0.00		0	0	0	1
Ruby-crowned Kinglet	1	0	0	0.11	0.00	0.00		23	0	0	.
Scarlet Tanager	0	1	0	0.00	0.11	0.00		0	23	0	.
Swainson's Thrush	1	1	0	0.11	0.11	0.00		23	23	0	.
Tree Swallow	1	0	0	0.11	0.00	0.00		23	0	0	1
Yellow-bellied Sapsucker	1	0	0	0.11	0.00	0.00		23	0	0	.
Yellow-throated Vireo	1	0	0	0.11	0.00	0.00		23	0	0	.
Unidentified Bird	6	2	7	0.69	0.23	0.27		137	46	53	4
Unidentified Non-Passerine.	0	0	1	0.00	0.00	0.04		0	0	8	.
Unidentified Vireo Species	0	0	1	0.00	0.00	0.04		0	0	8	.
Unidentified Warbler Species	0	0	1	0.00	0.00	0.04		0	0	8	1
Total Small Birds	**50**	**22**	**48**	**5.75**	**2.53**	**1.84**	**Total Estd. Small**	**1138**	**501**	**364**	**13**
Total Birds	**51**	**24**	**50**	**5.81**	**2.66**	**1.90**	**Total Estd. Birds**	**1151**	**536**	**376**	**17**
Bats											
Hoary Bat	26	20	39	*	--	--		758	646	501	16
Eastern Red Bat	2	11	10	--	--	--		58	355	128	5
Silver-haired Bat	5	10	12	--	--	--		146	323	154	9
Little Brown Bat	5	5	15	--	--	--		146	161	193	4
Big Brown Bat	4	3	3	--	--	--		117	97	39	1
Myotis Species	2	2	4	--	--	--		58	65	51	0
Unknown Species	4	2	0	--	--	--		117	65	0	1
Unprocessed Species	53	30	59	--	--	--		1545	969	758	22
Total Bats	**101**	**83**	**142**	**15**	**14**	**9**	**Total Estd. Bats**	**2943**	**2680**	**1824**	**58**
Total (Birds & Bats)	**152**	**107**	**192**				**Total Estd. (Birds & Bats)**	**4094**	**3217**	**2200**	**72**

**Bats/Mw not calculated per species, pending complete species identification

4.0 DISCUSSION

4.1 Search Interval

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

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

One of the goals of this study was to search groups of turbines at different frequencies (1, 3 and 7-day frequencies) to determine the optimal search rate. Arnett *et al*. (2005) searched at one and 7-day frequencies, although they only searched during August and part of September. Nicholson (2005) searched every day during spring and fall migration, but that project included only three turbines so every day searches were relatively easy to accomplish. Jain (2005) searched every two days, from late spring to early winter over a two year period

Several factors during the pilot season may have resulted in differing estimates of mortality between the sites searched at different frequencies. The reader is cautioned that more intensive search efficiency and scavenging studies for birds and bats are required in subsequent years. The impact of this paucity of information for determining fatality rates for medium and large birds was minimal this year as only 3 medium and 2 large birds were found on site. Most small bird scavenge testing occurred in the late fall, when scavenging may have been lower than the rest of the study period. This may have resulted in an unusually low scavenge rate calculated for small, medium and large birds, compared to actual scavenge occurrence during the entire field season, and caused a lower estimate of mortality seen in the 3 and 7-day sites versus the 1-day sites. Also, the difference in project duration between 1, 3 and 7-day sites may have caused some bias in the estimates of bird and bat fatality. The 10 1-day sites represented a greater weekly search effort (70 searches/week) than the combined effort of searching 10 3-day sites (23.33 searches/week) and the 30 7-day sites (30 searches/week).Thus, the former sites were given the greatest priority in initial setup. Due to the urgency in establishing the search protocols, 1-day sites were chosen for their immediate readiness for search as well as for the maximum possible area of search (minimal wooded area, which was not searchable.) The effect of an earlier startup date may be more pronounced for estimates of bat mortality, as bat migration began earlier than bird migration, during the project setup phase. Finally, the period when the MRWRA project was fully operational (mowing and full site search) was late fall and early winter. Thus, the pilot year MRWRA project should only be compared to datasets that span the same seasons.

Much was learned during 2006 regarding acquisition of bird and bat carcasses, and the conduct of searcher efficiency and carcass removal testing. Our findings and efforts in 2006 will provide a basis for designing the 2007 study. Planned improvements in 2007 include: more extensive Se and Sc testing and spring, summer and fall site monitoring. A more thorough analysis of searchable area and ground cover using a combination of GIS coverages and ground-truthing will also occur. Comparisons between site types that typically differ in searchable area (e.g. wooded vs. non-wooded sites) will be weighted by the proportion of searchable area.

4.2 Seasonal Distribution of Fatalities

Similar to other Midwestern and Eastern WRA sites, the greatest mortality for both birds and bats is expected to occur during the migration season. Although this pilot project did not extend through the entire year, an increase in mortalities (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. Bird mortality continued to be regularly noted on surveys in November, indicating that, had the search season been extended, a number of additional fatalities may have been recorded. 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 Night Migrant Fatalities

As with most turbine facilities across the United States, the numbers of fatalities of night migrants was fairly low at the Maple Ridge facility. Determining the exact number of night migrants is difficult, however, as the birds involved may be resident breeders. The numbers were especially small in comparison with fatality rates of these birds at tall, guyed communication towers in the Midwestern and eastern United States where fatalities sometimes involve hundreds or even thousands of birds in a single night or migration season. Those towers have two types of Federal Aviation Administration lighting (steady burning red L-810 and flashing red incandescent beacons – L-864), multiple sets of guy wires, and are almost always in excess of 500 feet (152 m). We conducted tests of night migrant incidents found at lit and unlit towers for both the 30 7-day search sites and the 10 1-day search sites (The 10 3-day search sites were not suitable for this analysis as they were not deployed with FAA obstruction beacons). If the red flashing beacons attracted birds to turbines, a disproportionately greater number of these fatalities would have been found at turbines with lights and, or large-scale, multiple fatality events would have been observed. We did not see a clear relationship between the numbers of night migrant fatalities and the presence of L-864 red flashing beacons on turbines. We did observe marginal evidence ($0.05 < p < 0.10$) of higher night migrant fatalities at the lit one-day sites but not at seven-day sites. 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).

We also observed no significant evidence of a higher proportion of bat fatalities at FAA lit towers. For both bats and birds, there is no clear evidence that FAA lighting in the form of flashing red beacons attracted birds or bats to towers or that the presence of those lights cause large scale fatality events at wind 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 explain the smaller numbers of night migrant fatalities at those turbines as compared to fatalities at tall communication towers (>500 feet, 152 m). Kerlinger (2004a, 2004b) has recently demonstrated that flashing red, strobe-like lights (L-864) of the type recommended by FAA and used most often on wind turbines do not appear to attract night migrants like the combination of the same lights in combination with L-810 steady burning red lights. These results continue to suggest that wind turbines in the eastern United States do not appear to kill night migrants in numbers similar to tall communication towers. However, Erickson (2001) attempts to summarize the range of night migrant incidents noted at several wind farm sites in the US.

4.4 Bird Population Trends:

None of the bird carcasses, that were found and identified during standardized or incidental surveys, are state or federally listed species. Table 21 describes the range and estimated North American population of the species identified. Those populations come from larger geographic ranges than the source area of birds migrating over Maple Ridge. Those birds are from a subset of the North American population located in far upstate New York, Quebec, and Ontario. It is also possible that some birds originate as far west as Manitoba or even Saskatchewan, but those would account for a small portion of the migrants that fly over Maple Ridge.

Most of the species listed are stable or increasing 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 tower collision) on entire populations, the estimated total number of incidents at the Maple Ridge WRA are very small compared to the overall population of the species involved. The eastern population of the Golden-crowned Kinglet, which was found most often during searches, is estimated to be 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 presume that collision mortality at the Maple Ridge WRA has a significant adverse effect on population levels, even with respect to cumulative impacts of fatalities from many wind plants. The population of the second most common find (Red-eyed vireo) is listed as increasing, with an estimated overall population level of 140 million. The only two species listed as significantly decreasing are the Red-winged Blackbird and the Common Grackle, both very common and wide ranging species.

Table 21. BBS Population trends and geographical distribution of bird species found at the Maple Ridge WRA during standardized surveys and incidentally (Sauer *et al*. 2005)

Species	North America Population	Population Trends	Geographic Range
American Kestrel	5.8 million	Stable	North America (S of Tundra)
American Crow	31 million	Increasing	North America
Common Grackle	97 million	**Sig. Decrease**	Temp. North America (E of Rockies)
Ruffed Grouse	8.3 million	Non-Sig. Decrease	N Temp. and Boreal Forests
Canada Goose	5 million	Increasing	North America
American Goldfinch	24 million	Decreasing	Temp. North America
American Redstart	25 million	Non-Sig. Decrease	E Temp. and North Temp. Forest
Blackburnian Warbler	5.9 million	Stable	N Temp. and Boreal Forest (E of Rockies)
Blackpoll Warbler	21 million	Non-Sig Decrease	Boreal Forest
Black-throated Blue Warbler	2 million	Stable	E Boreal and North Temp. Forest
Black-throated Green Warbler	9.6 million	Stable	North Temp. and Boreal Forest East of Rockies
Brown Creeper	5.4 million	Non-Sig. Decrease	North Temp. Forest
Cedar Waxwing	15 million	Increasing	Temp. North America
Chestnut-sided Warbler	9.4 million	Non-Sig. Decrease	E North Temp. Forest (E of Rockies)
Cliff Swallow	89 million	Increasing	North America (S of Tundra)
Eastern Phoebe	16 million	Stable	Eastern North America
Golden-crowned Kinglet	34 million	**Increasing in East, Sig. Decrease across US**	Boreal Forest North America
Hermit Thrush	56 million	Increasing	Boreal and North Temp. Forest North America
Magnolia Warbler	32 million	Increasing	Boreal and North Temp. Forest (Mostly E of Rockies)
Ovenbird	24 million	Increasing	Temp. and Boreal Forest (E of Rockies)
Palm Warbler	23 million	Stable	Boreal and North Temp. Forest (E of Rockies)
Philadelphia Vireo	4.3 million	Stable	N Temp. and Boreal Forest (E of Rockies)
Pine Warbler	11 million	Increasing	Eastern Temp. Forest
Red-eyed Vireo	140 million	Increasing	Temp. and Boreal Forests
Red-winged Blackbird	210 million	**Sig. Decrease**	North America
Ruby-crowned Kinglet	72 million	Stable	Boreal Forest North America
Scarlet Tanager	2.2 million	Stable	E Temp. Forest
Swainson's Thrush	100 million	Non-Sig. Decrease	Boreal Forest
Tree Swallow	20 million	Increasing	North Temp. and Boreal North America
Yellow-bellied Sapsucker	9.2 million	Stable	Boreal and North Temp.. Forest
Yellow-throated Vireo	1.4 million	Increasing	E Temp. Forest

4.5 Bat Fatalities

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

While only the 30 7-day sites showed a significant negative trend, the direction of the relationship between the number of bat incidents and distance to the nearest wetland was negative for all three site types. The sample size for the 1 and 3-day sites (n = 10 each) may have been inadequate to test for the relationship. However, the foraging and water needs of the bat species found at the MRWRA and the strong significant trend at the 30 7-day sites shows that this issue is potentially important in understanding causes of bat mortality. It is likely that if degrees of freedom from these three analyses were pooled, a significant difference would emerge supporting the contention that turbines nearer to wetlands are likely to be involved in greater numbers of collisions of bats than turbines farther from wetlands.

4.6 Significance of 2006 Findings

Bird and bat fatalities found at the Maple Ridge turbines were within the range of fatalities found during late summer and fall migration at wind turbines in the United States. It is important to note that for bats, mortality at wind turbine sites during the spring period has repeatedly been documented to be much lower than during the late summer and fall migration and swarming period (Erickson 2002, Jain 2005, Johnson *et al*. 2003, Kerns and Kerlinger 2005). However, for reasons stated above, the results of this study are not yet in a form to be compared directly with those from other studies that do estimate mortality for an entire year, or at least the spring period. The current estimates are for the project period from mid-June onwards to mid-November.

The identifiable bird species involved in the fatalities at Maple Ridge were primarily species that are relatively common and none are considered threatened or endangered. However, some of the species are thought to be declining, though BBS data frequently showed non-significant population decreases. The biological significance of the fatalities at wind turbines needs to be investigated.

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

With respect to bats, the fatality rates at Maple Ridge are slightly lower than the rates at turbines studied on Appalachian ridges in Pennsylvania (Meyersdale) and West Virginia (Arnett *et al*. 2005, Kerns and Kerlinger 2004) and Tennessee (Nicholson 2002) and higher than the rates found at some Midwestern turbines (Table 20) during comparable seasons. However, these numbers are reported for rough comparison of WRA's with comparatively low rates (0-5 bats/tower/year) and WRA's with evidently higher rates (>10 bats/turbine/period). More robust comparisons can be made once complete year data is available at the MRWRA. The rates at Maple Ridge also include a longer sampling period than the study by Arnett *et al*., which only considered the period August-September 15. What is most striking is the finding that the period during which the peak of fatalities occurred corresponds to the peak periods reported in studies in the eastern, Midwestern, and western United States, suggesting that some of the mechanics of these fatalities are independent of geography.

Table 22: Results from recent bat mortality studies at WRA's in the Eastern, Midwestern and Western United States

Wind Resource Area	Bat Mortalities/Turbine/Year	Reference
Mountaineer, WV, 45 turbines	45.3*	Kerns and Kerlinger, 2004
Buffalo Mountain, TN, 3 turbines	28.5	Nicholson 2003
Meyersdale, PA, 20 turbines	25**	Arnett *et al*. 2005
Top of Iowa, IA, 89 turbines	6.6-8.5 (2003-2004)	Jain 2005
Northeastern Wisconsin 31 turbines	4.3	Howe *et al*. 2002
Buffalo Ridge, MN, 281 turbines	2	Johnson *et al*. 2003a
Foote Creek Rim, WY, 105 turbines	1.3	Johnson *et al*. 2000, Young *et al*. 2003, Gruver 2002
Klondike, OR, 16 turbines	1.2	Johnson *et al.* 2003b
Vansycle, OR, 38 turbines	0.7	Erickson *et al*. 2000

*Results are Bat Mortalities/Turbine/14-week fall period
** Results are Bat Mortalities/Turbine/6-week fall period

5.0 REFERENCES

Arnett, E.B., technical editor. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Erickson, W.P., G.D. Johnson, M.D. Strickland, and K. Kronner. 2000. Avian and bat mortality associated with the Vansycle Wind Project, Umatilla County, Oregon: 1999 study year. Tech. Report to Umatilla County Dept. of Resource Services and Development, Pendleton, OR.

Erickson, W., G.D. Johnson, M.D. Strickland, K.J. Sernka, and R. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of collision mortality in the United States. White paper prepared for the National Wind Coordinating Committee, Avian Subcommittee, Washington, DC.

Erickson, W.P., G.D. Johnson, D.P. Young, M.D. Strickland, R.E. Good, M. Bourassa, K., Bay, and K. Sernka. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Prepared for Bonneville Power Administration, PO Box 3621, Portland, Oregon 97208

Erickson, W., J. Jeffrey, K. Kronner, and K. Bay. 2003. Stateline wind project wildlife monitoring annual report, results for the period July 2001 – December 2002. Tech. Rpt. to FPL Energy, Oregon Office of Energy, and Stateline Technical Advisory Committee.

Erickson, W., K. Kronner, and B. Gritski. 2003. Nine Canyon Wind Power Project avian and bat monitoring report. September 2002-August 2003. Prepared for Nine Canyon Technical Advisory Committee and Energy Northwest.

Furlonger, C.L., H.J. Dewar, and M.B. Fenton. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology 65:284-288.

Gehring, J., and P. Kerlinger. 2007. Avian collisions at communication towers: the role of Federal Aviation Administration obstruction lighting systems. Report prepared for the Michigan Public Safety Communication System, office of the Michigan Attorney General, and U. S. Fish and Wildlife Service.

Genter, D.L., and K.A. Jurist. 1995. Bats of Montana. Montana Natural Heritage. Program. Helena, USA.

Goodman, L.A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Gruver, J.C. 2002. Assessment of bat community structure and roosting habitat preferences for the hoary bat (*Lasiurus cinereus*) near Foote Creek Rim, Wyoming. M.S. Thesis, University of Wyoming, Laramie. 149pp.

Howe, R.W., W. Evans, and A.T. Wolf. 2002. Effects of wind turbines on birds and bats in northeastern Wisconsin. Report to Wisconsin Public Service Corporation and Madison Gas and Electric Company.

Jain, A.A. 2005. Bird and bat behavior and mortality at a northern Iowa windfarm. M.S. Thesis. Iowa State University, Ames, IA.

Johnson, G.D., D.P. Young, Jr., W.P. Erickson, M.D. Strickland, R.E. Good, and P. Becker. 2000. Avian and bat mortality associated with the initial phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming: November 3, 1998-October 31, 1999. Report to SeaWest Energy Corp. and Bureau of Land Management.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at the large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnson, G., W. Erickson, J. White, and R. McKinney. 2003. Avian and bat mortality during the first year of operation at the Klondike Phase I Wind Project, Sherman County, Oregon. Draft report to Northwestern Wind Power.

Kerlinger, P. 2004a. Wind turbines and avian risk: lessons from communication towers. Presented at the American Bird Conservancy-American Wind Energy Association Meeting, May 18-19, 2004, Washington, DC.

Kerlinger, P. 2004b. Attraction of night migrating birds to FAA and other types of lights. National Wind Coordinating Committee – Wildlife Working Group Meeting, November 3-4, 2004, Lansdowne, VA.

Kerlinger, P., J. Gehring, W. Erickson, and R. Curry. In prep. Federal Aviation Administration obstruction lighting and night migrant fatalities at wind turbines in North America: A review of data from existing studies. In review at Journal of the Wilson Ornithological Society (Wilson Bulletin).

Kerns, J., and P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Report to FPL Energy and the MWEC Technical Review Committee.

Koford, R., A. Jain, G. Zenner, and A. Hancock. 2005. Avian mortality associated with the Top of Iowa Wind Power Project. Report to Iowa Department of Natural Resources.

Kurta, A. 2000. The Need for Shelter, Food, and Water, pg. 197. Bat Conservation and Mining: A Technical Interactive Forum (2000: St. Louis, Missouri) Eds. Kimery C. Vories, Dianne Throgmorton; U.S. Dept. of the Interior, Office of Surface Mining,

Nicholson, C. P. 2001, 2002. Buffalo Mountain Windfarm bird and bat mortality monitoring report: October 2000 – September 2002. Preliminary report. Tennessee Valley Authority, Knoxville, TN.

Ramsey, F. L. and D. W. Schafer. 2002. The Statistical Sleuth. Second Edition. Duxbury, Pacific Grove, CA, USA.

Sauer, J. R., J. E. Hines, and J. Fallon. 2005. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD. <http://www.mbr-pwrc.usgs.gov/bbs/>

Shire, G.G., K. Brown, and G. Winegrad. 2000. Communication towers: a deadly hazard to birds. American Bird Conservancy, Washington, DC.

Smallwood, J. A., and D. M. Bird. 2002. American Kestrel (*Falco sparverius*). *In* The Birds of North America, No. 602 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Trapp, J. L. 1998. Bird kills at towers and other man-made structures: an annotated partial bibliography (1960-1998). U. S. Fish and Wildlife Service web report: www.fws.gov/r9mbmo.

Young, D.P., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003. Avian and bat mortality associated with the initial phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming. Report to Pacificorp, Inc., Sea West Windpower, Inc., and Bureau of Land Management.

APPENDICES

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

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

Date	Time Surveyed	Temp °F	% Cloud Cover	Survey Weather Conditions	Wind Direction	Wind	Prior Evening Conditions	Bird Carcasses	Bat Carcasses	Observer	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 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 #	Search Frequency	# Tests (Bat)	# Tests (Bird)
12	7 day	0	0
16	7 day	1	1
17	1 day	1	4
23	7 day	0	0
24	7 day	0	3
26	7 day	0	0
27	7 day	1	0
32	7 day	2	0
34	7 day	2	2
35	7 day	2	0
37	7 day	0	0
39	7 day	0	0
40	7 day	0	0
45	3 day	2	0
50	7 day	0	2
52	1 day	0	0
53	7 day	0	0
56	1 day	2	2
57	1 day	2	2
59	7 day	0	0
64	7 day	0	0
71	1 day	0	0
75	1 day	1	0
76	3 day	3	0
77	1 day	2	0
82	3 day	1	0
83	3 day	2	0
86	3 day	0	0

Tower #	Search Frequency	# Tests (Bat)	# Tests (Bird)
89	1 day	2	0
90	7 day	0	0
97	1 day	2	0
98	1 day	1	0
99	1 day	0	0
101	7 day	0	0
102	3 day	2	0
103	7 day	3	0
104	7 day	2	0
108	7 day	0	0
109	7 day	0	0
110	7 day	0	0
179	3 day	4	1
180	7 day	2	1
181	7 day	0	0
183	7 day	0	0
185	7 day	0	0
189	1 day	2	0
192	7 day	0	0
193	3 day	3	1
195	3 day	2	1
197	3 day	1	0
22A	7 day	0	0
54A	7 day	1	0
Met #1	3 day	0	0
Met #2	1 day	0	0
Total		**51**	**20**

Note: Turbines 71 and 99 were replaced early in the study

APPENDIX E: List of Missed Dates (1-Day sites)

Missed 1-Days[1]
6/19/06
7/28/06
8/27/06
9/13/06
9/14/06
9/23/06
9/24/06
10/1/06
10/11/06
10/12/06
10/15/06
10/17/06
10/20/06
10/21/06
10/23/06
10/28/06
10/29/06
10/30/06
11/2/06
11/3/06
11/4/06
11/5/06
11/6/06
11/11/06
11/12/06
11/14/06

[1]A Missed Day is defined by 5 or more out of 10 1-day sites missed on that day:

APPENDIX F: Model for assessment of tradeoff in precision for sampling frequency and number of searched sites

Assessment of Trade-offs in Precision Relative to Sampling Frequency and Site Number of Sampling Bat and Bird "In Fall" at the Maple Ridge Wind Farm, Tug Hill, New York

James P. Gibbs
SUNY-ESF, Syracuse

March 7, 2007

[Augmented March 28, 2007]

This document summarizes application of the previously described Monte Carlo model for simulating the field sampling of bird and bat carcasses at Maple Ridge Wind Farm. The model permits assessment of the interactions among key variables affecting carcass accumulation beneath wind power installations. Key innovations in this formulation of the model over the previous version were:

- conversion of the model to sample *without replacement* of carcasses to mimic the actual sampling protocol at Maple Ridge (carcasses are removed from the site once discovered)
- modification of the initial bird/bat carcasses in-fall rate to be a Poisson deviate of the mean daily in-fall estimated by Jain *et al*. from field studies at Maple Ridge
- accommodation of daily, three-day or seven-day sampling frequencies (with sampling *without replacement* at these frequencies to incorporate their subsequent effects on carcass accumulation rates)

The key parameter estimates for these simulations were in-fall rates for **bats** of 21.32 total bats per tower per season/127 days per season = 0.168 bats per tower per day. For **birds,** in-fall rates were estimated at 9.48 total birds per tower per season/127 days per season = 0.074646 birds per tower per day. This simulation explored the tradeoffs in precision**,** as indexed by the coefficient of variation (sample standard deviation divided by the sample mean), in terms of equal effort scenarios with explicit trade-offs between sampling frequency and sites over which carcass counts are accumulated, that is, 17 sites sampled every day, 51 sites sampled every 3 days, and 119 sites sampled every 7 days. Simulations represent the average of 100 iterations of each scenario, with the estimates being the mean across iterations. All results are for aggregate counts made over all sites on a given sampling occasion after a 10-day "settling" period over a 100 day field season (a 90-day-long effective sampling window). Simulations were conducted to evaluate the following non-equal-effort scenarios, that is, 1-, 3-, and 7-day checks at 25, 50, 75 and 100 sites:

	Total Counts (Sites x Surveys over 100 days)	Total survey events over 100 days, i.e., *n*	Mean Carcasses Recovered per Survey	SD	CV (%)	95% LCL	95%UCL	Width of confidence interval as % of mean
Birds								
25 sites sampled every day	2500	100	1.29	1.08	84	1.07	1.50	33
50 sites sampled every day	5000	100	2.55	1.51	59	2.25	2.85	23
75 sites sampled every day	7500	100	3.89	1.91	49	3.52	4.26	19
100 sites sampled every day	10000	100	5.17	2.23	43	4.73	5.60	17
25 sites sampled every three days	833	33	3.15	1.79	57	2.54	3.76	39
50 sites sampled every three days	1667	33	6.26	2.79	45	5.31	7.21	30
75 sites sampled every three days	2500	33	9.51	3.48	37	8.32	10.70	25
100 sites sampled every three days	3333	33	12.86	4.15	32	11.44	14.27	22
25 sites sampled every seven days	357	14	4.72	2.04	44	3.65	5.79	45
50 sites sampled every seven days	714	14	9.53	2.48	26	8.23	10.83	27
75 sites sampled every seven days	1071	14	14.40	2.43	17	13.13	15.68	18
100 sites sampled every seven days	1429	14	19.20	2.48	13	17.91	20.50	14
Bats								
25 sites sampled every day	2500	100	3.19	1.86	58	2.83	3.55	23
50 sites sampled every day	5000	100	6.36	2.54	40	5.86	6.86	16
75 sites sampled every day	7500	100	9.69	3.16	33	9.07	10.31	13
100 sites sampled every day	10000	100	12.87	3.72	29	12.14	13.60	11
25 sites sampled every three days	833	33	7.09	2.72	39	6.16	8.02	26
50 sites sampled every three days	1667	33	14.32	3.83	27	13.02	15.63	18
75 sites sampled every three days	2500	33	21.76	4.56	21	20.21	23.32	14

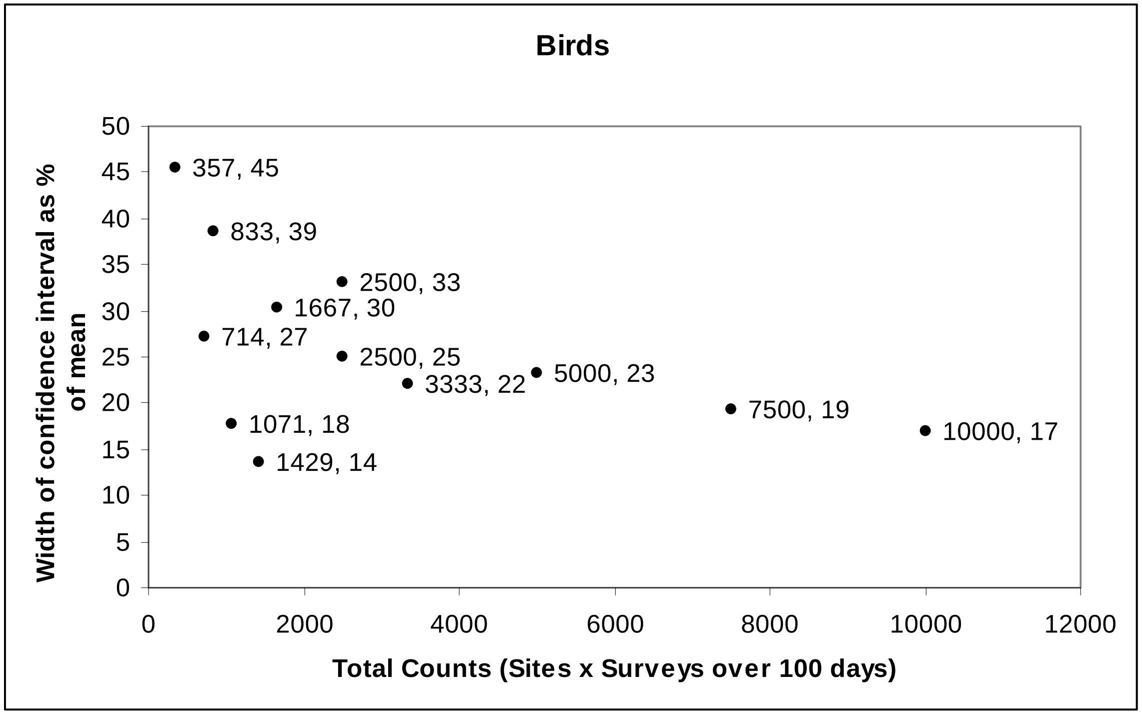
	Total Counts (Sites x Surveys over 100 days)	Total survey events over 100 days, i.e., *n*	Mean Carcasses Recovered per Survey	SD	CV (%)	95% LCL	95%UCL	Width of confidence interval as % of mean
100 sites sampled every three days	3333	33	28.56	4.95	17	26.87	30.25	12
25 sites sampled every seven days	357	14	12.35	3.63	30	10.45	14.25	31
50 sites sampled every seven days	714	14	25.29	5.36	21	22.48	28.09	22
75 sites sampled every seven days	1071	14	38.47	6.94	18	34.83	42.10	19
100 sites sampled every seven days	1429	14	49.49	8.31	17	45.14	53.85	18

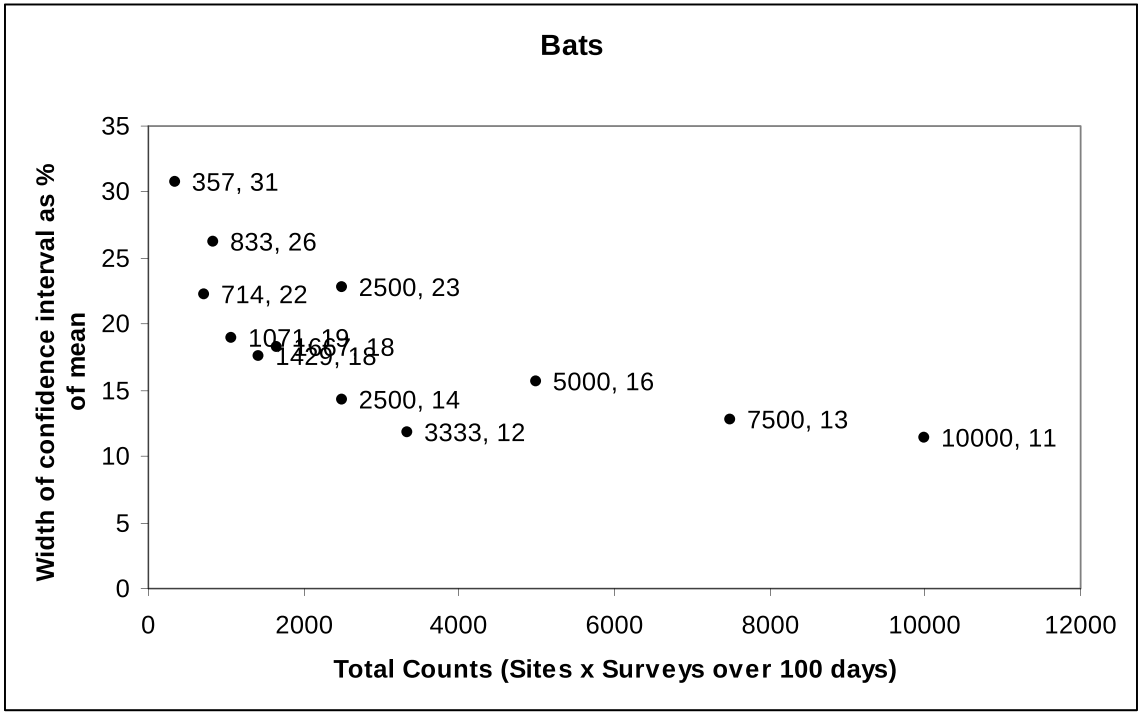
These simulations revealed that the sampling approaches associated with highest precision of estimates are not necessarily those associated with the greatest sampling effort. The primary reason for this is that very frequent sampling, e.g., every day, is associated with collection of many, small numbers of carcasses and hence accumulation of what is essentially dichotomous data (0's and 1's), which introduces a high degree of stochastic error into the estimates. Least frequent sampling at the largest number of sites was associated with the highest precision levels. Notably, low sampling frequency at an intermediate number of sites generated a highly favorable relationship between survey effort and precision of estimate gained.

Augmentation [March 28, 2007]:

As requested by the TAC 3/23/07 further simulations as well as graphical analyses were performed as follows:

Graphical depiction of the relationship between survey costs and precision of the estimate.- TAC members requested the tabular material presented above could be better interpreted if depicted graphically. To this end, total survey counts (directly proportional to effort and cost) is plotted against width of the confidence interval as a percentage of the mean in the following figures. Points are labeled to permit them to be easily "cross-walked" with the tabular data. For birds the graphs clearly suggest a favorable trade-off between sampling costs and precision of the estimate for the following sampling regimes: 75 sites sampled every seven days *or* 100 sites sampled every seven days. For bats the following sampling regimes clearly suggest a favorable trade-off between sampling costs and precision of the estimate: 75 sites sampled every three days *or* 100 sites sampled every three days.


Birds
Width of confidence interval as % of mean
Total Counts (Sites x Surveys over 100 days)
357, 45
833, 39
2500, 33
1667, 30
714, 27
2500, 25
3333, 22
5000, 23
7500, 19
10000, 17
1071, 18
1429, 14
0
5
10
15
20
25
30
35
40
45
50
0
2000
4000
6000
8000
10000
12000



Sensitivity analysis of contribution of the key parameters in the sampling model to variation in estimates of sample precision. -- TAC members requested an evaluation of the potential contribution of variation the carcass disappearance rates and the carcass detection rates to the overall estimates of sample precision. These are the key parameters of the sampling model and it is important to understand how sensitive the model outputs are to variation in these parameters. To the end, Jain provided Gibbs with the following estimates of lowest and highest rates drawn from various studies conducted to date elsewhere (Johnson *et al*. 2003 (Buffalo Ridge), Young 2003 (Foote Creek), Kerns and Kerlinger, unpubl., Johnson *et al*. 2003 (Klondike), Vansycle 2004, and Jain 2005):

	Sm. Birds	**Sm. Birds**
	Scavenging rate (days)	**Detection rate**
Minimum	6 days	29.40%
Maximum	19 days	75%

	Sm. Birds	Sm. Birds
	Scavenging rate (days)	**Detection rate**
Minimum	7.8 days	63%
Maximum	16.5 days	63%

To evaluate the relative sensitivity of the model outputs to variation in these key model parameters, the daily sampling regime across 25, 50, 75 and 100 sites was simulated for birds and bats and contrasted with the original model outputs based on the Maple Ridge-derived estimates:

	Total Counts (Sites x Surveys over 100 days)	Total survey events over 100 days, i.e., *n*	Mean Carcasses Recovered per Survey	SD	CV (%)	95% LCL	95%UCL	Width of confidence interval as % of mean
Birds								
25 sites sampled every day								
Maple Ridge Data	2500	100	1.29	1.08	84	1.07	1.50	33
Highest reported scavenging rate (6 days)/Lowest reported detection rate (0.294)	2500	100	0.89	0.94	106	0.71	1.07	41
Lowest reported scavenging rate (19 days)/Highest reported detection rate (0.75)	2500	100	1.60	1.28	81	1.34	1.85	32
50 sites sampled every day								
Maple Ridge Data	5000	100	2.55	1.51	59	2.25	2.85	23
Highest reported scavenging rate (6 days)/Lowest reported detection rate (0.294)	5000	100	1.74	1.28	73	1.49	2.00	29
Lowest reported scavenging rate (19 days)/Highest reported detection rate (0.75)	5000	100	3.24	1.77	55	2.89	3.59	21
75 sites sampled every day								
Maple Ridge Data	7500	100	3.89	1.91	49	3.52	4.26	19
Highest reported scavenging rate (6 days)/Lowest reported detection rate (0.294)	7500	100	2.67	1.56	59	2.36	2.97	23
Lowest reported scavenging rate (19 days)/Highest reported detection rate (0.75)	7500	100	4.90	2.00	41	4.51	5.30	16
100 sites sampled every day								
Maple Ridge Data	10000	100	5.17	2.23	43	4.73	5.60	17
Highest reported scavenging rate (6 days)/Lowest reported detection rate (0.294)	10000	100	3.59	1.75	49	3.25	3.94	19
Lowest reported scavenging rate (19 days)/Highest reported detection rate (0.75)	10000	100	6.41	2.33	36	5.95	6.86	14

	Total Counts (Sites x Surveys over 100 days)	Total survey events over 100 days, i.e., *n*	Mean Carcasses Recovered per Survey	SD	CV (%)	95% LCL	95%UCL	Width of confidence interval as % of mean
Bats								
25 sites sampled every day								
Maple Ridge Data	2500	100	1.29	1.08	84	1.07	1.50	33
Highest reported scavenging rate (7.8 days)/Only other reported detection rate (0.63)	2500	100	3.19	1.85	58	2.83	3.56	23
Lowest reported scavenging rate (16.5 days)/Only other reported detection rate (0.63)	2500	100	3.56	1.83	51	3.20	3.92	20
50 sites sampled every day								
Maple Ridge Data	5000	100	2.55	1.51	59	2.25	2.85	23
Highest reported scavenging rate (7.8 days)/Only other reported detection rate (0.63)	5000	100	6.33	2.65	42	5.81	6.85	16
Lowest reported scavenging rate (16.5 days)/Only other reported detection rate (0.63)	5000	100	7.12	2.63	37	6.60	7.63	14
75 sites sampled every day								
Maple Ridge Data	7500	100	3.89	1.91	49	3.52	4.26	19
Highest reported scavenging rate (7.8 days)/Only other reported detection rate (0.63)	7500	100	9.65	3.28	34	9.01	10.30	13
Lowest reported scavenging rate (16.5 days)/Only other reported detection rate (0.63)	7500	100	10.81	3.22	30	10.18	11.44	12
100 sites sampled every day								
Maple Ridge Data	10000	100	5.17	2.23	43	4.73	5.60	17
Highest reported scavenging rate (7.8 days)/Only other reported detection rate (0.63)	10000	100	12.95	4.04	31	12.16	13.74	12
Lowest reported scavenging rate (16.5 days)/Only other reported detection rate (0.63)	10000	100	14.32	3.76	26	13.58	15.05	10

Contrasting these estimates for birds suggests that incorporation of inter-study variability in estimates of carcass detection rates and carcass scavenging rates does not substantially alter the conclusions drawn from the original analysis based on Maple Ridge-derived estimates. Generally speaking, the combinations of lowest detection rate/highest scavenging rate and highest detection rate/lowest scavenging rate reported elsewhere yielded estimates of sampling precision in the same relative domain as those from the Maple

Ridge-derived rates for any given sampling regime. This suggests that the model outputs are relatively robust to variation in key model estimates. Consistent patterns for birds were that the worst-case detection/scavenging scenario yielded poorer precision than either the Maple Ridge or the best-case detection/scavenging scenario. For bats, both worst- and best-case detection/scavenging scenarios gave better estimates of precision but this is an artifact of there only being a single, other estimate of bat-specific carcass detection rate available from other studies, which was (1) greater than that reported from Maple Ridge and (2) had to be applied to both the best- and worst-case scenarios.