

# **Post-construction Monitoring at the Mars Hill Wind Farm, Maine – Year 2**

**2008**

## **Prepared For:**

First Wind Management, LLC  
One Dana Street, Second Floor  
Portland, ME 04101

## **Prepared By:**

Stantec Consulting  
30 Park Drive  
Topsham, ME 04086

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## Executive Summary

Construction for the Mars Hill Wind Farm, Aroostook County, Maine was approved by the Maine Department of Environmental Protection in June 2004. The 28 turbines became fully operational as of March 27, 2007. The GE 1.5 sle turbines have a maximum height of 119 meters (m; 389 feet [ft]) (tower and blade-tip height combined). The wind farm is a 42 megawatt (MW) facility. Ten of the 28 turbines are lit with FAA approved lighting.

In accordance with the Maine Department of Environmental Protection (ME DEP) permit conditions, post-construction monitoring was conducted by Stantec Consulting on behalf of First Wind for two years to determine if the Mars Hill Wind Farm presents an unreasonable adverse impact on wildlife. The three-season post-construction monitoring protocol, targeting potential avian and bat mortality, was developed in consultation with the Maine Department of Inland Fisheries and Wildlife (ME IF&W). The first year of post-construction bird and bat mortality surveys was completed in September 2007. After the first year of monitoring, the annual report was reviewed by the ME DEP and ME IF&W on March 28, 2008. Minor adjustments to the protocol were incorporated into the work scope for the second year of monitoring, which was completed in October 2008.

During Year 2 monitoring, bird and bat mortality surveys were conducted for seven weeks during the spring (April 19 to June 6), five weeks in the late-summer (July 15 to August 12), and for eight weeks in the fall (August 13 to October 8). Mortality surveys involved both standardized searches conducted according to the ME IF&W approved protocol, as well as supplemental dog surveys initiated by Stantec Consulting and First Wind as a means of validating the results of standardized searches. Standardized searches consisted of surveying while walking transects established every 3 to 4 m (10 to 13 ft) across the cleared and leveled lay-down areas surrounding each turbine. The average search plot diameter at the turbines was approximately 76 m (250 ft). Additional supplemental post-construction wildlife monitoring initiated by Stantec Consulting and First Wind included documentation of incidental wildlife observations and standardized raptor migration surveys.

During surveys, any intact carcasses or evidence of scavenged birds or bats found were documented and collected. During each survey season (spring, summer, and fall), all 28 turbines were searched once every 7 days (typically over a period of 4 days). In addition, a subset of turbines (an average of 10 per season), a meteorological tower, and a communication tower on-site were searched by a surveyor with a leashed dog once or twice during the spring, summer, and fall survey seasons. The results of dog searches were kept separate from those of standard weekly searches and a different estimate of total mortality was calculated based on both datasets. An extended plot search, consisting of a search area radius of 119 m (390 ft) from a tower, was conducted once during each of the spring, summer, and fall sessions to investigate the percentage of carcasses that fall outside of the cleared turbine plots. Additional fatalities found by maintenance personnel or by surveyors outside of the standardized searches were recorded as incidental findings and were not included in the estimates of total mortality.

A total of 21 bird fatalities were documented during the 2008 surveys: 14 were found during standard searches, 2 were found during dog searches, 1 was found during an extended plot search with a dog (however, the bird was inside the standard search plot area), and 4 were found incidentally. Ninety percent of bird species found during standard surveys, incidental findings, and during dog searches consisted of songbird species. A barred owl (*Strix varia*) and

a ruffed grouse (*Bonasa umbellus*) were the exceptions. Of songbird species found, warblers represented 37 percent (n=7). Magnolia warbler (*Dendroica magnolia*) in particular (n=3 of 7 total warblers) represented 16 percent of all songbirds found. Red-eyed vireo (*Vireo olivaceus*) represented 32 percent (n=6) of songbirds found. Yellow-bellied sapsucker (*Sphyrapicus varius*) represented 16 percent (n=3). There were no state endangered or threatened species found during mortality searches. Based on the dates of discovery, bird fatalities were believed to occur during both small-scale and localized resident bird movements, as well as during nighttime migration movements. The average distance of bird fatalities from the turbines was 39 m (128 ft).

A total of five bats were recovered over the course of the 2008 study period, four during standard searches, and one during a dog search. Hoary bat (*Lasiurus cinereus*) (n=2) and eastern red bat (*Lasiurus borealis*) (n=2) each accounted for 40 percent of detected bat fatalities. Silver-haired bat (*Lasionycteris noctivagans*) (n=1) accounted for 20 percent of bat fatalities discovered in 2008. The timing of all the bat fatalities detected in 2008 occurred between late-July and the beginning of September. These results are consistent with the findings of other studies suggesting that bats are at greatest risk of collision during the late-summer/early fall dispersal period. The average distance of bat fatalities from the turbines was 14 m (46 ft).

Fatalities were detected at turbines located throughout the project area. There were no relationships between the number of fatalities found at lit versus unlit turbines, and no relationships between fatalities found at turbines located in different habitats or landscape features within the project area. Greater search plot size at specific turbines was not found to result in a higher number of fatalities detected at those turbines. There were more fatalities found at turbines that were not centered within the cleared lay-down areas than were found at centered turbines. The average distances of bird and bat carcasses found at centered versus non-centered turbines were similar. No fatalities were detected under the met or communication towers. During the extended plot searches, 1 bird was found 18 m (59 ft) from turbine 1 and was within the standard search plot area; no birds or bats were found outside of the cleared and leveled areas.

To account for the number of carcasses that may be removed by scavengers, a scavenger carcass removal trial using bird and bat carcasses was conducted during each of the spring, summer, and fall survey seasons. Of those birds that were scavenged during the 14-day trial period, the average number of days before the birds were scavenged was 4.7 days. Only two of the 20 total placed birds remained untouched by mammalian or avian scavengers during the 14-day trial period. On day 4 (the average period between potential impact and discovery during weekly search intervals), 65 percent of bird carcasses remained detectable to the surveyor. All of the six bats placed during the scavenger carcass removal trial were eventually removed during the 14-day trial period. Bats, on average, were scavenged by avian or mammalian predators on day 6. On day 4 (the average period between potential impact and discovery for weekly search intervals), 50 percent of bat carcasses remained detectable to the surveyor. On day 14, 15 percent of bird carcasses remained visible to the surveyor, and 0 percent of bat carcasses remained.

Bird and bat carcasses were placed among turbine plots once during each survey season for searcher efficiency trials. The results of the standard search trials were pooled among the survey seasons for birds and bats. A total of 16 bird carcasses were placed, of which the surveyor found 6, resulting in a searcher efficiency rate of 38 percent of birds. For bats, five of

12 bats placed were recovered, resulting in a searcher efficiency rate of 42 percent bat carcasses.

There were two dog searcher efficiency trials conducted during fall 2008. The results of these trials were pooled. For 12 birds placed, the surveyor with the dog recovered nine (75 percent). For seven bats placed, four were recovered by the surveyor with the dog (57 percent).

The results of the scavenger carcass removal and the searcher efficiency trials, the proportion of turbines searched, and the number of bird or bat carcasses found during standard searches were used to calculate an estimated total of bird and bat fatalities, an estimate of fatalities per turbine per year (fatalities/turbine/year), and an estimate of fatalities per megawatt (MW) per year (fatalities/MW/year). The weekly surveys resulted in an estimated total of 57 bird fatalities per year ( $\pm 6.77$ ), with 2.04 birds/turbine/year and 1.36 birds/MW/year. The estimated total number of bat fatalities was 19 per year ( $\pm 5.13$ ), with 0.68 bats/turbine/year and 0.45 bats/MW/year.

The results of the searcher efficiency trials, the percent of carcasses scavenged, the average number of turbines searched per survey season, and the number of carcasses found during dog searches was used to calculate a separate estimate of bird and bat mortality during 2008. Based on dog searches, the estimate of bird fatalities is 74 birds per year ( $\pm 28.27$ ), with 2.65 birds/turbine/year and 1.76 birds/MW/year; and an estimated total of 5 bats per year ( $\pm 0.00$ ), with 0.17 bats/turbine/year and 0.12 bats/MW/year.

The results of the 2 years of monitoring for birds are very similar with 22 and 21 birds found, and a high total estimate of 69 and 74 bird fatalities in 2007 and 2008, respectively. Twenty-four bats were found in 2007 compared to the 5 found in 2008. The results of 2007 monitoring for bats resulted in a notably higher estimate of mortality than the second year of monitoring: the high estimate of mortality in 2007 (based on dog searches) was 4.4 bats/turbine/year. It should be noted that there were variations in scavenger carcass removal and searcher efficiency for both birds and bats among the two survey years. The scavenger carcass removal rate for birds on a weekly basis increased by 25 percent during the second year of monitoring, while the rate for bats decreased by 34 percent during the second year. Searcher efficiency for birds and for bats decreased by 32 percent and 16 percent, respectively. However, the statistical analysis accounted for these differences in scavenger carcass removal and searcher efficiency rates when the mortality rates were calculated for each year of monitoring. Therefore, the explanation for this variation between the two years may be due to a variety of other factors including: variable bat populations among years, variable activity of bats due to weather conditions (August 2008 was relatively cool and wet), or behavioral adaptations to wind turbines by local bats.

There was no State Threatened or Endangered species of bird or bat found during fatality searches. There was one bird species of special concern found during the 2008 searches: black-and-white warbler (*Mniotilta varia*); and three bird species of special concern found during 2007: black-and-white warbler, veery (*Catharus fuscescens*), and white-throated sparrow (*Zonotrichia albicollis*). Bat species of special concern, including silver-haired bat, eastern red bat, and hoary bat were found during fatality searches at Mars Hill. The timing of the peak number of bird and bat fatalities at Mars Hill was similar to that of other studies in the U.S. The majority of bat species found during fatality searches at Mars Hill is also consistent with the species of bat commonly found during searches at other wind farms. However, the rates of bird and bat fatalities found at Mars Hill were generally much lower than the results of other existing wind farms in the eastern U.S. There were fatalities of species of special concern at Mars Hill

during 2007 and 2008; however, the numbers of fatalities for each of these species of bird and bat were relatively low. The results of two years of mortality monitoring suggest that bird and bat mortality due to the project does not represent an unreasonable adverse impact to wildlife.

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## 1.0 Introduction

In accordance with the Maine Department of Environmental Protection (ME DEP) permit conditions, post-construction monitoring was conducted by Stantec Consulting on behalf of First Wind, LLC<sup>1</sup> (First Wind) for two years to determine if the Mars Hill Wind Farm presents an unreasonable adverse impact on wildlife. The post-construction monitoring protocol was developed in consultation with the Maine Department of Inland Fisheries and Wildlife (ME IF&W). The first year of post-construction bird and bat mortality surveys was completed in September 2007. After reviewing the first annual post-construction report on March 28, 2008, ME DEP requested minor adjustments be made to the protocol, which were subsequently incorporated into the work scope for the second year of monitoring. The second year of monitoring was completed in October 2008.

Birds and bats are known to collide with tall man-made structures including communication towers, buildings, and wind turbines. Emerging evidence suggests that bats may be at greatest risk of collision during periods of low cloud cover and calm wind speeds, often after the passing of storm fronts (Kunz *et al.* 2007). Birds may be at greater risk of collision with tall structures when weather conditions reduce visibility (Crawford 1981; Avery *et al.* 1976, 1977).

A review of existing mortality studies indicated that bat mortality in the U.S. ranged from 0 to 63.9 bats per turbine per year (bats/turbine/year) (Kerlinger 2002, 2006; GAO 2005; Arnett 2005; Fiedler *et al.* 2007). The Buffalo Mountain facility in Tennessee observed rates among the highest reported in the U.S. at 63.9 bats/turbine/year (1,149 total bats) (Fiedler *et al.* 2007). Locations in the Appalachian Mountains observed mortality as high as 38 bats/turbine during a 6-week study period (1,364 to 1,980 total bats) (Arnett 2005). Another recent study in New York documented 15.54 to 18.53 bats/turbine/year (3,030 to 3,614 total bats) (Jain *et al.* 2008). Raptor mortality in the U.S. has been low at wind farms with modern turbine models, ranging from 0 to 0.41 raptors/turbine/year (Erickson *et al.* 2002, GAO 2005, Jain *et al.* 2008). Nocturnal migrant songbird fatalities at most existing wind farms have also been relatively low, despite the high reported number of collisions with large, lit and guyed communication towers (typically greater than 153 meters [m; 500 feet {ft}]) in the U.S. (Jain *et al.* 2007). The number of reported songbird fatalities associated with wind farms in the U.S. has ranged from 0 to 9.48 fatalities/turbine/year (GAO 2005, National Research Council 2007, Jain *et al.* 2007, Jain *et al.* 2008).

To assess the level of mortality of birds and bats resulting from the Mars Hill Wind Farm, a bird and bat mortality study was initiated in April 2007, approximately one month after the start of operation of the facility. The second year of monitoring was completed in October 2008. In addition to the bird and bat mortality searches, incidental observations of wildlife within the wind farm were documented in 2007 and 2008. Supplemental raptor turbine interaction surveys were also conducted during migration in fall 2007, spring 2008, and fall 2008.

During Year 2, mortality surveys were conducted for seven weeks during the spring (April 19 to June 6), five weeks in the late-summer (July 15 to August 12), and for eight weeks in the fall (August 13 to October 8). The spring and fall survey periods were designated to include the

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<sup>1</sup> UPC Wind Management, LLC became First Wind, LLC in 2008. Evergreen Windpower, LLC developed the Mars Hill Wind Farm and UPC now operates the facility.

peak migration periods of birds, and the late-summer period was designated to include the peak period of bat activity and dispersal.

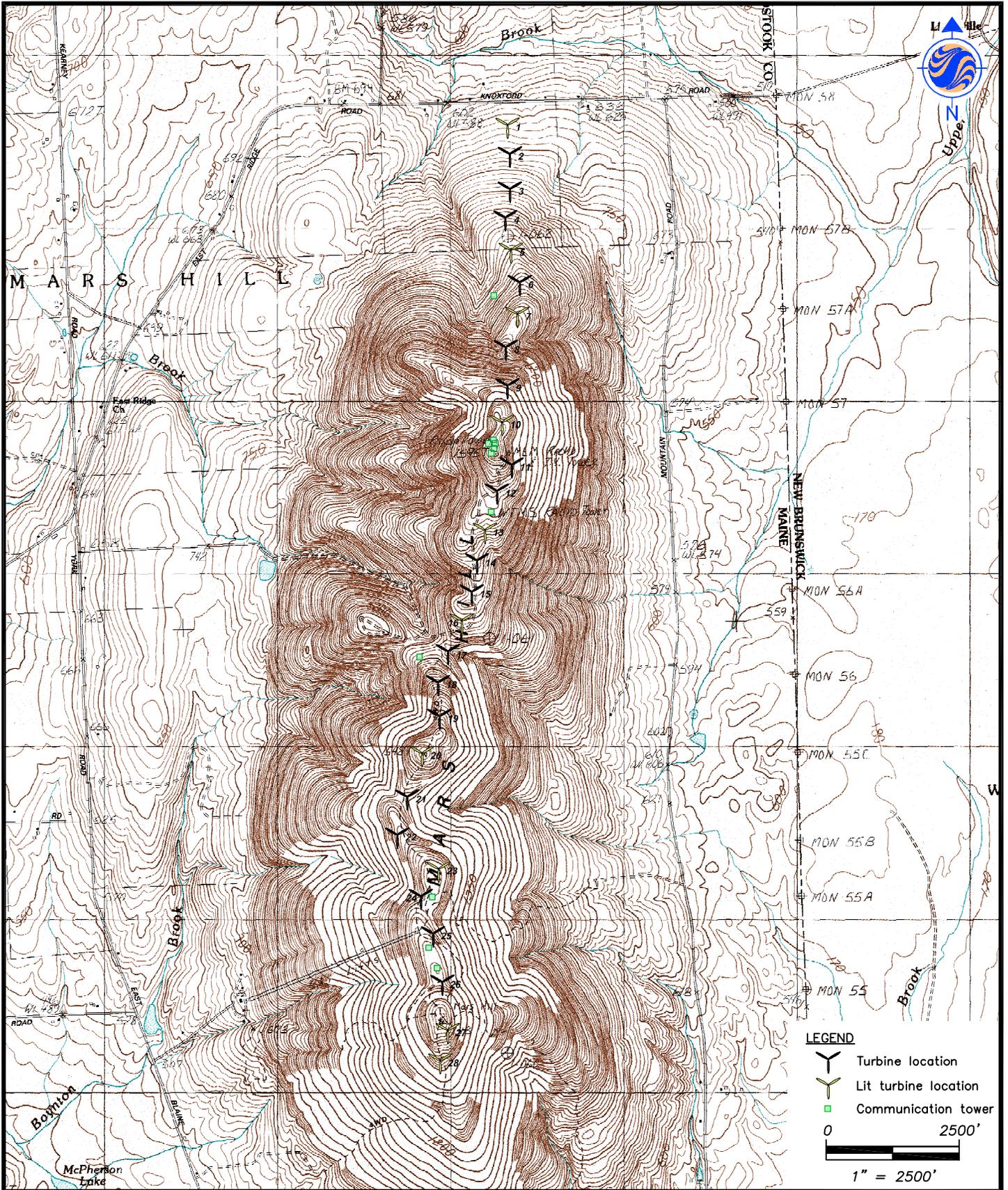
## **1.1 Project Area Description**

The Mars Hill Wind Farm is a 42 megawatt (MW) facility. The project is located on the Mars Hill ridge-top in Aroostook County, Maine (Figure 1). The project area occurs in the Aroostook Lowlands Biophysical Region of Maine in the northeast region of the State, bordering New Brunswick, Canada. The Aroostook Lowlands Biophysical Region is relatively low in elevation except for a few peaks over 244 m (m; 800 feet [ft]) above sea level (asl), including Mars Hill at 533 m (1,748 ft). Others include Number Nine Mountain at 499 m (1,638 ft) and Squa Pan Mountain at 366 m (1,200 ft). The climate is relatively uniform throughout the region, with the highest average temperature in July of 77°F (25°C) and an average low temperature in January of -1°F (-18°C). The growing season ranges from 95 to 110 days. The average annual precipitation is approximately 71 centimeters (cm) (38 inches ["]). Northern hardwood is dominant forest types in the region (McMahon 1990).

Within the project area, elevations range from 486 m (1,595 ft) on the north end of Mars Hill to 533 m (1,748 ft) on the south end. Ridge top habitat consists of northern hardwood – hemlock - spruce forests dominated by sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*), and quaking aspen (*Populus tremuloides*). Eastern hemlock (*Tsuga canadensis*) and spruce (*Picea* sp.) are intermittent species. American beech, striped maple (*Acer pensylvanicum*), and hobblebush (*Viburnum lantanoides*) are the dominant under story species. Lower elevation habitat is mainly the same as ridge top habitat except paper birch (*Betula papyrifera*) is more evident in the canopy and forested and scrub-shrub wetlands are common.

The landscape surrounding Mars Hill is mainly agricultural, which includes mostly potato, cabbage, and broccoli fields. However, the Big Rock Ski Area is located at the southwest end of the Mars Hill ridgeline. There are five freestanding and one guyed communication towers located on the northern end of the ridge, and one free standing and three guyed communication towers positioned along the southern part of the ridge (Figure 1). The communication tower heights range from approximately 10 m (33 ft) to greater than 153 m (500 ft); three are equipped with lighting. There is one meteorological (met) tower located near the center of the ridgeline, with a second tower located on the northern shoulder of the ridge; both are unlit. There is a hiking trail that follows the ridge, and ATV use is permitted along portions of the access roads of the ridgeline.

The wind farm became operational as of March 27, 2007. The facility consists of 28 GE 1.5 sle turbines that have a maximum tower and rotor blade-tip height of 119 m (389 ft). The turbines have a maximum rotor-blade diameter of 77 m (252 ft). The turbines activate at a wind speed of 3.5 meters/second (m/s) and stop at a maximum wind speed of 25 m/s. A total of 10 of the 28 turbines (turbines 1, 5, 7, 10, 13, 16, 20, 23, 27, and 28) are lit by L-864 red flashing FAA lighting.



PREPARED BY:



**Stantec**

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SHEET TITLE:

### Project Location Map

PROJECT:

Mars Hill Wind Farm  
Mars Hill, Maine

DATE: Nov. 18, 2008

SCALE: 1"=2500'

PROJ. NO.: 195600122

FIGURE:

1

## **1.2 Study Area**

The northern-most turbines, turbines 1 to 4, occur in old field (grassland) or partially forested and grassland habitats. The habitats surrounding the remaining turbines are generally characterized by northern hardwood forest. Turbine lay-down areas, with a typical diameter of 76 m (250 ft), were created during construction of the project. Cleared areas and steep side slopes have since been covered with crushed stone. Since construction of the project, the cleared flat areas have been mulched with hay and seeded with grass. During the summer 2007 surveys, grass began to grow in several plots. During the fall 2007 surveys, the grass had grown in all plots, with some patches of grass several inches high. During the 2008 surveys, patches of thick clover and patches of grass as high as 0.6 to 0.9 m (2 to 3 ft), as well as areas of crushed stone with sparse grass, characterized ground conditions at most plots. The turbine driveways and the base of the towers consisted of gravel and crushed stone.

Roughly half of the turbines are centered within the cleared and leveled areas while the remaining turbines are positioned near the edge of the clearings. Therefore, the area under a turbine equivalent to the distance between the ground and the maximum rotor-swept zone (119 m [389 ft]) may consist of cleared and leveled areas, as well as sections of access road, forest, grassland, scrub-shrub, or steep terrain. Although 76 m (250 ft) is a typical turbine plot diameter, where a turbine is located at the edge of a plot, a cleared area may extend as far as 100 m (328 ft) from a side of the tower, and in some cases less than 10 m (33 ft) on the side closest to a forest edge. An example of a centered turbine is number 20 and a non-centered turbine is 22 (Figure 3c).

## **2.0 Methods**

### **2.1 Standardized Searches**

The 2008 Wildlife Casualty Monitoring protocol, as developed during the March 28, 2008 meeting between First Wind, Stantec, MDIFW, and MDEP, is attached as Appendix A.

Although fatalities may occur at distances from the turbine tower equal to or greater than the distance between the ground and the maximum blade-tip swept area (119 m [389 ft]), it was determined during protocol development that survey efforts would focus primarily on the cleared and leveled turbine lay-down areas due to the significantly greater difficulty of searching steep and rocky or forested terrain. Other mortality studies in forested regions have used reduced search areas for similar reasons. Mitigating this reduced search effort is the fact that other studies have found that the majority of bird and bat fatalities fall to the ground within half the maximum distance from the tip height to the ground (Arnett 2005). Other studies suggest that greater than 80 percent of fatalities occur within 40 m (131 ft) of towers. For example, studies conducted at Mountaineer, West Virginia and Myersdale, Pennsylvania determined that approximately 80 percent of fatalities are found within half the maximum distance from the height of the blade-tip to the ground (roughly 40 m) (Arnett 2005). At the Maple Ridge Wind Power Project in New York, the fall distances were evaluated for 69 birds, of which 80 percent were within 60 m (197 ft) of the tower; and the fall distances for 74 bats, of which 80 percent were within 40 m (131 ft) and 98 percent were within 60 m (Jain *et al.* 2007). Another mitigating factor for this study is that at non-centered turbines carcass searches extended as far as 100 m (328 ft) from the side of a tower in some locations, allowing for detection of carcasses at greater distances from a tower.

Search transects were established under all 28 turbines on April 10 and 11, 2008. Depending on the size of the cleared turbine plot, between 12 and 26 transects (an increase from the 7 to 14 transects per plot used during Year 1 monitoring) were established within the turbine lay-down areas. Transects were oriented east to west during Year 2 (to facilitate dog searches by orienting transects with the prevailing WNW winds). Transects were spaced 3 to 4 m (10 to 13 ft) apart (a decrease from the 6-8 m [20 to 26 ft] spaced transects used in 2007). The start and end points of each transect were marked along the edge of the plot (on rocks or trees or with flags).

During each survey season (5 week or 8 week period), all 28 turbines were searched once every 7 days. The order of turbines searched weekly during each survey session was determined by a random sequence generator.

A local individual from the town of Presque Isle conducted the majority of the weekly turbine searches. The individual was trained by a Stantec biologist during transect set-up. During a turbine plot search, the surveyor would walk at a rate of approximately 45 to 60 m (148-197 ft) per minute, searching on both sides of a transect for bird or bat fatalities. Any fatality found along or between transects were documented.

All intact bird or bat carcasses or remnants of scavenged carcasses (a cluster of feathers representing more than a molt, or a patch of skin and bone) were documented as fatalities. When a carcass was found, the surveyor used a laser range finder to determine the carcass' distance from the nearest turbine (or communication tower). The surveyor would then take a compass reading of the carcass' position from the turbine. Multiple pictures were taken of a carcass for positive identification by Stantec biologists. The turbine number, date, surveyor, time discovered, ground conditions (vegetation type and height, wet, dry, etc.), species identification, age and sex, carcass position, the age of decomposition of the carcass (previous night, 2 to 3 days, 4 to 7 days, 7 to 14 days, greater than 2 weeks, scavenged), any evidence of scavenger activity, and any other notes were recorded. The carcasses were collected and frozen. To the extent possible, casualties believed to be associated with the wind farm were distinguished from those believed to be associated with communication towers, vehicle collisions, or natural sources of mortality. Those birds that were found scavenged and not identifiable to species were sent to the Smithsonian National Museum of Natural History for feather or DNA identification. Bird carcasses found and collected in 2007 that were not identifiable to species for the annual report were sent to the Smithsonian in 2008 as well.

## **2.2 Extended Plot Searches**

An extended search area (238 m [780 ft] diameter) at one of either of the two northern most turbines was searched during each survey season to determine the number of fatalities that may occur outside of the typical search plot diameter of 76 m (250 ft). Each of the two northern turbines occurs in grassland habitats bordered by shrub-scrub or woodland. The hayfields surrounding the towers were mowed during the fall survey period. Because no fatalities were found outside of the cleared-and-leveled areas during extended plot searches in 2007, it was determined that dogs would be used during the 2008 extended searches in an effort to increase searcher efficiency.

During an extended plot search, a biologist walked the standard transects with a leashed dog; however, when reaching the endpoint of a marked transect, the biologist would continue beyond the end point of the transect to a distance of 119 m (389 ft), using a hand-held GPS or laser

range finder to maintain their distance from the tower. Any carcasses found were documented and collected according to standardized search protocol.

### **2.3 *Incidental Findings***

Any fatalities found by maintenance personnel or surveyors outside of the standardized searches were documented and collected according to the standardized protocol. These findings were reported as incidental and were not included in the estimates of total mortality for birds and bats; however, these findings were included in the spatial and temporal summary of bird and fatalities.

### **2.4 *Dog Searches***

A subset of turbines, and the cleared area under a communication tower and a met tower, was searched by a biologist with a dog once or twice during the spring, summer, and fall survey seasons. A Siberian husky with a demonstrated ability to find bird and bat carcasses was used for the surveys. During searches, the biologist searched according to the standardized protocol by walking transects with the dog on a 1-m (4-ft) leash, allowing the dog to stop or move toward a carcass it detected along or adjacent to each transect. Turbines searched with the dog included those that had been searched previously that week by the surveyor alone in an effort to validate the results of standard searches. The findings of dog searches were used to generate an alternative estimate of total bird and bat mortality.

### **2.5 *Searcher Efficiency Trials***

During each of the spring, summer, and fall seasons, a searcher efficiency trial, unannounced to the surveyor, was conducted to estimate the percent of bird and bat carcasses that may go undetected during standardized searches. For the trials, a Stantec biologist left out carcasses early in the morning at turbines scheduled to be searched that day. As recommended by the New York State Department of Environmental Conservations (NYSDEC) (2007), the number of carcasses used in trials was limited to avoid creating an excessive attraction to scavengers.

Carcasses were placed within search plots throughout the project area within a variety of ground cover types. Carcasses were placed within clover and grass growth at a variety of heights, bare gravel and rock, and sparse grass or clover growth on gravel or rock. Carcasses were marked with tape or an elastic band, unnoticeable to the surveyor until the carcass was in hand, so that the surveyor would be able to distinguish trial carcasses. Bat carcasses and small, medium, and large bird carcasses found during surveys, and at varying stages of decomposition, were placed during trials<sup>2</sup>. Carcasses were placed at random within search plots. As the surveyor searched turbines according to the standard protocol, carcasses found during the trial were collected. After the test, the Stantec biologist collected those trial carcasses to determine the number of carcasses recovered by the surveyor.

### **2.6 *Scavenger Carcass Removal Trials***

During each season, a scavenger carcass removal trial was conducted to estimate the percent of carcasses removed by scavengers during the 7-day search intervals. Fresh bird carcasses,

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<sup>2</sup> In addition to carcasses found during mortality searches, small and medium sized songbirds, and one small owl, were obtained from the Maine Audubon Society and the York Center for Wildlife.

including small, medium, and large bird carcasses and bat carcasses were used. As recommended by the NYSDEC (2007), the number of carcasses used in trials was limited to avoid creating an excessive attraction to scavengers. During trials, carcasses were placed at turbines throughout the project area within a variety of ground cover types. Carcasses were placed within clover and grass growth at a variety of heights and thicknesses, as well as on bare gravel or rock, and were left out either along the edge of search plots or within search plots. Carcasses were discreetly marked with a leg tape or elastic band to distinguish trial birds and bats from new fatalities.

The status of the carcasses was monitored daily for the next five days, then on days 7, 10, and 14. If a carcass showed evidence of scavenging, it was noted if the carcass was completely removed (scavenged/removed), or if feathers or parts of the carcass were still evident to the surveyor (scavenged/detectable). This also allowed for monitoring of how long scavenged carcasses remained in search plots. Jain *et al.* (2007, 2008) noted that the period between carcass fall and discovery is approximately half the actual search cycle, rounded up. Therefore, the status of the carcasses on the day equivalent to the average time between impact and discovery was noted (day 4 for weekly search intervals and day 14 for seasonal dog searches). If an intact carcass remained on day 14, or if the carcass was scavenged but remained detectable to the surveyor, it was documented as not removed and all remaining parts were taken from the search plot.

## **2.7 Statistical Analysis**

The estimated total number of bird and bat wind farm-related fatalities is influenced by the total number of birds and bats found, the proportion of turbines searched, the percent of carcasses found by the surveyor, the percent of carcasses removed by scavengers, and the percent of carcasses that may occur outside of the standard search plot area. The statistical analysis used to estimate total annual mortality was modeled after Jain *et al.* (2007, 2008).

- The results of the three scavenger trials were pooled for the trial bird and bat carcasses. The analysis considered the percent of trial birds that remained visible (including scavenged birds with substantial feather piles remaining) on day 4 for weekly search intervals, and on day 14 for dog search intervals. Birds that were entirely removed (including birds moved substantial distances from where they were originally placed) were considered absent.
- The results of the three searcher efficiency trials were also pooled for the trial bird and bat carcasses. The searcher efficiency rate was determined as the total number of carcasses found divided by the total number of carcasses placed.
- There were no carcasses found outside of the standard search plot areas during the extended plot surveys (there was only one bird found within the standard plot area during an extended search); therefore, there were no data to account for the percent of carcasses that may occur outside of the standard search areas.

As described by Jain *et al.* (2007, 2008), an estimate of the total bird and bat mortality that occurred at Mars Hill during the search period ( $\hat{C}$ ) was calculated for weekly searches and for dog searches based on the number of carcasses found during each type of survey ( $C$ ), the proportion of turbines searched ( $P_s$ ), the percent of carcasses not removed by scavengers after

the average number of days between potential impact and discovery for each search interval ( $Sc$ ), and the percent of carcasses found by the surveyor ( $Se$ ).

$$\hat{C} = \frac{C}{Sc \times Se \times Ps}$$

The variance was also calculated as described by Jain *et al.* (2007, 2008).

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

The standard deviation was then calculated based on the square root of the variance divided by the square root of the number of searched turbines, multiplied by a factor of 95 percent confidence (1.96).

## **2.8 Wildlife observations and raptor surveys**

When surveyors were on-site for mortality searches, incidental observations of wildlife in the vicinity of the project were documented in 2007 and 2008. When possible, the species, distance from the nearest tower, flight height (if applicable), and behavioral notes were recorded.

Supplemental raptor turbine interaction surveys were conducted during migration in fall 2007, spring 2008, and fall 2008. Raptor surveys were generally conducted between the hours of 9 am and 4 pm. The number of individuals, species, flight height, flight direction, flight position along the ridge, distance to the closest turbine (when applicable), and any turbine interaction or general behavior notes were recorded.

## **3.0 Results**

The results for standard weekly searches, dog searches, and incidental findings are reported in Table 1, and more detail for carcasses found during the different types of surveys is provided in the separate sections following.

<b>Table 1.</b> Species of birds and bats found during standard, dog, or extended plot searches, or incidentally in 2008		
<b>Turbine</b>	<b>Survey type</b>	<b>Species</b>
<b>Birds</b>		
14	standard	yellow-bellied sapsucker
12	standard	downy woodpecker
26	standard	ruby-crowned kinglet
9	standard	bay-breasted warbler
12	standard	red-eyed vireo
16	standard	red-eyed vireo
16	standard	common yellowthroat
12	standard	red-eyed vireo
22	standard	magnolia warbler
4	standard	magnolia warbler
11	standard	ruffed grouse
10	standard	red-eyed vireo
20	standard	yellow-bellied sapsucker
10	standard	black-and-white warbler
26	dog	ovenbird
25	dog	yellow-bellied sapsucker
24	Incidental	golden-crowned kinglet
19	Incidental	barred owl
7	Incidental	red-eyed vireo
5	Incidental	magnolia warbler
1	extended plot search (with dog)	red-eyed vireo
<b>Bats</b>		
4	standard	red bat
2	standard	red bat
10	standard	hoary bat
22	standard	hoary bat
26	dog	silver-haired bat

Ground cover conditions varied throughout the survey season. Figure 2 shows the ground cover conditions of a typical search plot during the 2008 surveys. Table 2 summarizes the weekly ground cover conditions during the 2008 study.

<b>Table 2. Ground cover conditions during Year 2 Monitoring at Mars Hill</b>	
<b>Search period</b>	<b>General ground cover conditions</b>
4/19/2008 - 4/22/2008	snow (2.5 to 3 ft) covered most plots except for the plowed tower access drive, some patches of old matted vegetation and mud
4/26/2008 - 4/29/2008	snow and patches of old matted vegetation, bare gravel access drive
5/3/2008 - 5/6/2008	patches of snow, gravel access drive, new grass and clover growing up (1.5 in.), old matted vegetation
5/10/2008 - 5/13/2008	gravel access drive, new grass and clover growing up (1.5 in.), old matted vegetation
5/17/2008 - 5/20/2008	up to 3-5 in. grass and clover growth, gravel and rock patches including access road
5/21/2008 - 5/24/2008	up to 3-6 in. grass and clover growth, gravel and rock patches including access road
5/27/2008 - 5/30/2008	thick clover up to 5 in. and grass 10 in., sparse patches of grass and gravel, gravel and rock patches including access road
6/3/2008 - 6/6/2008	thick clover up to 5 in. and grass 10 in., sparse patches of grass and gravel, gravel and rock patches including access road
7/15/2008 - 7/19/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
7/22/2008 - 7/25/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
7/29/2008 - 8/1/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
8/5/2008 - 8/8/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
8/12/2008 - 8/15/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
8/19/2008 - 8/22/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
8/26/2008 - 8/29/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
9/2/2008 - 9/5/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
9/6/2008 - 9/9/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
9/13/2008 - 9/16/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
9/20/2008 - 9/23/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
9/27/2008 - 9/29/2008	clover several inches, grass up to 2-3 ft, sparse patches of grass and gravel, gravel and rock patches including access road
10/6/2008 - 10/8/2008	grass and clover dying back, sparse patches of grass and gravel, gravel and rock patches including access road



**Figure 2.** Ground cover conditions at a typical turbine search area (photo taken October 8, 2008)

Incidental carcass findings, the results of dog searches, and the results of extended plot searches were included with the findings of standard weekly searches in the spatial and temporal analysis of detected mortalities. The results of the spatial analysis are reported in the Discussion and include:

- the location of fatalities in the project area during 2008, and a comparison of the locations of fatalities during 2007 and 2008;
- the location of the fatalities at specific turbines (lit and unlit turbines, turbines centered in search plots and not centered in search plots); and
- the average distance of bird and bat fatalities from towers.

The temporal analysis, also reported in the Discussion, includes the timing of the majority of bird and bat fatalities, and a comparison of the timing of those fatalities found fresh with weather data.

### **3.1 Standardized Searches**

Appendix B Table 1 includes a summary of survey effort for weekly standard searches. All 28 turbines were searched once a week according to the standardized protocol with a few exceptions: due to turbine maintenance activities, during the week of May 17, turbines 10 and 13 were not searched; during the week of June 3, turbine 13 was not searched; during the week of September 2, turbine 12 was not searched. Also, during the week of July 29, turbines 17 and 25 were not searched due to heavy rain and thick fog which inhibited visibility; and during the week of October 6, only half of turbine 16 was searched due to time constraints.

A total of 14 of 21 total bird fatalities were found during the standardized searches (6 during the spring and 8 during the late-summer/fall) (see Appendix B Table 2 for details on each bird found). Species found during standard searches include yellow-bellied sapsucker (*Sphyrapicus varius*) (2), downy woodpecker (*Picoides pubescens*) (1), ruby-crowned kinglet (*Regulus calendula*) (1), bay-breasted warbler (*Dendroica castanea*) (1), magnolia warbler (*Dendroica magnolia*) (2), common yellowthroat (*Geothlypis trichas*) (1), black-and-white warbler (*Mniotilta varia*) (1), red-eyed vireo (*Vireo olivaceus*) (4), and ruffed grouse (*Bonasa umbellus*) (1).

Four of 5 total bats were found during standard surveys, all of which were found during the late-summer/early fall (see Appendix B Table 2 for details on each bat found). Species found include eastern red bat (*Lasiurus borealis*) (2) and hoary bat (*Lasiurus cinereus*) (2).

### **3.2 Extended Plot Searches**

Appendix B Table 1 includes a summary of survey effort for extended plot searches with dogs. An extended survey plot search (238 m [780 ft] diameter plot) was conducted on June 3 at turbine 1, September 9 at turbine 2, and September 29 at turbine 1.

During the first extended plot search at turbine 1, habitat conditions included the cleared and leveled areas with gravel and grass (13 to 25 cm), patches of bare ground with gravel, hayfield with 12-inch grass, alder and raspberry shrub-scrub, as well as sections of access road, and a small patch of woodland. During the search at turbine 2, conditions included thick grass and clover growth over a foot tall within the cleared and leveled areas, patches of bare ground and gravel, tall grass and alder-raspberry shrub-scrub growth (0.3 to 1.1 m tall), portions of access road, and a small woodlot. During the final search at turbine 1, conditions included thick grass and clover growth over a half meter tall within the cleared and leveled areas, patches of bare ground and gravel, recently mowed hayfield (0.6 to 1.2 cm), alder-raspberry shrub-scrub, as well as sections of access road, and a small patch of woodland.

No fatalities were found outside of the cleared and leveled search plots during the extended plot searches. One feather pile from a scavenged red-eyed vireo was found by the dog within the standard search plot area at turbine 1 on June 3 (Appendix B Table 2). The feather pile was 18 m [59 ft] from the tower.

The fact that no carcasses were found outside of cleared and leveled search plot areas is consistent with the results of other studies. However, these results may also reflect the difficulties in recovering carcasses in areas of thick scrub-shrub, tall grass, and patches of woods.

### **3.3 Incidental Findings**

There were four incidental bird carcasses found. A barred owl (*Strix varia*) and a golden-crowned kinglet (*Regulus satrapa*) were found during transect set up in April (Appendix B Table 2). A red-eyed vireo and a magnolia warbler were found in August (Appendix B Table 2). The barred owl found in early April was scavenged and was located on the access road between two turbines. Although it is unknown if this bird was a collision fatality or died as a result of natural causes, its death was attributed to the wind farm because it was found along the ridge where the turbines are located. It also should be noted that the scavenged remains of a hooded merganser (*Lophodytes cucullatus*) were found near the access gate located at a pond at the base of the mountain. This fatality was attributed to natural causes of mortality due to its location away from any turbines.

### **3.4 Dog Searches**

Appendix B Table 1 includes a summary of survey effort for all dog searches. In addition to the scavenged bird found by the dog during an extended plot search, there were two other scavenged birds found during dog searches during the late-summer and fall: an ovenbird (*Seiurus aurocapillus*) and a yellow-bellied sapsucker (*Sphyrapicus varius*) (Appendix B Table 2).

A silver-haired bat (*Lasionycteris noctivagans*) was found by the dog in late-summer (Appendix B Table 2).

### **3.5 Searcher Efficiency Trials**

Searcher efficiency trials were conducted for both standard searches and dog searches. A searcher efficiency trial was conducted during each season for the standard searches: June 3, August 15, and September 30. There were two dog searcher efficiency trials conducted in the fall on September 9 and October 1.

Appendix B Table 3 and Table 4 provide detail on each trial carcass placed for the standard searches and dog searches, respectively. The results of the standard search trials were pooled among the survey seasons for birds and bats. A total of 16 bird carcasses were placed in 2008, of which the surveyor found six, for a searcher efficiency rate of 38 percent of birds. For bats, five of 12 bats placed were recovered for a searcher efficiency rate of 42 percent. The results of the two dog search trials in 2008 at Mars Hill were pooled for birds and bats (Appendix B, Table 4). For 12 birds placed, the surveyor with the dog recovered nine (75 percent). For seven bats placed, four were recovered by the surveyor with the dog (57 percent).

There were a few cases where carcasses were found during dog searches at turbines that had been searched previously that week by the surveyor alone: a scavenged bird believed to be 2 to 3 days decomposed, and a bat that was believed to be 2 weeks decomposed were each found at turbine 26 during a dog search on August 15 (the turbine had been searched previously that week on August 13); a scavenged yellow-bellied sapsucker (decomposed over 2 weeks) was found on October 1 during a dog search at turbine 25 (the turbine had been previously searched that week on September 29).

### **3.6 Scavenger Carcass Removal Trials**

A scavenger carcass removal trial was set-up during each of the survey seasons: May 12, August 19, and September 19. The results of the three separate trials were pooled for birds and bats. In total, 20 birds and 6 bats were placed. The results of scavenger carcass removal trials are included in Appendix B Table 5.

Of those birds that were scavenged during the 14-day trial period, the average number of days before the birds were scavenged was 4.7 days. Only two of the 20 total birds placed remained untouched by mammalian or avian scavengers during the 14-day trial period. When trial birds were scavenged by avian or mammalian species, they were completely removed and no parts remained detectable to the surveyor (except for a few feathers in some cases that were not easily detectable to the surveyor so the carcass was considered absent). The exception was one bird for which the tail and another clump of feathers remained visible for four days before the trial was complete. On day 4 (the average period between potential impact and discovery during weekly intervals), 65 percent of carcasses remained detectable for the surveyor. On day 14, 15 percent of carcasses remained visible to the surveyor. Insect scavenging activity became visible on avian carcasses typically 4 to 6 days after the carcasses were placed. A gull, placed at turbine 2, was moved by a scavenger, on day 5, 52 m from where it was placed. Because this bird was moved a considerable distance from where it was placed, it was counted as absent on the day it was moved. However, the bird provided information on how long large carcasses remain visible in search plots after they have been scavenged. The bird was scavenged/moved on September 24, and the majority of the carcass, clumps of feathers, and a separated wing remained for at least 14 days after it was scavenged (and was then removed from the search plot by the surveyor).

All of the six bats placed during the scavenger carcass removal trial were eventually removed during the 14-day trial period. Bats, on average, were scavenged by avian or mammalian predators on day 6. On day 4 (the average period between potential impact and discovery during weekly intervals), 50 percent of bat carcasses remained detectable for the surveyor. Zero percent of carcasses remained on day 14. When trial bats were scavenged, they were completely removed and no parts remained detectable to the surveyor.

Observations of potential scavengers occurred throughout the study period. Appendix B Table 6 provides a description of observations of species that may have been scavenging carcasses including American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*), and red fox (*Vulpes vulpes*).

### **3.7 Statistical Analysis**

Table 3 summarizes the results of the statistical analysis of the 2008 results. The weekly surveys resulted in an estimated total of 57 bird fatalities per year ( $\pm 6.77$ ), with 2.04 birds/turbine/year and 1.36 birds/MW/year. The estimated total number of bat fatalities was 19 per year ( $\pm 5.13$ ), with 0.68 bats/turbine/year and 0.45 bats/MW/year.

Based on dog searches, the estimate of bird fatalities is 74 birds per year ( $\pm 28.27$ ), with 2.65 birds/turbine/year and 1.76 birds/MW/year; and an estimated total of 5 bats per year ( $\pm 0.00$ ), with 0.17 bats/turbine/year and 0.12 bats/MW/year.

<b>Table 3. Results of standard weekly searches and surveyor with dog searches during Year 2 Monitoring at Mars Hill (2008)</b>		
<b>Standard Weekly Surveys</b>		
Correction factors	<b>Birds</b>	<b>Bats</b>
# found (C )	14	4
% carcasses remaining after 4 days (average # days between potential impact and discovery, rounded up) (Sc)	65%	50%
searcher efficiency (Se)	38%	42%
proportion of towers searched weekly (Ps)	100%	100%
<b>Adjusted total fatalities per study year</b>	<b>57</b>	<b>19</b>
95% CI (±)	6.77	5.13
<b>Adjusted total fatalities per/turbine/study year at Mars Hill</b>	<b>2.04</b>	<b>0.68</b>
<b>Adjusted # Fatalities/MW/year</b>	<b>1.36</b>	<b>0.45</b>
<b>Surveyor with Dog Surveys (Once or twice per season)</b>		
Correction factors	<b>Birds</b>	<b>Bats</b>
# found (C )	3	1
% scavenger trial carcasses remaining after 14 days (Sc)	15%	0%
searcher efficiency (Se)	75%	57%
proportion of towers searched (10 = average # turbines searched per season) (Ps)	36%	36%
<b>Adjusted total fatalities per study year at Mars Hill</b>	<b>74</b>	<b>5</b>
95% CI (±)	28.27	0.00
<b>Adjusted total fatalities per/turbine/study year</b>	<b>2.65</b>	<b>0.17</b>
<b>Adjusted # Fatalities/MW/year</b>	<b>1.76</b>	<b>0.12</b>

### **3.8 Wildlife observations and raptor surveys**

Observations of mammalian species observed in the project area and songbirds seen within turbine clearings are available in Appendix B Table 6. The species list of songbirds (migrant and resident species) visually or acoustically observed on-site during 2007 and 2008 is available in Appendix B Table 7. Wildlife observations within the project area indicate continued use of the site by a variety of mammalian and avian species during operation of the wind farm.

Table 4 summarizes the dates, survey effort, and weather conditions during supplemental raptor migration surveys at Mars Hill.

<b>Date</b>	<b>Location</b>	<b>Observer</b>	<b>Time</b>	<b>Wind Speed</b>	<b>Wind Direction</b>	<b>Temp (F)</b>	<b>Cloud Cover (%)</b>	<b>Precipitation</b>
9/25/2007	Turbine 20	AG	10:00 - 4:00	1-3 mph	SW	70	partly cloudy	0
9/25/2007	Turbine 26	MD	11:00 - 4:00	1-3 mph	SW	77	cloudy to partly cloudy	0
5/6/2008	Turbine 19	JC	12:50 - 2:30	2-6 mph	SW	68	partly cloudy	0
9/8/2008	Turbine 19, 25	JC	10:10 - 3:00	7-10 mph	SW	56-65	mostly cloudy	0
9/10/2008	Turbine 19	JC and BR	9:20 - 3:00	8-14 mph	NW	50-59	partly cloudy	0
9/30/2008	Turbine 1	JC	10:30 - 2:50	3-8 mph	NNE	55-63	partly cloudy	0

Incidental observations of raptors seen on-site during mortality search visits and during raptor migration surveys are included in Appendix B Table 8. The observations indicate continued use of the project area by a variety of migrant and resident raptors species (including bald eagle, osprey, peregrine falcon, red-tailed hawk, northern harrier, etc.) with some documentation of direct turbine avoidance behaviors. These observations correlated with minimal raptor fatalities (one owl fatality found during 2 years of study) indicate low collision risk to raptors despite continued use of the project area by both migrants and residents.

## **4.0 Discussion**

### **4.1 Carcass Species Composition**

Ninety percent of bird species found during standard surveys, incidental findings, and during dog searches consisted of songbird species. A barred owl and a ruffed grouse were the exceptions. Of songbird species found warblers represented 37 percent (n=7), magnolia warblers specifically represented 16 percent of songbirds found (n=3). Red-eyed vireo represented 32 percent (n=6) of songbirds found. Yellow-bellied sapsucker represented 16 percent (n=3). There were no state endangered or threatened species found. There was a single state species of special concern found during the 2008 mortality surveys, black-and-white warbler.

Nine birds found in 2008 that were scavenged and were not identifiable to species were sent to the Smithsonian for positive identification. All birds were positively identified by feather or DNA analysis. The remains from eight scavenged bird carcasses found in 2007 that could not be positively identified were also sent to the Smithsonian for identification. Seven of these birds were identified. A revised list of avian species found during the 2007 searches is available in Appendix B Table 9. Additionally, Appendix B Table 9 includes the results of supplemental dog mortality searches that were conducted in conjunction with experimental radar surveys after the completion of the 2007 search period. Dog searches were conducted at turbines 20, 27, 25, 9, 11, 13, 10, 12, 14, 16, 17, and 19 on September 25 and 26, 2007. These surveys were

completed after the mortality search period so the findings are included as incidental and were not included in the 2007 report.

Hoary bat (n=2) and eastern red bat (n=2) each accounted for 40 percent of detected bat fatalities. Silver-haired bat (n=1) accounted for 20 percent of bat fatalities discovered in 2008. Each of these species is designated state species of special concern.

## **4.2 Spatial Analysis**

In 2008, fatalities occurred at 17 of 28 turbines located throughout the project area (Figure 3a-d<sup>3</sup>). No fatalities occurred at turbines 3, 6, 8, 13, 15, 17, 18, 21, 23, 27, and 28 during 2008. There were no fatalities detected under the met towers or communication towers that were searched once or twice during each survey season. Of the turbines that resulted in fatalities, the number of fatalities ranged from 1 to 3 birds or fatalities.

No observable trends are evident when comparing the habitats or topographical characteristics at turbine locations at which fatalities occurred in 2008 (Figure 3a-d, Figure 4). There are no relationships between greater search areas and the number of fatalities at individual turbines during 2008 (Table 5, Figure 5). These findings are consistent with the 2007 results. The only notable coincidence found when looking at the number of fatalities at specific turbines among the two survey years, is the same number of bird fatalities at turbines 12, 16, 19, 24, and 26 between the two survey years (Figure 3a-d, Figure 4).

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<sup>3</sup> Figure 3a-d is a National Agriculture Inventory Program mosaic and was taken during construction of the project on August 11, 2006. Therefore, the figure does not show site conditions after re-establishment of vegetation after construction.



PREPARED BY:



**Stantec**

195600122-F3a-d-Mortality.dwg

SHEET TITLE:

**Bird and Bat Fatality Map  
2007 & 2008**

PROJECT:

Mars Hill Wind Farm  
Mars Hill, Maine

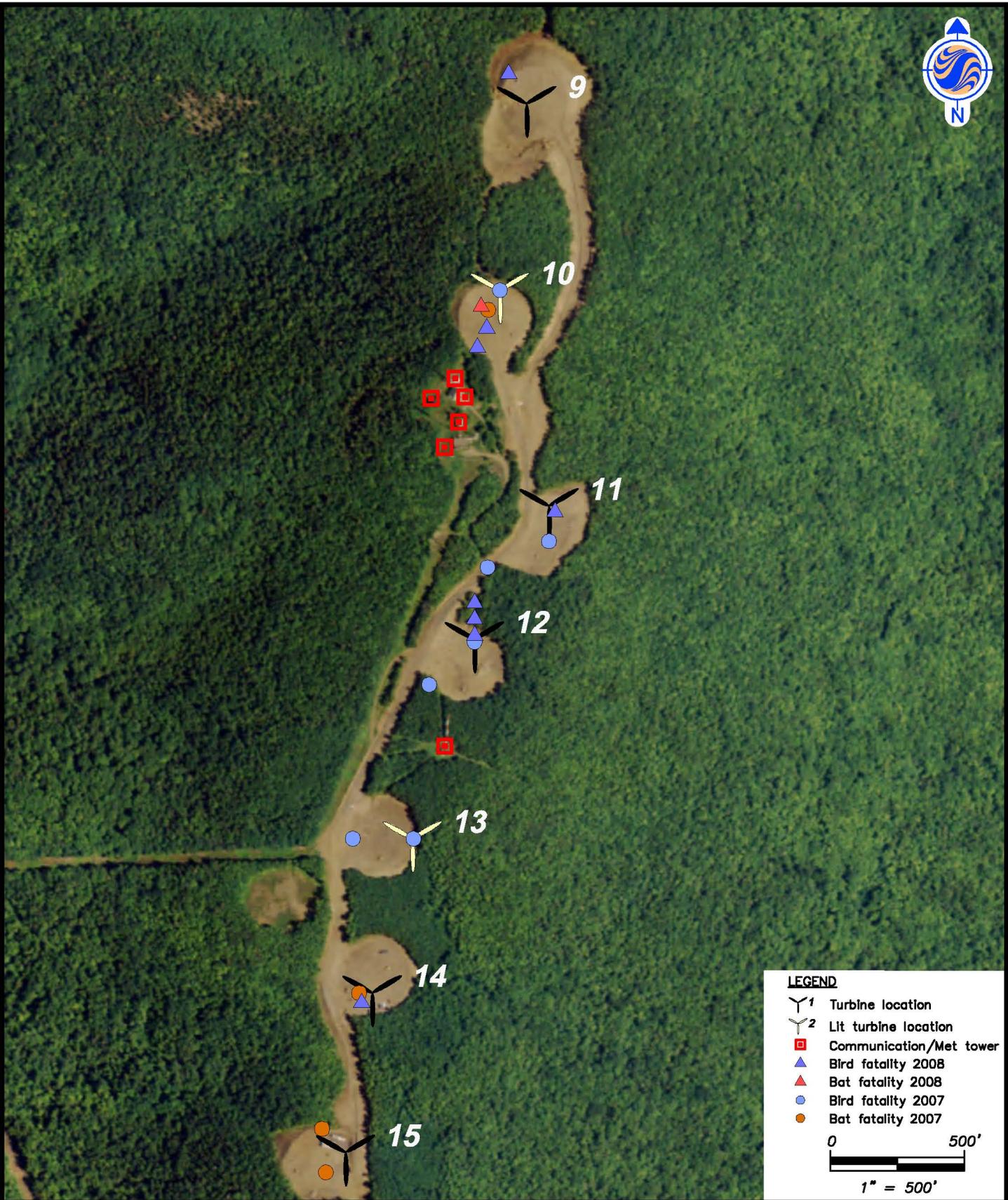
DATE: Nov. 19, 2008

SCALE: 1"=500'

PROJ. NO.: 195600122

FIGURE:

**3a**



PREPARED BY:



**Stantec**

195600122-F3e-d-Mortality.dwg

SHEET TITLE:

### Bird and Bat Fatality Map 2007 & 2008

PROJECT:

Mars Hill Wind Farm  
Mars Hill, Maine

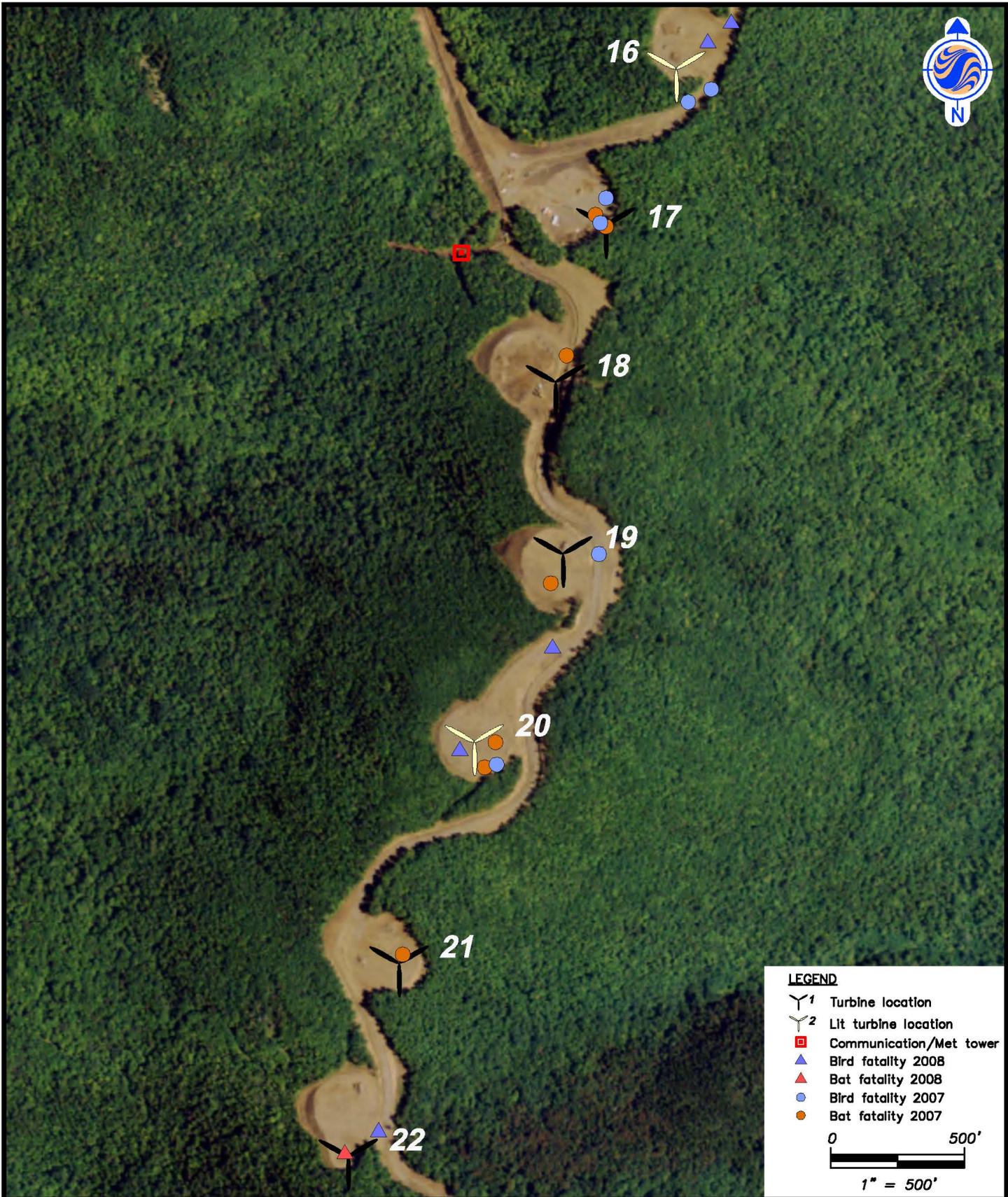
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PROJ. NO.: 195600122

FIGURE:

# 3b



PREPARED BY:



**Stantec**

195600122-F3e-d-Mortality.dwg

SHEET TITLE:

**Bird and Bat Fatality Map  
2007 & 2008**

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PROJECT:

Mars Hill Wind Farm  
Mars Hill, Maine

DATE: Nov. 19, 2008

SCALE: 1"=500'

PROJ. NO.: 195600122

FIGURE:

**3c**



**LEGEND**

-  1 Turbine location
-  2 Lit turbine location
-  Communication/Met tower
-  Bird fatality 2008
-  Bat fatality 2008
-  Bird fatality 2007
-  Bat fatality 2007



1" = 500'

PREPARED BY:



**Stantec**

195600122-F3e-d-Mortality.dwg

SHEET TITLE:

**Bird and Bat Fatality Map  
2007 & 2008**

PROJECT:

Mars Hill Wind Farm  
Mars Hill, Maine

DATE: Nov. 19, 2008

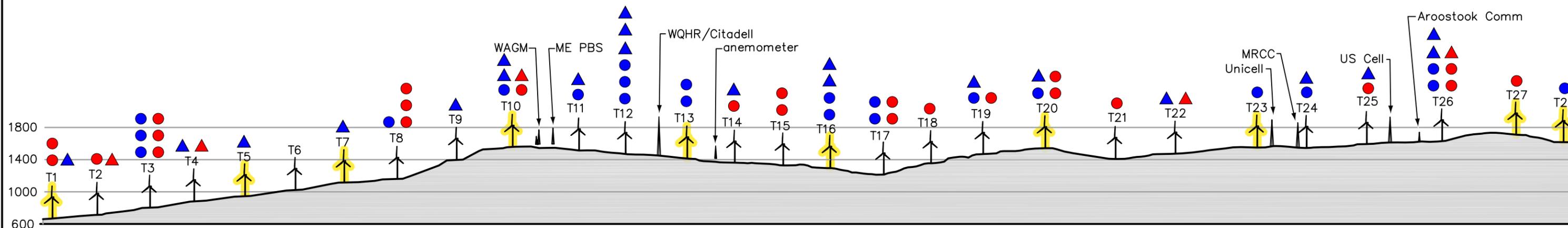
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FIGURE:

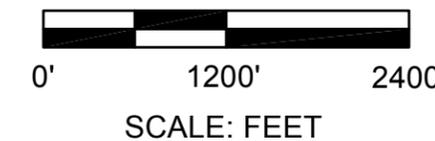
**3d**

Figure 4  
Ridge Profile Fatality Map  
2007 & 2008



Legend

- 1 Bird Fatality (2007) [n = 22]
- 1 Bat Fatality (2007) [n = 24]
- ▲ 1 Bird Fatality (2008) [n = 21]
- ▲ 1 Bat Fatality (2008) [n = 5]
- ⚡ Lit Turbine

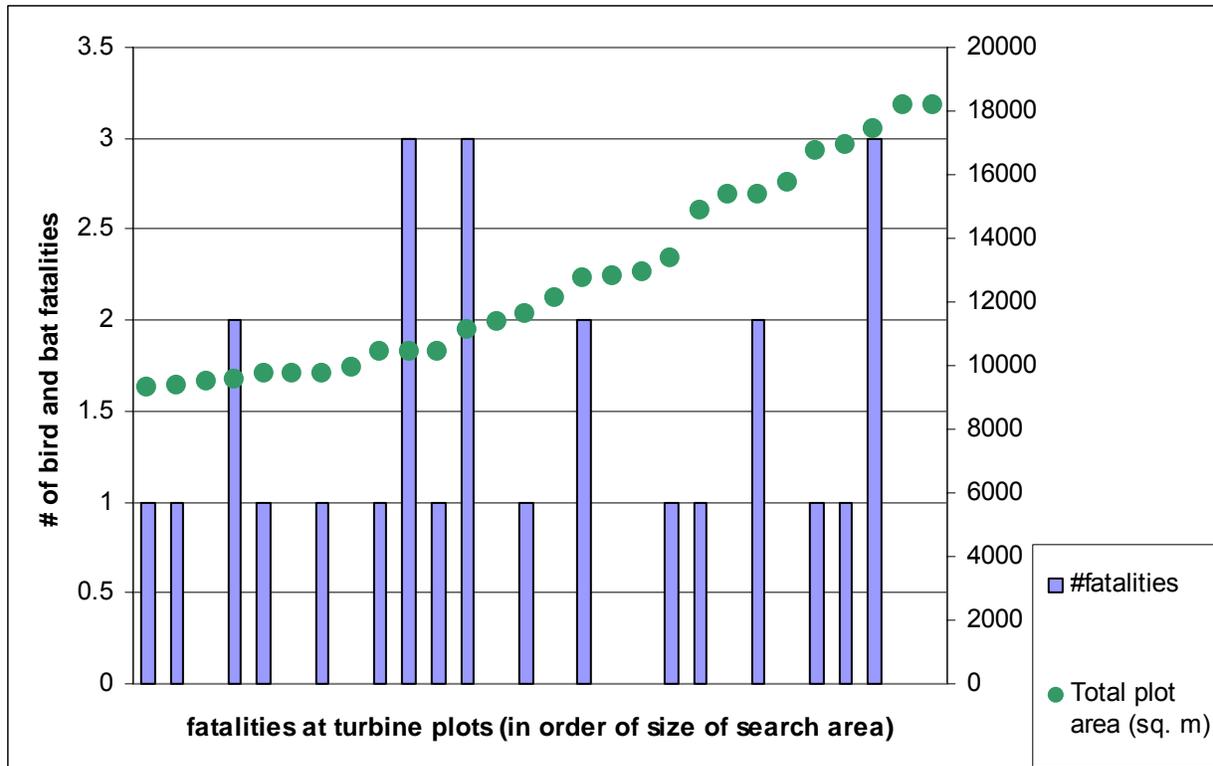


Mars Hill Wind Farm  
Mars Hill, Maine



**Table 5.** Searchable area and the number of bird and bat fatalities per turbine at Mars Hill 2008

<b>Turbine #</b>	<b>Total plot area (sq. m)</b>	<b># of bird fatalities</b>	<b># of bats</b>	<b>#fatalities</b>
1	17425	1		1
2	12787		1	1
3	11150			0
4	11399	1	1	2
5	15746	1		1
6	9317			0
7	9520	1		1
8	9572			0
9	9742	1		1
10	10420	2	1	3
11	12098	1		1
12	16719	3		3
13	9742			0
14	9742	1		1
15	14891			0
16	10467	2		2
17	11637			0
18	15384			0
19	10467	1		1
20	9923	1		1
21	9400			0
22	13399	1	1	2
23	12969			0
24	12728	1		1
25	18180	1		1
26	18180	2	1	3
27	16961			0
28	15364			0
<b>Total</b>	<b>355329</b>	<b>21</b>	<b>5</b>	<b>26</b>



**Figure 5.** Total search area compared to the total number of fatalities at each turbine

A separate analysis was conducted to determine if the number of fatalities found, and where fatalities were found, was influenced by searchable area at those turbines that are generally centered in search plots compared to those turbines that are located at the edge of search plots. Experimental estimates of total mortality for birds and bats during the 2008 study period were calculated using the numbers found during standard searches at centered turbines and non-centered turbines. The turbines considered generally centered in turbine plots include 1, 3, 4, 9, 19, 20, 23, 25, 27, and 28 (Figure 3a-d). Table 6 summarizes the results of the experimental mortality estimates. Estimates of mortality for birds and bats at non-centered turbines were nearly double that of centered turbines. The average number of bird and bat fatalities at non-centered and centered turbines was 0.61 birds and 0.17 bats, and 0.3 birds and 0.1 bats, respectively. Generally, more birds were found at non-centered plots than at centered plots.

<b>Table 6.</b> Experimental results of standard weekly searches at centered turbines compared to non-centered turbines during 2008		
<b>Standard Weekly Surveys at Centered Turbines</b> (turbines 1, 3, 4, 9, 19, 20, 23, 25, 27, and 28)		
Correction factors	<b>Birds</b>	<b>Bats</b>
# found (C )	3	1
% carcasses remaining after 4 days (average # days between potential impact and discovery, rounded up) (Sc)	65%	50%
searcher efficiency (Se)	38%	42%
proportion of towers searched weekly (Ps)	36%	36%
<b>Adjusted total fatalities per year</b>	<b>33.7</b>	<b>13.2</b>
<b>Adjusted total fatalities per/turbine/year at Mars Hill</b>	<b>1.2</b>	<b>0.47</b>
<b>Standard Weekly Surveys at Non-centered Turbines</b> (turbines 2, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 21, 22, 24, 26)		
Correction factors	<b>Birds</b>	<b>Bats</b>
# found (C )	11	3
% carcasses remaining after 4 days (average # days between potential impact and discovery, rounded up) (Sc)	65%	50%
searcher efficiency (Se)	38%	42%
proportion of towers searched weekly (Ps)	64%	64%
<b>Adjusted total fatalities per year</b>	<b>69</b>	<b>22.32</b>
<b>Adjusted total fatalities per/turbine/year at Mars Hill</b>	<b>2.49</b>	<b>0.79</b>

Additionally, Stantec investigated whether carcasses found at non-centered turbines were detected at greater distances from the tower on the cleared side of the turbine plot (these distances from non-centered towers extend out to 100 m or greater in some cases). Using birds and bats found during standard searches at centered turbines and non-centered turbines, the average carcass distances from towers at centered verses non-centered plots for birds and bats were calculated. The distances at centered verses non-centered turbines were comparable: birds were found at 33.3 m (109 ft) and 39.7 m (130 ft), and bats were found at 10 m (32.8 ft) and 11.2 m (36.7 ft) at centered and non-centered turbines, respectively. The analysis supports the theory that the majority of carcasses fall within 60 m of turbines. These results also suggest that the average search plot size was sufficient for the detection of the majority of carcasses.

The 10 FAA lit turbines at Mars Hill are turbines 1, 5, 7, 10, 13, 16, 20, 23, 27, and 28. Fatalities were dispersed at both lit verses unlit turbines. For all detected fatalities, including results from incidental, dog searches, and extended survey plot searches, there was a greater number of fatalities at unlit turbines. However, the average number of bird fatalities at lit turbines was slightly higher: the average number of fatalities at lit turbines verses unlit turbines was 0.8 and 0.72, respectively. The data do not suggest that FAA lighting on the 10 lit turbines at Mars Hill increases the risk of collision mortality for birds or bats. These results are consistent with the 2007 Mars Hill results as well as those of other studies (Jain *et al.* 2007, Arnett 2005). The substantially higher numbers of fatalities observed at lit communication towers (at heights greater than 305 m [1,000 ft]) in the U.S. may be influenced by the greater heights of the towers, the guy wires, or the steady-burning lights mounted on many towers (Jain *et al.* 2007), verses the pulsing lights on wind turbines.

Analysis of the distance of birds and bats from the turbines included fatalities that were found scavenged and may have been moved from their original location. The average distance of bird fatalities from the turbines was 39 m (128 ft). The maximum and minimum detected distance of a bird fatality from a tower was 113 m (370 ft) (scavenged remains found in plowed access road) and 0 m, respectively. The average distance of bat fatalities from the turbines was 14 m (46 ft). The closest distance of a bat fatality from a turbine was 0.5 m (1.5 ft) and the furthest detected distance was 28 m (92 ft).

### **4.3 Temporal Analysis**

The majority of bird fatalities were believed to occur during seasonal (spring and fall) nocturnal migration movements; however, bird fatalities were suspected to also occur during small-scale and localized resident bird movements. Fatalities were found during peak migration periods as well as during the breeding season (Appendix B Table 2). Forty-three percent (n=9) of all detected bird fatalities were found in the spring (between April 10 to June 6), 10 percent (n=2) were found in the summer/late-breeding season (between July 15 to August 15), and 48 percent (n=10) were found in the late-summer/fall (August 16 to October 8).

Most fatalities were believed to occur during nocturnal migration movements due to the nature of the species found and the dates the carcasses were discovered. However, because songbirds are mainly active during the day during the breeding season, the 2 fatalities recovered during the summer (a common yellowthroat and an ovenbird), may have collided during the day or during crepuscular hours. Additionally, the ruffed grouse found during the fall is a non-migratory species but was believed to have collided with the turbine because there was no evidence of predation. It is unknown what time of day this fatality occurred as grouse may be active both during the day and at night. The yellow-bellied sapsucker fatality discovered on October 8 was still warm when it was found at 10:40 am and, therefore, the collision was believed to have occurred that morning.

One hundred percent of bats detected in 2008 were found during the late-summer/fall survey period. The timing of the majority of fatalities of bats were consistent with other studies: a mortality study at the Maple Ridge Wind Power Project in New York found that 69.9 percent of bat fatalities occurred between July 1 and August 31 (Jain *et al.* 2007); a study at the Buffalo Mountain Wind Farm in Tennessee documented 69 percent of bat mortality between late-August and early-September (Fiedler *et al.* 2007); and, at the Mountaineer facility in West Virginia, a 6 week period from July 31 to September 11, observed a high mortality rate of 38 bats/turbine/study period (Arnett 2005). The findings at Mars Hill support the theory that most bat collisions occur during the mid-to-late summer dispersal period, and that long-distance migratory species (hoary bat, silver-haired bat, and red bat) are at a greater risk of collision.

### **4.4 Weather Correlations**

Due to the overall low number of fatalities and the limited number of fatalities found fresh, there is little mortality data to correlate to weather events. Table 7 shows the dates of fresh fatalities found along with a summary of weather data for the previous night or the day of discovery. The single fresh bat fatality found collided on a warm night with a passing storm front, with overcast skies and periods of heavy rain, and calm to light variable winds. The five birds found that were believed to have collided with a turbine the previous night were found on days following cold to mild nights with clear or overcast conditions, and light to moderate winds.

<b>Table 7. Comparison of suspected dates of mortality events with weather data</b>			
<b>Date discovered</b>	<b>Date of suspected collision</b>	<b>Species</b>	<b>Weather during period of collision*</b>
5/28/2008	5/27/2008	red-eyed vireo	mostly clear, 38 to 42 d F, WNW winds 5-10 mph
5/29/2008	5/28/2008	red-eyed vireo	clear to overcast, 28 to 46 d F, SSW winds 5-8 mph
8/27/2008	8/26/2008	magnolia warbler	clear to overcast, 46 to 54 d F, NW-W winds calm to 13.8 mph
8/27/2008	8/26/2008	magnolia warbler	clear to overcast, 46 to 54 d F, NW-W winds calm to 13.8 mph
9/20/2008	9/19 or 9/20/2008**	ruffed grouse	night of 9/19: clear, 24 to 26 d F, SSW winds calm to 12 mph; day of 9/20: cloudy, 40 to 43 d F, SSW winds 17 to 24 mph
9/22/2008	9/21/2008	red-eyed vireo	clear to overcast, 41 to 45 d F, SSW winds 3.5 to 6.9 mph
10/8/2008	10/8/2008***	yellow-bellied sapsucker	clear and sunny, 34 d F, N wind 9 mph
8/5/2008	8/4/2008	red bat	storm front passed at sunset, 60 d F, overcast with periods of heavy rain, calm to 3.5 mph variable winds
*Weather data was obtained for Houlton, Maine. Weather Underground [Internet]. 2008. [Accessed on November 3, 2008. Available at <a href="http://www.weatherunderground.com">www.weatherunderground.com</a>			
**Collision may have occurred the night of September 19th or during the day on the 20th.			
***Carcass was found at 10:40 am and was still warm; therefore collision was believed to have occurred within an hour prior to discovery.			

#### 4.5 Comparison of Results with Other Public Studies

Table 8 provides the habitat, survey effort, and results of mortality monitoring at existing wind farms in the east and upper mid-western United State

Table 8. Comparison of bird and bat mortality at existing wind farms in eastern and upper mid-western United States								
Site	Habitat type (# turbines)	Dates surveyed	Search interval	# BATS found during surveys (incidental)	Estimated total BAT fatalities/turbine/year	# BIRDS found during surveys (incidental)	Estimated total BIRD fatalities/turbine/year	Reference
Buffalo Ridge, Minnesota	agricultural grassland (73)	January - December 1995	30-50 weekly	n/a	n/a	7	0.33-0.66 fatalities/t/yr (36 total)	Osborn <i>et al.</i> 2000
Buffalo Ridge, Minnesota	agricultural grassland (138)	15 March - 15 November, 1999	30 bi-weekly	n/a	n/a	20	4.45/t/yr (613)	Johnson 2002
Buffalo Ridge, Minnesota	agricultural grassland (281)	15 June - 15 September, 2001 and 2002	83 or 103 bi-weekly	151	1.30-3.02/t/yr (364-849)	n/a	n/a	Johnson <i>et al.</i> 2004
Searsburg, Vermont	forested (11)	30 June - 18 October, 1997	11 total (4 per search) 2 to 6 days per month	0	n/a	0	n/a	Kerlinger 2002
Kewaunee County, Wisconsin	agricultural (31)	1999 - 2001	n/a	n/a	1.16-4.26/t/yr (36-132)	25	1.29/t/yr (40)	Sagrillo 2003, Sagrillo 2007
Somerset County, Pennsylvania	agricultural (8)	2000 (12 months)	n/a	0	n/a	0	n/a	Kerlinger 2006
Mountaineer, West Virginia	forested ridgeline (44)	31 July- 11 September, 2004	22 daily, 22 weekly	398 (68)	38/t/yr (1364-1980)	15 (n/a)	n/a	Arnett 2005
Myersdale, Pennsylvania	forested ridgeline (20)	2 August - 13 September, 2004	10 daily, 10 weekly	262 (37)	25/t/yr (400-660)	13 (4)	n/a	Arnett 2005
Top of Iowa, Iowa	agricultural (89)	24 March- 10 December, 2004	26 3-days	44 (n/a)	10.17/t/yr (905)	5 (n/a)	0.9/t/yr (80 total)	Koford 2005
Buffalo Mtn, Tennessee	open/shrubland (18)	April - December, 2005	18 of 18 every 2-5 days to bi-weekly	243 (14)	63.9/t/yr (1,149)	9 (2)	1.8/t/yr (111.6 total)	Fiedler <i>et al.</i> 2007
Maple Ridge, New York	woodland, grassland, agricultural (120)	June 17 - November 15, 2006	10 3-days, 30 7-days, 10 daily	326 (58)	11.39-20.31/t/yr (1367-2437.2)	123 (15)	3.10-9.48/t/yr (372-1138 total)	Jain <i>et al.</i> 2007
Maple Ridge, New York	woodland, grassland, agricultural (195)	April 30 - November 14, 2007	64 weekly	202 (81)	15.54-18.53/t/yr (3030-3614)	64 (32)	5.67-6.31/t/yr (1106-1230)	Jain <i>et al.</i> 2008
Mars Hill, Maine	forested ridgeline (28)	23 April- 3 June, 15 July-23 Sept 2007	2 of 28 daily, 28 of 28 weekly, seasonal dog searches	22 (2)	0.43/t/yr-4.4/t/yr (12.1-122.5)	19 (3)	0.44-2.5/t/yr (26.8-69.2 total)	Stantec 2008
Mars Hill, Maine	forested ridgeline (28)	19 April- 6 June, 15 July-8 Oct 2008	28 of 28 weekly, seasonal dog searches	5	0.17/t/yr-0.68/t/yr (5-19)	17(4)	2.4/t/yr-2.65/t/yr (57-74)	<i>this report</i>

The range of average estimates of mortality determined by nine different studies at the wind farms included in Table 8 is 18.54 to 49.73 bats/t/yr. Estimates of bat mortality are as high as 63.9 bats/t/yr (Buffalo Mountain, Tennessee) and as low as 0.17 bats/t/yr (Mars Hill, 2008). The estimates of mortality for bats at Mars Hill, particularly during the second year of monitoring, are among the lowest levels of bat mortality reported here. Emerging bat fatality data suggests that latitude, or geographic location, may influence bat mortality at wind farms as notably higher estimates of bat kills per turbine per year have been documented in the southeastern U.S. (Arnett 2005, Fielder *et al.* 2007, Arnett *et al.* 2008). In general, estimates of bat mortality have been found to be highest in the eastern U.S., particularly along forested ridgelines (Arnett *et al.* 2008). Bat mortality has been found to be lower in other regions such as the Rocky Mountains or the Pacific Northwest (Arnett *et al.* 2008). However, regional differences in bat habitat and populations limit the value of direct comparison among these regions.

The range of average estimates of mortality determined by 8 different studies at the wind farms included in Table 8 is 2.25 to 3.42 birds/t/yr. Estimates of bird mortality are as high as 9.48 birds/t/yr (Maple Ridge, New York) and as low as 0.33 birds/t/yr (Buffalo Ridge, Minnesota). Mortality estimates at Mars Hill among both survey years are comparable to the low end of the range of average estimates determined by studies reported here.

#### **4.6 Comparison of Mars Hill Year 1 and Year 2 results**

Searcher efficiency was decreased during Year 2 monitoring as the vegetation grew over a couple of feet tall in most search areas. Based on standard searches, searcher efficiency for birds and for bats decreased by 32 percent and 16 percent, respectively. Rates of searcher efficiency at other study sites have been variable and are likely dependent on the level of vegetation at a particular site as well as the size of the carcasses used in trials. Searcher efficiency for bat carcasses at Mountaineer, West Virginia, and at Meyersdale, Pennsylvania, was 44 percent and 25 percent, respectively (Arnett 2005). At Nine Canyon, Washington, searcher efficiency for small carcasses was 44 percent and 78 percent for large carcasses (Erickson 2003). Searcher efficiency at the Maple Ridge Wind Power Project in New York was 100 percent for large bird carcasses, 56 percent for small and medium sized birds, and 51 percent for bats (Jain *et al.* 2007). During a second year of monitoring at Maple Ridge (2007), searcher efficiency was 46 percent for small birds, 56 percent for medium birds, and 65 percent for large birds and 55 percent for bats (Jain *et al.* 2008).

The level of carcass scavenging at a wind site may change over time (Arnett 2005) and may be variable among survey years. At Mars Hill, the scavenger carcass removal rate for birds on a weekly basis increased by 25 percent during the second year of monitoring, while the scavenger removal rate for bats decreased by 34 percent during the second year.

The results of the 2 years of monitoring for birds are very similar with 22 and 21 birds found, and a high total estimate of 69 and 74 bird fatalities in 2007 and 2008, respectively. The results of Year 2 monitoring for bats resulted in a much lower estimate of mortality than the Year 1 results. The statistical analysis accounted for the differences in scavenger carcass removal and searcher efficiency rates when the mortality rates were calculated for each year of monitoring. Therefore, the explanation for this variation in bat mortality among the survey years may be due to a variety of factors including: variable bat populations among years, variable activity of bats due to weather conditions (August 2008 was relatively cool and wet), or behavioral adaptations to wind turbines by local bats.

## 5.0 Conclusions

Avian mortality at the Mars Hill wind farm among the 2 years of post-construction monitoring included 25 different species (including 2 unidentified warbler species and 1 unidentified songbird species). All species were songbirds with the exception of one owl and one grouse. The highest estimate of bird mortality at Mars Hill among the two years of survey (2.65/t/yr [74 total birds]) represents a relatively low impact to regional or local bird populations. This is supported by the fact that the species that represent the majority of avian mortality at Mars Hill are species that are common and abundant (red-eyed vireo and magnolia warbler accounted for 32 percent and 16 percent of songbird mortality detected in 2008, respectively). The North American population of red-eyed vireo is believed to be increasing and is estimated at 140 million and the population of Magnolia warbler is believed to be increasing and is estimated to be at 32 million (Sauer *et al.* 2005 as cited by Jain *et al.* 2008). There was one Maine species of special concern detected during the 2008 mortality searches: black-and-white warbler (n=1); and three species of special concern found in 2007: black-and-white warbler (n=1), white-throated sparrow (n=1), and veery (n=1). These species are of conservation concern due to decreases in habitat or generally declining regional population trends. One fatality of black-and-white warbler per year, and less than one fatality of white-throated sparrow and veery per year at Mars Hill represent a relatively minor impact. Raptors may be more susceptible to impacts associated with collision mortality at wind farms because they are less common than many songbird species and have a lower reproductive rate (NRC 2007). However, incidental raptor observations and observations during standardized raptor migration surveys correlated with minimal raptor fatalities (one owl fatality found during 2 years of study) indicate low collision risk to raptors at Mars Hill, despite continued use of the project area by both migrants and residents. Avian mortality at Mars Hill, and at wind farms in the U.S. in general, represent a relatively low impact to birds when considering the hundreds of millions of birds that die as a result of collisions with buildings and windows, predation by house cats, collisions with communication towers, and other sources of human induced mortality in the U.S. each year (Erickson *et al.* 2005). The results of two years of post-construction mortality monitoring suggest that there are no unreasonable adverse impacts to avian species resulting from the wind farm.

Two years of mortality monitoring at Mars Hill detected the mortality of four species of bats: silver-haired bat, eastern red bat, hoary bat, and little brown bat. The three bat species most commonly detected during the 2007 and 2008 mortality surveys are Maine species of special concern: eastern red bat, hoary bat, and silver-haired bat. Hoary bats, silver-haired bats, and eastern red bats (the long-distance migratory species), as well as little brown bats, have been most commonly found during mortality searches at other wind farms (Jain *et al.* 2007, Arnett 2005). Bat species have low reproductive rates and therefore may be more susceptible to cumulative impacts resulting from fatalities at wind farms and other sources of human induced mortality. Updated bat population estimates as well as the numbers of bats impacted by pesticides, collisions with man-made objects, as well as other sources of human induced mortality are required to put the number of bat collisions with wind turbines into perspective (Kunz *et al.* 2007). The highest estimate of mortality for bats at Mars Hill between the two survey years, 4.4 bats/t/yr (122.5 total bats), is among the lowest estimates of bat mortality reported at existing studies in the east. There was considerable variation in bat mortality between the first and second year of monitoring, with the second year's estimate of mortality for bats substantially lower at 5 to 19 total bats. This variation may be attributable to a range of factors beyond the scope of this study. The results of two years of monitoring suggest that the Mars Hill Wind Farm presents no unreasonable adverse impacts to bat species.

## 6.0 Literature Cited

- 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.
- Arnett, E. B., W. K. Brown, W. P. Erickson, J. K. Fielder, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. J. O'Connell, M. D. Piorkowski, R. D. Tankersley, Jr. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. *Journal of Wildlife Management* 72(1):61-78.
- Avery, M.L., P.F. Spring, and J.F. Cassel. 1976. The effects of a tall tower on nocturnal bird migration – A portable ceilometer study. *Auk*. 93(2):281-291.
- Avery, M.L., P.F. Spring, and J.F. Cassel. 1977. Weather influences on nocturnal bird mortality at a North Dakota tower. *Wilson Bulletin*. 89(2):291-299.
- Crawford, R.L. 1981. Bird kills at a lighted man-made structure: often on nights close to a full moon. *Amer. Birds*. 35:913-914.
- Erickson, W., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernk. 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.
- Erickson, W. 2003. Nine Canyon Wind Power Project Avian and Bat Monitoring Report September 2002 – August 2003. Prepared for Nine Canyon Technical Advisory Committee Energy Northwest, October 2003.
- Erickson, W., G. Johnson, and D. Young Jr. 2005. A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. Technical Report for the USDA Forest Service. PSW-GTR-191.
- Fiedler, J.K., T.H. Henry, R.D. Tankersley, and C.P. Nicholson 2007. Results of Bat and Bird Mortality Monitoring at the Expanded Buffalo Mountain Windfarm, 2005 June 28, 2007. Prepared for Tennessee Valley Authority.
- GAO (Government Accountability Office). 2005. Wind Power: Impacts on wildlife and government responsibilities for regulating development and protecting wildlife. Report to congressional requesters, September 2005.
- Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual Report for the Maple Ridge Wind Power Project Postconstruction Bird and Bat Fatality Study – 2006 FINAL REPORT June 25, 2007. Prepared for PPM Energy and Horizon Energy and Technical Advisory Committee (TAC for the Maple Ridge Project Study).
- Jain, A., P. Kerlinger, R. Curry, L. Slobodnik. 2008. Annual Report for the Maple Ridge Wind Power Project Postconstruction Bird and Bat Fatality Study – 2007 (May 2, 2008).

Prepared for PPM Energy and Horizon Energy and Technical Advisory Committee (TAC for the Maple Ridge Project Study).

Johnson, G., W. Erickson, M. Strickland, M. Shepherd, S. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind-power development on Buffalo Ridge, Minnesota. *Wildlife Society Bulletin* 20: 879-887.

Johnson, G.D., and M.D. Strickland. 2004. An assessment of potential collision mortality of migrating Indiana bats (*Myotis sodalis*) and Virginia big-eared bats (*Corynorhinus townsendii virginianus*) traversing between caves supplement to: biological assessment for the federally endangered Indiana Bat (*Myotis sodalis*) and Virginia big-eared bat (*Corynorhinus townsendii virginianus*). Western EcoSystems Technology, Inc. Cheyenne, WY.

Kerlinger, P. 2002. An Assessment of the Impacts of Green Mountain Power Corporation's Wind Power Facility on Breeding and Migrating Birds in Searsburg, Vermont, July 1996 – July 1998. Prepared for the Vermont Department of Public Service Montpelier, Vermont.

Kerlinger, P. 2006. Supplement to the Phase I Avian Risk Assessment and Breeding Bird Study for the Deerfield Wind Project, Bennington County, Vermont. Prepared for Deerfield Wind, LLC.

Koford, R., A. Jain, G. Zenner, and A. Hancock. 2005. Avian Mortality Associated with the Top of Iowa Wind Farm Progress Report 2004 February 2, 2005.

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research, needs, and hypotheses. *Front Ecol Environ* 2007; 5(6): 315-324.

McMahon, J. 1990. *The Biophysical Regions of Maine: Patterns in the Landscape and Vegetation*. University of Maine, Orono, ME.

National Research Council of the National Academies. 2007. Environmental Impacts of Wind-Energy Projects. Committee on Environmental Impacts of Wind Energy Projects Board on Environmental Studies and Toxicology Division on Earth and Life Studies. Available at <http://www.nap.edu/catalog/11935.html>

New York State Department of Environmental Conservation. 2007. Draft Guidelines for Conducting Bird and Bat Studies at Commercial Wind Energy Projects – December 2007. Prepared by NYSDEC Division of Environmental Permits and Division of Fish, Wildlife, and Marine Resources.

Osborn, R.G., K.F. Higgins, R.E. Usgaard, C.D. Dieter, and R.D. Neiger. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge Wind Resource Area, Manitoba. *Am. Middle. Nat.* 143: 41-52.

Sagrillo, Mick. 2003. Wind Energy Technical Info: Bats and Wind Turbines. American Wind Energy Association.

Sagrillo, Mick. 2007. Wind turbines and birds - Putting the situation in perspective in Wisconsin. Wisconsin Focus on Energy REN-2033-020. Available at: [focusonenergy.com](http://focusonenergy.com).

Stantec Consulting (formerly Woodlot Alternatives). 2008. 2007 Spring, Summer, and Fall Post-construction Bird and Bat Mortality Study at the Mars Hill Wind Farm, Maine. Prepared for UPC Wind Management, LLC.

## **Appendix A**

### **Wildlife Casualty Monitoring Protocol, Year 2**

## **Wildlife Casualty Monitoring Protocol, Year 2**

### **Mars Hill Wind Farm UPC Wind Management, LLC April 2008**

The protocol for the second year of wildlife monitoring at the Mars Hill Wind Farm is based on the original Wildlife Casualty Monitoring Protocol (November 2006) developed for the project by UPC, and the discussion of the 2007 results and 2008 protocol changes at the March 28, 2008 meeting between UPC, Stantec, Maine Department of Inland Fisheries and Wildlife (MDIFW), and Maine Department of Environmental Protection (DEP). The 2008 work plan, particularly any changes to the original protocol, is outlined below.

During Year 2 of monitoring, the surveys will be conducted during the same three periods that were surveyed in 2007, with the exception of a two week extension at the end of the fall period: six weeks in the spring (April 15 – May 31), four weeks in summer (July 15 – August 15), and eight weeks in the fall (August 15 – October 6). All 28 turbines will be surveyed weekly by searching the cleared lay-down areas. No daily searches will be conducted. Transects will be established three to four meters apart in each search plot (decreased from the six to eight meters transects used in 2007). Transects will be oriented perpendicular to the predominant wind direction to facilitate supplemental dog searches. Leashed dog searches will be conducted at a subset of turbines and at a meteorological and telecommunication tower twice during each of the spring, summer, and fall seasons (increased from once per season during 2007). An extended plot search (120 m radius around a turbine) will also be conducted once per season with a dog at one of the two northern turbines positioned in an overgrown field (turbines 1 or 2).

All carcasses found will be photographed, collected, tagged, cataloged (date, turbine number, bearing to center of turbine tower and transect, distance to tower and transect), and frozen. Ground conditions and vegetation height within search plots will also be monitored throughout the survey period, as well as nightly weather conditions.

In addition to the mortality searches, searcher efficiency trials will be conducted to estimate the percentage of bird and bat fatalities that are found by the searcher. One trial will be conducted each season to account for changes in efficiency due to experience and familiarity with the site as well as changing ground cover conditions. Two searcher efficiency trials will be conducted to assess the searcher surveying with a leashed dog (increased from one dog searcher efficiency trial in 2007). Depending on availability of carcasses obtained from wildlife centers or from previous searches, evaluators will use up to 25 (but a minimum of six) carcasses of different sized species of birds and bats. Personnel conducting mortality searches will not be told where or when these trials will be conducted.

A carcass removal/scavenger trial will also be conducted once during each season. These trials will be separate from the searcher efficiency trials and will include a minimum of six, but preferably 25, carcasses to be planted near and sometimes within search plots in order to estimate the percentage of avian/bat fatalities that are lost to scavengers within individual study plots. The use of fresh intact carcasses as well as feather spots or partially scavenged carcasses will be used in trials to investigate any difference in the length of time these types of carcasses remain detectable to the surveyor. Two different scavenger carcass removal rates will be developed for the different carcass types (i.e., feather spots/partial carcass versus intact carcasses). Estimates of carcass removal will then be used to adjust the number of carcasses

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found during mortality searches, correcting for removal bias. All bird or bat carcasses deployed in the carcass removal trial will be checked on days 1, 2, 3, 4, 5, 7, 10, and 14, or until evidence of the carcass is absent.

A final report will be prepared to summarize all three seasons combined. The report will present estimates of the overall rate of fatalities at the project during the 2008 survey period. In order to investigate the percent of carcasses that may fall over forested areas, specifically at those turbines that are not centered in the lay-down cleared areas, the adjusted estimate for total mortality per turbine per year will be based on 1) the results of all turbines searched, and 2) an additional estimate based on the results of only those turbines that are centered within the lay-down clearings (i.e., the 40 to 60 m, or greater radius around each turbine where the majority of carcasses fall).

## **Appendix B**

### **Year 2 Mortality Search Data Tables**

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA	4/19/2008	11	n/a	n/a	SA	7/15/2008	9	5:30am	6:30am	SA	8/19/2008	4	5:40am	6:40am
SA		14	n/a	n/a	SA		11	6:30am	7:35am	SA		9	7:00am	7:50am
SA		22	n/a	n/a	SA		12	7:40am	8:45am	SA		11	8:00am	9:05am
SA		25	n/a	n/a	SA		13	8:50am	9:55am	SA		12	9:10am	10:15am
SA		27	n/a	n/a	SA		14	10:00am	11:10am	SA		13	10:20am	11:20am
SA		28	n/a	n/a	SA		19	11:20am	12:20am	SA		14	11:30am	12:45pm
SA		7	n/a	n/a	SA	7/16/2008	4	5:00am	6:30am	SA		19	1:00pm	2:00pm
SA	4/20/2008	2	n/a	n/a	SA		6	6:40am	7:50am	SA		27	2:15pm	3:15pm
SA		6	n/a	n/a	SA		7	8:00am	9:20am	SA	8/20/2008	6	5:30am	6:40am
SA		12	n/a	n/a	SA		18	10:00am	11:30am	SA		7	6:45am	7:55am
SA		15	n/a	n/a	SA		22	11:45am	1:00pm	SA		18	9:05am	10:05am
SA		17	n/a	n/a	SA		23	1:05am	2:10pm	SA		22	10:15am	11:15am
SA		19	n/a	n/a	SA	7/17/2008	24	5:15am	6:40am	SA		23	11:20am	12:30pm
SA		20	n/a	n/a	SA		26	6:45am	7:45am	SA		24	12:35pm	1:45pm
SA	4/22/2008	1	n/a	n/a	SA		27	7:50am	9:00am	SA		26	1:50pm	3:00pm
SA		3	n/a	n/a	SA		28	9:10am	10:30am	SA		28	3:05pm	4:15pm
SA		5	n/a	n/a	SA		1	11:00am	12:00pm	SA	8/21/2008	1	5:30am	6:30am
SA		13	n/a	n/a	SA		3	12:05pm	1:15pm	SA		3	6:35am	7:50am
SA		16	n/a	n/a	SA	7/18/2008	5	4:45am	6:15am	SA		5	7:55am	9:00am
SA		18	n/a	n/a	SA		8	6:20am	7:20am	SA		15	9:20am	10:20am
SA		24	n/a	n/a	SA		2	7:25am	8:30am	SA		16	10:25am	11:45am
SA		26	n/a	n/a	SA		15	8:45am	9:50am	SA		20	12:00pm	1:00pm
SA		4	n/a	n/a	SA		16	9:55am	11:00am	SA		21	1:05pm	1:15pm
SA		8	n/a	n/a	SA		20	11:10am	12:10pm	SA	8/22/2008	2	5:30am	6:40am
SA		9	n/a	n/a	SA		21	12:15am	1:15pm	SA		8	6:45am	7:50am
SA		10	n/a	n/a	SA	7/19/2008	10	5:00am	6am	SA		10	8:15am	9:20am
SA		21	n/a	n/a	SA		17	6:10am	7:10am	SA		17	9:25am	10:30am
SA		23	n/a	n/a	SA		25	7:20am	8:20am	SA		25	10:45am	12:00pm
SA	4/26/2008	7	7:00am	n/a	SA	7/22/2008	4	4:45am	5:50am	SA	8/26/2008	4	6:45am	7:50am
SA		11	8:15am	n/a	SA		9	6:15am	7:00am	SA		9	8:20am	9:15am
SA		14	9:00am	n/a	SA		11	7:10am	8:10am	SA		11	9:20am	10:25am
SA		22	10:00am	n/a	SA		12	8:15am	9:15am	SA		12	10:30am	11:30am
SA		25	10:45am	n/a	SA		13	9:20am	10:25am	SA		13	11:35am	12:40pm
SA		27	12pm	n/a	SA		14	10:30am	11:30am	SA		14	12:45apm	1:55pm
SA		28	12:45pm	n/a	SA		19	11:35am	12:30pm	SA		19	2:05pm	3:00pm
SA		2	1:45pm	n/a	SA		27	12:45am	1:45pm	SA	8/27/2008	27	3:05pm	4:00pm
SA		6	2:45pm	n/a	SA	7/23/2008	6	5:00am	6:00am	SA		6	5:50am	7:00am
SA	4/27/2008	12	7:00am	n/a	SA		7	6:15am	7:30am	SA		7	7:05am	8:15am
SA		15	7:45am	n/a	SA		18	7:50am	9:15am	SA		18	8:30am	9:30am
SA		17	8:45am	n/a	SA		22	9:30am	10:50am	SA		22	9:50am	11:00am
SA		19	9:30am	n/a	SA		23	11:00am	12:00pm	SA		23	11:05am	12:10pm
SA		20	10:15am	n/a	SA		24	12:05pm	1:10pm	SA		24	12:15pm	1:30pm

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA		1	11:15am	n/a	SA		26	1:15pm	2:15pm	SA		26	1:40pm	2:40pm
SA		3	12:00pm	n/a	SA		28	2:30pm	3:30pm	SA	8/28/2008	1	5:45am	6:50am
SA		5	12:45pm	n/a	SA	7/24/2008	1	5:30am	6:30am	SA		3	6:55am	7:45am
SA	4/28/2008	16	3:00pm	n/a	SA		3	6:40am	7:45am	SA		5	7:45am	9:00am
SA		18	4:00pm	n/a	SA		5	7:50am	9:00am	SA		15	9:15am	10:15am
SA		24	4:45pm	n/a	SA		15	9:20am	10:30am	SA		16	10:20am	11:30am
SA		26	5:45pm	n/a	SA		16	10:35am	11:45am	SA		20	11:40am	12:40pm
SA	4/29/2008	4	n/a	n/a	SA		17	11:50am	12:50pm	SA		21	12:45pm	1:45pm
SA		8	n/a	n/a	SA		20	1:00pm	2:00pm	SA		28	2:00pm	3:00pm
SA		9	n/a	n/a	SA		21	2:05pm	3:10pm	SA	8/29/2008	2	5:45am	7:50am
SA		10	n/a	n/a	SA	7/25/2008	2	5:00am	6:15am	SA		8	7:55am	8:55am
SA		13	n/a	n/a	SA		8	6:30am	7:55am	SA		10	9:15am	10:15am
SA		21	n/a	n/a	SA		10	8:15am	9:20am	SA		17	10:30am	11:35am
SA		23	n/a	n/a	SA		25	9:35am	10:45am	SA		25	11:45am	12:45pm
SA	5/3/2008	7	6:30am	n/a	SA	7/29/2008	4	5:00am	6:00am	SA	9/2/2008	4	1:00pm	2:00pm
SA		11	n/a	n/a	SA		9	6:20am	7:20am	SA		9	2:15pm	3:00pm
SA		14	n/a	n/a	SA		11	7:30am	8:30am	SA		11	3:05pm	4:00pm
SA		22	n/a	n/a	SA		12	8:35am	9:40am	12 not searched due to turbine maintenance activities				
SA		25	n/a	n/a	SA		13	9:45am	10:50am	SA		13	4:05pm	5:05pm
SA		27	n/a	n/a	SA		14	11:00am	11:15am	SA		14	5:15pm	6:15pm
SA		28	n/a	n/a	SA		19	11:30am	12:30pm	SA	9/3/2008	19	1:00pm	2:00pm
SA		2	n/a	n/a	SA		27	12:45pm	2:00pm	SA		27	2:15pm	3:15pm
SA		6	n/a	n/a	SA	7/30/2008	6	4:55am	6:10am	SA		18	3:30pm	4:30pm
SA	5/4/2008	12	n/a	n/a	SA		7	6:15am	7:10am	SA		22	4:45pm	5:45pm
SA		15	n/a	n/a	SA		18	7:20am	8:20am	SA		23	5:50pm	5:50pm
SA		17	n/a	n/a	SA		22	8:30am	9:40am	SA	9/4/2008	24	5:45pm	7:00am
SA		19	n/a	n/a	SA		23	9:45am	10:45am	SA		26	7:05am	8:05am
SA		20	n/a	n/a	SA		24	10:50am	12:00pm	SA		28	9:15am	10:15am
SA		1	n/a	n/a	SA		26	12:10pm	1:15pm	SA		1	10:30am	11:15am
SA		3	11:30am	n/a	SA		28	1:30am	2:30pm	SA		3	11:20am	12:20pm
SA		5	12:30pm	n/a	SA	7/31/2008	1	6:00am	7:00am	SA		5	12:25pm	1:30pm
SA	5/5/2008	4	n/a	n/a	SA		3	7:15am	8:10am	SA		6	1:35pm	2:35pm
SA		8	n/a	n/a	SA		5	8:15am	9:15am	SA		7	2:40pm	3:45pm
SA		9	n/a	n/a	SA		15	9:30am	10:35am	SA		2	4:00pm	5:00pm
SA		10	n/a	n/a	SA		16	10:40am	11:55am	SA	9/5/2008	8	4:45am	5:45am
SA		26	n/a	n/a	SA		20	12:00pm	1:00pm	SA		10	6:00am	7:10am
SA		24	n/a	n/a	SA		21	1:05pm	2:10pm	SA		17	7:15am	8:15am
SA		18	n/a	n/a	SA	8/1/2008	2	8:00am	9:15am	SA		25	8:30am	9:30am
SA		16	n/a	n/a	SA		8	9:20am	10:15am	SA		15	9:45am	10:45am
SA	5/6/2008	13	n/a	n/a	SA		10	10:20am	11:30am	SA		16	10:50am	11:55am
SA		21	n/a	n/a	17 not searched due to heavy rain and thick fog					SA		20	12:15pm	1:15pm
SA		23	n/a	n/a	25 not searched due to heavy rain and thick fog					SA		21	1:20pm	2:20pm
SA	5/10/2008	7	6:00am	n/a	SA	8/5/2008	4	4:55am	6:25am	SA	9/6/2008	4	6:00am	7:00am

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA		11	7:15am	n/a	SA		9	6:50am	7:50am	SA		9	7:20am	8:15am
SA		14	8:15am	n/a	SA		11	7:55am	9:15am	SA		11	8:20am	9:20am
SA		22	9:15am	n/a	SA		12	9:20am	10:30am	SA		12	9:30am	10:30am
SA		25	10:30am	n/a	SA		13	10:35am	11:40am	SA		13	10:35am	11:35am
SA		27	11:45am	n/a	SA		14	11:45am	12:15pm	SA		14	11:40am	12:45pm
SA		28	1:00pm	n/a	SA		19	12:30pm	1:30pm	SA		19	1:00pm	2:00pm
SA	5/11/2008	2	5:45am	n/a	SA		27	1:45pm	2:45pm	SA		27	2:15pm	3:15pm
SA		6	7:00am	n/a	SA	8/6/2008	6	5:00am	6:10am	SA	9/7/2008	6	6:00am	7:00am
SA		12	8:15am	n/a	SA		7	6:15am	7:30am	SA		7	7:05am	8:15am
SA		15	9:15am	n/a	SA		18	7:45am	8:45am	SA		18	8:30am	9:30am
SA		17	10:15am	n/a	SA		22	8:50am	9:35am	SA		22	9:40am	10:40am
SA		19	11:15am	n/a	SA		23	9:45am	10:55am	SA		23	10:45am	11:45am
SA		20	12:15pm	n/a	SA		24	11:00am	12:15pm	SA		24	11:50am	12:55pm
SA	5/12/2008	1	6:00am	n/a	SA		26	12:25pm	1:40pm	SA		26	1:00pm	2:00pm
SA		3	7:00am	n/a	SA		28	1:45pm	2:45pm	SA		28	2:15pm	3:15pm
SA		5	n/a	n/a	SA	8/7/2008	1	4:55am	6:15am	SA	9/8/2008	1	12:00pm	1:00pm
SA		16	9:45am	n/a	SA		3	6:20am	7:10am	SA		3	1:05pm	2:05pm
SA		18	12:00pm	n/a	SA		5	7:15am	8:15am	SA		5	2:15pm	3:15pm
SA		24	1:00pm	n/a	SA		15	8:20am	9:30am	SA		15	3:30pm	4:40pm
SA		26	2:00pm	n/a	SA		16	9:35am	10:45am	SA		16	4:35pm	5:35pm
SA	5/13/2008	4	6:30am	n/a	SA		20	11:00am	12:00pm	SA		20	5:45pm	6:45am
SA		8	8:00am	n/a	SA		21	12:05pm	1:15pm	SA	9/9/2008	2	12:00pm	1:00pm
SA		9	10:00am	n/a	SA	8/8/2008	2	5:00am	6:10am	SA		8	1:10pm	2:10pm
SA		10	11:00am	12:15pm	SA		8	6:15am	7:30am	SA		10	2:30pm	3:30pm
SA		13	12:30pm	n/a	SA		10	7:45am	8:50am	SA		17	3:45pm	4:45pm
SA		21	1:45pm	n/a	SA		17	9:00am	10:00am	SA		21	4:50pm	5:50pm
SA		23	2:50pm	n/a	SA		25	10:15am	11:30am	SA		25	6:00pm	7:00pm
SA	5/17/2008	7	5:30am	6:30am	SA	8/12/2008	4	5:30am	6:50am	SA	9/13/2008	4	6:15am	7:15am
SA		11	7:00am	8:00am	SA		9	7:10am	7:55am	SA		9	7:35am	8:30am
SA		14	8:00am	8:55am	SA		11	8:00am	9:00am	SA		11	8:35am	9:40am
SA		22	9:00am	10:15am	SA		12	9:05am	10:10am	SA		12	9:45am	10:45am
SA		25	10:30am	11:15am	SA		13	10:15am	11:15am	SA		13	10:50am	11:50am
SA		27	11:15am	12:15pm	SA		14	11:20am	12:30pm	SA		14	11:55am	1:00pm
SA		28	12:15pm	1:15pm	SA		19	12:40pm	1:40pm	SA		19	1:10pm	2:10pm
SA	5/18/2008	2	5:30am	6:30am	SA		27	1:50pm	2:50pm	SA		27	2:20pm	3:20pm
SA		6	6:45am	8:00am	SA	8/13/2008	6	5:20am	6:30am	SA	9/14/2008	6	6:00am	7:00am
SA		12	8:30am	9:30am	SA		7	6:35am	7:45am	SA		7	7:05am	8:15am
SA		15	9:30am	10:40am	SA		18	8:00am	9:15am	SA		18	8:40am	9:40am
SA		17	10:45am	11:35am	SA		22	9:20am	10:30am	SA		22	9:50am	10:50am
SA		19	11:45am	12:30am	SA		23	10:35am	11:40am	SA		23	11:00am	12:00pm
SA		20	12:30am	1:30am	SA		24	11:45am	1:00pm	SA		24	12:05pm	1:15pm
SA	5/19/2008	1	5:30am	6:30am	SA		26	1:10pm	2:15pm	SA		26	1:20pm	2:25pm
SA		3	6:35am	7:35am	SA		28	2:25pm	3:30pm	SA		28	2:30pm	3:30pm

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA		5	7:35am	8:40am	SA	8/14/2008	1	5:30am	6:45am	SA	9/15/2008	2	12:00pm	1:00pm
SA		16	9:00am	10:00am	SA		3	6:50am	7:50am	SA		8	1:10pm	2:10pm
SA		18	10:00am	11:00am	SA		5	7:55am	9:00am	SA		10	2:30pm	3:40pm
SA	5/20/2008	24	5:00am	6:15am	SA		15	9:15am	10:10am	SA		17	3:50pm	4:50pm
SA		26	6:20am	7:30am	SA		16	10:15am	11:10am	SA		25	5:00pm	6:00pm
SA		4	7:45am	8:45am	SA		20	11:20am	12:20pm	SA	9/16/2008	1	10:00am	11:00am
SA		8	9:00am	10:00am	SA		21	12:25pm	1:30pm	SA		3	11:05am	12:5pm
SA		9	10:30am	11:30am	SA	8/15/2008	2	5:30am	6:45am	SA		5	12:10pm	1:10pm
10 not searched due to turbine maintenance activities					SA		8	7:00am	8:10am	SA		15	1:30pm	2:30pm
13 not searched due to turbine maintenance activities					SA		10	8:30am	9:45am	SA		16	2:35pm	3:45pm
SA		21	12:00pm	1:15pm	SA		17	10:00am	11:15am	SA		20	3:50pm	4:50pm
SA		23	1:30pm	2:30pm	SA		25	11:30am	12:30pm	SA		21	5:00pm	6:00pm
SA	5/21/2008	7	5:00am	6:15am						SA	9/20/2008	4	6:00am	7:00am
SA		11	6:40am	7:40am						SA		9	7:15am	8:15am
SA		14	7:50am	8:50am						SA		11	8:20am	9:20am
SA		22	9:00am	9:45am						SA		12	9:25am	10:25am
SA		25	9:50am	10:50am						SA		13	10:30am	11:30am
SA		27	10:55am	12:00pm						SA		14	11:35am	12:45pm
SA		28	12:00pm	1:00pm						SA		19	1:00pm	2:00pm
SA	5/22/2008	2	5:00am	6:00am						SA		27	2:15pm	3:15pm
SA		6	6:05am	7:15am						SA	9/21/2008	6	6:00am	7:00am
SA		12	7:45am	8:30am						SA		7	7:05am	8:15am
SA		15	8:35am	9:25am						SA		18	8:30am	9:30am
SA		17	9:30am	10:15am						SA		22	9:35am	10:35am
SA		19	10:30am	11:15am						SA		23	10:40am	11:40am
SA		20	11:20am	12:15pm						SA		24	11:45am	1:00pm
SA	5/23/2008	1	5:15am	6:15am						SA		26	1:10pm	2:10pm
SA		3	6:20am	7:20am						SA		28	2:15pm	3:15pm
SA		5	7:20am	8:15am						SA	9/22/2008	2	12:00pm	1:00pm
SA		16	9:00am	10:05am						SA		8	1:10pm	2:10pm
SA		18	10:00am	11:00am						SA		10	2:30pm	3:40pm
SA		24	11:05am	11:55am						SA		17	3:50pm	4:50pm
SA		26	12:00pm	12:45pm						SA		25	5:00pm	6:00pm
SA	5/24/2008	4	5:10am	6:15am						SA	9/23/2008	1	10:00am	11:00am
SA		8	6:20am	7:05am						SA		3	11:05am	12:05pm
SA		9	7:25am	8:25am						SA		5	12:10pm	1:10pm
SA		10	n/a	n/a						SA		15	1:30pm	2:30pm
SA		13	n/a	n/a						SA		16	2:35pm	3:45pm
SA		21	n/a	n/a						SA		20	3:50pm	4:50pm
SA		23	n/a	n/a						SA		21	5:00pm	6:00pm
SA	5/27/2008	7	4:50am	6am						SA	9/27/2008	4	6:30am	7:30am
SA		11	6:15am	7:10am						SA		9	7:50am	8:50am
SA		14	7:15am	8:30am						SA		11	9:00am	10:00am

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA		22	9am	10:15am						SA		12	10:05am	11:05am
SA		25	10:30am	11:30am						SA		13	11:10am	12:10pm
SA		27	11:45am	12:30am						SA		14	12:15pm	1:30pm
SA		28	12:30pm	1:30am						SA		19	1:10pm	2:40pm
SA	5/28/2008	2	5am	6am						SA		27	2:50pm	3:50pm
SA		6	6:05am	7:10am						SA	9/28/2008	6	6:00am	7:00am
SA		12	7:25am	9am						SA		7	7:05am	8:15am
SA		15	9:05am	10am						SA		18	8:40am	9:40am
SA		17	10:10am	11am						SA		22	9:50am	10:50am
SA		19	11:05am	12pm						SA		23	10:55am	11:55am
SA		20	12:05pm	1pm						SA		24	12:00pm	1:20pm
SA	5/29/2008	1	5am	5:50am						SA		26	1:25pm	2:25pm
SA		3	5:55am	6:55am						SA		28	2:30pm	3:30pm
SA		5	7am	8:10am						SA	9/29/2008	2	12:00pm	1:00pm
SA		16	9:15am	10:30am						SA		8	1:10pm	2:10pm
SA		18	10:45am	11:30am						SA		10	2:25pm	3:35pm
SA		24	11:45am	12:45pm						SA		17	3:40pm	4:40pm
SA		26	12:50am	1:00pm						SA		25	4:50pm	5:50pm
SA	5/30/2008	4	5am	6am						SA	9/30/2008	1	10:00am	11:00pm
SA		8	6:10am	7:10am						SA		3	11:05am	12:05pm
SA		9	7:30am	8:15am						SA		5	12:10pm	1:10pm
SA		10	8:20am	9:20am						SA		15	1:30pm	2:30pm
SA		13	9:25am	10:25am						SA		16	2:35pm	3:45pm
SA		21	10:30am	11:15am						SA		20	3:55pm	4:55pm
SA		23	11:20am	12:30pm						SA		21	5:00pm	6:00pm
SA	6/3/2008	7	4:45am	6am						SA	10/6/2008	9	12:00pm	1:00pm
SA		11	6:20am	7:05am						SA		11	1:05pm	2:05pm
SA		14	7:10am	8am						SA		12	2:10pm	3:10pm
SA		22	8:10am	9:25am						SA		13	3:15pm	4:15pm
SA		23	9:30am	10:45am						SA		14	4:20pm	5:30pm
SA		27	10:50am	11:50am						SA		19	5:35pm	6:35pm
SA		28	11:55am	12:45am						SA	10/7/2008	4	12:00pm	1:00pm
SA	6/4/2008	2	5am	6am						SA		6	1:05pm	2:05pm
SA		6	6:05am	7am						SA		7	2:10pm	3:15pm
SA		12	7:20am	8:10am						SA		1	3:25pm	4:20pm
SA		15	8:15am	9:05am						SA		3	4:25pm	5:25pm
SA		17	9:10am	9:50am						SA		5	5:30pm	6:30pm
SA		19	9:55am	10:40am						DN	10/8/2008	2	9:02am	9:48am
SA		20	10:45am	11:45am						DN		20	10:23am	10:53am
SA	6/5/2008	1	4:45am	5:50am						DN		21	10:58am	11:29am
SA		3	5:55am	6am						DN		22	11:32am	12:03pm
SA		5	6:10am	7:20am						DN		23	12:06pm	12:39pm
SA		16	7:55am	9:15am						DN		25	3:35pm	4:04pm

Appendix B Table 1. Mars Hill 2008 mortality survey effort during standard weekly and seasonal dog searches														
Standard weekly surveys														
Spring					Summer					Fall				
surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time	surveyor	date	turbine #	start time	end time
SA		18	9:30am	10:15am						DN		17	4:07pm	4:38pm
SA		24	10:20am	11:20am						JC		8	9:06am	9:32am
SA		26	11:30am	12:30am						JC		28	10:26am	11:01am
SA	6/6/2008	4	5am	5:50am						JC		27	11:05am	11:32am
SA		8	6am	6:50am						JC		26	11:35am	12:06pm
SA		9	7:20am	8:15am						JC		24	3:31pm	4:00pm
SA		10	8:20am	9:15am						JC		18	4:05pm	4:30pm
13 not searched due to turbine maintenance activities										BR		10	n/a	n/a
SA		21	9:30am	10:15am						BR		15	n/a	n/a
SA		23	10:20am	11:30am						BR		16	n/a	n/a



**Appendix B Table 2. Avian and bat fatalities found during Year 2 mortality monitoring at Mars Hill (2008)**

<b>Birds</b>											
Carcass #	Turbine	Date	Surveyor	Survey type	Time found	Species	Age/Sex	Carcass Position	Carcass disposition	Distance to Turbine (m)	Direction to Turbine
1	24	4/10/2008	J.C.	Incidental	12:00pm	golden-crowned kinglet	adult	on side	2-3 days	35	E 118
2	19	4/11/2008	J.C.	Incidental	8:30am	barred owl	n/a	scav	scav, 4-7 days	113	S 210
3	14	4/19/2008	S.A.	standard	8:30am	yellow-bellied sapsucker	n/a	scav	?	16	SW 230
4	12	4/20/2008	S.A.	standard	9:30am	downy woodpecker	n/a	scav	?	23	N 360
5	26	5/12/2008	S.A.	standard	1:30pm	ruby-crowned kinglet	adult	face up	1-2 weeks??	54	NW 310
6	9	5/20/2008	S.A.	standard	10:30am	bay-breasted warbler	adult male	face up	2-3 days	41	NNW 330
7	12	5/28/2008	S.A.	standard	8:40am	red-eyed vireo	adult	on side	fresh	42	N 360
8	16	5/29/2008	S.A.	standard	9:15am	red-eyed vireo	adult	face up	fresh	82	NE 50
9	1	6/3/2008	J.C.	dog, extended plot search	8:15am	red-eyed vireo	n/a	scav	?	18	N 358
10	16	7/31/2008	S.A.	standard	11:25am	common yellowthroat	n/a	face up	2+ weeks	47	NE 50
11	26	8/15/2008	J.C.	dog	8:28am	ovenbird	n/a	scav	scav, 2-3 days	40	NNW 340
12	12	8/23/2008	S.A.	standard	11:00am	red-eyed vireo	n/a	face up, scav	2+ weeks	5	N 360
13	7	8/26/2008	S.A.	Incidental	n/a	red-eyed vireo	adult	face up	2-3 days	on turbine platform	n/a
14	5	8/27/2008	S.A.	Incidental	8:00am	magnolia warbler	adult	on side	fresh	39	SW 230
15	22	8/27/2008	S.A.	standard	10:20am	magnolia warbler	adult	n/a	fresh	45	NE 50
16	4	9/2/2008	S.A.	standard	1:50pm	magnolia warbler	adult	n/a	over 2 weeks	40	SE 130
17	11	9/20/2008	S.A.	standard	8:30am	ruffed grouse	adult	on side	fresh	9	SE 130
18	10	9/22/2008	S.A.	standard	4:45am	red-eyed vireo	adult	on side	fresh	45	SSW 200
19	25	10/1/2008	J.C. and R.H.	dog	10:09am	yellow-bellied sapsucker	n/a	scav on edge of plot	2+weeks	50	SSE 170
20	20	10/8/2008	D.N.	standard	10:40am	yellow-bellied sapsucker	adult/female	belly up	fresh/still warm	19	WSW 243
21	10	10/8/2008	B.R.	standard	10:00am	black-and-white warbler	n/a	run-over	2+weeks	69	SSW 202
<b>Bats</b>											
1	4	8/5/2008	S.A.	standard	5:30am	red bat	scrotal male	face up, wing extended	fresh	10	NW 310
2	26	8/15/2008	J.C.	dog	8:06am	silver-haired bat	n/a	face down with wings folded under, wedged near rock	2+ weeks	28	NNW 340
3	2	8/23/2008	S.A.	standard	6:45am	red bat	n/a	face down	2-3 days	0.5	NNW 340
4	10	8/29/2008	S.A.	standard	9:10am	hoary bat	n/a	n/a	over 2 weeks	28	SW 230
5	22	9/3/2008	S.A.	standard	3:30pm	hoary bat	n/a	n/a	over 2 weeks	5	NW 310

**Appendix B Table 3.** Results of standard searcher efficiency trials for bird and bat carcasses 2008

<b>Birds</b>						
<b>Trial</b>	<b>Date</b>	<b>Turbine</b>	<b>Carcass id</b>	<b>carcass type</b>	<b>Ground cover type</b>	<b>Recovered in trial?</b>
1	6/3/2008	22	red-eyed vireo	medium bird	gravel/rock	no
1	6/3/2008	25	warbler sp.	small bird	bare rock patch in grass	no
1	6/3/2008	27	saw whet owl	large bird	short grass	yes
2	8/15/2008	2	black-capped chickadee	small bird	clover edge	no
2	8/15/2008	2	saw whet owl	large bird	clover	no
2	8/15/2008	2	warbler sp.	small bird	gravel	yes
2	8/15/2008	17	northern cardinal (f)	medium bird	gravel and sparse grass/clover	no
2	8/15/2008	10	gray catbird	medium bird	gravel	yes
2	8/15/2008	10	rose-breasted grosbeak (f)	medium bird	1-5" thicker-sparse grass	yes
3	9/30/2008	16	gray catbird	medium bird	gravel and clover	yes
3	9/30/2008	16	black-capped chickadee	small bird	gravel and grass	no
3	9/30/2008	3	house sparrow	medium bird	clump of grass in gravel	no
3	9/30/2008	3	house sparrow	medium bird	gravel and matted grass	no
3	9/30/2008	3	house sparrow	medium bird	pale rock	yes
3	9/30/2008	15	rose-breasted grosbeak (f)	medium bird	clover and grass	no
3	9/30/2008	15	saw whet owl	large bird	clover and grass	no
<b>Bats</b>						
<b>Trial</b>	<b>Date</b>	<b>Turbine</b>	<b>Carcass id</b>	<b>carcass type</b>	<b>Ground cover type</b>	<b>Recovered in trial?</b>
1	6/3/2008	22	little brown bat	small bat	bare ground in middle of grass	yes
1	6/3/2008	22	little brown bat	small bat	grass	no
1	6/3/2008	25	silver-haired bat	small bat	short grass/rock	yes
1	6/3/2008	25	silver-haired bat	small bat	short grass/rock	yes
1	6/3/2008	27	little brown bat	small bat	gravel and short grass	no
2	8/15/2008	2	little brown bat	small bat	gravel	no
2	8/15/2008	2	silver-haired bat	small bat	sparse clover	no
2	8/15/2008	17	silver-haired bat	small bat	gravel	no
2	8/15/2008	17	little brown bat	small bat	gravel and sparse grass/clover	no
2	8/15/2008	10	little brown bat	small bat	1-5" sparse grass/gravel	yes
3	9/30/2008	15	little brown bat	small bat	gravel	yes
3	9/30/2008	15	little brown bat	small bat	gravel near clump of grass	no

**Appendix B Table 4.** Results of dog searcher efficiency trials for bird and bat carcasses 2008

<b>Birds</b>						
<b>Trial</b>	<b>Date</b>	<b>Turbine</b>	<b>Carcass id</b>	<b>Carcass type</b>	<b>Ground cover type</b>	<b>Recovered in trial?</b>
1	9/9/2008	13	rose-breasted grosbeak	medium bird	sparse grass	yes
1	9/9/2008	7	saw-whet owl	large bird	tall grass/clover	yes
1	9/9/2008	7	bird	bird	tall grass/clover	no
1	9/9/2008	19	bird	bird	grass	no
1	9/9/2008	9	bird	bird	grass	no
2	10/1/2008	27	house sparrow (scavenged after left out that am)	medium bird	grass	yes
2	10/1/2008	25	house sparrow	medium bird	grass	yes
2	10/1/2008	25	house sparrow	medium bird	gravel	yes
2	10/1/2008	20	saw-whet owl	large bird	grass	yes
2	10/1/2008	20	rose-breasted grosbeak	medium bird	gravel and grass	yes
2	10/1/2008	17	gray catbird	medium bird	gravel and grass	yes
2	10/1/2008	17	black-capped chickadee	small bird	gravel and grass	yes
<b>Bats</b>						
<b>Trial</b>	<b>Date</b>	<b>Turbine</b>	<b>Carcass id</b>	<b>Carcass type</b>	<b>Ground cover type</b>	<b>Recovered in trial?</b>
1	9/9/2008	13	little brown bat	small bat	gravel	yes
1	9/9/2008	13	little brown bat	small bat	gravel	yes
1	9/9/2008	7	silver-haired bat	small bat	grass and gravel	no
1	9/9/2008	19	bat	bat	grass and gravel	no
1	9/9/2008	9	bat	bat	grass and gravel	no
2	10/1/2008	27	little brown bat	small bat	gravel	yes
2	10/1/2008	17	little brown bat	small bat	gravel and grass	yes

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Appendix B Table 5. Results of 14-day scavenger carcass removal trials 2008

Birds															
Trial #	Date	Turbine #	Carcass ID	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 10	Day 14	Removed on day	Notes	
1	5/12/2008	1	golden-crowned kinglet	present	present	present	present	present	unknown	absent - completely removed (except ribbon)			7		
1	5/12/2008	17	ovenbird	present	present	present	present	absent - ribbon and few feathers remained				5			
2	8/19/2008	5	American crow	present	present	present	present	absent (few feathers remained)				5			
2	8/19/2008	5	ruby-throated hummingbird	present	present	present	present	present	present	present	present	present	remained	insect scav activity visible on day 6, day 14 soft tissue removed by insects - feathers and skeletal remains	
2	8/19/2008	10	common grackle	present	present	present	present	present	present	present	scav but 2 feather spots still visible		remained visible	insect scav activity visible on day 6	
2	8/19/2008	10	American goldfinch	present	present	present	present	present	present	present	present	present	remained	head decay or insect activity visible on day 4	
2	8/19/2008	14	herring gull	absent									1		
2	8/19/2008	14	pigeon	absent (no evidence or parts remained)									1		
2	8/19/2008	21	American robin	absent (no evidence or parts remained)									1		
2	8/19/2008	21	mourning dove	present	present	present	present	absent (few feathers remained)				5	insect scav activity visible on day 4		
2	8/19/2008	26	blue jay	present	present	present	present	absent (few feathers remained)				5	insect scav activity visible on day 4		
2	8/19/2008	26	American woodcock	present	absent (no remains visible)									2	
3	9/19/2008	11	red-eyed vireo	present	present	present	present	present	present	present	absent (no remains visible)		10		
3	9/19/2008	11	house sparrow	present	present	present	present	present	present	absent (no remains visible)			7	possible insect scav on breast as of day 3	
3	9/19/2008	17	house sparrow	present	present	present	absent (no remains visible)				4				
3	9/19/2008	23	red-eyed vireo	present	absent (no remains)									2	
3	9/19/2008	23	house sparrow	present	present	present	present	present	absent (no remains)			6	insect scav activity visible on day 4		
3	9/19/2008	28	house sparrow	present	present	present	absent (no remains visible)				4				
3	9/19/2008	28	house sparrow	present	present	present	present	present	present	present	absent (no remains)		10	insect activity visible as of day 7	
3	9/19/2008	2	black-backed gull	present	present	present	present	absent, moved 52 m sse, wing separated from body				5	feather clumps and carcass still visible as of 10/8/2008 when removed (19 days after left out)		
13 of 20 remained on Day 4 = 65%															
3 of 20 remained on Day 14 = 15%															
Bats															
Trial #	Date	Turbine #	Carcass ID	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 10	Day 14	Removed on day	Notes	
1	5/12/2008	8	silver-haired bat	present	present	present	present	present	present	present	absent - completely removed (except ribbon)		10		
1	5/12/2008	8	silver-haired bat	present	present	present	present	present	present	present	absent - completely removed		10		
1	5/12/2008	1	little brown bat	present	absent - completely removed									2	
1	5/12/2008	17	silver-haired bat	present	present	absent - completely removed (except ribbon)				3					
2	8/19/2008	14	red bat	present	present	present	present	present	present	present	absent (no remaining parts)		10		
3	9/19/2008	17	red bat	absent (no remains visible)									1		
3 of 6 remained on Day 4 = 50%															
0 of 6 remained on Day 14 = 0%															

2008 Post-construction Monitoring  
Mars Hill Wind Farm, Maine

Appendix B Table 6. Incidental observations of songbirds and mammals within the Mars Hill Wind Farm (2007 and 2008)								
Date	Time	Surveyor	Weather conditions	Species ID	No. of closest turbine	Distance to closest turbine	If flying, flight height above ground	Description of general activity
<b>Songbirds</b>								
8/2/2007	n/a	JLC	n/a	thrush nest	15	118 m	n/a	nest found during extended plot search
4/11/2008	am	JLC	n/a	snow bunting	27	5-10 m	0-10 m	flushed from under tower by approaching vehicle, no observable reaction to turbine
4/11/2008	am	JLC	n/a	excessive woodpecker drumming marks on dead tree	11	20 m	n/a	appeared to be territorial drumming marks from a pileated woodpecker
4/22/2008	7:30am	SA	sunny	dark-eyed junco(s)	26	n/a	0.9 m	n/a
4/22/2008	7:30am	SA	sunny	dark-eyed junco	26	n/a	1 m	n/a
5/6/2008	11am	JLC	clear, calm warm	ruffed grouse (pair)	22	n/a	n/a	pair in woods
5/11/2008	5:45am	SA	sunny	sparrow sp.	2	n/a	n/a	flying within field in proximity of search plot
5/11/2008	8:15am	SA	sunny	American robin(s)	12	n/a	n/a	flying, some on ground
5/11/2008	10:15am	SA	n/a	dark-eyed junco	17	n/a	n/a	flew over surveyors head during search
5/12/2008	6am	SA	sunny	sparrow sp.	1	n/a	n/a	flushed from vicinity of tower into field
5/12/2008	8am	SA	sunny	American robin(s)	5	n/a	n/a	flying around, some on ground
5/17/2008	4am	SA	windy, partly cloudy	American robin	22	n/a	n/a	foraging on the ground in search plot
5/18/2008	6:45am	SA	sunny, light wind	song sparrow	2	n/a	0.3 m	approached vehicle when surveyor played recording of savannah sparrow, vocalized
5/18/2008	6:45am	SA	sunny, light wind	American robin	6	n/a	0.3 m	flushed from search plot
5/19/2008	5:30am	SA	overcast, light rain	song sparrow	1	0 m	n/a	song sparrow foraging at base of turbine, observed on platform
5/19/2008	6:35am	SA	heavy rain	American robin	3	n/a	0.61 m	flew over search plot
5/19/2008	7:45am	SA	heavy rain	dark-eyed junco	5	n/a	n/a	close to tower, foraging on ground in search plot
5/20/2008	7:20am	SA	partly cloudy, windy	dark-eyed junco	26	n/a	n/a	foraging in rocky area at edge of search plot
5/23/2008	5:15am	SA	partly cloudy, windy	American crow	1	5 m	n/a	flushed from search plot as surveyor approached
5/24/2008	5:10am	SA	overcast, light rain	American robin	4	n/a	n/a	on ground, flushed as surveyor approached
5/28/2008	7:10am	SA	sunny, windy	American robin(s)	3	n/a	1 m	flying about road and search plot, some on ground
5/29/2008	5:55am	SA	windy, overcast	American robin	3	n/a	1 m	in search plot area
5/30/2008	5am	SA	windy, sunny	American robin	4	n/a	n/a	spread out in plot, foraging in search area
5/30/2008	9:25am	SA	windy, sunny	dark-eyed junco	13	n/a	n/a	at search plot edge
6/4/2008	8:15am	SA	mostly cloudy, breezy	common raven	15	n/a	4.5 - 6 m	flew from search area as surveyor approached, something in beak
6/5/2008	4:45am	SA	fog, light wind	American crow(s)	1	n/a	n/a	flew to other edge of search plot as surveyor approached
6/5/2008	5:50am	SA	sunny, light wind	American robin (3)	3	n/a	n/a	foraging, flying in search area, no reaction to surveyor or turbine
7/15/2008	6:30am	SA	windy, partly cloudy	American robin	11	n/a	n/a	foraging in search plot
7/16/2008	6:40am	SA	light wind, sunny	dark-eyed junco	6	n/a	n/a	foraging in search plot
7/16/2008	8am	SA	light wind, sunny	dark-eyed junco	7	n/a	n/a	foraging in search plot
7/16/2008	8am	SA	light wind, sunny	American robin (2)	7	n/a	n/a	foraging in search plot
7/17/2008	11am	SA	light wind, sunny	sparrow sp. (3)	1	n/a	n/a	at edges of search plot
7/22/2008	4:45am	SA	light wind, cloudy	American crow (2)	4	n/a	n/a	flying low in turbine area, flushed as surveyor approached search plot
7/22/2008	7:10am	SA	light wind, cloudy	American robin	11	n/a	n/a	perched on transect markers and rocks
7/22/2008	10:30am	SA	light wind, cloudy	American robin	14	n/a	n/a	flying low and foraging, flushed as surveyor approached search plot
7/24/2008	10:50am	SA	light wind, cloudy	song sparrow(s)	1	n/a	n/a	in vicinity of search plot
7/25/2008	5:00am	SA	light rain and wind	song sparrow(s)	2	n/a	n/a	n/a
7/25/2008	6:35am	SA	light rain and wind	dark-eyed junco	5	17 m	n/a	foraging
7/26/2008	8:45am	SA	sunny, calm	common raven	15	n/a	n/a	flushed from site as surveyor approached
7/29/2008	8:15am	SA	partly cloudy	American robin (4)	12	n/a	n/a	perched on rocks at edge of plot
8/1/2008	8am	SA	showers	mourning dove	2	n/a	n/a	in access road to tower
8/1/2008	8am	SA	showers	song sparrow (2)	2	n/a	n/a	along edges of search plot
8/5/2008	6:31am	SA	cloudy, windy	red-winged blackbird	1	n/a	n/a	perched on branch at edge of search plot
8/6/2008	6:15am	SA	cloudy, windy	American robin	14	n/a	n/a	foraging in vicinity of tower
8/6/2008	9:20am	SA	cloudy, windy	dark-eyed junco(s)	27	n/a	n/a	foraging in grass
8/8/2008	6:15am	SA	fog and rain	dark-eyed junco(s)	7	20 m	n/a	foraging
8/9/2008	9:15am	SA	fog and rain	common raven	15	n/a	n/a	leaving site as surveyor approached
8/9/2008	9:30am	SA	fog and rain	American crow (2)	14	n/a	n/a	flying high in proximity of blades - blades not moving
8/9/2008	11:40am	SA	partly sunny	dark-eyed junco(s)	17	25 m	n/a	foraging in tall clover
8/14/2008	5:30am	SA	foggy and windy	red-winged blackbird(s)	1	n/a	n/a	agitated behavior in field surrounding search plot
8/15/2008	10am	JLC	fog	dark-eyed junco	21	50 m	n/a	flock foraging and resting in tall grass under towers
8/15/2008	10am	JLC	fog	dark-eyed junco	19	25 m	n/a	flock foraging and resting in tall grass under towers
8/15/2008	11:30am	JLC	partly cloudy	cedar waxwing	14	30-60 m	15 m	flying from perch at edge of plot to forage on insects perched on ground at the edge of the tower, flushed as vehicle approached
8/15/2008	2:10pm	JLC	sunny	American crow (6)	2	0 m	15 m	flushed as vehicle approached
8/15/2008	7:30am	SA	foggy and windy	dark-eyed junco(s)	8	n/a	n/a	foraging on side of road just outside search plot
8/23/2008	5:50am	SA	cloudy, calm	sparrow sp.	2	n/a	n/a	foraging at search plot
8/26/2008	10:30am	SA	foggy and windy	dark-eyed junco (flock)	12	n/a	n/a	foraging, flushed as surveyor approached
8/28/2008	5:45am	SA	cloudy and windy	dark-eyed junco	2	n/a	n/a	foraging
8/28/2008	5:45am	SA	cloudy and windy	dark-eyed junco (flock)	10	n/a	n/a	foraging, flushed as surveyor approached, some returned during mortality search
9/6/2008	2:15pm	SA	foggy and windy	dark-eyed junco	19	n/a	n/a	foraging on western edge of search plot
9/28/2008	8:20am	SA	rainy, windy, foggy	dark-eyed junco (2)	17	n/a	n/a	foraging on edge of search plot
<b>Mammals</b>								
2007	n/a	JLC	n/a	white-tailed deer tracks	T1	20 m	n/a	n/a
2007	n/a	JLC	n/a	moose tracks	T15	60 m	n/a	n/a
2007	n/a	JLC	n/a	moose tracks	T26	63 m	n/a	n/a
2007	n/a	JLC	n/a	moose scat and tracks, bear scat, deer tracks	general	60-119 m	n/a	scat and tracks regularly found during mortality searches in cleared and leveled plots
2007	am	JLC	n/a	moose	2 and 3	60-100 m	n/a	ran between turbines
2007	am	JLC	n/a	male and female white-tailed deer	2	300 m	n/a	ran through field east of turbine 2
4/11/2008	am	JLC	n/a	moose tracks	27	n/a	n/a	observed in search plot
4/11/2008	am	JLC	n/a	evidence of moose foraging	11	20 m	n/a	ungulate tooth marks on saplings
4/11/2008	am	JLC	n/a	fisher tracks	9	on edge of plot clearing	n/a	tracks in snow on west side of tower
4/19/2008	12:10pm	SA	sunny	juvenile moose	26	n/a	n/a	leaving site
5/4/2008	11:30am	SA	sunny	red fox	3	n/a	n/a	crossing road
5/4/2008	12:30pm	SA	sunny	red fox	5	n/a	n/a	crossing field, possibly same fox seen earlier, had prey in mouth
5/5/2008	early pm	JLC	overcast, 48-52 F, 0-3 mph	red fox	8	on east edge of plot	n/a	ran off as vehicle approached, ran along slope east of ridge
5/5/2008	4pm	JLC	overcast, 48-52 F, 0-3 mph	red fox	2	150 m	n/a	ran away as vehicle approached then foraging for rodents at woodlot edge
5/11/2008	7am	SA	sunny	red fox	2 and 3	n/a	n/a	wandering/foraging in field between the two towers
5/11/2008	7:10am	SA	sunny	moose (2)	7	n/a	n/a	2 juveniles seen leaving turbine clearing and entering woods
5/13/2008	6:30am	SA	sunny	juvenile moose	4	n/a	n/a	juvenile in forest border east of tower, staring at surveyor
5/27/2008	6:15am	SA	mostly cloudy, windy	porcupine	5	n/a	n/a	crossing road from turbine 5 and entered woods
5/28/2008	7:20am	SA	sunny, windy	juvenile moose	17	n/a	n/a	walking along road
5/30/2008	6am	SA	sunny, windy	juvenile moose	7 and 8	n/a	n/a	eating grass on the side of the road ran toward woods at turbine 8 as surveyor approached
8/21/2008	5:20am	SA	partly cloudy	bear cub	17	n/a	n/a	in road, entered woods as surveyor drove past
10/1/2008	11:00am	JLC	n/a	bear scat	20	35 m	n/a	scat found in search plot

<b>Appendix B Table 7. Songbirds heard or seen at Mars Hill during 2007 and 2008</b>	
<b>2007 - species heard on Project ridge or at pond near substation</b>	<b>2008 - species heard on project ridge or at pond near substation</b>
alder flycatcher	alder flycatcher
American crow	American crow
American goldfinch	American goldfinch
American kestrel (pair)	American redstart
American redstart	American robin
American robin	blackburnian warbler
blackburnian warbler	black-capped chickadee
black-capped chickadee	black-throated blue warbler
black-throated blue warbler	black-throated green warbler
black-throated green warbler	blue jay
blue jay	blue-headed vireo
bobolink	bobolink
Canada goose	chestnut-sided warbler
cedar waxwing	common raven
common raven	common yellowthroat
common yellowthroat	dark-eyed junco
dark-eyed junco	eastern phoebe
downy woodpecker	gray catbird
hermit thrush	great-created flycatcher
magnolia warbler	hermit thrush
mallard	hooded merganser
northern flicker	least flycatcher
northern harrier	northern parula
northern parula	ovenbird
ovenbird	red-eyed vireo
red-eyed vireo	red-winged blackbird
red-winged blackbird	ruby-throated hummingbird
savannah sparrow	savannah sparrow
song sparrow	song sparrow
spotted sandpiper	white-throated sparrow
white-breasted nuthatch	winter wren
white-throated sparrow	yellow warbler
yellow warbler	yellow-rumped warbler

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Appendix B Table 8. Raptor observations during standardized searches and observed incidentally during 2007 and 2008

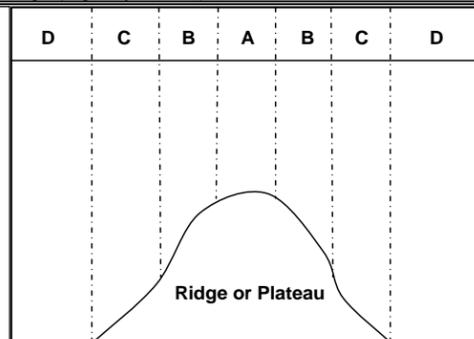
Date	Observer	Obs #	Time	No. of closest turbine	Species	Number of individuals	Age (J, Sub-A or A)	Minimum flight height agl (m) within 1 km buffer circle	Maximum flight height agl (m) within 1 km buffer circle	flight position A	flight position A1	flight position A2	flight position A3	flight position B	flight position C	flight position D	Flight Behavior (code)**	Flight Direction	Migrant/Resident (M,R)	General Activity, Location, Other	Distance to closest turbine
2007	JLC	1*	n/a	1 and 2	northern harrier	1	n/a	n/a	n/a								H	n/a	R	seen on multiple occasions foraging in fields surrounding northern most turbines	n/a
4/10/2008	JLC	1*	12pm	28	red-tailed hawk	1	n/a	600	n/a								l	n/a	r	not in direct vicinity of towers, hovering and diving over valley west of ridge, resident behavior	150 m
5/5/2008	JLC	1*	3:30pm	4	bald eagle	1	a	200	n/a								D	E	uknwn	flew directly over active tower	80 m above tower
5/6/2008	JLC	1*	3:34pm	14	red-tailed hawk	1	n/a	5	10	1							l	n/a	r	perched then flushed by approaching vehicle, low flight into trees	43 m
5/6/2008	JLC	1*	3:49pm	12	turkey vulture	1	n/a	100	n/a								D	S	uknwn	flying over slope east of ridge, heading south SE of turbine 20 soaring over slope and valley	150 m
5/6/2008	JC	1	12:10	n/a	turkey vulture	3	n/a	n/a	250								S	n/a	R	mobbed by raven as soaring over ridge N of turbine 20	n/a
5/6/2008	JC	2	12:15	n/a	bald eagle	1	j	200	300								S	n/a	uknwn	mobbed by raven, flew north then west near turbine 20 and 19	n/a
5/6/2008	JC	3	1:29	n/a	red-tailed hawk	1	a	n/a	200								l	NW	uknwn	circled over valley east of ridge	n/a
5/6/2008	JC	4	2:09	n/a	turkey vulture	3	n/a	n/a	300								l	n/a	R	flushed from site when surveyor arrived	n/a
5/11/2008	SA	1*	9:15am	15	raptor sp.	1	n/a	n/a	n/a								n/a	n/a	r	flew low over road and moving vehicle of surveyor	n/a
5/17/2008	SA	1*	1:30am	17	red-tailed hawk	1	n/a	1 m	n/a								n/a	n/a	r	flew over turbine clearing	n/a
5/20/2008	SA	1*	11:40am	26	red-tailed hawk	1	n/a	4.5	n/a								n/a	n/a	r	flying south on east side of ridge	n/a
9/25/2007	AG	1	1:22	n/a	osprey	1	n/a	153	n/a								n/a	S	n/a	kiting to the north, heading south on east side of ridge	n/a
9/25/2007	AG	2	1:43	n/a	osprey	1	n/a	153	n/a								n/a	S	n/a	flying low east of the ridge, disappeared below ridge	n/a
9/25/2007	AG	3	3:26	n/a	osprey	1	n/a	n/a	n/a								n/a	S	n/a	moving SSW along east side of ridge, attempted to cross ridge at turbine 27 got less than 80 m from turbine 27 and directly avoided approaching the spinning blade by flying SE	n/a
9/25/2007	MD	1	1:50	n/a	osprey	1	n/a	75	250								n/a	S	n/a	soaring over valley to the NW	n/a
9/25/2007	MD	2	2:25	n/a	unidentified buteo	1	n/a	n/a	100								n/a	n/a	n/a	mobbed by raven flying over slope west of turbine 20	n/a
9/8/2008	JC	1	10:10	n/a	broad-winged hawk	1	n/a	70	95	1							D	n/a	n/a	raven attacking then RTHA diving at raven west of T 20	70 to 100 m
9/8/2008	JC	2	10:15	n/a	red-tailed hawk	1	a	40	95	1							l	n/a	possible	slope west of 20	n/a
9/8/2008	JC	3	10:22	n/a	broad-winged hawk	1	n/a	70	300	1							D	n/a	n/a	soaring high over valley mobbed by raven then diving at raven	n/a
9/8/2008	JC	4	10:22	n/a	broad-winged hawk	1	n/a	95	400								D	S	m	40 m from turbine 19, flew over turbine clearing then the slope west of turbine 20	40 m
9/8/2008	JC	5	10:44	n/a	red-tailed hawk	1	n/a	n/a	1000								l	SW	possible	flying west away from ridge	n/a
9/8/2008	JC	6	11:06	n/a	broad-winged hawk	2	n/a	30	n/a	2							D	n/a	m	was at 80 m when crossed ridge north of turbine 19	n/a
9/8/2008	JC	7	11:10	n/a	broad-winged hawk	1	n/a	400	n/a								D	W	m	direct flight sw of ridge over valley	n/a
9/8/2008	JC	8	11:19	n/a	red-tailed hawk	1	n/a	80	800								D	E	n/a	hovering into wind over valley and slope west of turbine 20	n/a
9/8/2008	JC	9	11:20	n/a	bald eagle	1	a	500	800								D	SSE	n/a	came within 50-70 m of turbine 19 at closest point, crossed ridge between turbine 19 and 20, increased altitude as crested ridge, flew along west slope of ridge	50-70 m
9/8/2008	JC	10	1:20	n/a	red-tailed hawk	1	n/a	10	800								n/a	SSW	R	hovering and moving low over slope west of turbine 20	250 m
9/8/2008	JC	11	2:33	n/a	osprey	1	n/a	150	n/a								D	n/a	M	soaring high west of ridge then crossed over at south end of ridge	n/a
9/8/2008	JC	12	2:53	n/a	red-tailed hawk	1	n/a	20	700	1							l	n/a	R	soaring high west of ridge then crossed over at south end of ridge	n/a
9/10/2008	JC & BR	1	9:44	n/a	red-tailed hawk	1	A	n/a	150								D	S	m	soaring locally 400 m west of turbine 1	400 m
9/10/2008	JC & BR	2	10:39	n/a	broad-winged hawk	2	n/a	n/a	519	2							D	S	m	soaring locally 400 m west of turbine 1	400 m
9/10/2008	JC & BR	3	10:49	n/a	broad-winged hawk	1	n/a	n/a	213								D	SSW	m	soaring locally 400 m west of turbine 1	400 m
9/10/2008	JC & BR	4	10:57	n/a	broad-winged hawk	1	n/a	n/a	213	1							D	SSW	m	soaring locally 400 m west of turbine 1	400 m
9/10/2008	JC & BR	5	1:05	n/a	broad-winged hawk	2	n/a	n/a	6100	2							D	SSE	m	soaring locally 400 m west of turbine 1	400 m
9/29/2008	JLC	1*	3:30pm	1	peregrine falcon	1	n/a	45	n/a								D	S	m	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JC	1	10:55	n/a	bald eagle	1	j	130	140								l	ENE	uknwn	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JC	2	11:09	n/a	red-tailed hawk	2	a	35	80								l	n/a	r	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JC	3	11:37	n/a	northern harrier	1	a/female	30	50								l	N	r	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JC	4	1:07	n/a	red-tailed hawk	1	a	70	90								l	S	n/a	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JC	5	1:14	n/a	sharp-shinned hawk	1	n/a	60	100								D	WNW	r	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JLC	1*	9:30am	16	red-shouldered hawk	1	n/a	10	15	1							l	n/a	uknwn	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JLC	1*	4:13pm	23	red-tailed hawk	1	n/a	40	n/a	1							l	n/a	r	soaring locally 400 m west of turbine 1	400 m
9/30/2008	JLC	2*	4:15pm	19	red-tailed hawk	1	n/a	25	n/a	1							l	n/a	r	soaring locally 400 m west of turbine 1	400 m

\*Observation made incidentally, not during standardized surveys.

\*\*H=hunting, S=soaring, l=indirect flight (non-migratory behavior), D=direct flight (migratory behavior).

Horizontal Position Code (see figure):

- A) occurred directly over ridge top or plateau
- A1.) majority of observed flight occurred parallel to/along ridge
- A2.) crossed ridge (perpendicularly) at some point and only a fraction of observed flight occurred over ridge
- A3.) crossed ridge within a depression in elevation/saddle of mountain
- B) upper slope of ridge
- C) lower slope of ridge
- D) over valley



<b>Appendix B Table 9. Revised species identifications of 7 bird fatalities found at the Mars Hill Wind Farm during 2007 surveys and supplemental fall 2007 findings</b>								
<b>Survey Type or Incidental</b>	<b>Common name</b>	<b>Scientific name</b>	<b>Date</b>	<b>Time</b>	<b>Turbine #</b>	<b>Distance (m) from tower</b>	<b>Compass direction from tower</b>	<b># of days decomposed</b>
Incidental	hairy woodpecker	<i>Picoides villosus</i>	4/20/2007	9:30 AM	12	71	22.5 N	2-3
Incidental	white-throated sparrow	<i>Zonotrichia albicollis</i>	4/23/2007	3:30 PM	19	41	East	fresh
Standard	golden-crowned kinglet	<i>Regulus satrapa</i>	4/24/2007	3:20 PM	23	40	due south	4-7
Standard	black-throated green warbler	<i>Dendroica virens</i>	5/18/2007	12:15 PM	16	46	120 SE	fresh
Standard	blackburnian warbler	<i>Dendroica fusca</i>	5/18/2007	12:30 PM	16	40	160 SE	fresh
w/ dog	warbler sp.	<i>Parulinae sp.</i>	6/2/2007	4:45 PM	12	73	SW	scavenged
w/ dog	golden-crowned kinglet	<i>Regulus satrapa</i>	6/2/2007	5:15 PM	26	59	N	2 weeks+
Standard	ovenbird	<i>Seiurus aurocapillus</i>	6/3/2007	10:30 AM	3	38	S	fresh
Incidental	blackburnian warbler	<i>Dendroica fusca</i>	6/21/2007	n/a	13	1	E	2 weeks+
w/ dog	unidentified songbird	n/a	8/10/2007	3:46 PM	20	36	SE	scavenged
w/ dog	red crossbill	<i>Loxia curvirostra</i>	8/10/2007	5:23 PM	17	7	WNW	2 weeks+
w/ dog	red-eyed vireo	<i>Vireo olivaceus</i>	8/10/2007	6:53 PM	10	1.2	understairs to tower	2 weeks+
w/ dog	bay-breasted warbler	<i>Dendroica castanea</i>	8/12/2007	10:37 AM	11	40	S	4-7
Standard	warbler sp.	<i>Parulinae sp.</i>	8/16/2007	3:45 PM	12	3	S	2 weeks+
Standard	veery	<i>Catharus fuscescens</i>	9/2/2007	3:00 PM	3	25	SW	fresh
w/ dog	yellow-rumped warbler*	<i>Dendroica coronata</i>	9/20/2007	10:00 AM	8	40	NNE 30	scavenged
w/ dog	black-and-white warbler*	<i>Mniotilta varia</i>	9/20/2007	12:00 PM	13	68	W	scavenged
w/ dog	song sparrow*	<i>Melospiza melodia</i>	9/20/2007	1:00 PM	17	31	N	scavenged
w/ dog	magnolia warbler*	<i>Dendroica magnolia</i>	9/21/2007	10:45 AM	24	26	NW	scavenged
w/ dog	red-eyed vireo*	<i>Vireo olivaceus</i>	9/21/2007	12:24 PM	28	39	N	scavenged
w/ dog	ovenbird*	<i>Seiurus aurocapillus</i>	9/21/2007	1:56 PM	26	40	N	scavenged
w/ dog	red-eyed vireo*	<i>Vireo olivaceus</i>	9/22/2007	6:55 AM	3	19	NE	4-7
<b>Supplemental fall 2007 results (surveys conducted after completion of mortality search season)</b>								
Incidental (w/ dog)	golden-crowned kinglet	<i>Regulus satrapa</i>	9/25/2007	9:30 AM	27	22	N	scavenged
Incidental	dark-eyed junco	<i>Junco hyemalis</i>	9/25/2007	7:00 AM	20	122	E	run over
Incidental (w/ dog)	swamp sparrow	<i>Melospiza georgiana</i>	9/26/2007	9:00 AM	16	33	ENE	scavenged

\*Indicates bird that was identified to species level in 2008 by Smithsonian National Museum of History.