Summer and Fall 2009 Avian and Bat Survey Report

Summer and Fall 2009
Avian and Bat Survey Report

for the Bull Hill Project
In T16 MD, Maine

Prepared for

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Executive Summary

In advance of permitting activities for the proposed Bull Hill Wind Project (Project) in T16 MD, Maine, Blue Sky East Wind, LLC contracted Stantec Consulting Services Inc. (Stantec) to perform bird and bat scientific surveys for the purpose of evaluating 2009 summer and fall activity within the Project area. Survey methods and work plans, including nocturnal marine radar surveys, bat detector surveys, and raptor migration field surveys, were developed in consultation with state and federal wildlife agencies.

Nocturnal Marine Radar Survey

Radar surveys were conducted during 20 nights in fall 2009 (between September 1 and October 15) to characterize nocturnal migration activity in the Project area. Surveys were conducted using X-band radar, sampling from sunset to sunrise. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar was located on the summit of Bull Hill and provided adequate visibility of the surrounding airspace to characterize migration.

The overall mean passage rate for the entire fall survey period was 614 ± 32 targets per kilometer per hour (t/km/hr), and nightly passage rates varied from 188 ± 30 to 1500 ± 209 t/km/hr. Mean flight direction through the Project area for the season was 260± 66°. The seasonal mean flight height of targets was 356 ± 9 meters (m; 1168 ft ['']) above the radar site, and nightly flight heights ranged from 208 ± 9 m to 558 ± 22 m. The percent of targets observed flying below 145 m (476') (the height of the proposed turbines) was 14 percent for the entire season.

The mean passage rate of 614 t/km/hr at Bull Hill is on the higher end of the range of results reported at other sites in forested landscapes in the northeast. Mean flight height of targets at the Project is similar to flight heights reported from other studies.

Bat Detector Survey

The goal of the acoustic surveys was to characterize seasonal patterns in bat activity levels and examine how weather conditions influence bat activity at the Project. Six Anabat® acoustic bat detectors were deployed in the Project area between mid July and early November to document bat activity. Two detectors were deployed on the Little Bull Hill meteorological tower (met tower), and four were deployed in trees throughout the Project area. Detectors were deployed at relatively low heights where increased bat activity levels are generally documented, particularly during the non-migratory periods. Data were summarized by guild and species and tallied per detector on an hourly and nightly basis.

Detectors operated properly for most of the season, resulting in 634 detector nights of data. During this survey period, 4657 call sequences were recorded, resulting in a detection rate of 0.2 bat call sequences per detector night for the met tower detectors combined, and 10.8 bat

call sequences per detector night for the tree detectors combined. The NE Tree Detector had the highest monthly detection rate (37.4 call sequences per detector night) in July. Detection rates recorded during the fall 2009 season at the Project are at the low end of the range found at other forest edge detector sites in the northeast.

Raptor Migration Field Survey

Raptor migration surveys were conducted during two seasons: on 6 survey days from August 1 to August 27 for summer surveys, and on 12 survey days from September 2 to October 14 for fall raptor migration surveys. The primary goal of summer surveys was to characterize bald eagle activity in the Project area during the late-fledging period. The primary goal of the fall surveys was to characterize raptor movement in the Project area during the fall migration season. Total survey hours for each season were 46 and 87, respectively. Visual observation surveys were conducted from 9 am to 4 pm and were based on Hawk Migration Association of North America methods.

No bald eagles were observed during summer surveys. A total of 24 raptors representing 6 species were observed during summer surveys. Red-tailed hawk (*Buteo jamaicensis*) and turkey vulture (*Cathartes aura*) were the most commonly observed species. Daily counts ranged from 2 to 6 raptors and the overall passage rate was 0.52 birds/hour. Of total raptors observed, four percent were observed in the Project area during summer surveys, and 100 percent of those were documented flying at heights less than 145 m for at least a portion of their flight during summer surveys.

During fall raptor migration surveys, a total of 124 raptors representing 11 species were observed. Sharp-shinned hawk (*Accipiter striatus*) and turkey vulture were the most commonly observed species. Daily counts ranged from 5 to 19 raptors and the overall passage rate was 1.43 birds/hour. Of total raptors observed during fall migration surveys, 48 percent were observed in the Project area, and 98 percent of those were documented at heights less than 145 m for at least a portion of their flight.

No state or federal endangered, threatened or special concern raptor species were observed during the 2009 summer surveys. During fall 2009 surveys, one state endangered raptor species, peregrine falcon (*Falco peregrinus*), was observed in the Project area, as well as two state special concern species, bald eagle (*Haliaeetus leucocephalus*) and northern harrier (*Circus cyaneus)*.

Patterns in flight characteristics at the Project are similar to the results of other surveys in forested ridges in the northeast.

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* *This report was prepared by Stantec Consulting Services Inc. for Blue Sky East Wind, LLC. The material in it reflects Stantec's judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any suffered by any third party as a result of decisions made or actions based on this report.*

1.0 Introduction

Blue Sky East, LLC. (Blue Sky East), an affiliate of First Wind, is considering construction of a commercial-scale wind energy project located in T16 MD, Hancock County, Maine (Figure 1-1). The Bull Hill Wind Farm (the Project) includes two separate turbine arrays[1] on lower elevation hillsides: one on Bull Hill and one on Heifer Hill and Beech Knoll. The Project will consist of 19 turbines, access roads, and a transmission line. Turbines will be mounted on tubular steel towers with an approximate hub height of up to 95 meters (m) and a rotor diameter of 100 m. The proposed turbines would have a height of up to 145 m (476 feet ['']) to the tip of a fully extended blade.

Following is a brief description of the Project; a review of the methods used to conduct scientific surveys and the results of those surveys; a discussion of results; and the conclusions reached based on those results.

1.1 PROJECT BACKGROUND

In advance of permitting activities for the Project, Blue Sky East contracted Stantec to perform bird and bat scientific surveys for the purpose of evaluating 2009 summer and fall activity near and within the Project area. This report describes the work conducted by Stantec during summer and fall 2009, including summer eagle surveys and fall radar surveys, raptor surveys and acoustic bat surveys.

On July 30, 2009, prior to initiation of field surveys, Blue Sky East and Stantec presented a draft work plan for comprehensive natural resource surveys during an initial agency consultation with biologists from the Maine Department of Inland Fisheries and Wildlife (MDIFW).

Stantec conducted a site visit with regional and state MDIFW biologists on October 6, 2009, to allow agency staff to observe existing ecological conditions within the Project area, to be informed of remaining field survey efforts and field survey results to date, and to assess future Project planning considerations. Three meteorological towers (met towers) were erected in the summer of 2009 in the Project area.

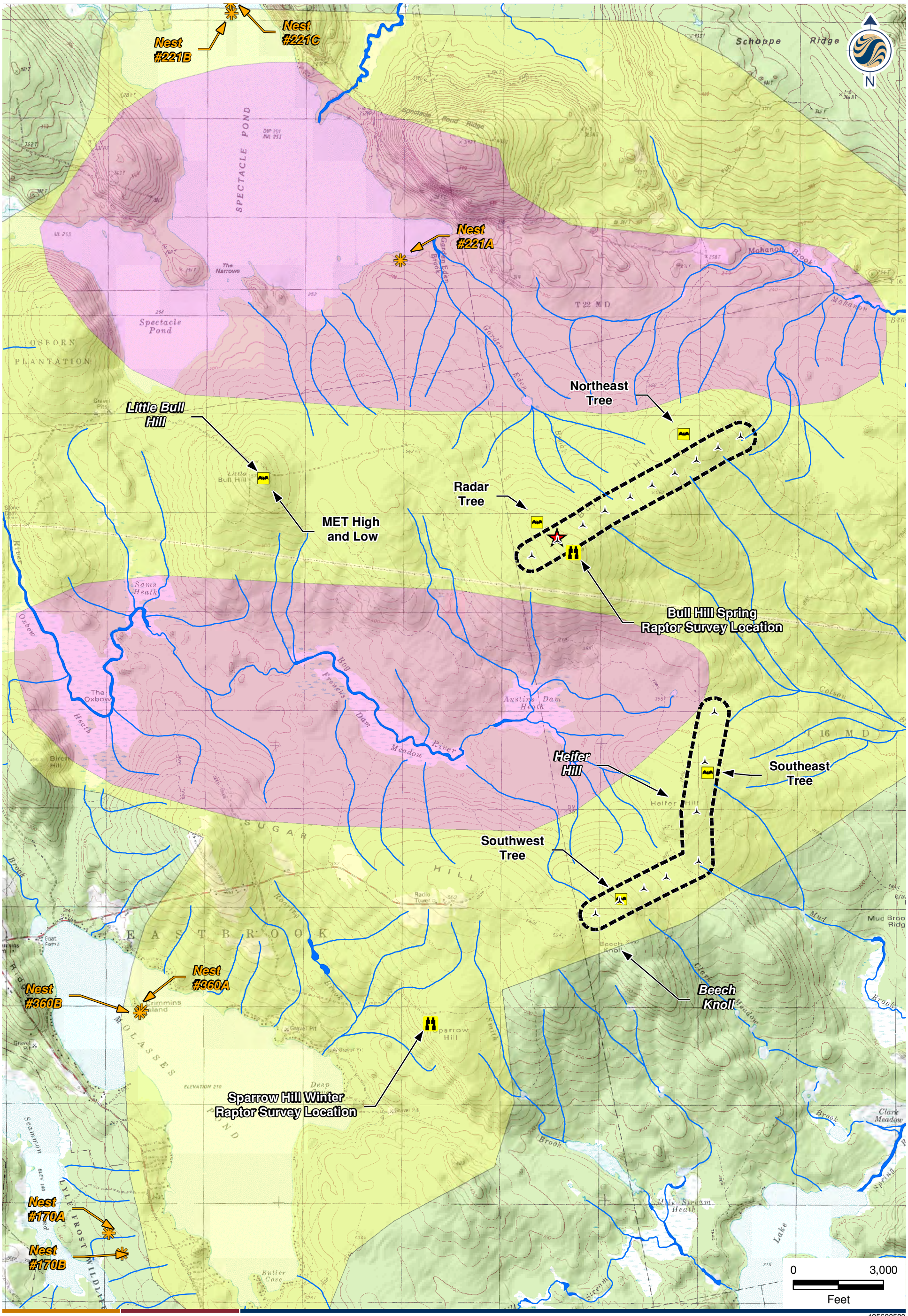
1.2 PROJECT AREA DESCRIPTION

The Project area consists of a series of coastal low elevation hills: Bull Hill, Beech Knoll and Heifer Hill (Figure 1-1). At 255 meters ([m], 837 feet ['']) above sea level, Bull Hill has the highest elevation in the Project area and like the other peaks, consists of gently sloping to moderately steep topography. An existing network of well-maintained logging roads is present throughout the Project area and the effects of past and current timber harvesting are evident across the entire Project area, from large clear-cuts to small selective harvesting areas. Aside from the roads and skidder trails, the Project area is almost entirely undeveloped.

[1] This report was revised in October 2010 to reflect the height of the recently chosen turbines and the revised 19-turbine, two turbine array, Project area layout.

The Project is located in the Eastern Lowlands biophysical region. This region is characterized by extensive lowlands with elevations generally below 600'. The region also contains the largest concentration of peatlands, marshes, and swamps in the state. The representative vegetation communities present within the Project area include: forested uplands and wetlands, scrub-shrub wetlands, emergent wetlands, and stream systems. Examples of these wetland communities present near the Project area include: Oxbow Heath, Frenchs Dam Meadow, and Austins Dam Heath. These communities are large, open wetland systems with dense ericaceous shrubs amidst areas of open water; stands and even individual dead standings trees appear to be infrequent based on initial visits to these areas. Forested communities are representative throughout and dominate higher elevations within the Project area, while wetland systems are most common at lower elevations. The proposed Project area includes a variety of natural community types including, but not limited to, Beech-Birch-Maple Forest, Spruce-Northern Hardwoods Forest, and Red Oak-Northern Hardwoods-White Pine Forest. Dominant canopy species present in the Project area include white pine (*Pinus strobus*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), balsam fir (*Abies balsamea*), red oak (*Quercus rubra*), white ash (*Fraxinus americana*), paper birch (*Betula papyrifera*), and gray birch (*Betula populifolia*). Common shrub species include hobblebush (*Viburnum lantanoides*), witch-hazel *(Hamamelis virginiana*), American beech (*Fagus grandifolia*), and the aforementioned tree species. Herbaceous species present in the Project area include Canada mayflower (*Maianthemum canadense*), partridgeberry (*Mitchella repens*), wintergreen (*Gaultheria procumbens*), bunchberry (*Cornus canadensis*), bracken fern (*Pteridium aquilinum*), wild sarsaparilla (*Aralia nudicaulis*), starflower (*Trientalis borealis*), and evergreen wood fern (*Dryopteris intermedia*). The majority of wetlands in the area are forested, with occasional scrub-shrub and emergent wetlands associated with disturbance from timber harvesting. Streams are primarily high-gradient, fast-moving perennial and intermittent streams that exhibit heavy flow in spring and during rain events, and little to no flow during the summer and dry periods.

The Project area is located between the Union River and Narraguagus River watersheds. These rivers and associated perennial streams are Designated Critical Habitat for the federally-listed Atlantic salmon (*Salmo salar*). The Project area is not within designated critical habitat for Canada lynx (*Lynx canadensis*). Three bald eagle nests were identified within four miles of the Project area located on Spectacle Pond, Molasses Pond, and Scammon Pond (Figure 1-1). The proposed turbine portion of the Project area does not intersect any state protected wildlife areas, such as Inland Waterfowl and Wading Bird Habitat or Deer Wintering Areas.



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Legend

- Proposed Turbine Layout (7-16-10)
- Radar Location
- Bat Detector
- Bald Eagle Nests
- Areas Visible During Raptor Survey
- Areas Not Visible During Raptor Survey
- Bull Hill Turbine Delineation Limit (7-16-10)
- USGS River and Streams

Client/Project
Blue Sky East Wind, LLC
Bull Hill
Eastbrook and T16 MD, Maine

Figure No.
1-1

Title
2010 Radar, Raptor, & Acoustic Survey Location Map
August 5, 2010

00500-F001-1-EagleRaptor-Survey-Viewshed.mxd

2.0 Nocturnal Radar Survey

2.1 INTRODUCTION

Radar surveys were conducted in the Project area to characterize fall 2009 nocturnal migration patterns. The majority of North American passerines (songbirds) migrate at night; the strategy of migrating at night may have evolved to take advantage of more stable atmospheric conditions for their flapping flight (Kerlinger 1995). Additionally, cooler nighttime temperatures may provide a more efficient medium to regulate body temperature during more active, flapping flight and reduce predation risk while in flight (Alerstam 1990, Kerlinger 1995). Documenting the patterns of nocturnal migrants requires the use of radar or other non-visual technologies. The goal of the surveys was to document the overall passage rates for nocturnal migration in the vicinity of the Project area, including the number of migrants, their flight direction, and their flight altitude.

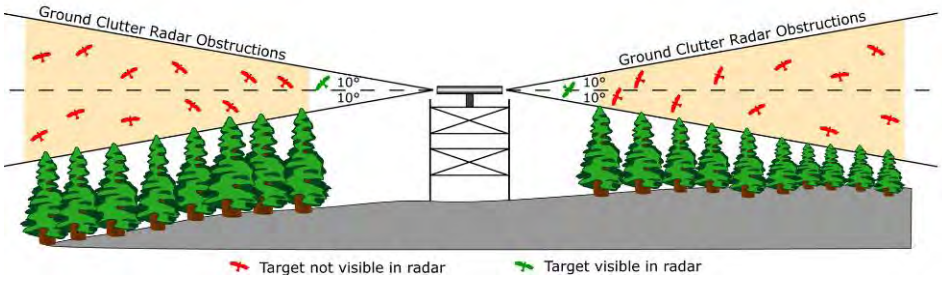
Radar surveys were conducted from sunset to sunrise over the course of 20 nights between September 1 and October 15. The radar was deployed on Bull Hill (Figure 1-1), at an elevation of 188 m (616').

2.2 DATA COLLECTION METHODS

2.2.1 Radar Data

Marine surveillance radar, similar to that described by Cooper *et al.* (1991), was used during field data collection. The radar has a peak power output of 12 kilowatts (kW) and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen were identified as "targets." The radar has an "echo trail" function which captures past echoes of flight trails, enabling determination of flight direction. During all operations, the radar's echo trail was set to 30 seconds. The radar was equipped with a 2 m (6.5') waveguide antenna, deployed 7 m (25') above ground. The antenna has a vertical beam height of 20° (10° above and below horizontal), and the front end of the antenna was inclined approximately 5° to increase the proportion of the beam directed into the sky.

Objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas (Figure 2-1).


Ground Clutter Radar Obstructions
10°
10°
Ground Clutter Radar Obstructions
10°
10°
Target not visible in radar
Target visible in radar

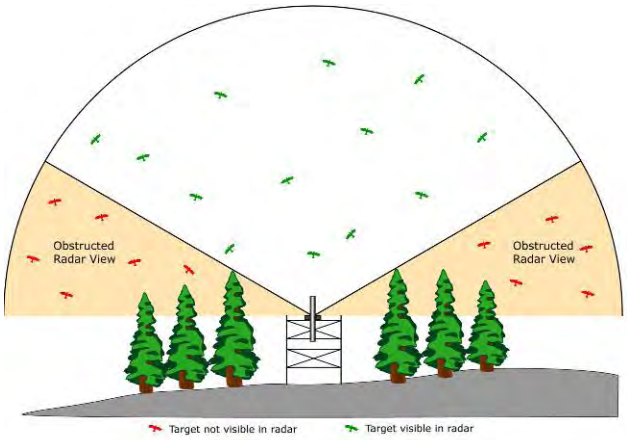


Figure 2-1. An example of ground clutter causing objects in horizontal mode (top) and vertical mode (bottom). Although the radar records three-dimensional space, it is translated by the radar screen into a two dimensional representation, which can cause targets to be obscured from view.

However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by "hiding" clutter-causing objects from the radar. These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen – targets are indistinguishable from the "clutter" as represented on the radar screen (Figure 2-2). However, targets traveling into and out of the ground clutter areas can be tracked. The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during active rainfall. Therefore, surveys were planned largely for nights without rain. However, in order to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers, mist, or fog were sampled.

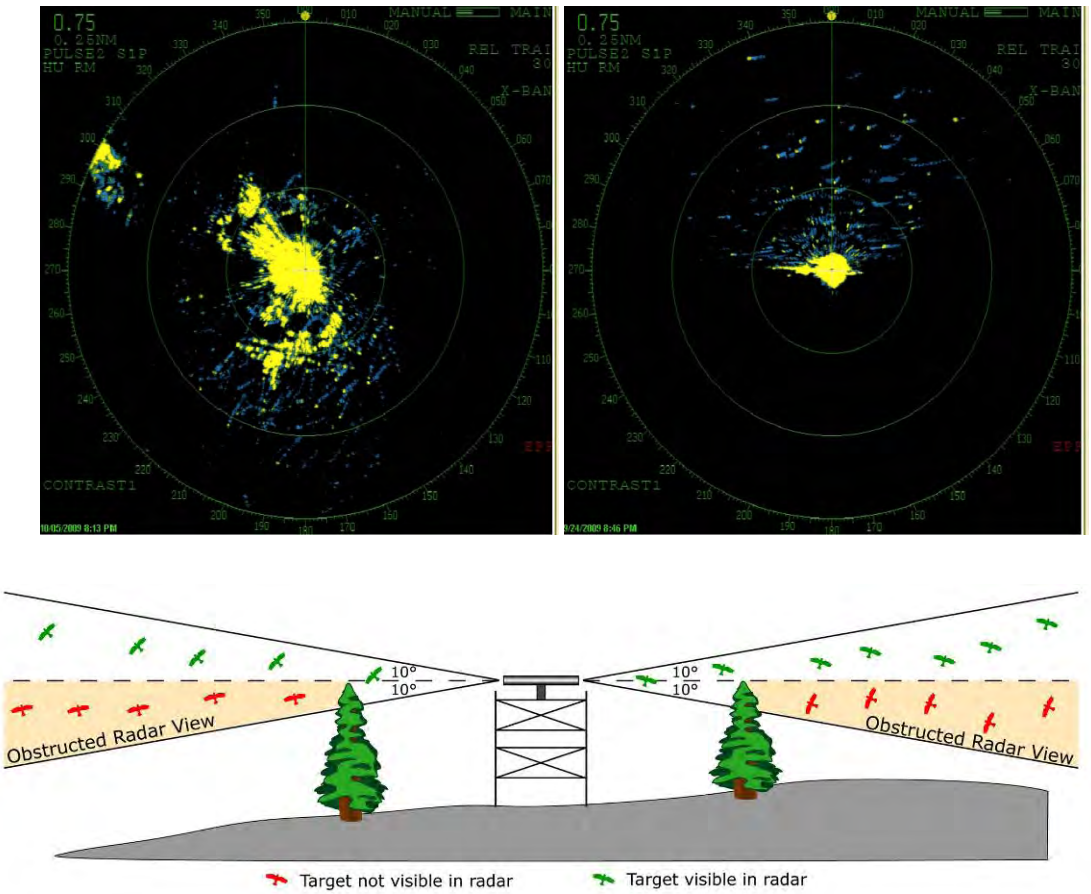


Figure 2-2. Proper site selection can reduce ground clutter to the center of the radar screen (bottom), so that the majority of the two-dimensional radar screen remains relatively uncluttered, allowing targets to be tracked as they both enter and leave the cluttered area (top; horizontal screenshot is on the left and vertical is on the right).

The radar was operated in two modes throughout the course of each night. In surveillance mode, the antenna spins horizontally to survey the airspace around the radar and detects the number of targets and their flight direction as they pass through the Project Site (Figure 2-3). By analyzing the echo trail, the flight direction and flight speed of targets can be determined.

In vertical mode, the radar unit is tilted 90° to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20° radar beam (Figure 2-3). Both modes of operation were used during each hour of sampling.

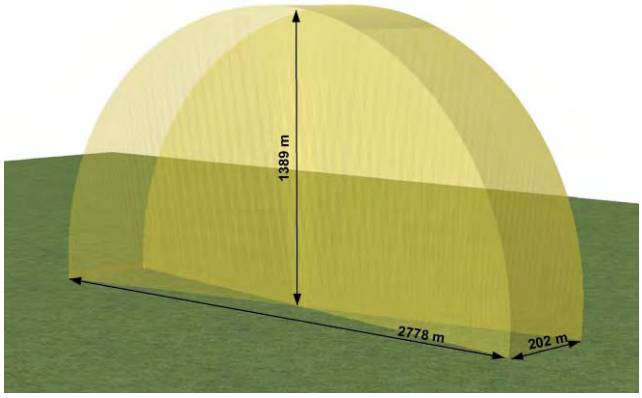


Figure 2-3. Detection Range of the radar in vertical mode

The radar was operated at a range of 1.4 km (0.75 nautical miles) to ensure detection of small targets. When radar is operated at ranges greater than 1.4 km, larger birds can be detected but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, thus limiting the ability to observe the movement pattern of individual targets; consequently, 1.4 km is the appropriate detection range for this type of study.

The radar display was connected to the video recording software of a computer enabling digital archiving of the radar data for subsequent analysis. This software recorded and archived video samples continuously every hour from sunset to sunrise of each survey night. By alternating the radar antenna every ten minutes from vertical mode to horizontal mode, a total of 30 minutes of vertical samples and 30 minutes of horizontal samples were collected within each hour. A stratified random sample set was developed by randomly selecting 6 horizontal samples and 6 vertical samples per hour of survey. This sampling schedule allowed for randomization of sample selection and prevented double-counting of targets due to the 30-second echo trail used to determine the flight path vector.

2.2.2 Weather Data

Temperature, wind speed and wind direction were recorded on an hourly basis from the top of a 197' on-site met tower located on Little Bull Hill for the duration of the survey period. This information was used during data analysis to help characterize any patterns in migration activity for particular nights and for the season overall.

2.3 DATA ANALYSIS METHODS

2.3.1 Radar Data

Video samples were analyzed using a digital analysis software tool developed by Stantec. For horizontal samples, targets (either birds or bats) were differentiated from insects based on their flight speed. Following adjustment for wind speed and direction, targets traveling faster than approximately 6 m (20') per second were identified as a bird or bat target (Larkin 1991, Bruderer and Boldt 2001). The software tool recorded the time, location, and flight vector for each target

traveling fast enough to be a bird or bat within each horizontal sample, and these results were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location, and then subsequently outputs the data to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular standard deviation) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this analysis are based on those used by Batschelet (1965), because they take into account the circular nature of the data.

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 145 m (476'), the approximate maximum height of the proposed wind turbines with blades, was also calculated hourly, for each night, and for the entire survey period.

2.3.2 Weather Data

The mean nightly temperature, wind speed and wind direction were calculated for each night of the survey period.

2.4 RESULTS

Radar surveys were conducted during 20 nights from September 1 to October 15 (Appendix A, Table 1). Although the radar's view was partially obscured in some areas of the radar detection range, targets could be tracked as they moved in and out of those areas; the radar view was adequate to characterize migration. The radar was elevated off the ground thus reducing the amount of the radar beam reflected back by surrounding vegetation (Figure 2-4).

2.4.1 Passage Rates

Nightly passage rates varied from 188 ± 30 targets per kilometer per hour (t/km/hr) on September 10 to 1500 ± 209 t/km/h on October 6, and the overall passage rate for the entire survey period was 614 ± 32 t/km/hr (Figure 2-4; also Appendix A, Table 1). Individual hourly passage rates ranged from 0 to 2507 t/km/hr (Appendix A, Table 2). Hourly passage rates were variable within and between nights. For the entire season, passage rates were typically highest during the third hour after sunset and gradually decreased until sunrise (Figure 2-5).

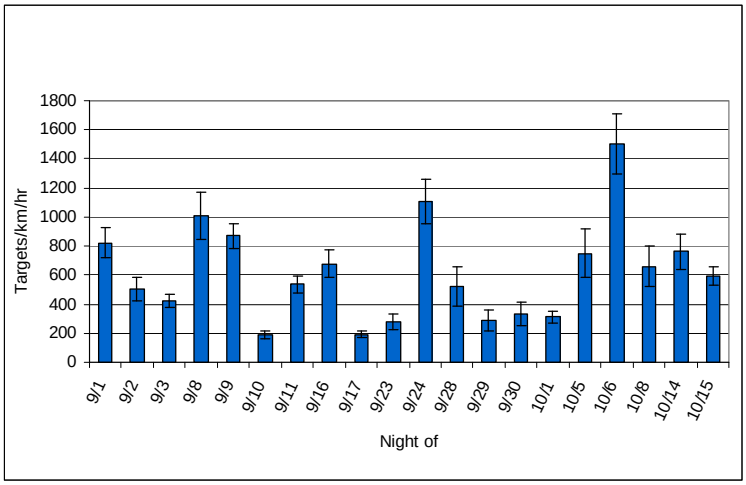


Figure 2-4. Nightly passage rates observed (error bars ± 1 SE) at Bull Hill, 2009

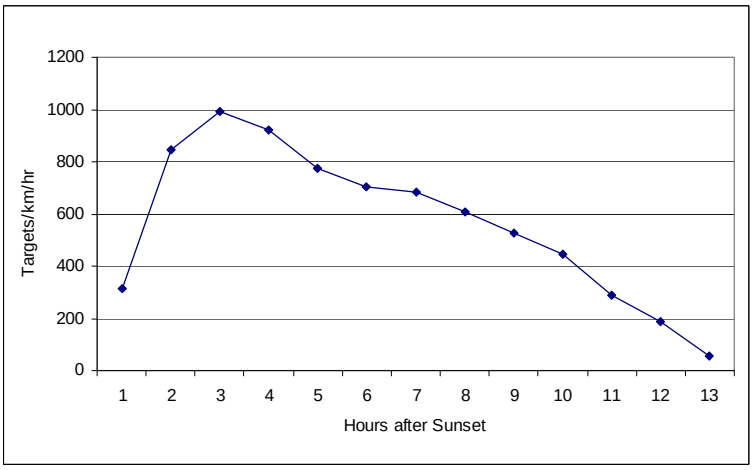


Figure 2-5. Hourly passage rates for entire season at Bull Hill, 2009

2.4.2 Flight Direction

Mean flight direction through the Project area was 260° ± 66° (Figure 2-6). Flight directions were generally to the southwest, but varied between nights (Appendix A, Table 3).

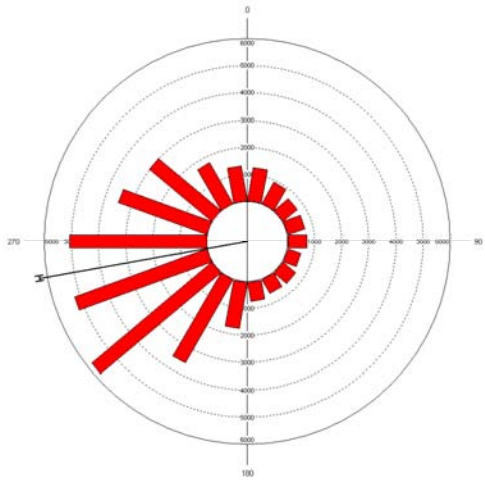


Figure 2-6. Mean flight direction for the entire season at Bull Hill, 2009 (the bracket along the margin of the histogram is the 95% confidence interval)

2.4.3 Flight Altitude

The seasonal average mean flight height of all targets was 356 ± 9 m (1168') above the radar site. The average nightly flight height ranged from 208 ± 9 m on September 2 to 558 ± 22 m on October 14 (Figure 2-7; Appendix A, Table 4). The percent of targets observed flying below 145 m was 14 percent for the season and varied nightly from 4 percent on September 24 and October 8 to 45 percent on September 2 (Figure 2-8). For the entire season, the mean hourly flight heights were typically highest from the fifth to the sixth hour after sunset (Figure 2-9).

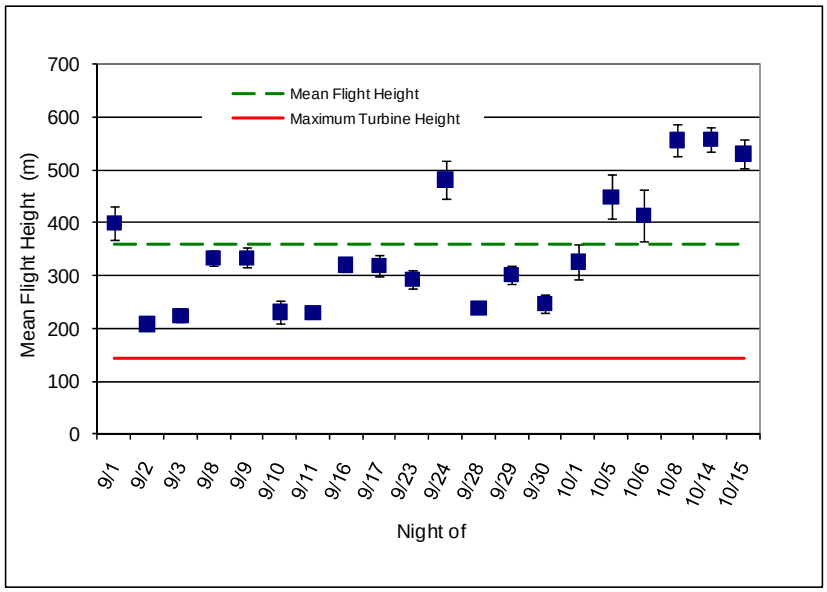


Figure 2-7. Mean nightly flight height of targets at Bull Hill, 2009 (error bars ± 1 SE)

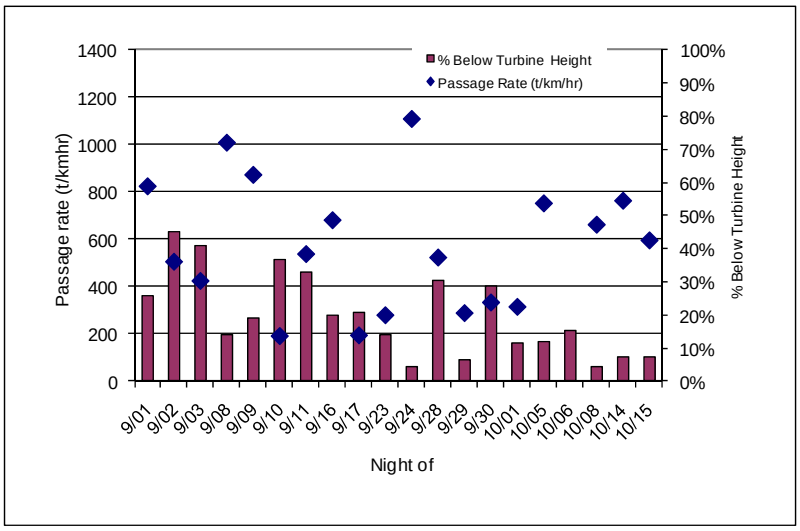


Figure 2-8. Percent of targets observed flying below a height of 145 m (476') at Bull Hill, 2009

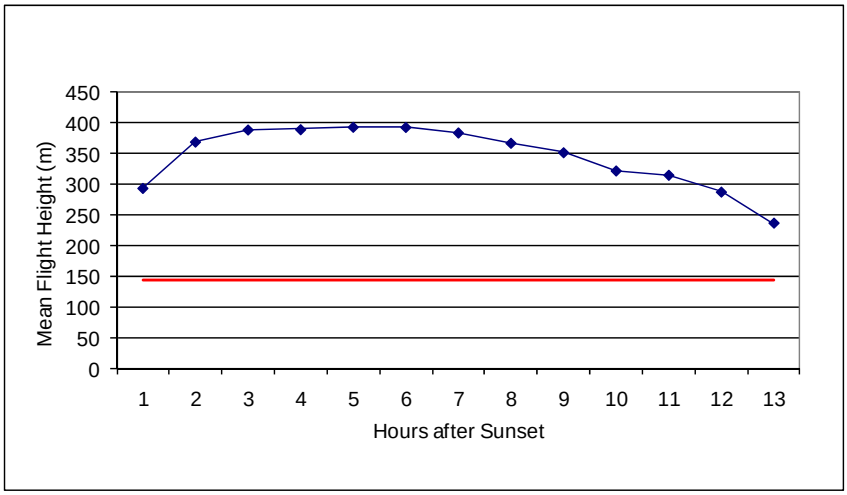


Figure 2-9. Hourly target flight height distribution at Bull Hill, 2009

2.4.4 Weather Data

Weather data was available from September 1 to October 15. Mean nightly wind speeds in the Project area varied between 2.7 and 7.5 meters per second (m/s), with an overall mean of 6.0 m/s (Figure 2-10). Mean nightly temperatures varied between -1.3°C and 16.6°C, with an overall mean of 8.0°C (Figure 2-11).

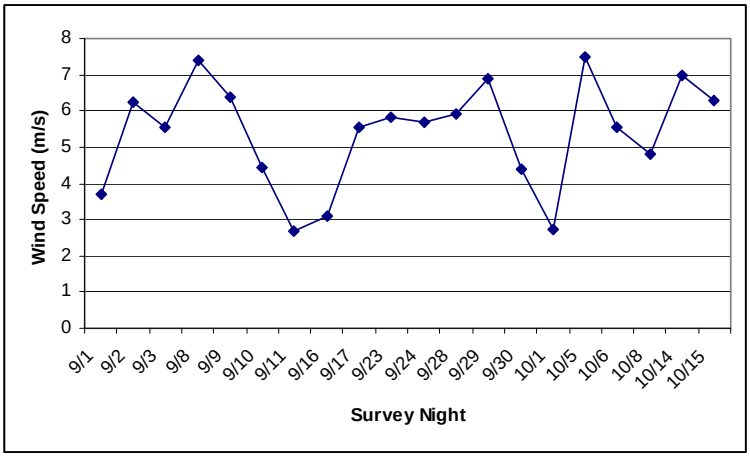


Figure 2-10. Nightly mean wind speed (m/s) at Bull Hill, 2009

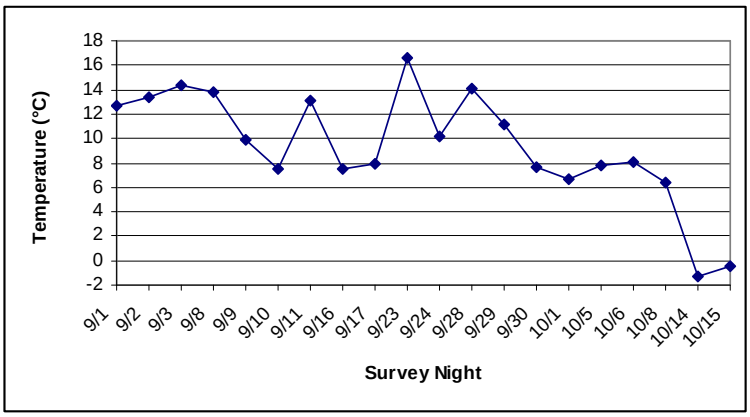


Figure 2-11. Nightly mean temperature at Bull Hill, 2009 (°Celsius)
(nightly maximum and minimum temperatures not available)

2.5 DISCUSSION

Radar surveys are designed and carried out to sample migration activity over a given point in order to provide baseline site data prior to the construction and operation of proposed commercial wind projects. The results of this nocturnal radar survey provide a snapshot of avian migration in space and time; in this case, over Bull Hill during dates typical for fall migration in northern Maine. Results of the survey are within the range of results for publicly available fall studies in the northeast conducted on forested ridges. These include highly variable passage rates between nights and flight heights primarily occurring between 200 and 600 m above the ridgeline. Within nights, migration activity was generally greatest three hours after sunset; flight height appeared to peak during the fifth to sixth hour after sunset within nights. Nightly variation in the magnitude and flight characteristics of nocturnally-migrating songbirds is not uncommon and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler et al. 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973,

Bingman et al. 1982, Gauthreaux 1991). Large migration events are generally thought to occur on mild nights with a following wind. This appeared to be true in regard to wind direction at Bull Hill, as nights with the highest passage rates (1500 t/km/hr on October 6 and 1108 t/km/hr on September 24) had northerly winds on average (from 312˚ and 357˚, respectively; Appendix A, Table 1). Within the fall radar survey at Bull Hill, nightly average mean passage rates were highly variable, ranging from 188 to 1500 t/km/hr; this indicates that nocturnal migration was pulsed, presumably related to seasonal timing and regional weather conditions. Variability in the range of nightly fall passage rates is common at other proposed commercial wind energy projects (Appendix A, Table 5).

Flight direction varied slightly from directions recorded at other radar sites in the northeast (Appendix A, Table 5). A more westerly flight direction at Bull Hill may be due to the fact that Bull Hill is much closer geographically to the coast (roughly 15 miles inland) than other northeast radar sites. Birds migrating along large-scale coastal features (Alerstam 1978, Bruderer 1997, Fortin *et al*. 1999 and Hagstrum 2000) have been documented altering their flight direction as the night progresses, from a direction following the coastline, to a more landward direction (Fortin *et al*. 1999). Thus, birds flying over the Project area may be flying westward before sunrise, given the northeast-southwest orientation of the coastline nearest to the Project area.

The mean passage rate of 614 t/km/hr at Bull Hill is on the higher end of the range of results from these other studies (91 to 620 t/km/hr; Appendix A Table 5). Comparison of mean passage rates between radar surveys at the Project and similar surveys conducted at other sites must be done with caution, as differences in passage rates may be due to a variety of factors including level of survey effort, differences in radar view between sites, topography, local landscape conditions, and vegetation surrounding a radar survey location. The radar location at Bull Hill provided adequate visibility of the surrounding airspace in all directions to characterize migration. Merging of migration flyways may lead to increased densities of birds in certain areas (Bruderer 1997). Birds may concentrate at points along the coast in the northeastern United States for several reasons, including to avoid predation, and to reach suitable habitats for resting and feeding (Alerstam 1978). Possible concentrations of birds along the coast in the northeast may explain relatively high passage rates at the Project.

The emerging body of studies characterizing nocturnal bird movements shows a relatively consistent pattern in flight altitude, with most birds appearing to fly at altitudes of several hundred meters or more above the ground (Appendix A, Table 5). Mean flight height at Bull Hill (356 t/km/hr) is similar to mean flight heights reported from other fall radar studies conducted in the northeast. Comparison of flight height between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. The radar survey location on Bull Hill resulted in most of the surrounding tree canopy being level with, or slightly below, the antenna of the radar; thus the location provided good visibility of the surrounding airspace.

No nights at the Project exhibited a total mean flight height below 145 m (Appendix A, Table 1). Where radar surveys have been conducted at any Project, it is expected that some target

activity will be observed within the turbine elevation zone. Post construction mortality studies have demonstrated that identifying pre-construction targets flying within turbine elevations does not directly correlate to collision risk. In addition, the majority of hourly and nightly mean flight heights of targets documented at the Project were found to be well above the height of the proposed turbines.

3.0 Acoustic Bat Survey

3.1 INTRODUCTION

Acoustic sampling of bat activity has become a standard aspect of pre-construction surveys for proposed wind-energy development (Kunz *et al.* 2007). Acoustic surveys were associated with several major assumptions (Hayes 2000) and results cannot be used to determine the number of bats inhabiting an area or determine the number of bats which may be killed post-construction. However, acoustic surveys can provide insight into seasonal patterns in activity levels and examine how weather conditions influence bat activity. While this data may be useful in predicting trends in post-construction mortality rates, the current lack of data on this topic precludes quantitative prediction of risk. The object of acoustic surveys at Bull Hill were (1) to document bat activity patterns from July to late fall in airspace near the rotor zone of the proposed turbines, at an intermediate height, and near the ground; and (2) to document bat activity patterns in relation to weather factors, including wind speed and temperature.

Eight species of bats occur in Maine, based upon their normal geographical range. These are the little brown bat (*Myotis lucifugus*), northern long-eared bat, (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), tri-colored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*) (BCI 2001). All eight bat species found in Maine are listed as species of Special Concern in Maine's Wildlife Action Plan due to the lack of information about the species in Maine and their apparent decline in recent years. Additionally, the eastern small-footed bat is listed as a Species of Greatest Conservation Need because only one hibernacula record and few summer records exist for the state of Maine. No known bat hibernacula exists in the vicinity of the Project area.

3.2 DATA COLLECTION METHODS

3.2.1 Acoustic Detector Site Selection

Anabat II and Anabat SDI detectors (Titley Electronics Pty Ltd.) were used for the duration of the fall 2009 acoustic bat survey. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of the species of bats that could occur in the Project area. Anabat II detectors were coupled with CF Storage ZCAIM (Titley Electronics Pty Ltd.), which programmed the on/off times and stored data on removable 1 GB compact flash

cards; newer SD1 model detectors do not require use of a ZCAIM. Anabat detectors are frequency division detectors, dividing the frequency of echolocation sounds made by bats by a factor of 16, then recording these sounds for subsequent analysis. The audio sensitivity setting of each Anabat system was set between six and seven (on a scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33').

Each Anabat detector was powered by 12-volt batteries charged by solar panels. Each solar-powered Anabat system was deployed in waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing suspends the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic is placed at a 45-degree angle directly below the microphone. The angled reflector allows the microphone to record the airspace horizontally surrounding the detector and is only slightly less sensitive than an unmodified Anabat unit.

Six detectors were deployed for the duration of the fall survey period (Figure 1-1). Two detectors were suspended in a met tower on Little Bull Hill and four detectors were deployed in trees on either end of the northern and southern Project area ridgelines. Detectors were mobilized on July 14 and operated until November 4 when they were demobilized. Each detector was programmed to record nightly from 7:00pm to 7:00am. Maintenance visits were conducted approximately every two weeks to check the condition of the detectors and to download data to a computer for analysis.

Detector Descriptions:

In order to record bats flying above and below the turbine rotor zone, "met detectors" were deployed at a height of 50 and 35 m. Both were attached to a fixed pulley system suspended in the guy wires of the Little Bull Hill Met Tower. Two guy lines were used to secure the detector in place and ensure the solar panel faced south. The tower clearing was approximately 50 m in diameter and the surrounding landscape was a relatively open forest canopy and understory with predominantly birch with a small component of spruce. No source of water or available snags was observed near the turbine clearing.

Photo 1 – Bull Hill Met Tower

The “NE Tree” detector was deployed at a height of 5 m high in a tree along the edge of a gravel logging road. The surrounding forest was a mix of hardwood and soft wood; birch was the dominant tree species. Undergrowth was a mix of raspberry and grasses. Logging trails perpendicular to the road were filled with slash left behind from recent a harvest. At least one snag was visible from the detector location. The surrounding forest canopy was predominantly young regenerating birch species and appeared to have been cut within the previous five year.

Photo 2 – NE Tree Detector

The “Radar Tree” detector was deployed in a tree at the end of a logging road that bisected a patch of young even-aged spruce. The detector was suspended over an old log landing filled with slash from a recent harvest. The logging road was heavily ditched on either side and standing water was frequently observed along the roadway. Several large snags were apparent from the detector location. The surrounding forest canopy was relatively open with very little ground clutter.

Photo 3 – Radar Tree Detector

The “SE Tree” detector was deployed at a height of approximately 3 m high in a tree along a logging road, at an intersection. The surrounding forest showed signs of recent harvest and was predominately red spruce, a small component of hardwood, and a few mature white pine throughout. The gravel logging roads were heavily ditched with signs of standing water along the roadway. A few large snags were visible from the detector location and an abandoned log landing filled with slash and planted in a mix of grasses was located a few hundred feet from the detector.

Photo 4 – SE Tree Detector

The “SW Tree” detector was suspended at a height of approximately 5 m high in a mature spruce along a gravel logging road at the edge of a log landing filled with slash. The surrounding forest was predominately red spruce with a small component of hardwood species and a relatively open forest canopy. The understory was a mix of raspberry and grasses. A few large snags were observed in the vicinity of the detector.

Photo 5 – SW Tree Detector

3.3 DATA ANALYSIS METHODS

Ultrasound recordings of bat echolocation may be broken into recordings of a single bat call or recordings of bat call sequences. A call is a single pulse of sound produced by a bat, while a call sequence is a combination of two or more pulses recorded in an Anabat file. Recordings with only one call were eliminated from analysis as has been done in similar studies (Arnett *et al*. 2006). Call sequences typically include a series of calls characteristic of normal flight or prey location ("search phase") and capture periods (feeding "buzzes").

Potential call files were extracted from data files using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of bats that occur in the northeast. This software screens all data recorded by the bat detector and extracts call files using a filter. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences are retained within the data set.

Following extraction of call files, each file was visually inspected for species identification and to ensure that only bat calls were included in the data set. Insect activity, wind, and interference can also sometimes produce Anabat files that pass through the initial filter and need to be visually inspected and removed from the data set. Call sequences are easily differentiated from other recordings, which typically form a diffuse band of dots at either a constant frequency or widely varying frequency.

Because bat activity levels are highly variable among individual nights and individual hours (Hayes 1997, Arnett *et al*. 2006), detection rates are summarized on both of these temporal

scales. Nightly detection rates were summarized by month as well as for the entire sampling period. Hourly detection rates were summarized by hour after sunset, as recommended by Kunz *et al*. (2007). Quantitative comparisons among these temporal periods was not attempted because the high amount of variability associated with bat detection would required much larger sample sizes (Arnett *et al*. 2006, Hayes 1997).

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, as well as other bat researchers. However, due to similarity of call signatures between several species, all classified calls have been categorized into five guilds[2] reflecting the bat community in the region of the Project area, as follows:

- **Unknown (UNKN)** – All call sequences with less than five calls, or poor quality sequences (those with indistinct call characteristics or background static). These sequences were further identified as either "high frequency unknown" (HFUN) for sequences with a minimum frequency above 30 to 35 kHz, or "low frequency unknown" (LFUN) for sequences with a minimum frequency below 30 to 35 kHz.

- **Myotis (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings.

- **Eastern red bat/tri-colored bat[3] (RBTB)** – Eastern red bats and tri-colored bats. These two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur.

- **Big brown/silver-haired bat (BBSH)** – Big brown and silver-haired bats. These species' call signatures commonly overlap and have therefore been included as one guild in this report.

- **Hoary bat (HB)** – Hoary bats. Calls of hoary bats can usually be distinguished from those of big brown and silver-haired bats by minimum frequency extending below 20 kHz or by calls varying widely in minimum frequency across a sequence.

[2] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI. We broke hoary bats out into a separate guild due to the importance of reporting activity patterns of migratory species in the context of wind energy development.
[3] The scientific and common name of the eastern pipistrelle (*Pipistrellus subflavus*) has been changed to the tri-colored bat (*Perimyotis subflavus*).

This method of guild identification represents a conservative approach to bat call identification. Since some species sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of recordings/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined.

3.3.1 Weather Data

Weather data was collected from the Little Bull Hill met tower for direct comparison with acoustic bat data. The mean, maximum, and minimum temperature, and wind speed were calculated for each night.

3.4 RESULTS

3.4.1 Timing of Activity

Detectors were deployed July 14 and continued to record data through November 4, for a total survey period of 634 detector nights. The range of dates that each detector was deployed is summarized in Table 3-1. Two incidents occurred during the fall survey to cause a lapse in data collection at two of the bat detectors. During demobilization, the met tower high detector became lodged in the guy wire system of the met tower and data was not retrieved. The missing acoustic data will be added to the fall data set when the met tower is dropped for regular maintenance. The second lapse in data was caused by theft of the SW Tree detector. The final download of the SW Tree detector was on October 15; missing data occurred from then until November 4. Few bat calls were recorded at other detectors from October 15 through November 4, indicating that few bat calls were likely missed by the malfunctioned or stolen detectors.

Activity levels at tree detectors peaked from late July to early August (Figure 3-1). Activity levels at the two met tower detectors peaked in early September (Figure 3-2). The four tree detectors recorded an overall detection rate of 10.8 bat call sequences per detector night during the fall season (Table 3-1). The overall detection rate for the two met tower detectors combined was 0.2 bat call sequences per detector night during the fall season (Table 3-1). Individual detector rates ranged from 0.1 to 15.0 bat call sequences per detector night. The highest monthly detection rate recorded at a tree detector was 37.4 bat call sequences per detector night during the month of July at the NE Tree detector. The highest monthly detection rate recorded at a met tower detector was recorded during September at the Met Tower Low detector, and was 0.6 bat call sequences per detector night. For all detectors combined, hourly bat activity was generally highest during the fifth hour after sunset, then declined until sunrise (Figure 3-3).

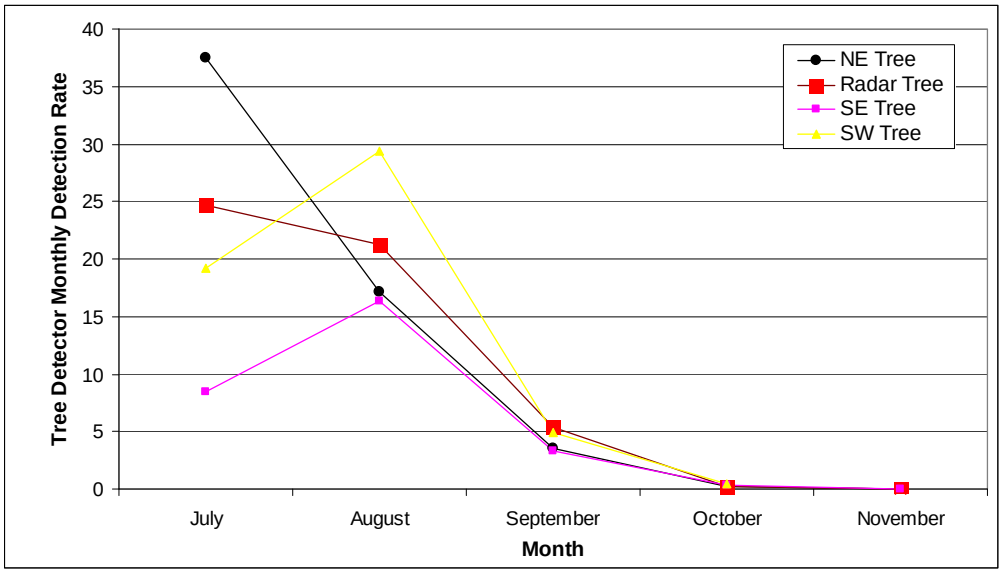


Figure 3-1. Monthly detection rates per detector at the tree detectors at Bull Hill, 2009

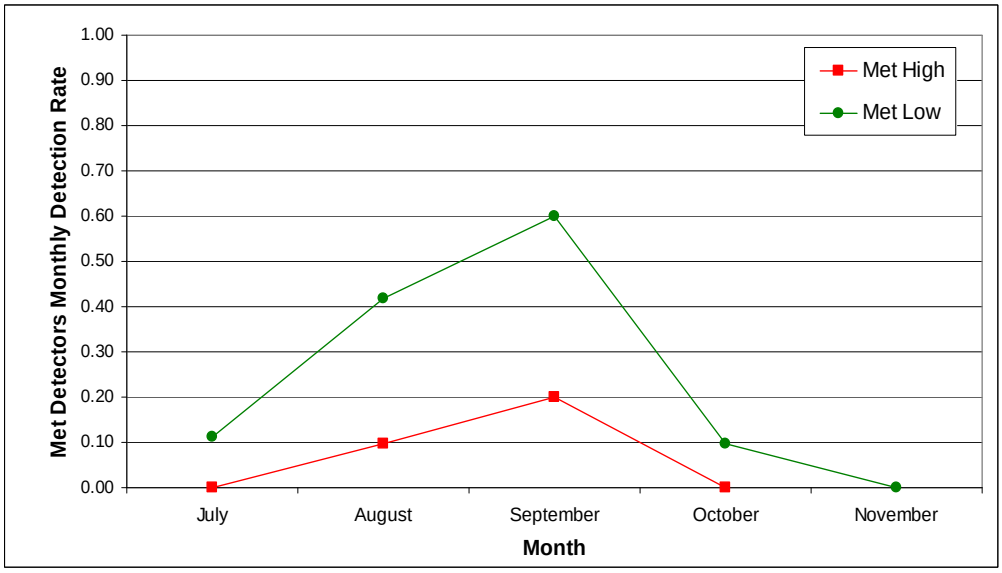


Figure 3-2. Monthly detection rates per detector at met tower detectors at Bull Hill, 2009

Table 3-1 Summary of bat detector field survey effort and results at Bull Hill, Summer-Fall, 2009						
Location	**Dates Deployed**	**Calendar Nights**	**Detector-Nights***	**Recorded Sequences**	**Detection Rate ****	**Maximum Sequences recorded *****
Met High	July 14 to Oct 15	94	94	9	0.1	3
Met Low	July 14 to Nov 4	114	114	36	0.3	6
NE Tree	July 14 to Nov 3	114	104	1164	11.2	223
Radar Tree	July 14 to Nov 4	114	114	1272	11.2	160
SE Tree	July 14 to Nov 4	114	114	767	6.7	47
SW Tree	July 14 to Oct 15	94	94	1409	15.0	73
Overall Met Results	**--**	***208***	***208***	***45***	***0.2***	**--**
Overall Tree Results	**--**	***436***	***426***	***4612***	***10.8***	**--**
* One detector-night is equal to a one detector successfully operating throughout the night.						
** Number of bat echolocation sequences recorded per detector-night.						
*** Maximum number of bat passes recorded from any single detector for a detector-night.						

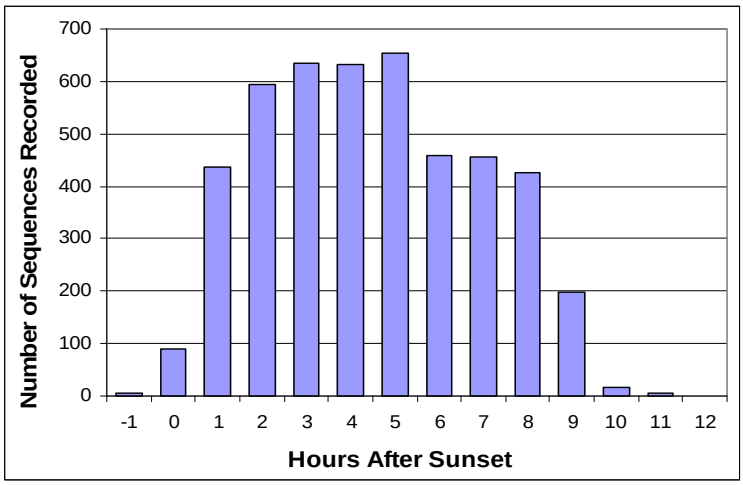


Figure 3-3. Hourly bat call sequence detections at the Bull Hill Wind Project.

3.4.2 Species Composition

The met tower detectors recorded similar ratios of the Big Brown-Silver Haired (n=10), Hoary Bat (n=9) and Myotis species (n=8) guilds (Table 3-2). However, the tree detectors recorded a higher divergence of species ratios. Myotis species (n=2,323) were the most frequently recorded bat call at the tree detectors followed by unknown species (n=1,614). The unknown species guild can be broken down into low-frequency and high-frequency calls (Figure 3-4).

Table 3-2 Distribution of detections by guild for detectors at Bull Hill, Summer-Fall, 2009

Detector	Guild					Total
	BBSH	HB	MYSP	RBTB	UNKN	
Met High	1	4	1	1	2	9
Met Low	9	5	7	2	13	36
NE Tree	98	0	358	26	682	1,164
Radar Tree	354	0	547	35	336	1,272
SE Tree	69	5	483	33	177	767
SW Tree	25	6	935	24	419	1,409
Total Met Detectors	**10**	**9**	**8**	**3**	**15**	**45**
Total Tree Detectors	**546**	**11**	**2,323**	**118**	**1,614**	**4,612**
Met Detector Guild Composition %	**22.2%**	**20.0%**	**17.8%**	**6.7%**	**33.3%**	**--**
Tree Detector Guild Composition %	**11.8%**	**0.2%**	**50.4%**	**2.6%**	**35.0%**	**--**

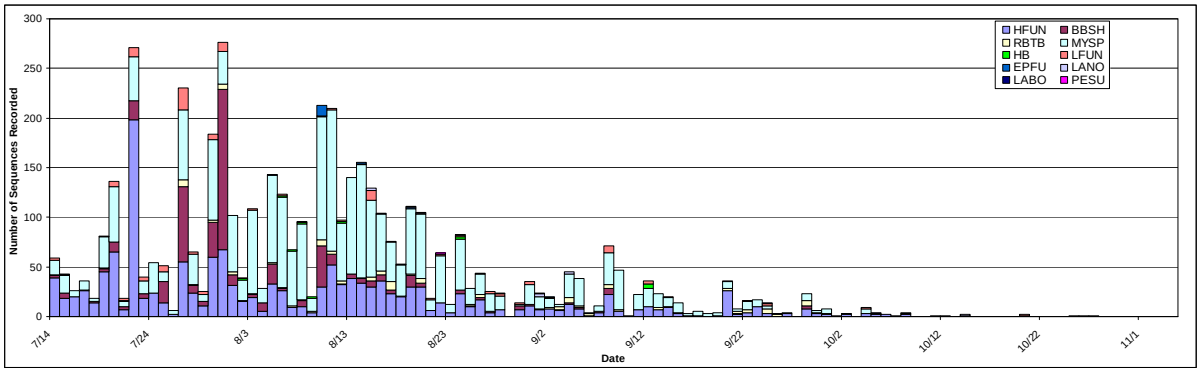


Figure 3-4. Total nightly bat call sequence detections at Bull Hill, 2009

Appendix B provides a series of tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Specifically, Appendix B Tables 1 through 6 provide information on the number of call sequences, by guild and suspected species, recorded at each detector and the weather conditions for that night. Analook files for all 4,657 recorded call sequences can be made available upon request.

3.4.3 Activity and Weather

Mean nightly wind speeds in the Project area from July 14 to November 4 varied between 2.3 and 9.9 m/s, with an overall mean of 5.6 m/s (Figure 3-5). Mean nightly temperatures varied between -1.2 °C and 21.1 °C, with an overall mean of 11.9 °C (Figure 3-6). In general nightly activity levels were highest on nights when temperatures were warm and winds were relatively calm.

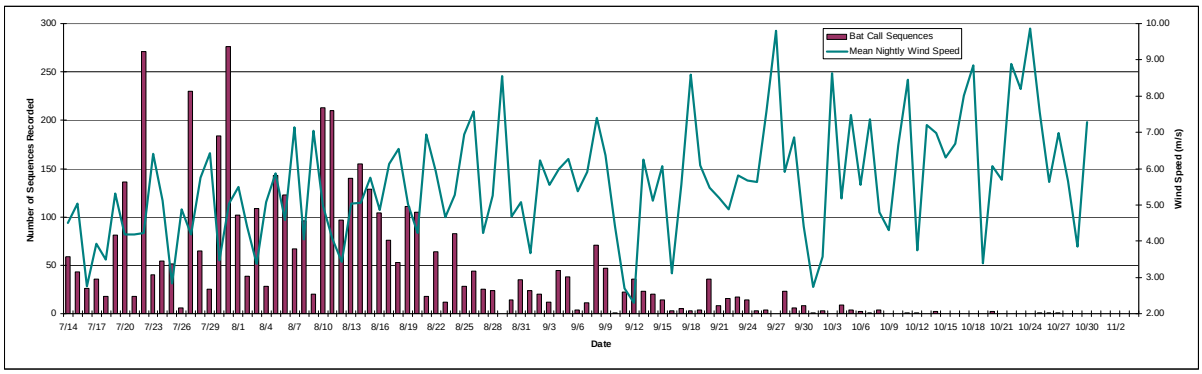


Figure 3-5. Nightly mean wind speed (m/s) (green line) and bat call detections at Bull Hill, 2009

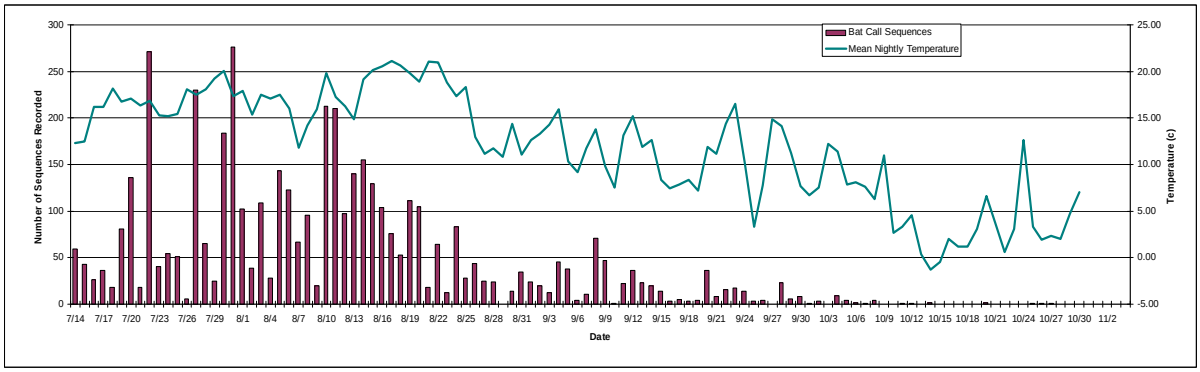


Figure 3-6. Nightly mean temperature (°Celsius) (green line) and bat detections at Bull Hill, 2009 (nightly maximum and minimum temperatures not available)

3.5 DISCUSSION

Bat activity was variable among detector heights and locations during the summer-fall 2009 migration season. However, some trends were observed. Call volumes varied month to month, although peaked early in the season (53% of call sequences were detected in August). Call volumes then declined through the month of September; during October, all detectors declined to a monthly average of less than 0.5 calls per detector night. The overall detection rate for the two met tower detectors was 0.2 call sequences per detector night, while the four tree detectors recorded and overall detection rate of 10.8 call sequences per detector night in October. Detection rates recorded at the Bull Hill Project area are consistent with pre-construction acoustic data from other proposed wind projects in similar landscapes in the northeast (Appendix B, Table 7). Furthermore detection rates recorded during the fall 2009 season at the Bull Hill Project are at the low end of the range found at other forested sites in the northeast (Appendix B, Table 7). The NE Tree detector recorded the highest average monthly detection rate of all six detectors during the month of July, 2009 (37.4 bat call sequences per night), the majority of which were from the HFUN guild. When considering the level of activity documented by acoustic surveys, the numbers of recorded bat call sequences cannot be directly correlated with the number of bats in an area because acoustic detectors do not allow for differentiation between individuals.

It is important to use caution when comparing detection rates across detectors and sites. Detector location and height can significantly affect detection rates. It is important to consider individual detector heights and habitats when making detection rate comparisons.

Bat calls were identified to guild within this report, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red bat and hoary bat, have easily identifiable calls. Other species, such as the big brown bat and silver-haired bat, are difficult to distinguish acoustically. Similarly, certain members of the Myotis genus, such as the little brown bat, are far more common and have slightly more distinguishable calls than other species. A total of 2,331 Myotis call sequences (50.1% of total call sequences recorded) were detected at the Project in fall 2009. Both Myotis and RBTB calls fall within the range of the HFUN category and are often identified as such when less than five calls are recorded. During the fall 2009 season, Myotis calls were labeled to guild nineteen times more often than RBTB calls, which likely indicates that more of the HFUN calls were from the Myotis guild than the RBTB guild.

The RBTB guild includes the tri-colored bat and eastern red bat. 121 call sequences, 2.6 percent of total call sequences recorded by detectors during the fall survey, belonged to the RBTB guild. Of these calls, three were identified as eastern red bats and two as tri-colored bats. Eastern red bats have relatively unique calls which span a wide range of frequency and have a characteristic hooked shape and variable minimum frequency. Tri-colored bats tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. Although both species do have distinct call characteristics their calls most often appear similar making differentiation difficult resulting in a RBTB classification.

The BBSH guild includes the big brown bat and silver-haired bat, both of which produce search-phase calls with minimum frequencies in the 25-30 kHz range. 556 call sequences from the BBSH guild composed 11.9 percent of all calls recorded during the fall 2009 survey period. Certain types of calls by each species are easily distinguishable from the other based on minimum frequency and call profile, but other calls in this range have overlapping characteristics and are difficult to distinguish. Sixteen of these calls were identified as big brown bats and twelve as silver-haired bats. One review of post construction mortality data from wind power sites in the eastern US found big brown mortality to occur less frequently than silver-haired bat mortality (Arnett et al, 2008).

The HB guild consists of the hoary bat, the largest bat species in the northeast. Only 20 (0.4%) call sequences recorded in the Project area belonged to the hoary bat. Hoary bat calls are generally distinguishable from all other species in the region and are characterized by highly variable minimum frequencies often extending below 20 kHz, and a hooked profile similar to the eastern red bat.

The height of a detector may determine the number of call sequences and the species composition it records; for example, long-distance migratory species are more likely to be recorded at detectors deployed above canopy height (Arnett et al. 2006). Detectors in and around canopy height likely detect foraging individuals passing by the detector multiple times, whereas much less concentrated foraging likely occurs within the recording zone of met tower

detectors, possibly resulting in fewer foraging bats being recorded multiple times. Two of the six detectors deployed during the fall 2009 survey were above tree canopy height and recorded a higher percentage of migratory species, (e.g., big brown bats and silver-haired bats) than the four tree detectors, which detected more Myotis and HFUN call sequences. Detectors at higher altitudes may often record lower detection rates since bats aren't remaining in those areas for long periods of time.

Recent studies have found that bat activity patterns are influenced by weather conditions (Arnett *et al*. 2006, Arnett *et al*. 2008, Reynolds 2006). Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett *et al*. 2005). These patterns suggest that during the fall, bats are more likely to migrate on nights with low wind speeds (less than 4 to 6 m/s) and generally warm temperatures. Thus, several weather variables can individually affect bat activity, as does the interaction among variables (i.e., warm nights with low wind speeds). Met tower wind speed data collected at Little Bull Hill during the fall 2009 survey indicated that the nights with the highest amount of bat activity occurred when the mean nightly temperatures were near or above 15 °C and wind speeds below 5 m/s.

4.0 Diurnal Raptor Surveys

4.1 INTRODUCTION

The purpose of the fall raptor surveys is to document the species that occur in the vicinity of the Project and to record the specific flight heights, flight path locations, and other flight behaviors of raptors within the Project area. Survey methodology and level of effort were discussed before and during the spring raptor migration surveys. During this initial agency meeting, MDIFW indicated raptor surveys should note all bald eagle, northern harrier (*Circus cyaneus*) (special concern), great blue heron (*Ardea herodias*) (special concern), and osprey (*Pandion haliaetus*), activity, as these species are suspected to occur in the vicinity of the Project area.

In the eastern United States, raptor migration tends to concentrate along the shores of large bodies of water including lakes and the Atlantic Coast (Kellogg 2007) as well as along ridgelines, where raptors take advantage of updrafts which form along the side slopes of ridges. Updrafts allow raptors to fly long distances with minimal exertion (Berthold 2001). Raptors also use thermals, which are pockets of warm, rising air that form as the ground's surface is heated by the sun, in order to minimize energy expenditure during migration movements (Bildstein 2006). Thus, raptor surveys were conducted from prominent locations on ridges inside the proposed Project area.

4.2 METHODS

4.2.1 Field Surveys

The summer survey period was August 1 to August 27 and the fall migration survey period was September 2 to October 14. Field surveys were conducted on days with favorable raptor flight and observer visibility conditions. Days with significant precipitation or extensive fog were not sampled. During the fall migration period specifically, days following the passage of weather fronts bringing favorable weather, high atmospheric pressure, and northerly winds were targeted. Raptor migration is facilitated by tail winds (winds aligned with the preferred direction of travel), which "push" migrating raptors forward (Bildstein 2006); however, some raptors will fly in light or moderate headwinds. Therefore, days with southerly winds were also sampled as some raptors' flight behaviors differ in moderate to strong headwinds.

Field surveys were conducted from two locations in the summer—Sparrow Hill (also known as Beech Knoll) and Bull Hill. Fall surveys were conducted from a single location on top of Bull Hill (Figure 1-1). Sparrow Hill had views of the north shore of Molasses Pond. Bull Hill is located in the east-central portion of the Project area. Observation locations for both sites were positioned on ridge summits in areas with recent timber removal, allowing excellent views of nearby project ridges and, to a lesser extent, the heaths and ponds in the valley below.

Surveys methods were developed in consultation with MDIFW and USFWS and were largely based on Hawk Migration Association of North America (HMANA) methods (HMANA 2009).

Surveys were conducted from 9 am to 4 pm, during the peak hours of thermal development and raptor movement. During surveys, observers scanned the sky and surrounding landscape for raptors with binoculars or a spotting scope. Detailed observation and weather information were recorded on standardized datasheets, including:

- Observation date and time;
- Species, number of individuals, and age (if possible);
- If the raptor occurred within the Project area (as depicted in Figure 1-1);
- The flight positions of each bird in relation to topography of the area;
- The flight height (above ground) of each bird (within each different topographical flight position);
- The specific flight behaviors of each bird;
- The general flight direction of each bird;
- If the bird was actively migrating;
- Total amount of time the bird was observed flying under 145 m over a Project ridge, as well as other notes describing the general activity of each bird;
- Hourly weather observations, including wind speed and direction, temperature, sky conditions, percent cloud cover, and relative cloud height and type; and
- The flight paths of raptors observed were recorded on Project area maps.

Topographical flight positions were summarized into categories that describe the landscape surrounding the observation site (these positions apply to birds observed both within as well as outside the Project area: A1) parallel to ridge, A2) perpendicular to ridge, A3) over saddle, B) flight path over slope of ridge, and D) flight path over a valley (see Figure 4-1 below). As individual birds traveled through or in the vicinity of the Project, all position categories in which a bird occurred were recorded.

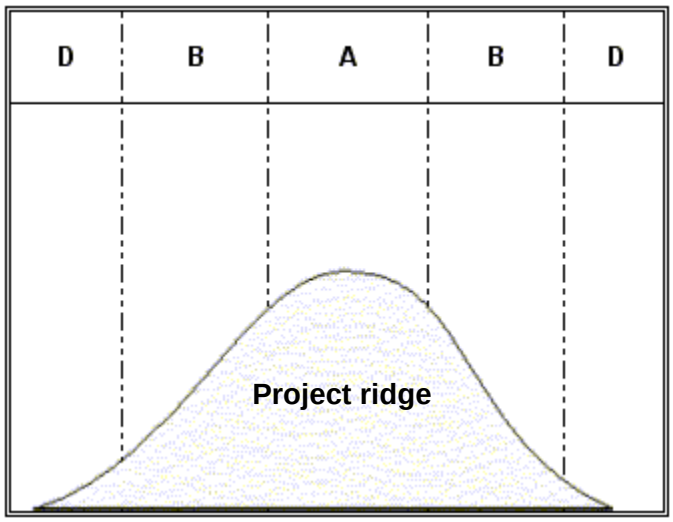


Figure 4-1. Raptor flight position categories in relation to the topography of the Project area and surrounding area.

Nearby objects with known heights, such as tree canopy, the met tower on Bull Hill, and the communication tower at Sparrow Hill, were each used to gauge flight height. Flight behaviors where categorized as: circle soaring, linear soaring (straight-line soaring or slow gliding in a 'thermal street' formed between updrafts), gliding (with wings partially closed and bent wrists), powered flight (flapping wings), banking (breaking with fully extended wings and tail fanned), diving (wings partially to mostly closed while in descent), kiting (using wind current to kite with partially closed wings and tail), hovering (maintaining a stationary altitude with some flapping and fanned tail while hunting and looking downward), aerial feeding (eating prey in flight while in a soar or slow glide), aerial hunting low over the ground, aerial display (territorial or courtship aerial display), or perched. These behaviors among others were used to describe birds as actively migrating or not-actively migrating.

Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, unidentified raptor. Priority was given to raptor observations; however, observers collected incidental data for other avian species observed including passerines and water birds.

4.2.2 Data Analysis

The raptor observation data was summarized separately for the summer and fall survey seasons. For each survey period, analysis included a summary of:

- The total number of individuals per species observed each survey day, and for the entire survey period;
- Daily passage rates (birds per hour) calculated for each survey day, as well as for the entire survey period;

- Hourly observation totals per species;
- The percentage of birds within each topographical flight position category;
- The average minimum flight height of birds within each topographical flight position category;
- The percentage of all birds that occurred within the Project area (as depicted in Figure 1-1);
- For all birds observed within the Project area, and within topographical positions where the turbines are to be located (A1, A2, A3, and B), flight heights were categorized as less than or greater than 145 m (476') above ground;
- The percentage of birds believed to be actively migrating; and
- A summary of the flight behaviors of all birds observed.

Observations made from the Bull Hill Project during the fall (migration) season were compared to fall 2009 data from HMANA hawk watch sites across New England and southern Canada (HMANA 2009). The hawk watch sites included for comparison are Cadillac Mountain, ME (approximately 26 miles from the Project); Greenlaw Mountain, NB; Harpswell Peninsula, ME; Pack Monodnock, NH; Pitcher Mountain, NH; and Putney Mountain, VT. Also provided for comparison of the fall migration surveys are the results of available regional fall surveys conducted at other proposed wind facilities in the northeast.

4.3 RESULTS

Summer surveys were conducted on six days (3 days at Bull Hill, 3 days at Sparrow Hill) from August 1 to August 27. Fall migration surveys were conducted on twelve survey days (all days at Bull Hill) from September 2 to October 14. Survey hours for each season totaled 46 and 87, respectively.

Surveys were generally conducted on clear days allowing for optimal visibility. However, for portions of some of the survey days, visibility was limited due to weather: fog reduced visibility for a few hours on August 26 and September 22, while rain showers reduced visibility the afternoon of August 11. Temperatures ranged from 4 to 30˚ Celsius (39 – 86 ˚F) during the survey period. Winds speed and direction was variable, without considerable difference between the survey seasons. Wind speeds under 9 mph (14 kph) occurred during 72 percent of observation hours and wind speeds in excess of 19 mph (31 kph) occurred during only 2 percent of observation hours. Wind direction during nine survey days was predominantly from the southwest; from the southeast during four survey days; from the northeast on one survey day; and from the northwest during four days. Similar numbers of birds were observed on days with headwinds and tailwinds.

Survey results are summarized in Table 4-1 and more detailed survey results are provided in Appendix C (Tables 3-7). No bald eagles were seen during summer habitat use surveys. A total of three bald eagles were observed during the fall migration survey period:

Table 4-1. Summary of raptor surveys conducted at the Bull Hill Wind Project in T16 MD, Maine, 2009	
Summer Surveys	
Total number of raptors detected	24
Total number of raptor species detected	6
Total number of hours surveyed	46
Overall survey passage rate (birds/hour)	0.52
Total number of raptors detected in the Project area and below maximum turbine height (percent of total detections)	1 (4%)
Fall Migration Surveys	
Total number of raptors detected	124
Total number of raptor species detected	11
Total number of hours surveyed	87
Overall survey passage rate (birds/hour)	1.43
Total number of raptors detected in the Project area and below maximum turbine height (percent of total detections)	59 (98%)

During summer surveys, a total of 24 raptors were observed. Daily counts ranged from 2 to 6 raptors, and daily passage rates ranged from 0.25 to 0.86 birds/hour. Days with the highest raptor counts were August 13 (n=6) and August 26 (n=6) (Figure 4-2; Appendix B, Table 1). For the entire summer season, the observation rate was 0.52 birds/hour. Six[5] different species were observed (Figure 4-3; Appendix B, Table 2). There were no bald eagles observed during the summer surveys. No state listed species were observed during the summer. The majority of raptors observed in the summer were turkey vulture (*Cathartes aura*) (n=13; 11%) and red-tailed hawk (*Buteo jamaicensis;* n=6; 4.8 %).

During fall raptor migration surveys, a total of 124 raptors were observed. Daily counts ranged from 5 to 19 raptors, and daily passage rates ranged from 0.63 to 2.71 birds/hour. The highest count days in the fall occurred on September 22 (n=19) and October 12 (n=18) (Figure 4-2; Appendix B, Table 1). For the entire fall season, the observation rate was 1.43 birds/hour. Eleven different species were observed, not including 2 unidentified accipiters, 11 unidentified buteos, 1 unidentified falcon, and 3 unidentified raptors. The majority of raptors observed were sharp-shinned hawk (*Accipiter striatus*) (n=32; 26%) and turkey vulture (n=32; 26%). One state endangered species, peregrine falcon (*Falco peregrinus*), was observed in the Project area during the fall, as well as two state special concern species, bald eagle and northern harrier. For more information on the observations of special concern species, refer to Section 4.3.1.

[5] While turkey vultures (*Cathartes aura*) are not phylogenetically considered true raptors, they are diurnal migrants that exhibit flight characteristics similar to *Buteos, Accipiters* and other *Falconiformes* species, therefore vultures are typically included during hawk watch surveys.

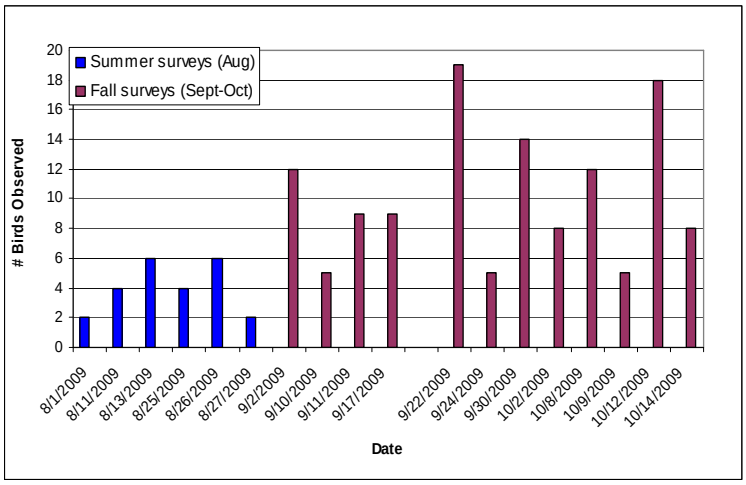


Figure 4-2. Total number of birds observed per survey day at Bull Hill, 2009

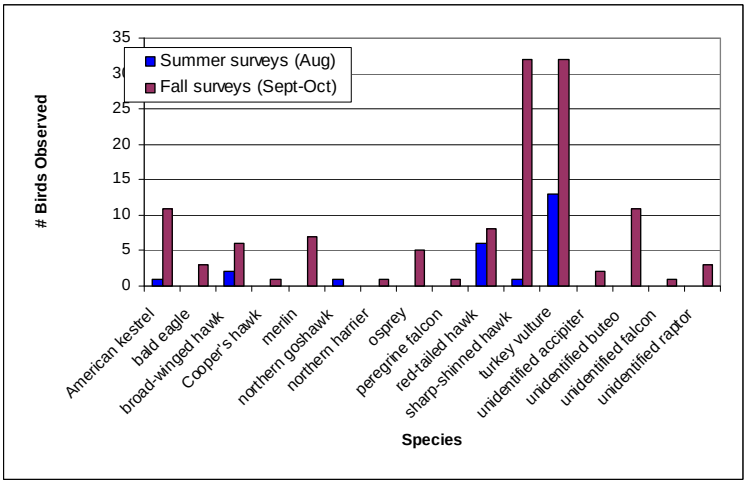


Figure 4-3. Number of individuals of species observed at Bull Hill, 2009

On a daily basis, the majority of observations occurred between 10:00 am and 12:00 pm during the initial period of thermal development for the day. The summer surveys show a clear peak in activity during this period, between 11:00 am and 12:00 pm, whereas the fall surveys have a more evenly distributed activity pattern throughout the day. Fall surveys have high activity mid-morning between 10:00 am and 12:00 pm and again in the afternoon between 1:00 pm and 4:00 pm (Figure 4-4; Appendix B, Table 2).

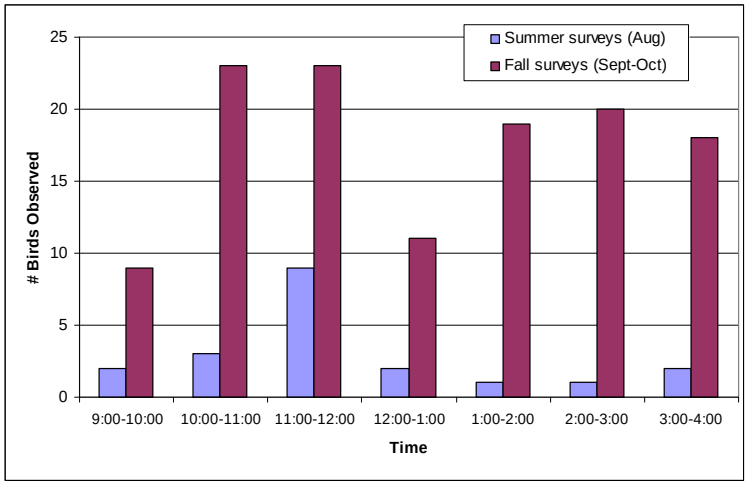


Figure 4-4. Number of individuals observed per survey hour at Bull Hill, 2009

Not all raptors observed during the survey seasons were observed moving through the proposed turbine areas (Project area), which is defined as horizontal position codes A1, A2, A3, and B on Bull Hill, Heifer Hill and Beech Knoll. Birds in flight position D (over the valley) were not considered within the Project area. During the summer, 4.2 percent (n=1) of all raptors seen were observed moving through the Project area. During the fall, 47.6 percent (n=59) of raptors were seen in the Project area.

One bird was observed passing over Project ridges in the summer, crossing the ridge (n=1; 100%) at a height of 100m. Of the birds passing over Project ridges in the fall, the highest percentage of birds either crossed ridges (n=65; 38%) or occurred along the slopes of ridges (n=50; 29%). Flight heights in these position categories averaged 40 and 43 meters, respectively (Table 4-2).

Table 4-2. Number of observations and average flight heights for each position category for birds observed at Bull Hill, 2009

		A1) flight along or parallel to ridge	A2) crossed ridge	A3) flight crossed depression or saddle	B) slope	D) over valley[2]
summer	No. of position observations[1] (percent of total observations)	2 (6%)	8 (23%)	0 (0%)	21 (60%)	4 (11%)
	Average minimum flight height (m)	37.50	79.38	n/a	88.81	170.00
fall	No. of position observations[1]	13 (8%)	65 (38%)	6 (4%)	50 (29%)	37 (22%)
	Average minimum flight height (m)	11.85	39.85	36.67	43.30	68.92

[1] no. positions will be greater than no. individuals because many birds crossed multiple position categories
[2] this position category is considered outside of Project area

Those raptors observed in flight positions A1, A2, A3, and B and occurred below 145 m were categorized as flying below maximum turbine height. Of the 24 birds observed during the summer surveys, one red-tailed hawk, was observed within the Project area. (Table 4-3). The single bird flew below maximum turbine height for the duration of its observed flight. Sixty five of the 124 birds observed during fall surveys were only seen over the valley. Excluding these 65 birds, 59 birds (48%) were in the Project area and 58 (98%) were in the Project area and flew below maximum turbine height for at least a portion of their observed flight. During the fall raptor migration season, sharp-shinned hawk and American kestrel were the species most commonly observed flying below maximum turbine height (Table 4-3).

Table 4-3. Number of individuals of species observed within Project boundary in proposed turbine areas (flight positions A1, A2, A3, and B) above or below 145 m at Bull Hill 2009

	Summer habitat use surveys		Fall migration surveys	
Species	**145 m or greater**	**less than 145 m**	**145 m or greater**	**less than 145 m**
American kestrel	0	0	0	10
bald eagle	0	0	0	1
broad-winged hawk	0	0	0	3
Cooper's hawk	0	0	0	1
merlin	0	0	0	3
northern goshawk	0	0	0	0
northern harrier	0	0	1	0
osprey	0	0	0	1
peregrine falcon	0	0	0	1
red-tailed hawk	0	1	0	8
sharp-shinned hawk	0	0	0	21
turkey vulture	0	0	0	7
unidentified buteo	0	0	0	1
unidentified falcon	0	0	0	1
Grand Total:	**0**	**1**	**1**	**58**

The timing of the summer surveys overlapped with the beginning of fall migration. While many of the birds observed during the summer surveys were believed to be seasonally local, one broad-winged hawk (*Buteo platypterus*) was suspected to be actively migrating based on its flight behaviors and direction of travel. Fifty-three percent of birds during fall surveys were believed to be actively migrating. Turkey vulture and sharp-shinned hawk are among species observed in the fall which were suspected to be seasonally local.

The most common flight behaviors for raptors observed during fall surveys were linear soaring, circle soaring and powered flight, which is consistent with migrating birds. The behavior most commonly observed was linear soaring (n=61; 37%) followed by powered flight (n=59; 36%) (Figure 4-5; Appendix C Table 4). Behaviors for raptors observed during summer were more diverse, including more behaviors associated with foraging. All behaviors displayed by individual birds were recorded; therefore the number of behavioral observations exceeds the number of individuals observed.

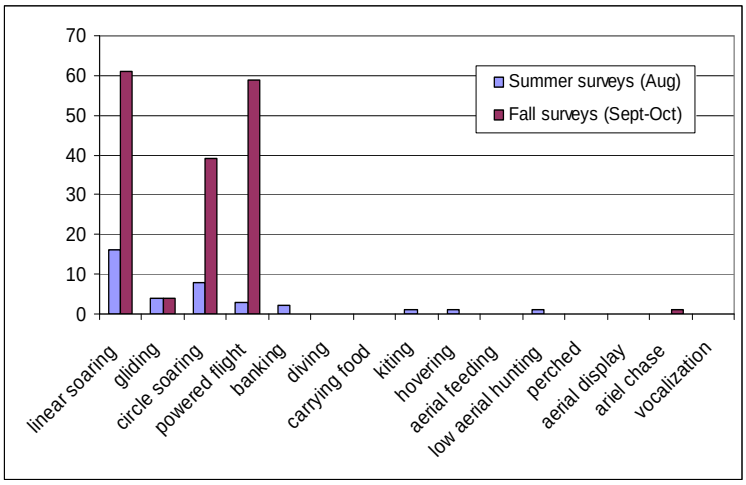


Figure 4-5. Number of observations of flight behaviors at Bull Hill, 2009

4.3.1 Rare, Threatened or Endangered Species

There were no state listed species observed during the summer surveys. In the fall one state endangered species, peregrine falcon, was observed in the Project area on October 9. The falcon was flying over tree canopy, approximately 15 m above ground, moving northwest over Bull Hill. Two state species of special concern were observed during the fall surveys—bald eagle and northern harrier. A total of three bald eagles were observed during the fall migration survey period: a sub-adult was seen on September 17 circling on a thermal (at 150 to 200 m) near Sparrow Hill, moving west; an adult was seen on October 2, outside of the Project area, circling at 70 m over the valley and moving northeast; and a sub-adult IV was seen crossing through the Project area over Bull Hill on October 14 at 30 m above ground level, moving north. A male northern harrier was observed crossing the Project area on September 17 flying at a height of 200 m.

4.3.2 Incidental Bird Observations

A total of 20 different non-raptor avian species of were observed incidentally during the summer and fall surveys. Table 4-4 lists the different species observed; none were water birds. Two incidental species that were observed in the Project area, American redstart (*Setophaga ruticilla*) and chestnut-sided warbler (*Dendroica pensylvanica*), are listed as state species of special concern.

Table 4-4. Incidental birds seen at Bull Hill, 2009	
American crow	*Corvus brachyrhynchos*
American goldfinch	*Carduelis tristis*
American redstart	*Setophaga ruticilla*
American robin	*Turdus migratorius*
American woodcock	*Scolopax minor*
Baltimore oriole	*Icterus galbula*
black-capped chickadee	*Poecile atricapilla*
blue jay	*Cyanocitta cristata*
black-throated green warbler	*Dendroica virens*
cedar waxwing	*Bombycilla cedrorum*
common raven	*Corvus corax*
chestnut-sided warbler	*Dendroica pensylvanica*
dark-eyed junco	*Junco hyemalis*
downy woodpecker	*Picoides pubescens*
hairy woodpecker	*Picoides villosus*
mourning dove	*Zenaida macroura*
northern flicker	*Colaptes auratus*
pileated woodpecker	*Dryocopus pileatus*
song sparrow	*Melospiza melodia*
white-throated sparrow	*Zonotrichia albicollis*

4.4 DISCUSSION

Summer Bald Eagle and Raptor Surveys

A primary goal of the summer surveys was to document the occurrence within, and use of, the Project area by bald eagle, and other raptor species, during the late-fledging period. Although bald eagles have historically nested in the area, and there was a non-breeding pair present at a nest site within three miles of the Project in 2009, there were no bald eagles, or other raptor species of conservation concern, observed during the summer surveys. Additionally, no osprey were observed during the summer survey despite the location of a nest roughly 2 kilometers west of Little Bull Hill on the transmission line.

The majority of birds observed during the summer survey period were suspected to be seasonally local to the area, with the exception of one migrant. The summer 2009 observation rate, 0.52 birds/hour, is not necessarily applicable to passage rates documented at HMANA or proposed wind facilities during the migration seasons. The summer observation rate likely included multiple observations of some of the same individual raptors that were seasonally local to the area. Conversely, while migration passage rates may include some observations of local birds, these rates predominantly consist of observations of migrants passing through the area.

Many of the observed flights during the summer season were believed to be associated with raptors traveling between foraging locations, and a few raptors were believed to be actively hunting in the area based on their behaviors. The majority of birds observed were not within the

Project area. The flight height of the single bird that flew within the Project area was below the proposed maximum rotor-swept zone. Relatively low flight heights would be expected during the summer as most flights observed likely involved small-scale, localized flights between foraging locations.

Fall Migration Surveys

The majority of birds observed during the fall surveys were suspected to be actively migrating based on flight behavior; however, 47 percent were suspected to be seasonally local to the Project area or stopping over in the area during migration. The fall passage rates at HMANA hawk watch sites in the region varied between 2.8 birds/hour (Harpswell Peninsula, Maine) and 18.4 birds/hour (Pitcher Mountain, ME), and was 10.78 birds/hour at Cadillac Mountain, roughly 26 miles from the Project (Appendix C, Table 5). The Bull Hill fall passage rate (1.4 birds/hour) is among the lower passage rates reported there. It should be noted that observers at HMANA sites typically do not count birds suspected to be local to the area while observers at Bull Hill included all raptors observed in the seasonal passage rate. Also available for comparison are the public results of fall surveys conducted at other proposed wind energy developments in the northeast. The seasonal passage rate recorded at Bull Hill is within the range of passage rates recorded for other publicly available sties in forested habitats in the northeast (Appendix C, Table 6).

There were three observations of bald eagle made during the fall surveys. One of these eagles occurred at locations within the Project area. The bald eagle observation rate within the Project area during fall surveys was low, 0.01 eagles/hour. The eagle observed within the Project area during fall was observed below the maximum turbine height of 145 m. Although the results of the 2009 summer and fall surveys indicate an infrequent occurrence of bald eagle within the Project area, bald eagles do occasionally occur within the Project area at heights below maximum turbine height. During the fall surveys, one state endangered species, peregrine falcon, was observed, as well as two state special concern species, bald eagle and northern harrier.

The majority of raptors observed during the fall surveys at Bull Hill were observed outside the Project area. Observer location within the Project area may have biased these results as birds closer to the observer may be more easily detected. The flight paths of raptors observed at Bull Hill varied between survey dates and were influenced by varying wind direction and weather. During raptor migration, flight pathways and flight heights along ridges, side slopes, and across valleys may vary seasonally, daily, or hourly. Raptors may shift and use different ridgelines and cross different valleys from year to year or season to season. Weather and wind are major factors that influence migration paths as well as flight heights. Wind strongly affects the propensity of raptors to congregate along ‘leading lines’ or topographic features (Richardson 1998). Wind, air temperature, and cloud cover influence the development of updrafts and thermals used by raptors while making long-distance flights.

The range of the percent of flight heights below the maximum turbine height at other wind sites in the region is 9 to 82 percent; the percent of flights of birds within the Project area below turbine height at Bull Hill falls above the range of these results (Appendix C, Table 6). However,

the reported range in flight heights at other projects likely includes birds flying anywhere in the observation area and not the Project area, only. In addition, variations in flight heights among sites, and among survey days at a single site are due to variable weather conditions and the particular flight behaviors of different raptor species. Typically, *accipiters* and falcons use up-drafts from side slopes to gain lift and, therefore, usually fly low over ridgelines. *Buteos* tend to use lift from thermals that develop over side slopes and valleys and tend to fly high during hours of peak thermal development. Raptors (*accipiters* in particular) typically fly lower than usual during windy or inclement conditions. Local birds may fly at lower altitudes while making small scale movements between foraging locations (Barrios and Rodriguez, 2004).

Despite generally low flight heights documented during raptor surveys in the region, studies have documented high raptor collision avoidance behaviors at modern wind facilities (Whitfield and Madders 2006, Chamberlain et al. 2006). As most raptors are diurnal, raptors may be able to visually, as well as acoustically detect turbines during periods of fair weather. Foraging raptors that may become distracted by prey, or migrant raptors flying during periods of reduced visibility, may be at increased risk of collision with wind turbines.

Pre-construction raptor studies can provide baseline data regarding the species of raptor that occur and the general flight behaviors of birds traveling through the area. However, currently there is no clear relationship between pre-construction visual surveys and post-construction mortality data for the prediction of raptor collision risk at wind sites.

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Appendix A

Radar survey results

Appendix A Table 1. Survey dates, results, level of effort, and weather - Fall 2009								
Date	**Passage rate**	**Flight Direction**	**Flight Height (m)**	**% below 145 m**	**Hours of Survey**	**Temperature (C)**	**Wind Speed (m/s)**	**Wind Direction (degrees)**
9/1	823	293	399	26%	11	12.63	3.68	281.284
9/2	503	337	208	45%	11	13.33	6.22	250.137
9/3	422	346	225	41%	11	14.31	5.55	215.355
9/8	1007	233	333	14%	10	13.81	7.41	300.754
9/9	871	272	334	19%	9	9.83	6.37	46.199
9/10	188	11	232	37%	11	7.51	4.42	155.014
9/11	536	320	230	33%	12	13.10	2.70	219.826
9/16	679	256	321	20%	12	7.46	3.11	28.726
9/17	191	358	318	21%	12	7.90	5.56	19.041
9/23	277	4	293	14%	11	16.55	5.81	203.333
9/24	1108	223	482	4%	11	10.23	5.68	321.913
9/28	521	318	240	30%	10	14.09	5.91	168.903
9/29	286	313	302	6%	12	11.20	6.87	174.808
9/30	331	247	247	29%	13	7.68	4.41	224.135
10/1	312	244	326	12%	12	6.68	2.73	261.606
10/5	751	235	449	12%	13	7.84	7.47	298.312
10/6	1500	272	413	15%	13	8.14	5.56	265.274
10/8	660	235	556	4%	13	6.33	4.81	319.545
10/14	762	250	558	7%	12	-1.26	6.98	310.5
10/15	594	247	531	7%	13	-0.43	6.31	330.021
Entire Season	**614**	**260**	**356**	**14%**	**11.6**	**9**	**5**	**264.116**

Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.

Night of	Passage Rate (targets/km/hr) by hour after sunset													Entire Night			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Mean**	**Median**	**Stdev**	**SE**
9/01	461	1489	993	861	646	543	956	1013	929	934	225	N/A	N/A	823	929	339	102
9/02	404	926	1029	634	391	350	354	480	386	468	116	N/A	N/A	503	404	266	80
9/03	379	604	550	506	497	334	400	414	544	389	21	N/A	N/A	422	414	158	48
9/08	718	1913	1786	1139	1020	994	866	810	386	443	N/A	N/A	N/A	1007	930	505	160
9/09	421	1140	1184	1021	990	879	886	714	604	N/A	N/A	N/A	N/A	871	886	251	84
9/10	51	346	339	207	232	229	236	89	107	90	146	N/A	N/A	188	207	100	30
9/11	450	654	626	626	707	587	686	671	609	475	304	38	N/A	536	617	196	57
9/16	421	651	707	850	1111	1277	969	677	589	364	496	36	N/A	679	664	341	98
9/17	161	233	223	223	253	210	245	240	217	170	108	13	N/A	191	220	70	20
9/23	17	432	450	407	386	296	364	9	N/A	134	271	0	N/A	277	296	167	53
9/24	659	1246	1393	1429	1436	1214	1468	1568	1325	279	171	N/A	N/A	1108	1325	498	150
9/28	204	1021	1246	1000	611	543	189	64	154	N/A	N/A	179	N/A	521	373	433	137
9/29	114	596	768	518	382	407	264	113	118	39	51	57	N/A	286	191	245	71
9/30	240	700	939	480	177	354	339	630	268	90	26	57	0	331	268	287	80
10/01	56	213	523	529	414	313	307	399	329	364	132	167	N/A	312	321	148	43
10/05	175	525	1911	1911	1243	886	754	814	550	346	266	314	64	751	550	608	169
10/06	268	1779	1961	2507	1916	2018	2039	1068	1343	2161	1529	907	7	1500	1779	752	209
10/08	393	996	1461	1718	1018	496	482	557	546	386	329	112	86	660	496	497	138
10/14	161	689	982	975	1364	1368	1064	1079	532	300	318	307	N/A	762	832	432	125
10/15	489	714	818	868	714	796	793	700	493	550	432	229	121	594	700	233	65
Entire Season	**312**	**843**	**994**	**920**	**775**	**705**	**683**	**605**	**528**	**443**	**291**	**186**	**56**	**614**	**486**	**492**	**32**

0 indicates no targets counted for that hour N/A indicates no data for that hour

Appendix A Table 3. Mean Nightly Flight Direction		
Night of	**Mean Flight Direction**	**Circular Stdev**
9/01	292.96	66.17
9/02	336.61	59.12
9/03	345.87	87.84
9/08	233.28	44.77
9/09	272.27	48.58
9/10	11.48	84.28
9/11	320.49	109.05
9/16	256.38	57.00
9/17	357.94	79.31
9/23	4.36	93.09
9/24	223.08	30.29
9/28	317.71	58.13
9/29	312.79	57.89
9/30	247.11	77.12
10/01	243.68	41.25
10/05	234.52	59.89
10/06	272.25	44.60
10/08	235.28	43.82
10/14	249.85	58.12
10/15	246.52	32.27
Entire Season	**259.90**	**65.53**

Appendix A Table 4. Summary of mean flight heights by hour, night, and for entire season.																		
Night of	Mean Flight Height (m) by hour after sunset													Entire Night				% of targets below 145 meters
	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean	Median	STDV	SE	
9/01	279	491	517	453	526	367	444	471	301	269	273	N/A	N/A	399	444	103	31	26%
9/02	190	189	183	221	206	217	192	173	196	255	266	N/A	N/A	208	196	30	9	45%
9/03	164	264	243	166	201	240	272	281	205	213	N/A	N/A	N/A	225	227	42	13	41%
9/08	287	385	404	346	338	370	337	317	287	257	N/A	N/A	N/A	333	337	47	15	14%
9/09	282	336	375	438	394	326	296	307	255	N/A	N/A	N/A	N/A	334	326	59	20	19%
9/10	166	340	327	300	179	274	150	236	253	169	152	N/A	N/A	232	236	72	22	37%
9/11	251	233	290	201	237	216	219	256	240	194	224	195	N/A	230	228	28	8	33%
9/16	269	260	269	350	380	384	350	328	339	292	273	355	N/A	321	333	46	13	20%
9/17	361	378	384	354	375	358	337	271	351	224	240	188	N/A	318	353	68	20	21%
9/23	433	290	228	303	282	306	267	281	N/A	291	248	N/A	N/A	293	286	55	17	14%
9/24	453	538	525	557	538	527	561	567	506	346	N/A	184	N/A	482	527	118	35	4%
9/28	219	225	266	235	254	231	263	269	N/A	N/A	N/A	194	N/A	240	235	25	8	30%
9/29	340	353	381	354	357	310	288	299	211	231	224	280	N/A	302	305	57	17	6%
9/30	175	199	222	314	262	261	350	207	183	234	306	--	--	247	234	57	17	29%
10/01	361	422	459	478	424	451	376	300	192	225	175	204	172	326	361	119	33	12%
10/05	253	521	500	438	557	570	605	546	549	519	441	205	140	449	519	152	42	12%
10/06	222	534	600	579	610	561	529	471	441	280	248	168	131	413	471	177	49	15%
10/08	398	438	452	483	524	701	661	644	672	667	617	569	401	556	569	112	31	4%
10/14	413	489	545	609	608	573	628	616	614	621	564	417	N/A	558	591	78	22	7%
10/15	368	517	628	628	630	635	575	521	550	523	485	498	342	531	523	95	26	7%
Entire Season	**294**	**370**	**390**	**390**	**394**	**394**	**385**	**368**	**353**	**323**	**316**	**288**	**237**	**356**	**327**	**143**	**9**	**14%**
-- indicates no targets counted for that hour														N/A indicates no data for that hour				

Appendix A Table 5. Summary of available avian fall radar survey results conducted at proposed (pre-construction) US wind power facilities on Forested Ridge landscapes in the Northeast using X-band mobile radar systems (2004-present)

Year	Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	(Turbine Ht) % Targets Below Turbine Height	Reference
Fall 2004										
2004	Sheffield, Caledonia Cty, VT	18	176	Forested ridge	91	19-320	200	566	(125 m) 1%	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
Fall 2005										
2005	Kibby, Franklin Cty, ME (Range 1)	12	101	Forested ridge	201	12-783	196	352	(125 m) 12%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
2005	Stamford, Delaware Cty, NY	48	418	Forested ridge	315	22-784	251	494	(110 m) 3%	Woodlot Alternatives, Inc. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
2005	Kibby, Franklin Cty, ME (Valley)	5	13	Forested ridge	452	52-995	193	391	(125 m) 16%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
2005	Mars Hill, Aroostook Cty, ME	18	117	Forested ridge	512	60-1092	228	424	(120 m) 8%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird Migration at the Mars Hill Wind Farm in Mars Hill, Maine. Prepared for Evergreen Windpower, LLC.
2005	Deerfield, Bennington Cty, VT	32	324	Forested ridge	559	3-1736	221	395	(100 m) 13%	Woodlot Alternatives, Inc. 2006. Fall 2005 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
2005	Kibby, Franklin Cty, ME (Mountain)	12	115	Forested ridge	565	109-1107	167	370	(125 m) 16%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Fall 2006										
2006	Stetson, Washington Cty, ME	12	77	Forested ridge	476	131-1192	227	378	(125 m) 13%	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Stetson Wind Project, Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2006	Lempster, Sullivan Cty, NH	32	290	Forested ridge	620	133-1609	206	387	(125 m) 8%	Woodlot Alternatives, Inc. 2007. A Fall 2007 Survey of Nocturnal Bird Migration,Breeding Birds, and Bicknell's Thrush at the Proposed Lempster Mountain Wind Power Project Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
Fall 2007										
2007	Errol, Coos County, NH	29	232	Forested ridge	366	54-1234	223	343	(125 m) 15%	Stantec Consulting Inc. 2007. Fall 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windpark in Coos County, New Hampshire by Granite Reliable Power, LLC. Prepared for Granite Reliable Power, LLC.
2007	Lincoln, Penobscot Cty, ME	22	231	Forested ridge	368	82-953	284	343	(120 m) 13%	Woodlot Alternatives, Inc. 2008. A Fall 2007 Survey of Bird and Bat Migration at the Rollins Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
2007	Roxbury, Oxford Cty, ME	20	220	Forested ridge	420	88-1006	227	365	(130 m) 14%	Woodlot Alternatives, Inc. 2007. A Fall 2007 Survey of Bird and Bat Migration at the Record Hill Wind Project, Roxbury, Maine. Prepared for Roxbury Hill Wind LLC.
2007	Allegany, Cattaraugus Cty, NY	46	n/a	Forested ridge	451	n/a	230	382	(150 m) 14%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Fall 2008										
2008	Georgia Mountain, VT	21	n/a	Forested ridge	326	56-700	230	371	(120 m) 7%	Stantec Consulting Services Inc. 2008. A Fall 2008 Survey of Bird Migration at the Georgia Mountain Wind Project, Vermont. Prepared for Georgia Mountain Community Wind.
2008	Oakfield, Penobscot Cty, ME	20	n/a	Forested ridge	501	116-945	200	309	(125 m) 18%	Woodlot Alternatives, Inc. 2008. A Fall 2008 Survey of Bird and Bat Migration at the Oakfield Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
Fall 2009										
2009	Bull Hill, Hancock Cty, ME	20	n/a	Forested ridge	614	188-1500	260	357	(175 m) 20%	*this report*

Appendix B

Bat survey results

Appendix B Table 1. Summary of acoustic bat data and weather during each survey night at the Met High detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1												**0**	4.49	12.35
07/15/09	1												**0**	5.03	12.44
07/16/09	1												**0**	2.75	16.16
07/17/09	1												**0**	3.93	16.18
07/18/09	1												**0**	3.49	18.18
07/19/09	1												**0**	5.31	16.74
07/20/09	1												**0**	4.18	17.10
07/21/09	1												**0**	4.18	16.36
07/22/09	1												**0**	4.23	16.81
07/23/09	1												**0**	6.40	15.28
07/24/09	1												**0**	5.11	15.20
07/25/09	1												**0**	2.84	15.43
07/26/09	1												**0**	4.88	18.07
07/27/09	1												**0**	4.19	17.48
07/28/09	1												**0**	5.76	18.09
07/29/09	1												**0**	6.42	19.22
07/30/09	1												**0**	3.47	20.03
07/31/09	1												**0**	5.04	17.33
08/01/09	1												**0**	5.48	17.94
08/02/09	1												**0**	4.41	15.32
08/03/09	1												**0**	3.36	17.52
08/04/09	1												**0**	5.08	17.09
08/05/09	1												**0**	5.87	17.48
08/06/09	1												**0**	4.58	15.98
08/07/09	1												**0**	7.14	11.78
08/08/09	1												**0**	4.05	14.23
08/09/09	1												**0**	7.04	15.96
08/10/09	1		1										**1**	4.98	19.78
08/11/09	1												**0**	4.07	17.24
08/12/09	1												**0**	3.42	16.29
08/13/09	1												**0**	5.04	14.89
08/14/09	1												**0**	5.06	19.18
08/15/09	1												**0**	5.75	20.13
08/16/09	1												**0**	4.86	20.58
08/17/09	1												**0**	6.13	21.10
08/18/09	1												**0**	6.54	20.60
08/19/09	1												**0**	5.03	19.79
08/20/09	1				1								**1**	4.22	18.90
08/21/09	1												**0**	6.94	21.04
08/22/09	1												**0**	5.93	20.94
08/23/09	1												**0**	4.66	18.80
08/24/09	1				1								**1**	5.28	17.37
08/25/09	1												**0**	6.94	18.33
08/26/09	1												**0**	7.57	12.96
08/27/09	1												**0**	4.22	11.18
08/28/09	1												**0**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1												**0**	4.69	14.33
08/31/09	1												**0**	5.08	11.04
09/01/09	1												**0**	3.68	12.63
09/02/09	1												**0**	6.22	13.33
09/03/09	1												**0**	5.55	14.31
09/04/09	1												**0**	6.00	15.91
09/05/09	1												**0**	6.28	10.34
09/06/09	1												**0**	5.37	9.19
09/07/09	1												**0**	5.91	11.70
09/08/09	1												**0**	7.41	13.81
09/09/09	1												**0**	6.37	9.83
09/10/09	1												**0**	4.42	7.51
09/11/09	1												**0**	2.70	13.10
09/12/09	1				2						1		**3**	2.30	15.23
09/13/09	1												**0**	6.25	11.89
09/14/09	1												**0**	5.12	12.64
09/15/09	1												**0**	6.08	8.39
09/16/09	1												**0**	3.11	7.46
09/17/09	1												**0**	5.56	7.90
09/18/09	1												**0**	8.60	8.38
09/19/09	1												**0**	6.08	7.24
09/20/09	1										1		**1**	5.47	11.92
09/21/09	1					1							**1**	5.19	11.18
09/22/09	1												**0**	4.88	14.36
09/23/09	1												**0**	5.81	16.55
09/24/09	1						1						**1**	5.68	10.23

(*continued*)

Appendix B Table 1 (cont.)

09/25/09	1												**0**	5.63	3.31
09/26/09	1												**0**	7.58	7.80
09/27/09	1												**0**	9.80	14.87
09/28/09	1												**0**	5.91	14.09
09/29/09	1												**0**	6.87	11.20
09/30/09	1												**0**	4.41	7.68
10/01/09	1												**0**	2.73	6.68
10/02/09	1												**0**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1												**0**	5.17	11.37
10/05/09	1												**0**	7.47	7.84
10/06/09	1												**0**	5.56	8.14
10/07/09	1												**0**	7.36	7.58
10/08/09	1												**0**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1												**0**	8.45	3.36
10/12/09	1												**0**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1												**0**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
By Species		**0**	**1**	**0**	**4**	**1**	**1**	**0**	**0**	**0**	**2**	**0**	**9**		
By Guild		**1**			**4**	**1**	**1**			**2**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 2. Summary of acoustic bat data and weather during each survey night at the Met Low detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1					1							**1**	4.49	12.35
07/15/09	1												**0**	5.03	12.44
07/16/09	1												**0**	2.75	16.16
07/17/09	1												**0**	3.93	16.18
07/18/09	1												**0**	3.49	18.18
07/19/09	1												**0**	5.31	16.74
07/20/09	1												**0**	4.18	17.10
07/21/09	1												**0**	4.18	16.36
07/22/09	1					1							**1**	4.23	16.81
07/23/09	1												**0**	6.40	15.28
07/24/09	1												**0**	5.11	15.20
07/25/09	1												**0**	2.84	15.43
07/26/09	1												**0**	4.88	18.07
07/27/09	1												**0**	4.19	17.48
07/28/09	1												**0**	5.76	18.09
07/29/09	1												**0**	6.42	19.22
07/30/09	1												**0**	3.47	20.03
07/31/09	1												**0**	5.04	17.33
08/01/09	1												**0**	5.48	17.94
08/02/09	1												**0**	4.41	15.32
08/03/09	1												**0**	3.36	17.52
08/04/09	1												**0**	5.08	17.09
08/05/09	1												**0**	5.87	17.48
08/06/09	1												**0**	4.58	15.98
08/07/09	1												**0**	7.14	11.78
08/08/09	1												**0**	4.05	14.23
08/09/09	1												**0**	7.04	15.96
08/10/09	1												**0**	4.98	19.78
08/11/09	1												**0**	4.07	17.24
08/12/09	1				1								**1**	3.42	16.29
08/13/09	1												**0**	5.04	14.89
08/14/09	1												**0**	5.06	19.18
08/15/09	1												**0**	5.75	20.13
08/16/09	1												**0**	4.86	20.58
08/17/09	1												**0**	6.13	21.10
08/18/09	1	1											**1**	6.54	20.60
08/19/09	1	2		1									**3**	5.03	19.79
08/20/09	1	1											**1**	4.22	18.90
08/21/09	1												**0**	6.94	21.04
08/22/09	1												**0**	5.93	20.94
08/23/09	1												**0**	4.66	18.80
08/24/09	1			1	1						2		**4**	5.28	17.37
08/25/09	1	1											**1**	6.94	18.33
08/26/09	1												**0**	7.57	12.96
08/27/09	1												**0**	4.22	11.18
08/28/09	1			1							1		**2**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1												**0**	4.69	14.33
08/31/09	1												**0**	5.08	11.04
09/01/09	1												**0**	3.68	12.63
09/02/09	1												**0**	6.22	13.33
09/03/09	1								1				**1**	5.55	14.31
09/04/09	1					1							**1**	6.00	15.91
09/05/09	1												**0**	6.28	10.34
09/06/09	1												**0**	5.37	9.19
09/07/09	1												**0**	5.91	11.70
09/08/09	1					1							**1**	7.41	13.81
09/09/09	1												**0**	6.37	9.83
09/10/09	1												**0**	4.42	7.51
09/11/09	1									1			**1**	2.70	13.10
09/12/09	1				3					1	2		**6**	2.30	15.23
09/13/09	1									1			**1**	6.25	11.89
09/14/09	1												**0**	5.12	12.64
09/15/09	1												**0**	6.08	8.39
09/16/09	1												**0**	3.11	7.46
09/17/09	1												**0**	5.56	7.90
09/18/09	1												**0**	8.60	8.38
09/19/09	1												**0**	6.08	7.24
09/20/09	1					2							**2**	5.47	11.92
09/21/09	1												**0**	5.19	11.18
09/22/09	1												**0**	4.88	14.36
09/23/09	1					1				1			**2**	5.81	16.55
09/24/09	1										2		**2**	5.68	10.23
09/25/09	1												**0**	5.63	3.31

(*continued*)

Appendix B Table 2 (cont.)

09/26/09	1												**0**	7.58	7.80
09/27/09	1												**0**	9.80	14.87
09/28/09	1	1											**1**	5.91	14.09
09/29/09	1												**0**	6.87	11.20
09/30/09	1												**0**	4.41	7.68
10/01/09	1												**0**	2.73	6.68
10/02/09	1												**0**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1												**0**	5.17	11.37
10/05/09	1									1			**1**	7.47	7.84
10/06/09	1												**0**	5.56	8.14
10/07/09	1								1				**1**	7.36	7.58
10/08/09	1												**0**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1												**0**	8.45	3.36
10/12/09	1												**0**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1												**0**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
10/16/09	1												**0**	6.69	2.04
10/17/09	1												**0**	8.01	1.14
10/18/09	1												**0**	8.85	1.21
10/19/09	1												**0**	3.39	3.09
10/20/09	1												**0**	6.06	6.59
10/21/09	1												**0**	5.69	3.70
10/22/09	1												**0**	8.88	0.57
10/23/09	1												**0**	8.19	3.09
10/24/09	1												**0**	9.87	12.64
10/25/09	1												**0**	7.56	3.35
10/26/09	1										1		**1**	5.64	1.89
10/27/09	1												**0**	6.99	2.37
10/28/09	1												**0**	5.64	2.04
10/29/09	1												**0**	3.85	4.75
10/30/09	1												**0**	7.28	7.02
10/31/09	1												**0**		
11/01/09	1												**0**		
11/02/09	1												**0**		
11/03/09	1												**0**		
11/04/09	1												**0**		
By Species		**6**	**0**	**3**	**5**	**7**	**0**	**0**	**2**	**5**	**8**	**0**	**36**		
By Guild		**9**			**5**	**7**	**2**			**13**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 3. Summary of acoustic bat data and weather during each survey night at the NE Tree detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1	2				2			1	30	1		**36**	4.49	12.35
07/15/09	1							1		6			**7**	5.03	12.44
07/16/09	1					1				10			**11**	2.75	16.16
07/17/09	1									4			**4**	3.93	16.18
07/18/09	1									6			**6**	3.49	18.18
07/19/09	1	2				3				29			**34**	5.31	16.74
07/20/09	1	10				36				48	5		**99**	4.18	17.10
07/21/09	1									3			**3**	4.18	16.36
07/22/09	1	18				28				168	9		**223**	4.23	16.81
07/23/09	1	5				1				7	2		**15**	6.40	15.28
07/24/09	1					4				19			**23**	5.11	15.20
07/25/09	1	12				3				10	5		**30**	2.84	15.43
07/26/09	1												**0**	4.88	18.07
07/27/09	1	1				6			1	33	9		**50**	4.19	17.48
07/28/09	1					3				10	2		**15**	5.76	18.09
07/29/09	1									5	2		**7**	6.42	19.22
07/30/09	1	10				2				18	5		**35**	3.47	20.03
07/31/09	1	23				2				46	5		**76**	5.04	17.33
08/01/09	1	2				5				9			**16**	5.48	17.94
08/02/09	1								1	4	1		**6**	4.41	15.32
08/03/09	0												**0**	3.36	17.52
08/04/09	0												**0**	5.08	17.09
08/05/09	0												**0**	5.87	17.48
08/06/09	0												**0**	4.58	15.98
08/07/09	0												**0**	7.14	11.78
08/08/09	0												**0**	4.05	14.23
08/09/09	0												**0**	7.04	15.96
08/10/09	0												**0**	4.98	19.78
08/11/09	0												**0**	4.07	17.24
08/12/09	1					24			2	9			**35**	3.42	16.29
08/13/09	1					30				19			**49**	5.04	14.89
08/14/09	1					37				8			**45**	5.06	19.18
08/15/09	1	2				22			2	9	1		**36**	5.75	20.13
08/16/09	1	1				18			3	12			**34**	4.86	20.58
08/17/09	1	2				6			5	3			**16**	6.13	21.10
08/18/09	1					3				8			**11**	6.54	20.60
08/19/09	1	2				7			2	9			**20**	5.03	19.79
08/20/09	1	1				13			4	11			**29**	4.22	18.90
08/21/09	1					2				1			**3**	6.94	21.04
08/22/09	1					5				2	2		**9**	5.93	20.94
08/23/09	1									2			**2**	4.66	18.80
08/24/09	1	1				11				8			**20**	5.28	17.37
08/25/09	1					3				2			**5**	6.94	18.33
08/26/09	1					5			1	9			**15**	7.57	12.96
08/27/09	1					3				2	1		**6**	4.22	11.18
08/28/09	1					7				3			**10**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1	1				1				4			**6**	4.69	14.33
08/31/09	1	1				1				2			**4**	5.08	11.04
09/01/09	1					6				1			**7**	3.68	12.63
09/02/09	1		1			4				4			**9**	6.22	13.33
09/03/09	1					2							**2**	5.55	14.31
09/04/09	1					6				2			**8**	6.00	15.91
09/05/09	1					1				2			**3**	6.28	10.34
09/06/09	1					1			2	1			**4**	5.37	9.19
09/07/09	1					3				2			**5**	5.91	11.70
09/08/09	1					3				5			**8**	7.41	13.81
09/09/09	1					2							**2**	6.37	9.83
09/10/09	1												**0**	4.42	7.51
09/11/09	1					9							**9**	2.70	13.10
09/12/09	1					7							**7**	2.30	15.23
09/13/09	1												**0**	6.25	11.89
09/14/09	1					8				3			**11**	5.12	12.64
09/15/09	1												**0**	6.08	8.39
09/16/09	1												**0**	3.11	7.46
09/17/09	1					2							**2**	5.56	7.90
09/18/09	1												**0**	8.60	8.38
09/19/09	1												**0**	6.08	7.24
09/20/09	1					5				19			**24**	5.47	11.92
09/21/09	1												**0**	5.19	11.18
09/22/09	1												**0**	4.88	14.36
09/23/09	1					1				1			**2**	5.81	16.55
09/24/09	1												**0**	5.68	10.23
09/25/09	1												**0**	5.63	3.31

(*continued*)

Appendix B Table 3 (cont.)

09/26/09	1												**0**	7.58	7.80
09/27/09	1												**0**	9.80	14.87
09/28/09	1	1								1			**2**	5.91	14.09
09/29/09	1												**0**	6.87	11.20
09/30/09	1					2							**2**	4.41	7.68
10/01/09	1												**0**	2.73	6.68
10/02/09	1												**0**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1									1			**1**	5.17	11.37
10/05/09	1					1	1			1			**3**	7.47	7.84
10/06/09	1												**0**	5.56	8.14
10/07/09	1												**0**	7.36	7.58
10/08/09	1									1			**1**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1												**0**	8.45	3.36
10/12/09	1												**0**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1												**0**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
10/16/09	1												**0**	6.69	2.04
10/17/09	1												**0**	8.01	1.14
10/18/09	1												**0**	8.85	1.21
10/19/09	1												**0**	3.39	3.09
10/20/09	1					1							**1**	6.06	6.59
10/21/09	1												**0**	5.69	3.70
10/22/09	1												**0**	8.88	0.57
10/23/09	1												**0**	8.19	3.09
10/24/09	1												**0**	9.87	12.64
10/25/09	1												**0**	7.56	3.35
10/26/09	1												**0**	5.64	1.89
10/27/09	1												**0**	6.99	2.37
10/28/09	1												**0**	5.64	2.04
10/29/09	1												**0**	3.85	4.75
10/30/09	1												**0**	7.28	7.02
10/31/09	1												**0**		
11/01/09	1												**0**		
11/02/09	1												**0**		
11/03/09	1												**0**		
By Species		**97**	**1**	**0**	**0**	**358**	**1**	**1**	**24**	**632**	**50**	**0**	**1164**		
By Guild		**98**			**0**	**358**	**26**			**682**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 4. Summary of acoustic bat data and weather during each survey night at the Radar Tree detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1					1				1			**2**	4.49	12.35
07/15/09	1									11			**11**	5.03	12.44
07/16/09	1												**0**	2.75	16.16
07/17/09	1												**0**	3.93	16.18
07/18/09	1									1			**1**	3.49	18.18
07/19/09	1									4			**4**	5.31	16.74
07/20/09	1									2			**2**	4.18	17.10
07/21/09	1												**0**	4.18	16.36
07/22/09	1									22			**22**	4.23	16.81
07/23/09	1					1				6			**7**	6.40	15.28
07/24/09	1					6							**6**	5.11	15.20
07/25/09	1	9				2				2	1		**14**	2.84	15.43
07/26/09	1									1			**1**	4.88	18.07
07/27/09	1	74				38			2	9	13		**136**	4.19	17.48
07/28/09	1	6				10			1	4			**21**	5.76	18.09
07/29/09	1	3				2					1		**6**	6.42	19.22
07/30/09	1	22				14			1	13	1		**51**	3.47	20.03
07/31/09	1	139				9				8	4		**160**	5.04	17.33
08/01/09	1	6				6			1	8			**21**	5.48	17.94
08/02/09	1					1				2			**3**	4.41	15.32
08/03/09	1	1				19				6			**26**	3.36	17.52
08/04/09	1	6				3							**9**	5.08	17.09
08/05/09	1	15				22				12			**49**	5.87	17.48
08/06/09	1	1				10				11			**22**	4.58	15.98
08/07/09	1					11				4			**15**	7.14	11.78
08/08/09	1	5				12			1	3			**21**	4.05	14.23
08/09/09	1					1			1	2			**4**	7.04	15.96
08/10/09	1	38	9			45			3	13	1		**109**	4.98	19.78
08/11/09	1	5				80			1	31	1		**118**	4.07	17.24
08/12/09	1					8				11			**19**	3.42	16.29
08/13/09	1	1				11				7			**19**	5.04	14.89
08/14/09	1					23				12			**35**	5.06	19.18
08/15/09	1	1		2		20				6	9		**38**	5.75	20.13
08/16/09	1					11				5			**16**	4.86	20.58
08/17/09	1					3				6	1		**10**	6.13	21.10
08/18/09	1					8				2	1		**11**	6.54	20.60
08/19/09	1					19				7			**26**	5.03	19.79
08/20/09	1	1				9				3			**13**	4.22	18.90
08/21/09	1					1				1	1		**3**	6.94	21.04
08/22/09	1					4		1		2			**7**	5.93	20.94
08/23/09	1					4				1			**5**	4.66	18.80
08/24/09	1	1				11				4			**16**	5.28	17.37
08/25/09	1					3				1			**4**	6.94	18.33
08/26/09	1	1				3				1			**5**	7.57	12.96
08/27/09	1	1				3				1			**5**	4.22	11.18
08/28/09	1					3				2	1		**6**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1	1											**1**	4.69	14.33
08/31/09	1					15				6	1		**22**	5.08	11.04
09/01/09	1					1				2			**3**	3.68	12.63
09/02/09	1												**0**	6.22	13.33
09/03/09	1												**0**	5.55	14.31
09/04/09	1					5			5	2			**12**	6.00	15.91
09/05/09	1					16			1	1			**18**	6.28	10.34
09/06/09	1												**0**	5.37	9.19
09/07/09	1												**0**	5.91	11.70
09/08/09	1	5				5			3	4	7		**24**	7.41	13.81
09/09/09	1					36			2	4			**42**	6.37	9.83
09/10/09	1												**0**	4.42	7.51
09/11/09	1					3							**3**	2.70	13.10
09/12/09	1					2				3			**5**	2.30	15.23
09/13/09	1					4			2	3			**9**	6.25	11.89
09/14/09	1					1			1	2	1		**5**	5.12	12.64
09/15/09	1					4							**4**	6.08	8.39
09/16/09	1					1							**1**	3.11	7.46
09/17/09	1					1							**1**	5.56	7.90
09/18/09	1												**0**	8.60	8.38
09/19/09	1					3			1				**4**	6.08	7.24
09/20/09	1								2	1			**3**	5.47	11.92
09/21/09	1					2			1				**3**	5.19	11.18
09/22/09	1								2	1			**3**	4.88	14.36
09/23/09	1					2				6			**8**	5.81	16.55
09/24/09	1					1				2			**3**	5.68	10.23
09/25/09	1												**0**	5.63	3.31
09/26/09	1									1			**1**	7.58	7.80

(*continued*)

Appendix B Table 4 (cont.)

09/27/09	1												**0**	9.80	14.87
09/28/09	1					4			1	2			**7**	5.91	14.09
09/29/09	1					1			1				**2**	6.87	11.20
09/30/09	1								1				**1**	4.41	7.68
10/01/09	1					1							**1**	2.73	6.68
10/02/09	1									1			**1**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1					1				1	1		**3**	5.17	11.37
10/05/09	1												**0**	7.47	7.84
10/06/09	1												**0**	5.56	8.14
10/07/09	1												**0**	7.36	7.58
10/08/09	1												**0**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1												**0**	8.45	3.36
10/12/09	1												**0**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1			1		1							**2**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
10/16/09	1												**0**	6.69	2.04
10/17/09	1												**0**	8.01	1.14
10/18/09	1												**0**	8.85	1.21
10/19/09	1												**0**	3.39	3.09
10/20/09	1												**0**	6.06	6.59
10/21/09	1												**0**	5.69	3.70
10/22/09	1												**0**	8.88	0.57
10/23/09	1												**0**	8.19	3.09
10/24/09	1												**0**	9.87	12.64
10/25/09	1									1			**1**	7.56	3.35
10/26/09	1												**0**	5.64	1.89
10/27/09	1												**0**	6.99	2.37
10/28/09	1												**0**	5.64	2.04
10/29/09	1												**0**	3.85	4.75
10/30/09	1												**0**	7.28	7.02
10/31/09	1												**0**		
11/01/09	1												**0**		
11/02/09	1												**0**		
11/03/09	1												**0**		
11/04/09	1												**0**		
By Species		**342**	**9**	**3**	**0**	**547**	**0**	**1**	**34**	**291**	**45**	**0**	**1272**		
By Guild		**354**			**0**	**547**	**35**			**336**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 5. Summary of acoustic bat data and weather during each survey night at the SE Tree detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1												**0**	4.49	12.35
07/15/09	1	6				6				1	1		**14**	5.03	12.44
07/16/09	1									5			**5**	2.75	16.16
07/17/09	1					2							**2**	3.93	16.18
07/18/09	1	1				2				2			**5**	3.49	18.18
07/19/09	1					18			1	5	1		**25**	5.31	16.74
07/20/09	1					9				4			**13**	4.18	17.10
07/21/09	1	2				2				1	2		**7**	4.18	16.36
07/22/09	1					6				4			**10**	4.23	16.81
07/23/09	1					2				2	1		**5**	6.40	15.28
07/24/09	1					4				2			**6**	5.11	15.20
07/25/09	1												**0**	2.84	15.43
07/26/09	1												**0**	4.88	18.07
07/27/09	1					8			4				**12**	4.19	17.48
07/28/09	1	1				2				2			**5**	5.76	18.09
07/29/09	1	1								2			**3**	6.42	19.22
07/30/09	1	1				19			1	4			**25**	3.47	20.03
07/31/09	1					9			2	5			**16**	5.04	17.33
08/01/09	1	2				23				3			**28**	5.48	17.94
08/02/09	1				1	11				1			**13**	4.41	15.32
08/03/09	1	2				21			1	5	2		**31**	3.36	17.52
08/04/09	1	3				5				2			**10**	5.08	17.09
08/05/09	1	5	1			18				4			**28**	5.87	17.48
08/06/09	1	1			1	40			1	3	1		**47**	4.58	15.98
08/07/09	1				1	20			2	1			**24**	7.14	11.78
08/08/09	1	1				35				1			**37**	4.05	14.23
08/09/09	1				1	5							**6**	7.04	15.96
08/10/09	1	3	1			36			1	1			**42**	4.98	19.78
08/11/09	1	4				14			1	4	1		**24**	4.07	17.24
08/12/09	1	1				9			1	2			**13**	3.42	16.29
08/13/09	1	4				11				7			**22**	5.04	14.89
08/14/09	1	4	1		1	6				6			**18**	5.06	19.18
08/15/09	1	3				10			1	6			**20**	5.75	20.13
08/16/09	1	3				6			1	2			**12**	4.86	20.58
08/17/09	1	2				9			1	6			**18**	6.13	21.10
08/18/09	1					7				4			**11**	6.54	20.60
08/19/09	1	3	1			7				3			**14**	5.03	19.79
08/20/09	1	1		1		17				5			**24**	4.22	18.90
08/21/09	1					5				2			**7**	6.94	21.04
08/22/09	1					24				3			**27**	5.93	20.94
08/23/09	1									1			**1**	4.66	18.80
08/24/09	1					13				1			**14**	5.28	17.37
08/25/09	1					4			1	1			**6**	6.94	18.33
08/26/09	1					2			1	2			**5**	7.57	12.96
08/27/09	1												**0**	4.22	11.18
08/28/09	1					2				1			**3**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1									1			**1**	4.69	14.33
08/31/09	1												**0**	5.08	11.04
09/01/09	1	1		3		1				3			**8**	3.68	12.63
09/02/09	1					1			1	3	1		**6**	6.22	13.33
09/03/09	1								2	4			**6**	5.55	14.31
09/04/09	1	2		2						5			**9**	6.00	15.91
09/05/09	1					3			1	1			**5**	6.28	10.34
09/06/09	1												**0**	5.37	9.19
09/07/09	1					1				1			**2**	5.91	11.70
09/08/09	1					5			1	3			**9**	7.41	13.81
09/09/09	1									1			**1**	6.37	9.83
09/10/09	1												**0**	4.42	7.51
09/11/09	1									3			**3**	2.70	13.10
09/12/09	1					5				3			**8**	2.30	15.23
09/13/09	1					1							**1**	6.25	11.89
09/14/09	1									2			**2**	5.12	12.64
09/15/09	1								1	1			**2**	6.08	8.39
09/16/09	1												**0**	3.11	7.46
09/17/09	1					1				1			**2**	5.56	7.90
09/18/09	1												**0**	8.60	8.38
09/19/09	1												**0**	6.08	7.24
09/20/09	1									4			**4**	5.47	11.92
09/21/09	1	1							1	1			**3**	5.19	11.18
09/22/09	1					6			1	1			**8**	4.88	14.36
09/23/09	1					3				1			**4**	5.81	16.55
09/24/09	1												**0**	5.68	10.23
09/25/09	1					1							**1**	5.63	3.31

(*continued*)

Appendix B Table 5 (cont.)

09/26/09	1					1				1			**2**	7.58	7.80
09/27/09	1												**0**	9.80	14.87
09/28/09	1	1				1			4	3			**9**	5.91	14.09
09/29/09	1					1				1			**2**	6.87	11.20
09/30/09	1					1				1			**2**	4.41	7.68
10/01/09	1												**0**	2.73	6.68
10/02/09	1									1			**1**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1					1							**1**	5.17	11.37
10/05/09	1												**0**	7.47	7.84
10/06/09	1									2			**2**	5.56	8.14
10/07/09	1												**0**	7.36	7.58
10/08/09	1									1			**1**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1										1		**1**	8.45	3.36
10/12/09	1								1				**1**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1												**0**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
10/16/09	1												**0**	6.69	2.04
10/17/09	1												**0**	8.01	1.14
10/18/09	1												**0**	8.85	1.21
10/19/09	1												**0**	3.39	3.09
10/20/09	1										1		**1**	6.06	6.59
10/21/09	1												**0**	5.69	3.70
10/22/09	1												**0**	8.88	0.57
10/23/09	1												**0**	8.19	3.09
10/24/09	1												**0**	9.87	12.64
10/25/09	1												**0**	7.56	3.35
10/26/09	1												**0**	5.64	1.89
10/27/09	1					1							**1**	6.99	2.37
10/28/09	1												**0**	5.64	2.04
10/29/09	1												**0**	3.85	4.75
10/30/09	1												**0**	7.28	7.02
10/31/09	1												**0**		
11/01/09	1												**0**		
11/02/09	1												**0**		
11/03/09	1												**0**		
11/04/09	1												**0**		
By Species		**59**	**4**	**6**	**5**	**483**	**0**	**0**	**33**	**165**	**12**	**0**	**767**		
By Guild		**69**			**5**	**483**	**33**			**177**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 6. Summary of acoustic bat data and weather during each survey night at the SW Tree detector – Fall, 2009

Night of	Operational?	BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
		BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
07/14/09	1					11				8	1		**20**	4.49	12.35
07/15/09	1					11							**11**	5.03	12.44
07/16/09	1					5				5			**10**	2.75	16.16
07/17/09	1					7			1	22			**30**	3.93	16.18
07/18/09	1					1				5			**6**	3.49	18.18
07/19/09	1	1				10				7			**18**	5.31	16.74
07/20/09	1					11				11			**22**	4.18	17.10
07/21/09	1	1			1	3				3			**8**	4.18	16.36
07/22/09	1	1				10				4			**15**	4.23	16.81
07/23/09	1					9				3	1		**13**	6.40	15.28
07/24/09	1					16				3			**19**	5.11	15.20
07/25/09	1					5				2			**7**	2.84	15.43
07/26/09	1					4				1			**5**	4.88	18.07
07/27/09	1	1				18				13			**32**	4.19	17.48
07/28/09	1					16				8			**24**	5.76	18.09
07/29/09	1					5				4			**9**	6.42	19.22
07/30/09	1	2				46				25			**73**	3.47	20.03
07/31/09	1					13			3	8			**24**	5.04	17.33
08/01/09	1	1				23			2	11			**37**	5.48	17.94
08/02/09	1					9				8			**17**	4.41	15.32
08/03/09	1					44				8			**52**	3.36	17.52
08/04/09	1					6				3			**9**	5.08	17.09
08/05/09	1					48			1	17			**66**	5.87	17.48
08/06/09	1				1	41				12			**54**	4.58	15.98
08/07/09	1					24				4			**28**	7.14	11.78
08/08/09	1				2	29				6	1		**38**	4.05	14.23
08/09/09	1				1	7				2			**10**	7.04	15.96
08/10/09	1					43			2	16			**61**	4.98	19.78
08/11/09	1	2				48			1	17			**68**	4.07	17.24
08/12/09	1				1	17				10	1		**29**	3.42	16.29
08/13/09	1					45				5			**50**	5.04	14.89
08/14/09	1					48			1	8			**57**	5.06	19.18
08/15/09	1					25			1	9			**35**	5.75	20.13
08/16/09	1	2	1			22				17			**42**	4.86	20.58
08/17/09	1					22			2	8			**32**	6.13	21.10
08/18/09	1					13				6			**19**	6.54	20.60
08/19/09	1	4				33				11			**48**	5.03	19.79
08/20/09	1					26				11			**37**	4.22	18.90
08/21/09	1					3				2			**5**	6.94	21.04
08/22/09	1					14				7			**21**	5.93	20.94
08/23/09	1					4							**4**	4.66	18.80
08/24/09	1	2				16				10			**28**	5.28	17.37
08/25/09	1					6				6			**12**	6.94	18.33
08/26/09	1	1				11			1	5	1		**19**	7.57	12.96
08/27/09	1					12				1	1		**14**	4.22	11.18
08/28/09	1					2				1			**3**	5.25	11.73
08/29/09	1												**0**	8.56	10.80
08/30/09	1	2								2	2		**6**	4.69	14.33
08/31/09	1					4				3	2		**9**	5.08	11.04
09/01/09	1					4	1			1			**6**	3.68	12.63
09/02/09	1					4				1			**5**	6.22	13.33
09/03/09	1	1								2			**3**	5.55	14.31
09/04/09	1					12				3			**15**	6.00	15.91
09/05/09	1	1				7				4			**12**	6.28	10.34
09/06/09	1												**0**	5.37	9.19
09/07/09	1	1				2				1			**4**	5.91	11.70
09/08/09	1	1				18				10			**29**	7.41	13.81
09/09/09	1					2							**2**	6.37	9.83
09/10/09	1					1							**1**	4.42	7.51
09/11/09	1					3				3			**6**	2.70	13.10
09/12/09	1					4				3			**7**	2.30	15.23
09/13/09	1					9				3			**12**	6.25	11.89
09/14/09	1									2			**2**	5.12	12.64
09/15/09	1					6				2			**8**	6.08	8.39
09/16/09	1					1				1			**2**	3.11	7.46
09/17/09	1												**0**	5.56	7.90
09/18/09	1					3							**3**	8.60	8.38
09/19/09	1												**0**	6.08	7.24
09/20/09	1									2			**2**	5.47	11.92
09/21/09	1									1			**1**	5.19	11.18
09/22/09	1					2				2	1		**5**	4.88	14.36
09/23/09	1									1			**1**	5.81	16.55
09/24/09	1					2			5	1			**8**	5.68	10.23
09/25/09	1								2				**2**	5.63	3.31

(*continued*)

Appendix B Table 6 (cont.)

09/26/09	1									1			**1**	7.58	7.80
09/27/09	1												**0**	9.80	14.87
09/28/09	1					2				2			**4**	5.91	14.09
09/29/09	1									2			**2**	6.87	11.20
09/30/09	1					2				1			**3**	4.41	7.68
10/01/09	1												**0**	2.73	6.68
10/02/09	1					1							**1**	3.56	7.53
10/03/09	1												**0**	8.64	12.25
10/04/09	1					3				1			**4**	5.17	11.37
10/05/09	1												**0**	7.47	7.84
10/06/09	1												**0**	5.56	8.14
10/07/09	1												**0**	7.36	7.58
10/08/09	1					1			1				**2**	4.81	6.33
10/09/09	1												**0**	4.31	10.96
10/10/09	1												**0**	6.65	2.65
10/11/09	1												**0**	8.45	3.36
10/12/09	1												**0**	3.75	4.52
10/13/09	1												**0**	7.20	0.32
10/14/09	1												**0**	6.98	-1.26
10/15/09	1												**0**	6.31	-0.43
By Species		**24**	**1**	**0**	**6**	**935**	**1**	**0**	**23**	**408**	**11**	**0**	**1409**		
By Guild		**25**			**6**	**935**	**24**			**419**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix B Table 7. Summary of available fall bat detector surveys in the northeast at forest edge habitat (results reported for individual detectors)

Year	Project	Project Location	Habitat	Height (m)	Detector Nights	Start	End	Calls	Rate	Reference
Tree or Low Tower detectors (10 m or below)										
2007	Rollins	Rollins, Penobscot Cty, ME	forest edge	3	114	7/12	11/2	12291	107.8	Stantec Consulting Services Inc. 2007. Fall 2007 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for FirstWind Management, LLC.
2007	Rollins	Rollins, Penobscot Cty, ME	forest edge	3	53	8/2	10/16	5360	101.1	Stantec Consulting Services Inc. 2007. Fall 2007 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for FirstWind Management, LLC.
2007	Rollins	Rollins, Penobscot Cty, ME	forest edge	3	107	7/12	11/2	8996	84.1	Stantec Consulting Services Inc. 2007. Fall 2007 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for FirstWind Management, LLC.
2005	Lempster	Lempster, Sullivan Cty, NH	forest edge	7.5	34	9/20	10/31	27	0.8	Woodlot Alternatives, Inc. 2005. Summary of fall 2005 Lempster bat survey. Memorandum to Jeff Keeler (CEI) from Bob Roy (Woodlot Alternatives, Inc.) dated November 18, 2005.
2005	Lempster	Lempster, Sullivan Cty, NH	forest edge	2	42	9/20	10/31	2	0	Woodlot Alternatives, Inc. 2005. Summary of fall 2005 Lempster bat survey. Memorandum to Jeff Keeler (CEI) from Bob Roy (Woodlot Alternatives, Inc.) dated November 18, 2005.
2006	Lempster	Lempster, Sullivan Cty, NH	forest edge	10	29	9/9	10/24	2	0.1	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Lempster Mountain Wind Power Project in Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
2006	Lempster	Lempster, Sullivan Cty, NH	forest edge	3	44	9/9	10/24	384	8.7	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Lempster Mountain Wind Power Project in Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
2005	Horse Creek	Clayton, Jefferson Cty, NY	forest edge	2	33	8/19	9/20	154	4.7	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Clayton Wind Project in Clayton, New York. Prepared for PPM Atlantic Renewable.
2005	Moresville	Stamford, Delaware Cty, NY	forest edge	2	58	8/15	10/15	280	4.8	Woodlot. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	2	13	8/9	8/21	148	11.4	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	5	4	8/9	8/21	1	0.3	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	3	13	8/9	8/21	524	40.3	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	10	13	8/9	8/21	1576	121.2	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
MET Tower Detectors										
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	45	46	8/22	10/18	7	0.2	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	20	58	8/22	10/18	93	1.6	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	45	59	8/22	10/19	18	0.4	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Record Hill	Roxbury, Oxford Cty, ME	forest edge	20	59	8/22	10/19	252	5.1	Stantec Consulting Services Inc. 2007. Fall 2007 Migration Report: Visual, Acoustic and Radar Surveys of Bird and Bat Migration Conducted at the Proposed Record Hill Wind Project in Roxbury, Maine. Prepared for Independence Wind, LLC.
2007	Rollins	Rollins, Penobscot Cty, ME	forest edge	40	95	7/12	11/2	66	0.7	Stantec Consulting Services Inc. 2007. Fall 2007 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for FirstWind Management, LLC.
2007	Rollins	Rollins, Penobscot Cty, ME	forest edge	20	106	7/12	11/2	155	1.5	Stantec Consulting Services Inc. 2007. Fall 2007 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for FirstWind Management, LLC.
2006	Kibby	Kibby, Franklin Cty, ME	forest edge	45	72	6/20	10/25	18	0.3	Woodlot Alternatives, Inc. 2006. Summer/Fall 2006 Survey of Bat Activity at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine Wind Development Inc.
2006	Kibby	Kibby, Franklin Cty, ME	forest edge	45	76	6/20	10/25	0	0	Woodlot Alternatives, Inc. 2006. Summer/Fall 2006 Survey of Bat Activity at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine Wind Development Inc.
2006	Kibby	Kibby, Franklin Cty, ME	forest edge	20	44	6/20	10/25	4	0.1	Woodlot Alternatives, Inc. 2006. Summer/Fall 2006 Survey of Bat Activity at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine Wind Development Inc.

(*continued*)

Appendix B Table 7. Summary of available fall bat detector surveys in the northeast at forest edge habitat (results reported for individual detectors)

Year	Project	Project Location	Habitat	Height (m)	Detector Nights	Start	End	Calls	Rate	Reference
2006	Kibby	Kibby, Franklin Cty, ME	forest edge	45	20	6/20	10/25	0	0	Woodlot Alternatives, Inc. 2006. Summer/Fall 2006 Survey of Bat Activity at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine Wind Development Inc.
2006	Redington	Redington, Franklin Cty, ME	forest edge	15	21	8/10	10/24	0	0	Woodlot Alternatives, Inc. 2006. Fall 2006 Bat Detector Surveys at the Proposed Redington Wind Project. Prepared for Maine Mountain Power.
2006	Redington	Redington, Franklin Cty, ME	forest edge	15	48	8/10	10/24	0	0	Woodlot Alternatives, Inc. 2006. Fall 2006 Bat Detector Surveys at the Proposed Redington Wind Project. Prepared for Maine Mountain Power.
2006	Redington	Redington, Franklin Cty, ME	forest edge	30	29	8/10	10/24	0	0	Woodlot Alternatives, Inc. 2006. Fall 2006 Bat Detector Surveys at the Proposed Redington Wind Project. Prepared for Maine Mountain Power.
2006	Redington	Redington, Franklin Cty, ME	forest edge	30	37	8/10	10/24	0	0	Woodlot Alternatives, Inc. 2006. Fall 2006 Bat Detector Surveys at the Proposed Redington Wind Project. Prepared for Maine Mountain Power.
2006	Stetson	Stetson, Penobscot Cty, ME	forest edge	30	73	6/28	10/16	8	0.1	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2006	Stetson	Stetson, Penobscot Cty, ME	forest edge	30	76	6/28	10/16	170	2.2	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2006	Stetson	Stetson, Penobscot Cty, ME	forest edge	15	105	6/28	10/16	108	1	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2006	Stetson	Stetson, Penobscot Cty, ME	forest edge	15	107	6/28	10/16	651	6.1	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2005	Lempster	Lempster, Sullivan Cty, NH	forest edge	15	42	9/20	10/31	14	0.3	Woodlot Alternatives, Inc. 2005. Summary of fall 2005 Lempster bat survey. Memorandum to Jeff Keeler (CEI) from Bob Roy (Woodlot Alternatives, Inc.) dated November 18, 2005.
2006	Lempster	Lempster, Sullivan Cty, NH	forest edge	40	43	9/9	10/24	16	0.4	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Lempster Mountain Wind Power Project in Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
2005	Clayton	Clayton, Jefferson Cty, NY	forest edge	30	0	8/19	9/20	0	0	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Clayton Wind Project in Clayton, New York. Prepared for PPM Atlantic Renewable.
2005	Moresville	Stamford, Delaware Cty, NY	forest edge	15	43	8/15	10/15	293	6.8	Woodlot. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
2005	Moresville	Stamford, Delaware Cty, NY	forest edge	30	54	8/15	10/15	285	5.3	Woodlot. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
2004	Sheffield	Sheffield, Caledonia Cty, VT	forest edge	15	6	9/10	9/15	30	0.23	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
2004	Sheffield	Sheffield, Caledonia Cty, VT	forest edge	30	5	10/17	10/21	0	0	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
2005	Mars Hill	Mars Hill, Aroostook Cty, ME	forest edge	20	22	8/31	9/21	25	n/a	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Mars Hill Wind Project in Mars Hill, Maine. Prepared for UPC Wind Management, LLC.
2005	Mars Hill	Mars Hill, Aroostook Cty, ME	forest edge	20	22	8/31	9/21	25	n/a	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Mars Hill Wind Project in Mars Hill, Maine. Prepared for UPC Wind Management, LLC.

Appendix C

Regional Raptor Survey results

Appendix C Table 1. Daily totals of raptor species observed and daily passage rates during Fall, 2009 at Bull Hill Wind Power Project

	Summer surveys (n=6; total bird observations=24)							**Fall surveys (n=12; total bird observations=124)**												
Species	Aug-09	Aug-09	Aug-09	Aug-09	Aug-09	Aug-09	Summer total	Sep-09	Sep-09	Sep-09	Sep-09	Sep-09	Sep-09	Sep-09	Oct-09	Oct-09	Oct-09	Oct-09	Oct-09	Fall Totals
American kestrel	1						1			1			1			4	2	2	1	11
bald eagle							0				1				1				1	3
broad-winged hawk		1	1				2		1	1	1	3								6
Cooper's hawk							0								1					1
merlin							0							3	2			2		7
northern goshawk				1			1													0
northern harrier							0				1									1
osprey							0					3		1				1		5
peregrine falcon							0										1			1
red-tailed hawk		1	1		3	1	6					1	1	1		1		2	2	8
sharp-shinned hawk		1					1	4	1	1	2	5	1			6	1	8	3	32
turkey vulture	1	1	4	3	3	1	13	5	3	6	2	5	2	6		1		2		32
unidentified accipiter							0				1						1			2
unidentified buteo							0	2			1	2		3	2			1		11
unidentified falcon							0												1	1
unidentified raptor							0	1							2					3
Daily Totals	**2**	**4**	**6**	**4**	**6**	**2**	**24**	**12**	**5**	**9**	**9**	**19**	**5**	**14**	**8**	**12**	**5**	**18**	**8**	**124**
Daily Passage Rates:	**0.25**	**0.50**	**0.75**	**0.57**	**0.86**	**0.25**	**0.52**	**1.50**	**0.63**	**1.13**	**1.29**	**2.71**	**0.71**	**2.00**	**1.14**	**1.71**	**0.71**	**2.57**	**1.14**	**1.43**

Appendix C Table 2. Hourly summary of raptor observations at Bull Hill during summer and fall surveys, 2009

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	5:00-6:00	Grand Total
Summer 2009; Eagle habitat use surveys										
American kestrel								1		1
broad-winged hawk	1								1	2
northern goshawk		1								1
red-tailed hawk	1		3	1	1					6
sharp-shinned hawk								1		1
turkey vulture		2	6	1		1	2	1		13
Hourly totals, Spring:	2	3	9	2	1	1	2	3	1	24
Fall 2009; Raptor migration surveys										
American kestrel	2	3	1	1	1	2	1			11
bald eagle			1	1		1				3
broad-winged hawk	1	2	2		1					6
Cooper's hawk	1									1
merlin		1			1	4	1			7
northern harrier			1							1
osprey		2	1				2			5
peregrine falcon				1						1
red-tailed hawk		1	1		1	3	2			8
sharp-shinned hawk	2	6	10	5	3	5	1			32
turkey vulture	2	3	4	2	6	5	9	1		32
unidentified accipiter	1		1							2
unidentified buteo		5	1		5					11
unidentified falcon				1						1
unidentified raptor					1		2			3
Hourly totals, Fall:	**9**	**23**	**23**	**11**	**19**	**20**	**18**	**1**	**0**	124

Appendix C Table 3. Number of individuals of species observed within Project boundary in proposed turbine areas (flight positions A1, A2, A3, and B) above or below 145 m at Bull Hill 2009				
	Summer habitat use surveys		Fall migration surveys	
Species	**145 m or greater**	**less than 145 m**	**145 m or greater**	**less than 145 m**
American kestrel	0	0	0	10
bald eagle	0	0	0	1
broad-winged hawk	0	0	0	3
Cooper's hawk	0	0	0	1
merlin	0	0	0	3
northern goshawk	0	0	0	0
northern harrier	0	0	1	0
osprey	0	0	0	1
peregrine falcon	0	0	0	1
red-tailed hawk	0	1	0	8
sharp-shinned hawk	0	0	0	21
turkey vulture	0	0	0	7
unidentified buteo	0	0	0	1
unidentified falcon	0	0	0	1
Grand Total:	**0**	**1**	**1**	**58**
Percent of Total Seasonal Observations:	**0.00%**	**100.00%**	**1.69%**	**98.31%**

Appendix C Table 4. Summary of raptor flight behaviors, Bull Hill, 2009

Species	linear soaring	gliding	circle soaring	powered flight	banking	diving	carrying food	kiting	hovering	aerial feeding	low aerial hunting	perched	aerial display	aerial chase	vocalization	**Grand Total**
Summer 2009; Eagle habitat use surveys																
American kestrel	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2
broad-winged hawk	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
northern goshawk	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2
red-tailed hawk	4	1	1	0	2	0	0	1	0	0	0	0	0	0	0	9
sharp-shinned hawk	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
turkey vulture	10	1	6	1	0	0	0	0	1	0	0	0	0	0	0	19
Behavior totals, Spring:	**16**	**4**	**8**	**3**	**2**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**36**
Fall 2009; Raptor migration surveys																
American kestrel	3	1	0	10	0	0	0	0	0	0	0	0	0	0	0	14
bald eagle	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	6
broad-winged hawk	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5
Cooper's hawk	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
merlin	4	0	0	6	0	0	0	0	0	0	0	0	0	0	0	10
osprey	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
northern harrier	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4
peregrine falcon	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
red-tailed hawk	3	0	4	4	0	0	0	0	0	0	0	0	0	0	0	11
sharp-shinned hawk	11	2	4	17	0	0	0	0	0	0	0	0	0	1	0	35
turkey vulture	25	0	15	12	0	0	0	0	0	0	0	0	0	0	0	52
unidentified accipiter	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	3
unidentified buteo	6	1	6	3	0	0	0	0	0	0	0	0	0	0	0	16
unidentified falcon	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
unidentified raptor	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
Behavior totals, Fall:	**61**	**4**	**39**	**59**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**164**

Appendix C Table 5. Summary of Regional Outbound (August to November, 2009) Migration Surveys[1]

Site Number	Location	Site Topography	Distance (miles)[2]	Observation Hours	BV	TV	OS	BE	NH	SS	CH	NG	RS	BW	RT	RL	GE	AK	ML	PG	UR	UB	UA	UF	UE	TOTAL	BIRDS / HOUR
1	Bull Hill, Fall 2009 raptor survey	inland ridge	- -	87	0	32	5	3	1	32	1	0	0	6	8	0	0	11	7	1	3	11	2	1	0	124	1.43
2	Cadillac Mountain; Acadia NP, ME	coastal ridge	26	282.75	0	74	154	33	132	1569	20	20	2	225	74	0	1	557	74	35	64	3	3	7	0	3047	10.78
3	Greenlaw Mountain; Saint Andrews, NB	coastal ridge	60	256.75	0	99	111	46	39	593	11	13	5	1457	152	0	0	129	38	13	55	3	1	1	3	2769	10.78
4	Harpswell Peninsula/Casco Bay; Harpswell, ME	coastal lowland	113	224.25	0	63	301	51	125	1910	83	10	11	532	55	0	0	602	216	101	39	3	3	19	0	4124	18.39
5	Pack Monadnock; Peterborough, NH	inland ridge	225	420.75	0	80	182	51	88	1196	133	25	129	4322	421	0	6	135	56	30	77	14	8	8	2	6963	16.55
6	Pitcher Mountain; Stoddard, NH	inland ridge	228	55	0	3	0	14	4	9	0	3	4	0	106	0	2	0	1	0	3	1	0	0	4	154	2.80
7	Putney Mountain, Putney, VT	inland ridge	250	391.5	0	164	144	44	41	1080	110	23	41	3627	421	3	5	129	25	35	2	0	0	1	0	5895	15.06

[1] Data obtained from http://hawkcount.org; accessed 1 December 2009.

[2] Straight-line distance from Bull Hill raptor observation location to HMANA site.

Appendix C Table 6. Summary of available fall raptor survey results at forested ridge wind sites in the east

Project Site	Landscape	Survey Period	# of Survey Days	# of Survey Hours	Total # Observed	# of Species Observed	Ave. Passage Rate (Raptors/Hr)	(Turbine Ht) % Raptors Below Turbine Height	Seasonal Passage Rate (raptors/hr)	Reference
Fall 1996										
Searsburg, Bennington County, VT	Forested ridge	Sept. 11 - Nov. 3	20	80	430	12	5.38	n/a	5.4	Kerlinger, Paul. 1996. A Study of Hawk Migration at Green Mountain Power Corporation's Searsburg, Vermont, Wind Powewer Site: Autumn 1996. Prepared for the Vermont Public Service Board, Green Mountain Power, National Renewable Energy Laboratory, VERA.
Fall 2004										
Deerfield, Bennington Cty, VT (Existing Facility)	Forested ridge	Sept. 2 - Oct. 31	10	60	147	11 for both sites combined	2.45	(100 m) 9% for both sites combined	2.5	Woodlot Alternatives, Inc. 2005. Fall 2004 Avian Migration Surveys at the Proposed Deerfield Wind/Searsburg Expansion Project in Searsburg and Readsboro, Vermont. Prepared for Deerfield Wind, LLC and Vermont Environmental Research Associates.
Deerfield, Bennington Cty, VT (Western Expansion)	Forested ridge	Sept. 2 - Oct. 31	10	57	725	11 for both sites combined	12.72	(100 m) 9% for both sites combined	12.7	Woodlot Alternatives, Inc. 2005. Fall 2004 Avian Migration Surveys at the Proposed Deerfield Wind/Searsburg Expansion Project in Searsburg and Readsboro, Vermont. Prepared for Deerfield Wind, LLC and Vermont Environmental Research Associates.
Sheffield, Caledonia Cty, VT	Forested ridge	Sept. 11 - Oct. 14	10	60	193	10	3.2	(125 m) 31%	3.2	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
Fall 2005										
New Grange, Chautauqua Cty, NY	Forested ridge	Sept. 17 - Oct. 15*	6	18	49	5	4.37	n/a	4.4	New York State Department of Environmental Conservation. 2008. Publicly Available Raptor Migration Data for Proposed Wind Sites in NYS. Available at http://www.dec.ny.gov/docs/wildlife_pdf/raptorwinsum. Accessed November 7, 2008.
Moresville, Deleware Cty, NY	Forested ridge	Aug. 31 - Nov. 3	11	72	228	11	3.2	n/a	3.2	New York State Department of Environmental Conservation. 2008. Publicly Available Raptor Migration Data for Proposed Wind Sites in NYS. Available at http://www.dec.ny.gov/docs/wildlife_pdf/raptorwinsum. Accessed November 7, 2008.
Mars Hill, Aroostook Cty, ME	Forested ridge	Sept. 9 - Oct. 13	8	42.5	115	13	1.52	(120 m) 42%	1.5	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Mars Hill Wind Project in Mars Hill, Maine. Prepared for UPC Wind Management, LLC.
Lempster, Sullivan County, NH	Forested ridge	Fall 2005	10	80	264	10	3.3	(125 m) 40%	3.3	Woodlot Alternatives, Inc. 2007. Lempster Wind Farm Wildlife Habitat Summary and Assessment. Prepared for Lempster Wind, LLC.
Fall 2006										
Stetson, Penobscot Cty, ME	Forested ridge	Sept. 14 - Oct. 26	7	42	86	11	2.05	(125 m) 63%	2.1	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Mountain Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V, LLC.
Lincoln, Penobscot Cty, ME	Forested ridge	Sept. 13 - Oct. 16	12	89	144	12	1.8	(120 m) 82%	1.8	Woodlot Alternatives, Inc. 2007. Fall 2006 Survey of Bird and Bat Migration at the Proposed Stetson Wind Power Project in Washington County, Maine. Prepared for Evergreen Wind V.
Fall 2007										
Roxbury, Oxford Cty, ME	Forested ridge	Sept. 3 - Oct. 15	14	86	96	12	1.1	n/a	1.1	Stantec Consulting. 2008. Fall 2007 Migration Survey Report Visual, Acoustic, and Radar Surveys of Bird and Bat Migration conducted at the proposed Record Hill Wind Project In Roxbury, Maine. Prepared for Independence Wind, LLC.
Errol, Coos Cty, NH	Forested ridge	Sept. 5 - Oct. 16	11	68	44	9	0.7	n/a	0.7	Stantec Consulting. 2007. Fall 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windpark in Coos County, New Hampshire by Granite Reliable Power, LLC. Prepared for Granite Reliable Power, LLC.
Laurel Mountain, Preston Cty, WV	Forested ridge	Sept. 12 - Dec. 1	24	147	769	12	5.2	(125 m) 65%	5.2	Stantec Consulting Services Inc. 2007. A Fall 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Laurel Mountain Wind Energy Project near Elkins, West Virginia. Prepared for AES Laurel Mountain, LLC.
Greenland, Grant Cty, WV	Forested ridge	Sept. 12 - Dec. 1	27		858	13	5.9	(125 m) 67%	5.9	Stantec Consulting Services Inc. 2008. A Fall 2007 Survey of Bird and Bat Migration at the New Creek Wind Project,West Virginia. Prepared for AES New Creek, LLC.
New Grange, Chautauqua Cty, NY	Forested ridge	Sept. 21 - Oct. 28	6	n/a	n/a	n/a	4.37	n/a	4.4	New York State Department of Environmental Conservation. 2008. Publicly Available Raptor Migration Data for Proposed Wind Sites in NYS. Available at http://www.dec.ny.gov/docs/wildlife_pdf/raptorwinsum. Accessed November 7, 2008.
Allegany, Cattaraugus Cty, NY	Forested ridge	Sept. 8 - Oct. 11	11	63.78	125	10	1.96	(150 m) 78%	2.0	New York State Department of Environmental Conservation. 2008. Publicly Available Raptor Migration Data for Proposed Wind Sites in NYS. Available at http://www.dec.ny.gov/docs/wildlife_pdf/raptorwinsum. Accessed November 7, 2008.

continued

Appendix C Table 6 *cont.*										
Fall 2009										
Bull Hill, Hancock Cty, ME	Forested ridge	Sept. 2 - Oct. 14	12	87	124	11	1.43	(145 m) 98%****	1.43	*this report*
*Calculated for spring and fall combined.										
**Calculated for spring and fall 2006 and 2007 combined.										
***Non-migrants were not included in seasonal passage rates in NYSDEC 2008 table but were included in passage rates here.										
**** %of raptors observed in project area below turbine height. Previous percentages may be of all raptors observed.										

Spring 2010 Avian and Bat Survey Report

Spring 2010
Avian and Bat Survey Report

for the Bull Hill Wind Project
In T16 MD, Maine

Prepared for

Blue Sky East Wind, LLC
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August 2010

Executive Summary

In advance of permitting activities for the proposed Bull Hill Wind Project (Project) in T16 MD, Maine, Blue Sky East Wind, LLC contracted Stantec Consulting Services Inc. (Stantec) to perform bird and bat scientific surveys for the purpose of evaluating 2009 summer and fall activity and spring, summer and fall 2010 activity within the Project area. This report covers information gathered in spring and summer 2010. The results of the 2009 surveys were presented in the report titled Summer and Fall 2009 Avian and Bat Survey Report, dated January 2010. Survey methods and work plans, including nocturnal marine radar surveys, bat detector surveys, and raptor migration field surveys, were developed in consultation with state and federal wildlife agencies.

Nocturnal Marine Radar Survey

Radar surveys were conducted during 20 nights in spring 2010 (between April 20 and May 24) to characterize nocturnal migration activity in the Project area. Surveys were conducted using X-band radar, sampling from sunset to sunrise. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar was located on the summit of Bull Hill and provided adequate visibility of the surrounding airspace to characterize migration.

The overall mean passage rate for the entire spring survey period was 387 ± 21 targets per kilometer per hour (t/km/hr), and nightly passage rates varied from 43 ± 16 t/km/hr on May 10 to 879 ± 76 t/km/hr on April 30. Mean flight direction through the Project area for the season was 48° ± 49°. The seasonal mean flight height of targets was 217 ± 8 meters (m; 712 ft ['']) above the radar site, and nightly flight heights ranged from 100 ± 10 m to 358 ± 53 m. The percent of targets observed flying below 145 m (476'; the highest height of potential turbine types) was 38 percent for the entire season.

Bat Detector Survey

The goal of the acoustic surveys was to characterize seasonal patterns in bat activity levels and examine how weather conditions influence bat activity at the Project. Six Anabat® acoustic bat detectors were deployed in the Project area on April 15 and operated until July 14 to document bat activity. Two detectors were deployed on the Little Bull Hill meteorological tower (met tower), and four were deployed in trees throughout the Project area. Detectors were deployed at relatively low heights where increased bat activity levels are generally documented, particularly during the non-migratory periods. Data were summarized by guild and species and tallied per detector on an hourly and nightly basis.

Detectors operated properly for most of the season, resulting in 467 detector nights of data between April 15 and July 14. During this survey period, 2,703 call sequences were recorded,

resulting in a detection rate of 0.4 bat call sequences per detector night for the met tower detectors combined, and 8.6 bat call sequences per detector night for the tree detectors combined. The Radar Tree Detector had the highest monthly detection rate (39.5 call sequences per detector night) in July.

Raptor Migration Field Survey

Raptor migration surveys were conducted during 3 days in winter 2010 (March 19, March 25 and April 6) from Sparrow Hill to target eagle activity in the Project area. In addition, a total of 12 surveys were conducted in spring 2010 (April 21 to May 23) from Bull Hill to document diurnal migration activity in the Project area. Visual observation surveys were conducted from 9 am to 4 pm from a prominent location in the Project area.

A total of 104.25 raptor migration survey hours (winter and spring surveys combined) were conducted and a total of 55 raptors, representing nine species were observed. Broad-winged hawk (*Buteo platypterus*) and turkey vulture (*Cathartes aura*) represent the most commonly observed species. Daily counts ranged from 0 to 15 raptors and the overall passage rate was 0.53 raptors per hour (raptors/hour). Of the total raptors observed, 27 percent (n=15) were observed in areas where turbines will be located. All observations of raptors within the Project area were documented at heights less than 145 m for at least a portion of their flight through the turbine areas.

Two raptor species of state special concern were observed in winter and spring 2010: six bald eagle (*Haliaeetus leucocephalus*) observations were recorded and one eagle was seen as the observer was leaving the Project after a survey. All bald eagle observations were outside the Project area. Five northern harrier (*Circus cyaneus*) observations were made during the spring surveys. One observation of northern harrier occurred within the Project area.

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* *This report was prepared by Stantec Consulting Services Inc. for Blue Sky East Wind, LLC. The material in it reflects Stantec's judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any suffered by any third party as a result of decisions made or actions based on this report.*

1.0 Introduction

Blue Sky East, LLC. (Blue Sky East), an affiliate of First Wind, is considering construction of a commercial-scale wind energy project located in T16 MD, Hancock County, Maine (Figure 1-1). The Bull Hill Wind Farm (the Project) includes two separate turbine arrays on lower elevation hillsides: one on Bull Hill and one on Heifer Hill. The Project is currently in the preliminary planning stage, which includes planning strategic placement of up to 18 turbines, access roads, meteorological towers, a substation and a collection line. The proposed turbines would have a height of up to 145 meters (m; 476 feet ['']) to the tip of a fully extended blade[1].

Following is a brief description of the Project; a review of the methods used to conduct scientific surveys and the results of those surveys; a discussion of results; and the conclusions reached based on those results.

1.1 PROJECT BACKGROUND

In advance of permitting activities for the Project, Blue Sky East contracted Stantec to perform bird and bat scientific surveys for the purpose of evaluating 2009 summer and fall activity and spring, summer and fall 2010 activity near and within the Project area. Results of the 2009 surveys may be found in the report titled Summer and Fall 2009 Avian and Bat Survey Report, dated January 2010. This report describes the work conducted by Stantec during spring 2010, including radar surveys, raptor surveys and acoustic bat surveys. Aerial nest surveys targeting bald eagle nests were also completed in spring 2010; the results of these surveys were summarized in the 2010 Bald Eagle Aerial Survey memo dated June 11, 2010, and therefore will not be included in this report.

On July 30, 2009, prior to initiation of field surveys, Blue Sky East and Stantec presented a draft work plan for comprehensive natural resource surveys during an initial agency consultation with biologists from the Maine Department of Inland Fisheries and Wildlife (MDIFW) and the United States Fish and Wildlife Service (USFWS). Since that meeting, ongoing consultation regarding survey methodology and preliminary results occurred throughout the spring survey season.

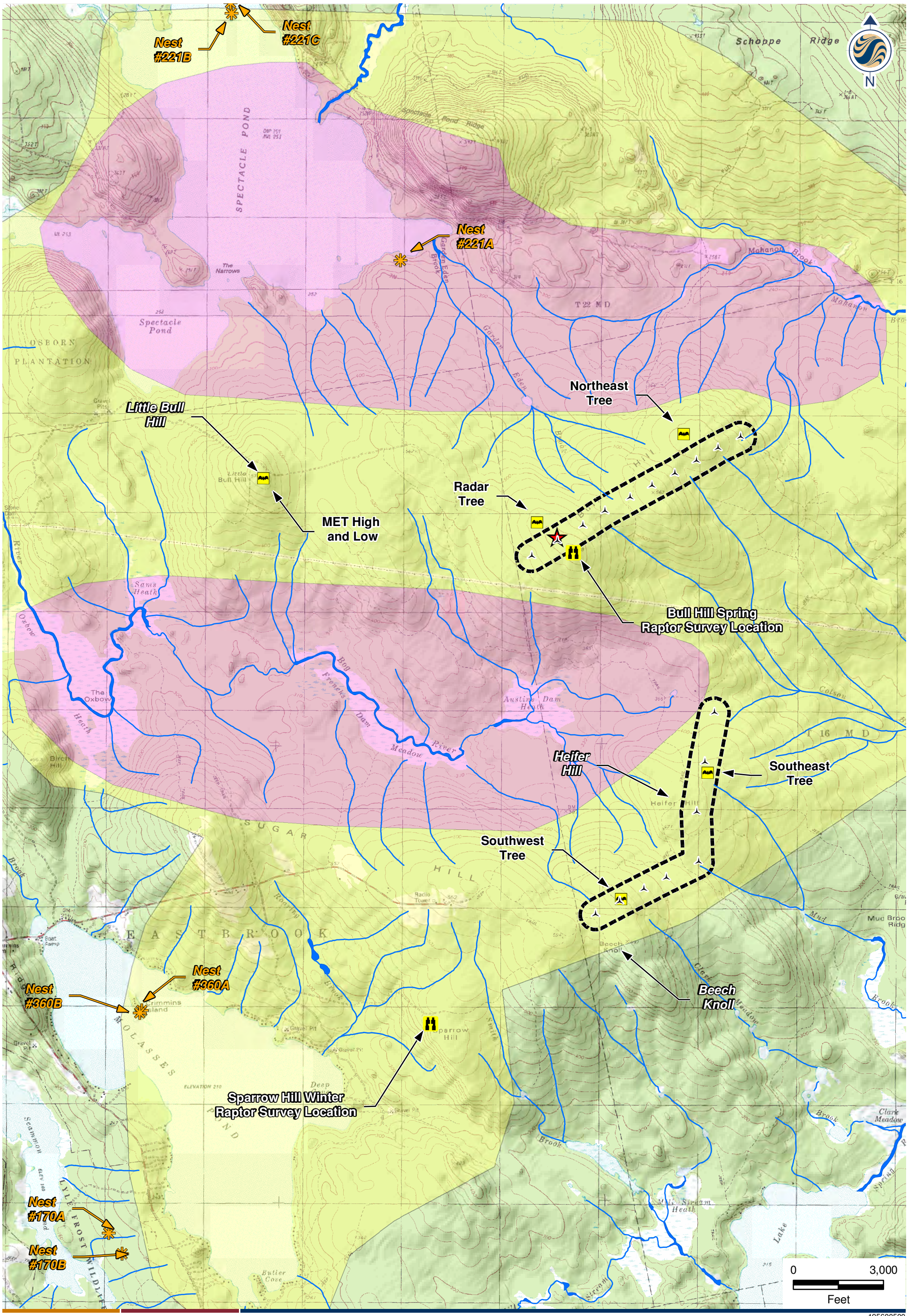
1.2 PROJECT AREA DESCRIPTION

The Project area consists of a series of coastal low elevation hills around Bull and Heifer Hill (Figure 1-1). At 255 meters (837') above sea level, Bull Hill has the highest elevation in the Project area and like the other peaks, consists of gently sloping to moderately steep topography. An existing network of well-maintained logging roads is present throughout the Project area and the effects of past and current timber harvesting are evident across the entire Project area, from large clear-cuts to small selective harvesting areas. Aside from the roads and skidder trails, the Project area is almost entirely undeveloped.

[1] All data in this report were analyzed based on a maximum turbine height of 145 m. This turbine height is based on the largest potential turbine type under consideration during early stages of project development. A different turbine type would require re-analysis to determine the number of targets in the rotor swept area.

The Project is located in the Eastern Lowlands biophysical region. This region is characterized by extensive lowlands with elevations generally below 600'. The region also contains the largest concentration of peatlands, marshes, and swamps in the state. The representative vegetation communities present within the Project area include: forested uplands and wetlands, scrub-shrub wetlands, emergent wetlands, and stream systems. Examples of these wetland communities present near the Project area include: Oxbow Heath, Frenchs Dam Meadow, and Austins Dam Heath. These communities are large, open wetland systems with dense ericaceous shrubs amidst areas of open water; stands and even individual dead standings trees appear to be infrequent based on initial visits to these areas. Forested communities are representative throughout and dominate higher elevations within the Project area, while wetland systems are most common at lower elevations. The proposed Project area includes a variety of natural community types including, but not limited to, Beech-Birch-Maple Forest, Spruce-Northern Hardwoods Forest, and Red Oak-Northern Hardwoods-White Pine Forest. Dominant canopy species present in the Project area include white pine (*Pinus strobus*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), balsam fir (*Abies balsamea*), red oak (*Quercus rubra*), white ash (*Fraxinus americana*), paper birch (*Betula papyrifera*), and gray birch (*Betula populifolia*). Common shrub species include hobblebush (*Viburnum lantanoides*), witch-hazel (*Hamamelis virginiana*), American beech (*Fagus grandifolia*), and the aforementioned tree species. Herbaceous species present in the Project area include Canada mayflower (*Maianthemum canadense*), partridgeberry (*Mitchella repens*), wintergreen (*Gaultheria procumbens*), bunchberry (*Cornus canadensis*), bracken fern (*Pteridium aquilinum*), wild sarsaparilla (*Aralia nudicaulis*), starflower (*Trientalis borealis*), and evergreen wood fern (*Dryopteris intermedia*). The majority of wetlands in the area are forested, with occasional scrub-shrub and emergent wetlands associated with disturbance from timber harvesting. Streams are primarily high-gradient, fast-moving perennial and intermittent streams that exhibit heavy flow in spring and during rain events, and little to no flow during the summer and dry periods.

The Project area is located between the Union River and Narraguagus River watersheds. These rivers and associated perennial streams are Designated Critical Habitat for the federally-listed Atlantic salmon (*Salmo salar*). The Project area is not within designated critical habitat for Canada lynx (*Lynx canadensis*). The Project area does not intersect any state-mapped wildlife areas, such as Inland Waterfowl and Wading Bird Habitat or Deer Wintering Areas.



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Legend

- Proposed Turbine Layout (7-16-10)
- Radar Location
- Bat Detector
- Bald Eagle Nests
- Areas Visible During Raptor Survey
- Areas Not Visible During Raptor Survey
- Bull Hill Turbine Delineation Limit (7-16-10)
- USGS River and Streams

Client/Project
Blue Sky East Wind, LLC
Bull Hill
Eastbrook and T16 MD, Maine

Figure No.
1-1

Title
2010 Radar, Raptor, & Acoustic Survey Location Map
August 5, 2010

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2.0 Nocturnal Radar Survey

2.1 INTRODUCTION

Nocturnal radar surveys were conducted in the Project area to characterize Spring 2010 nocturnal migration patterns. The majority of North American passerines (songbirds) migrate at night; the strategy of migrating at night may have evolved to take advantage of more stable atmospheric conditions for their flapping flight (Kerlinger 1995). Additionally, cooler nighttime temperatures may provide a more efficient medium to regulate body temperature during more active, flapping flight and reduce predation risk while in flight (Alerstam 1990, Kerlinger 1995). Documenting the patterns of nocturnal migrants requires the use of radar or other non-visual technologies. The goal of the surveys was to document the overall passage rates for nocturnal migration in the Project area, including the number of migrants, their flight direction, and their flight altitude.

Radar surveys were conducted from sunset to sunrise on 20 nights between April 20 and May 24, 2010. The radar was deployed on Bull Hill at an elevation of 188 m (616'; Figure 1-1), at the same location as in fall 2009. Efforts were made to maximize the airspace sampled by elevating the antenna to reduce the amount of the radar beam reflected back by surrounding vegetation; such reflection may cause ground clutter obstructions on the radar screen. The elevated radar resulted in an unobstructed view of the surrounding airspace within the radar's range settings. There was relatively little ground clutter interference, as the radar site was located in a large clearing with relatively short, regenerating spruce trees. The location on Bull Hill provided a good view of the airspace in most directions.

2.2 DATA COLLECTION METHODS

2.2.1 Radar Data

Marine surveillance radar, similar to that described by Cooper *et al.* (1991), was used during field data collection. The radar has a peak power output of 12 kilowatts (kW) and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. Insects can be identified and removed from the migration calculations based on flight speed; however, it cannot readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen (not including insects) were identified as "targets." The radar has an "echo trail" function which captures past echoes of flight trails, enabling determination of flight speed and direction. During all operations, the radar's echo trail was set to 30 seconds. The radar was equipped with a 2 m (6.5') waveguide antenna, deployed 7.3 m (24') above ground. The antenna has a vertical beam width of 20° (10° above and below horizontal).

Objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas (Figure 2-1).

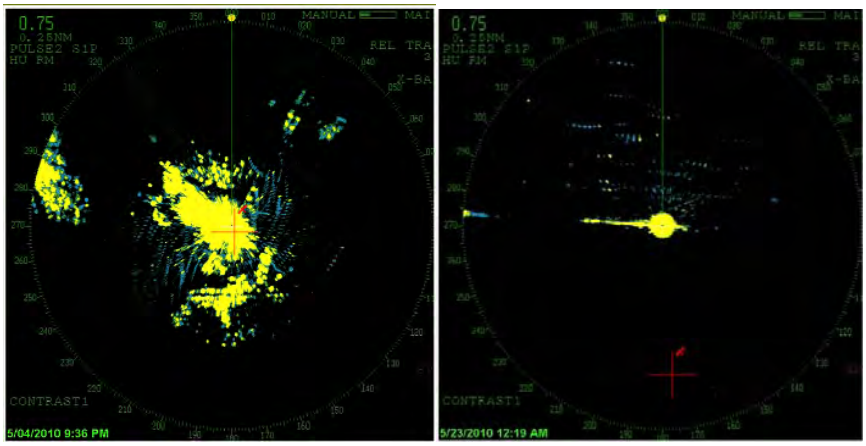

Figure 2-1. Screenshots from actual radar files for the Bull Hill Wind Project showing ground clutter in horizontal mode (left) and vertical mode (right). Although the radar records three-dimensional space, it is translated by the radar screen into a two dimensional representation, which can cause targets to be obscured from view.

However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by "hiding" clutter-causing objects from the radar (Figure 2-2). These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen. However, targets traveling into and out of the ground clutter areas can be tracked. The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

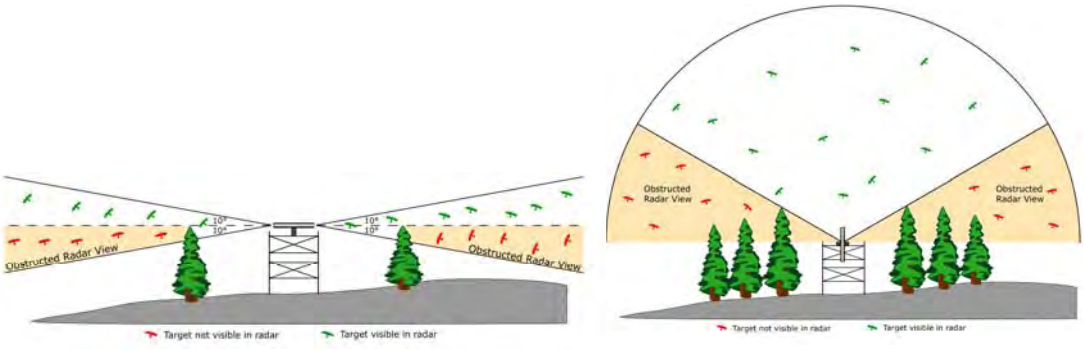

Figure 2-2. An example of a tree of a specific height that causes ground clutter, but "masks" a section of the radar beam, allowing adequate detection of targets beyond it (left). The effect of ground clutter on target detection in vertical mode is also shown (right).

Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during active rainfall. Therefore, surveys were planned

largely for nights without rain. However, in order to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers, mist, or fog were sampled.

The radar was operated in two modes throughout the course of each night. In surveillance mode, the antenna spins horizontally to survey the airspace around the radar and detects the number of targets and their flight direction as they pass through the project site (Figure 2-1). By analyzing the echo trail, the flight direction and flight speed of targets can be determined.

In vertical mode, the radar unit is tilted 90° to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20° radar beam (Figure 2-3). Both modes of operation were used during each hour of sampling.

Figure 2-3. Detection Range of the radar in vertical mode

The radar was operated at a range of 1.4 km (0.75 nautical miles) to ensure detection of small targets. When radar is operated at ranges greater than 1.4 km, larger birds can be detected but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, thus limiting the ability to observe the movement pattern of individual targets; consequently, 1.4 km is the appropriate detection range for this type of study.

The radar display was connected to the video recording software of a computer enabling digital archiving of the radar data for subsequent analysis. This software recorded and archived video samples continuously every hour from sunset to sunrise of each survey night. By alternating the radar antenna every ten minutes from vertical mode to horizontal mode, a total of 30 minutes of vertical samples and 30 minutes of horizontal samples were collected within each hour. A stratified random sample set was developed by randomly selecting 6 horizontal samples and 6 vertical samples per hour of survey. This sampling schedule allowed for randomization of sample selection and prevented double-counting of targets due to the 30-second echo trail used to determine the flight path vector.

2.2.2 Weather Data

Temperature, wind speed and direction were recorded by an on-site met tower[2]. In addition, in order to consider the atmospheric influences on migration, regional surface weather map images were interpreted to determine the dates that daytime pressure systems (high, low, or none) moved through the region. Surface weather maps, prepared by the National Centers for Environmental Prediction, the Hydro-meteorological Prediction Center, and the National Weather Service, were downloaded daily for the majority of the survey window.

2.3 DATA ANALYSIS METHODS

2.3.1 Radar Data

Video samples were analyzed using a digital analysis software tool developed by Stantec. For horizontal samples, targets (either birds or bats) were differentiated from insects based on their flight speed. Following adjustment for wind speed and direction, targets traveling faster than approximately 6 m (20') per second were identified as a bird or bat target (Larkin 1991, Bruderer and Boldt 2001). The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat within each horizontal sample, and these results were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location, and then subsequently outputs the data to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular standard deviation) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this analysis are based on those used by Batschelet (1965), because they take into account the circular nature of the data.

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 175 m (574'), the approximate maximum height of the proposed wind turbines with blades, was also calculated hourly, for each night, and for the entire survey period.

2.4 RESULTS

Radar surveys were conducted during 20 nights between April 20 and May 24, 2010 (Appendix A Table 1) resulting in 184 total hours surveyed.

[2] Met tower data was not available at the time of this report and was therefore not used in data analysis. Once this information becomes available, further analysis may be done. However, regional data from surface weather maps was summarized for this report.

2.4.1 Passage Rates

Nightly passage rates varied from 43 targets per kilometer per hour (t/km/hr) on May 10 to 879 t/km/h on April 30, and the overall passage rate for the entire survey period was 387 t/km/hr (Figure 2-4, Appendix A Table 1). Individual hourly passage rates varied between nights and throughout the season, and ranged from 0 t/km/hr on the 2nd hour of May 10 to 1486 t/km/hr on the 2nd hour of May 4 (Appendix A Table 2). For the entire season, passage rates gradually increased after sunset, were typically highest during the fifth hour after sunset, and then steadily declined until sunrise (Figure 2-5).

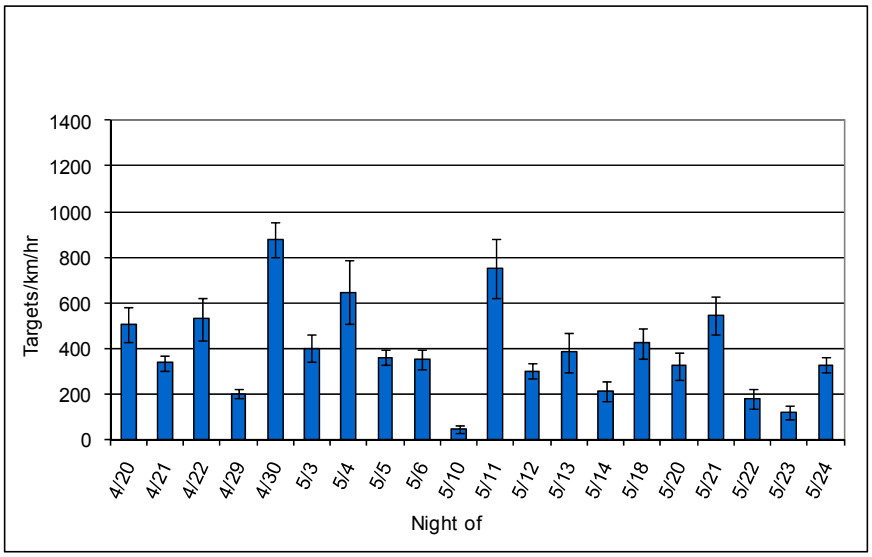

Figure 2-4. Nightly passage rates observed (error bars ± 1 SE) during Spring 2010 at the Bull Hill Wind Project.

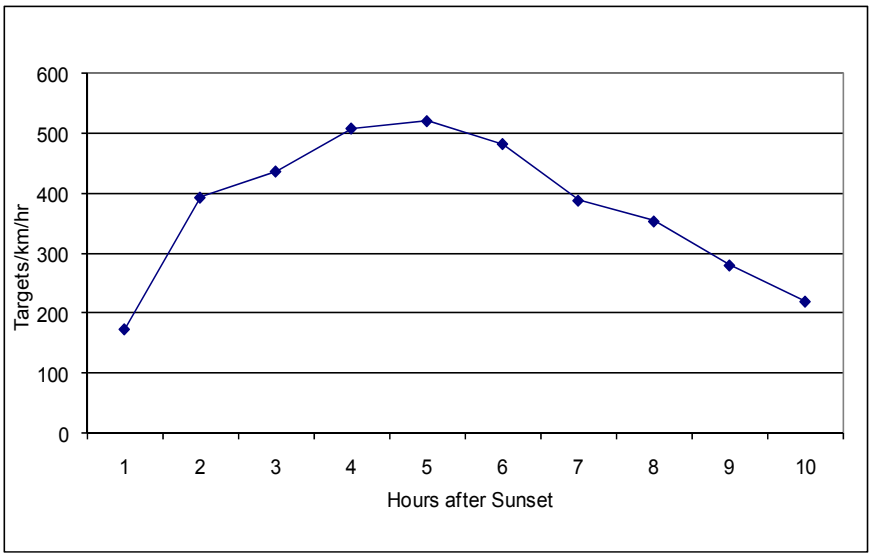

Figure 2-5. Hourly passage rates for entire season during Spring 2010 at the Bull Hill Wind Project

2.4.2 Flight Direction

Mean flight direction through the Project area was 48° ± 49° (Figure 2-6). Overall, the mean flight direction was toward the northeast, but varied between nights (Appendix A Table 3).

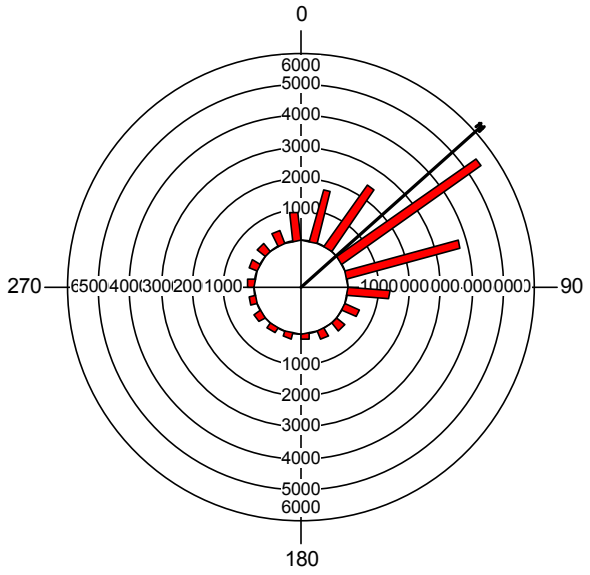

Figure 2-6. Mean flight direction for the entire season during Spring 2010 at the Bull Hill Wind Project (the bracket along the margin of the histogram is the 95% confidence interval)

2.4.3 Flight Altitude

The seasonal average mean flight height of all targets was 217 ± 8 m above the radar site. The average nightly flight height ranged from 100 m on May 12 to 358 m on April 21 (Figure 2-7, Appendix A Table 4). The percent of targets observed flying below 145 m was 38 percent for the season and varied nightly from 19 percent on May 23 to 82 percent on May 10 (Figure 2-8).

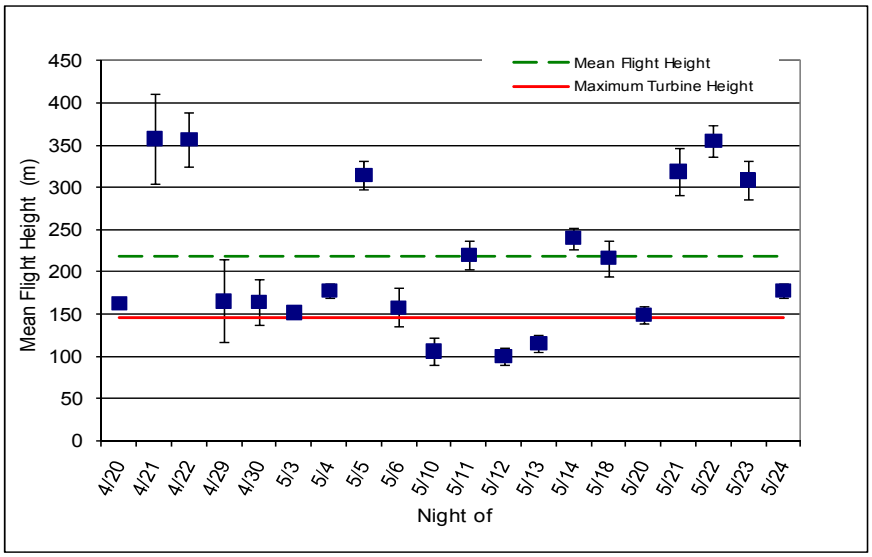

Figure 2-7. Mean nightly flight height of targets during Spring 2010 at the Bull Hill Wind Project (error bars ± 1 SE)

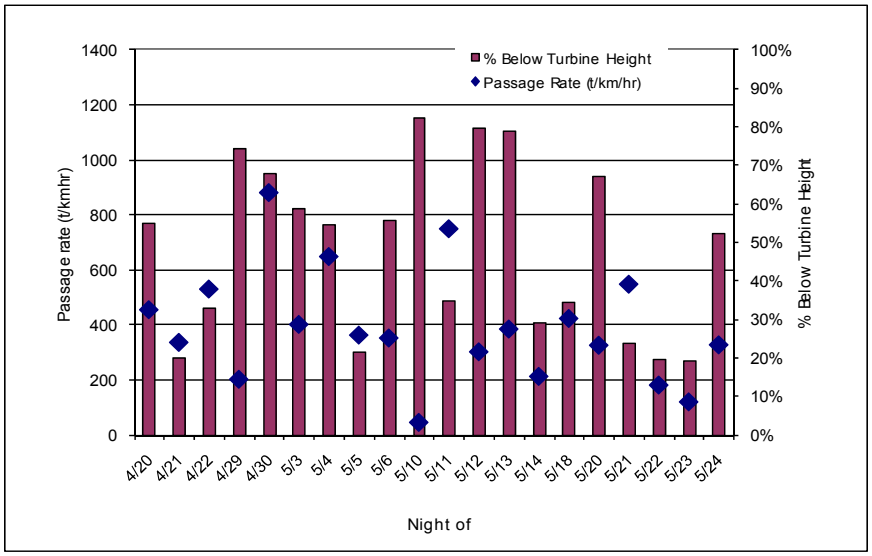

Figure 2-8. Percent of targets observed flying below a height of 145 m (476') during Spring 2010 at the Bull Hill Wind Project

Figure 2-9 displays nightly flight heights in a different format to highlight the range in individual flight heights of all targets recorded each survey night. This figure is different from Figure 2-7 which shows only the mean flight height for all targets each survey night. The "blocks" seen on Figure 2-9 depict the middle 50 percent of targets. The horizontal bar within each block depicts the median value for nightly flight height for all targets. The error bars depict the statistical outliers, or those 25 percent of birds flying well below the mean and well above the mean. The proposed turbine height is depicted as a red line.

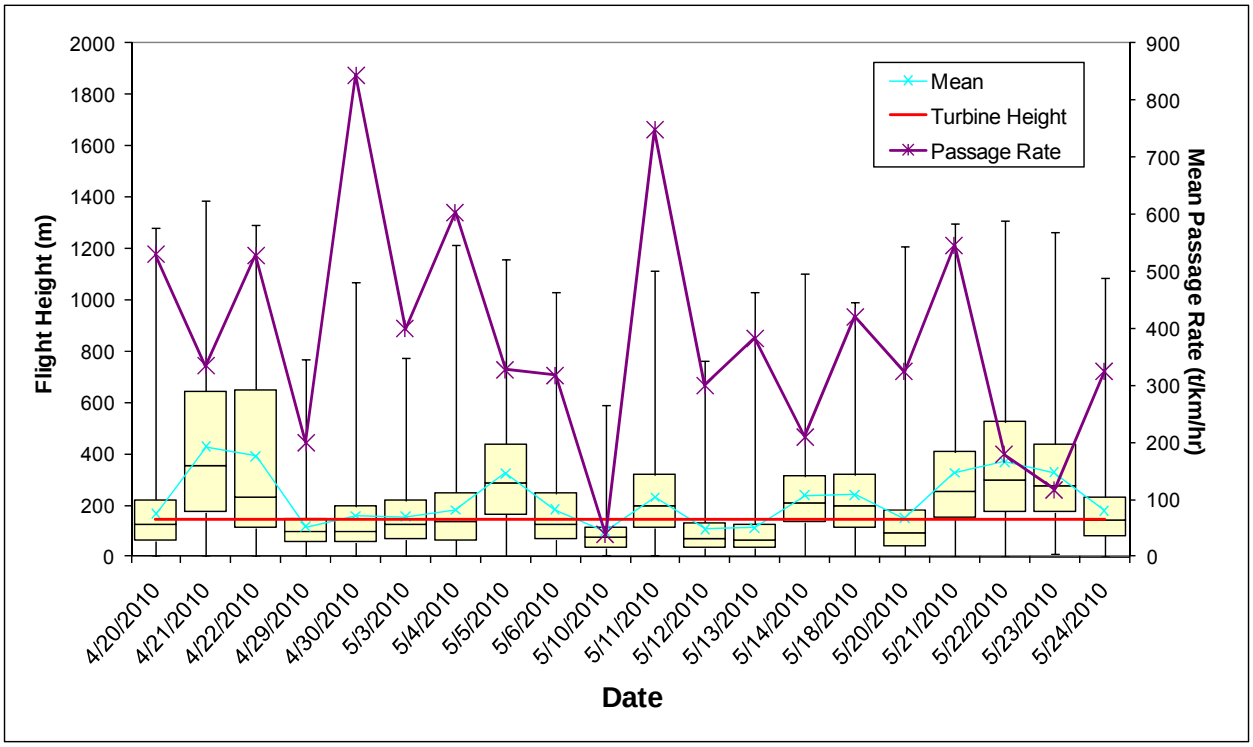

Figure 2-9. Whisker plot depicting the middle 50% and outliers of targets' flight heights for each survey night during Spring 2010 at the Bowers Wind Project

For the entire season, the mean hourly flight heights were typically highest during the second hour after sunset and generally decreased until sunrise (Figure 2-10).

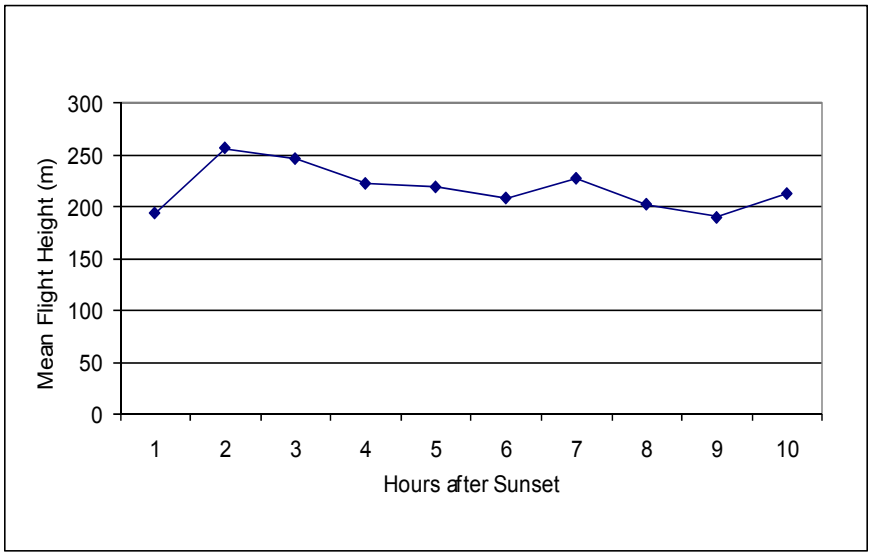

Figure 2-10. Hourly target flight height distribution during Spring 2010 at the Bull Hill Wind Project

2.4.4 Weather Data

Analysis of regional surface weather maps reveals that spring 2010 surveys were conducted during periods of high atmospheric pressure and favorable conditions for migration.

2.5 DISCUSSION

Radar surveys are designed and carried out to sample migration activity over a given point in order to provide baseline site data prior to the construction and operation of proposed commercial wind projects. The results of this nocturnal radar survey provide a snapshot of avian migration in space and time; in this case, over Bull Hill during dates typical for spring migration in eastern Maine. Spring radar surveys in the Project area documented patterns in nocturnal migration similar to those documented at recent radar surveys conducted in the eastern US (Appendix A Table 5). These include highly variable passage rates between nights, a generally northward flight direction, and flight heights typically averaging over 200 m. Within nights, migration activity was generally greatest five hours after sunset and declined steadily through the end of the night.

The radar site was located within a clearing near the highest point of Bull Hill surrounded by fairly short, regenerating spruce trees. Consequently, the radar site had good visibility and was capable of detecting targets within nearly all of its theoretical detection range. Within the spring radar survey at Bull Hill, nightly average mean passage rates were highly variable, ranging from 43 to 879 t/km/hr. This indicates that nocturnal migration was pulsed, presumably related to seasonal timing and regional weather conditions. The average passage rate at the Project (387 t/km/hr) is within the range of results of other radar studies conducted in the east (110 m to 1020 m, Appendix A Table 5). Comparison of passage rates between radar surveys at the Project and similar surveys conducted at other sites must be done with caution, as differences in passage rates are due to a large part to differences in radar view between sites, and not

necessarily the amount of migration above a radar site. Indeed, characteristics of individual radar sites, particularly the topography, local landscape conditions, and vegetation surrounding a radar survey location, can dramatically influence the ability of any radar unit to detect targets and the subsequent calculation of passage rate. These differences should be recognized as one of the more significant limiting factors in making direct site-to-site comparisons in passage rates.

The average flight height (217 m) is near the low end of the range of average flight heights recorded at other radar studies conducted in the east (210 m to 552 m), however the average flight height is above the proposed turbine height (145 m). The emerging body of studies characterizing nocturnal bird movements shows a relatively consistent pattern in flight altitude, with most birds appearing to fly at altitudes of several hundred meters or more above the ground (Figure 2-9; Appendix A Table 5). Comparison of flight height between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. Where radar surveys have been conducted at any Project, it is expected that some target activity will be observed within the turbine elevation zone. In addition, the majority of hourly and nightly mean flight heights of targets documented at the Project were found to be well above the height of the proposed turbines.

Nightly variation in the magnitude and flight characteristics of nocturnally-migrating songbirds is not uncommon and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). The night with the highest passage rate (April 30) occurred on a night following five nights of low pressure bringing snow and rain to the region. Flight heights were relatively low on this night, possibly due to lingering low cloud cover and relatively strong northwest winds (average wind speed of 9 mph). Relatively high passage rates on two days (May 4 and May 11) occurred during two nights when high pressure systems were either present or had passed through the region the night before, respectively. The majority of targets flying on these nights flew well above the proposed turbine height (Figure 2-9).

In summary, results at the Project are within the range of results recorded at other radar studies conducted in the east, and provide a sample of baseline migration activity over the Project during spring 2010 that is typical of data from other proposed projects on northeastern forested ridges.

3.0 Acoustic Bat Survey

3.1 INTRODUCTION

Acoustic sampling of bat activity has become a standard aspect of pre-construction surveys for proposed wind-energy development (Kunz *et al.* 2007). Acoustic surveys are snapshots of activity, and results cannot be used to determine the specific number of bats inhabiting an area. However, acoustic surveys can provide insight into seasonal patterns in activity levels and examine how weather conditions influence bat activity. While this data may be useful in predicting trends in post-construction mortality rates, the current lack of data on this topic precludes a quantitative prediction of risk. The objectives of acoustic surveys at Bull Hill were (1) to document bat activity patterns from April to mid July in airspace near the rotor zone of the proposed turbines, at an intermediate height, and near the ground; and (2) to document bat activity patterns in relation to weather factors, including wind speed and temperature.

Eight species of bats occur in Maine, based upon their normal geographical range. These are the little brown bat (*Myotis lucifugus*), northern long-eared bat, (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), tri-colored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*) (BCI 2001). All eight bat species found in Maine are listed as species of Special Concern in Maine's Wildlife Action Plan due to the lack of information about the species in Maine and their apparent decline in recent years. Additionally, the eastern small-footed bat is listed as a Species of Greatest Conservation Need because only one hibernacula record and few summer records exist for the state of Maine. No bat hibernacula have been identified in the vicinity of the Project area.

3.2 DATA COLLECTION METHODS

3.2.1 Acoustic Detector Site Selection

Anabat II and Anabat SD1 detectors (Titley Electronics Pty Ltd.) were used for the duration of the spring 2010 acoustic bat survey. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of the species of bats that could occur in the Project area. Anabat II detectors were coupled with CF Storage ZCAIM (Titley Electronics Pty Ltd.), which programmed the on/off times and stored data on removable 1 GB compact flash cards; newer SD1 model detectors do not require use of a ZCAIM. Anabat detectors are frequency division detectors, dividing the frequency of echolocation sounds made by bats by a factor of 16, then recording these sounds for subsequent analysis. The audio sensitivity setting of each Anabat system was set between six and seven (on a scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 to 30 meters (33' to 98').

Each Anabat detector was powered by 12-volt batteries charged by solar panels. Each solar-powered Anabat system was deployed in waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing suspends the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic is placed at a 45-degree angle directly below the microphone. The angled reflector allows the microphone to record the airspace horizontally surrounding the detector and is only slightly less sensitive than an unmodified Anabat unit.

Six detectors were deployed for the duration of the spring survey period (Figure 1-1). Two detectors were suspended in a met tower on Little Bull Hill and four detectors were deployed in trees on either end of the northern and southern Project area ridgelines. Detectors were mobilized on April 15 and operated until July 14 when they were demobilized. Each detector was programmed to record nightly from 7:00pm to 7:00am. Maintenance visits were conducted approximately every two weeks to check the condition of the detectors and to download data to a computer for analysis.

Detector Descriptions:

In order to record bats flying above and below the turbine rotor zone, “met detectors” were deployed at a height of 50 and 35 m. Both were attached to a fixed pulley system suspended in the guy wires of the met Tower. Two guy lines were used to secure the detector in place and ensure the solar panel faced south. The tower clearing was approximately 50 m in diameter and the surrounding landscape was a relatively open forest canopy and understory with predominantly birch with a small component of spruce. No source of water or available snags was observed near the turbine clearing.

Photo 1 –Met Tower

The “Northeast Tree” detector was deployed at a height of 5 m high in a tree along the edge of a gravel logging road. The surrounding forest was a mix of hardwood and soft wood; birch was the dominant tree species. Undergrowth was a mix of raspberry and grasses. Logging trails

perpendicular to the road were filled with slash left behind from recent a harvest. At least one snag was visible from the detector location. The surrounding forest canopy was predominantly young regenerating birch species and appeared to have been cut within the previous five year.

Photo 2 – Northeast (NE) Tree Detector

The “Radar Tree” detector was deployed approximately 3 m high in a tree at the end of a logging road that bisected a patch of young even-aged spruce. The detector was suspended over an old log landing filled with slash from a recent harvest. The logging road was heavily ditched on either side and standing water was frequently observed along the roadway. Several large snags were apparent from the detector location. The surrounding forest canopy was relatively open with very little ground clutter.

Photo 3 – Radar Tree Detector

The “Southeast Tree” detector was deployed at a height of approximately 3 m high in a tree along a logging road, at an intersection. The surrounding forest showed signs of recent harvest and was predominately red spruce, a small component of hardwood, and a few mature white

pine throughout. The gravel logging roads were heavily ditched with signs of standing water along the roadway. A few large snags were visible from the detector location and an abandoned log landing filled with slash and planted in a mix of grasses was located a few hundred feet from the detector.

Photo 4 – Southeast (SE) Tree Detector

The “Southwest Tree” detector was suspended at a height of approximately 5 m high in a mature spruce along a gravel logging road at the edge of a log landing filled with slash. The surrounding forest was predominately red spruce with a small component of hardwood species and a relatively open forest canopy. The understory was a mix of raspberry and grasses. A few large snags were observed in the vicinity of the detector.

Photo 5 – Southwest (SW) Tree Detector

3.3 DATA ANALYSIS METHODS

Ultrasound recordings of bat echolocation may be broken into recordings of a single bat call or recordings of bat call sequences. A call is a single pulse of sound produced by a bat, while a call sequence is a combination of two or more pulses recorded in an Anabat file. Recordings with only one call were eliminated from analysis as has been done in similar studies (Arnett *et al*. 2006). Call sequences typically include a series of calls characteristic of normal flight or prey location ("search phase") and capture periods (feeding "buzzes").

Potential call files were extracted from data files using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of bats that occur in the northeast. This software screens all data recorded by the bat detector and extracts call files using a filter. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences are retained within the data set.

Following extraction of call files, each file was visually inspected for species identification and to ensure that only bat calls were included in the data set. Insect activity, wind, and interference can also sometimes produce Anabat files that pass through the initial filter and need to be visually inspected and removed from the data set. Call sequences are easily differentiated from other recordings, which typically form a diffuse band of dots at either a constant frequency or widely varying frequency.

Because bat activity levels are highly variable among individual nights and individual hours (Hayes 1997, Arnett *et al*. 2006), detection rates are summarized on both of these temporal scales. Nightly detection rates were summarized by month as well as for the entire sampling period. Hourly detection rates were summarized by hour after sunset, as recommended by Kunz *et al*. (2007). Quantitative comparisons among these temporal periods was not attempted because the high amount of variability associated with bat detection would required much larger sample sizes (Arnett *et al*. 2006, Hayes 1997).

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, as well as other bat researchers. However, due to similarity of call signatures between several species, all

classified calls have been categorized into five guilds[3] reflecting the bat community in the region of the Project area, as follows:

- **Unknown (UNKN)** – All call sequences with less than five calls, or poor quality sequences (those with indistinct call characteristics or background static). These sequences were further identified as either "high frequency unknown" (HFUN) for sequences with a minimum frequency above 30 to 35 kHz, or "low frequency unknown" (LFUN) for sequences with a minimum frequency below 30 to 35 kHz.

- **Myotis (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings.

- **Eastern red bat/tri-colored bat[4] (RBTB)** – Eastern red bats and tri-colored bats. These two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur.

- **Big brown/silver-haired bat (BBSH)** – Big brown and silver-haired bats. These species' call signatures commonly overlap and have therefore been included as one guild in this report.

- **Hoary bat (HB)** – Hoary bats. Calls of hoary bats can usually be distinguished from those of big brown and silver-haired bats by minimum frequency extending below 20 kHz or by calls varying widely in minimum frequency across a sequence.

This method of guild identification represents a conservative approach to bat call identification. Since some species sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of recordings/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined.

[3] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI. We broke hoary bats out into a separate guild due to the importance of reporting activity patterns of migratory species in the context of wind energy development.
[4] The scientific and common name of the eastern pipistrelle (*Pipistrellus subflavus*) has been changed to the tri-colored bat (*Perimyotis subflavus*).

3.4 RESULTS

3.4.1 Timing of Activity

Detectors were deployed on April 15 and continued to record data through July 14, for a total survey period of 467 detector nights. The range of dates that each detector was deployed is summarized in Table 3-1. Throughout the season occasional equipment malfunction occurred causing a lapse in data collection. The majority of equipment malfunction occurred at the beginning of the survey period when bat activity levels were the lowest of the survey period. Collectively detectors recorded data 87 percent of the time they were deployed.

Activity levels peaked during mid July at all tree detectors except the SE tree detector which showed a slight decline from June to July 15 (Figure 3-1). Both met tower detectors recorded few calls throughout the survey period (Figure 3-2). While the met tower low detector recorded the highest activity level during July, the met tower high detector did not record calls during the month of July. The four tree detectors recorded 2,638 call sequences and had an overall detection rate of 8.6 call sequence per detector night. Detection rates of individual tree detectors ranged from 5.3 to 11.2 call sequences per detector night. The highest monthly detection rate occurring at a single tree detector was recorded during the month of July at the radar tree detector which had a detection rate of 39.5 call sequences per detector night. The met tower detectors recorded a total of 65 bat call sequences during the survey period resulting in an overall detection rate of 0.4 call sequences per detector night. Individual detector rates from the two met tower detectors ranged from 0.1 call sequence per night at the met high detector to 0.7 at the met low. The highest monthly met tower bat call detection rate was recorded at the low detector during the month of July and was 2.2 bat call sequences per detector night. The level of detection rates fluctuated throughout the night with the third hour after sunset being the busiest hour of recording (Figure 3-3). Activity levels declined after the third hour of sunset until a second smaller peak in activity occurred seven hours after sunset.

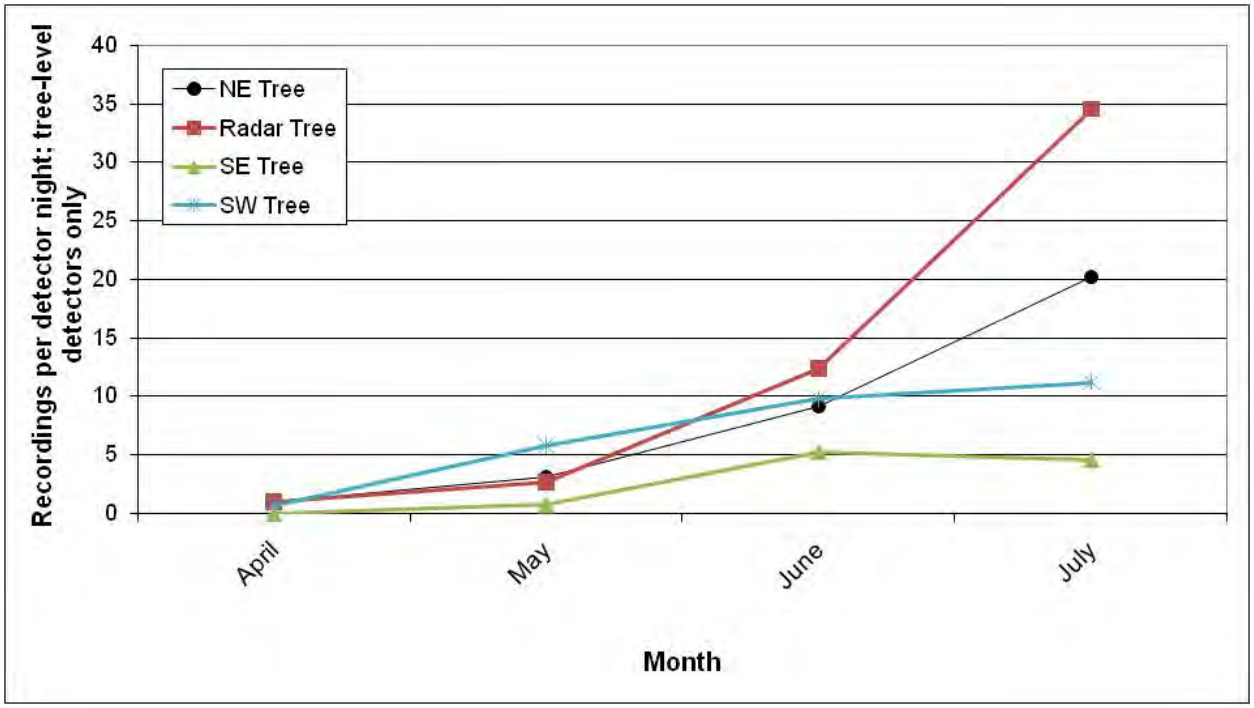

Figure 3-1. Monthly detection rates per detector at the tree detectors at Bull Hill, 2010

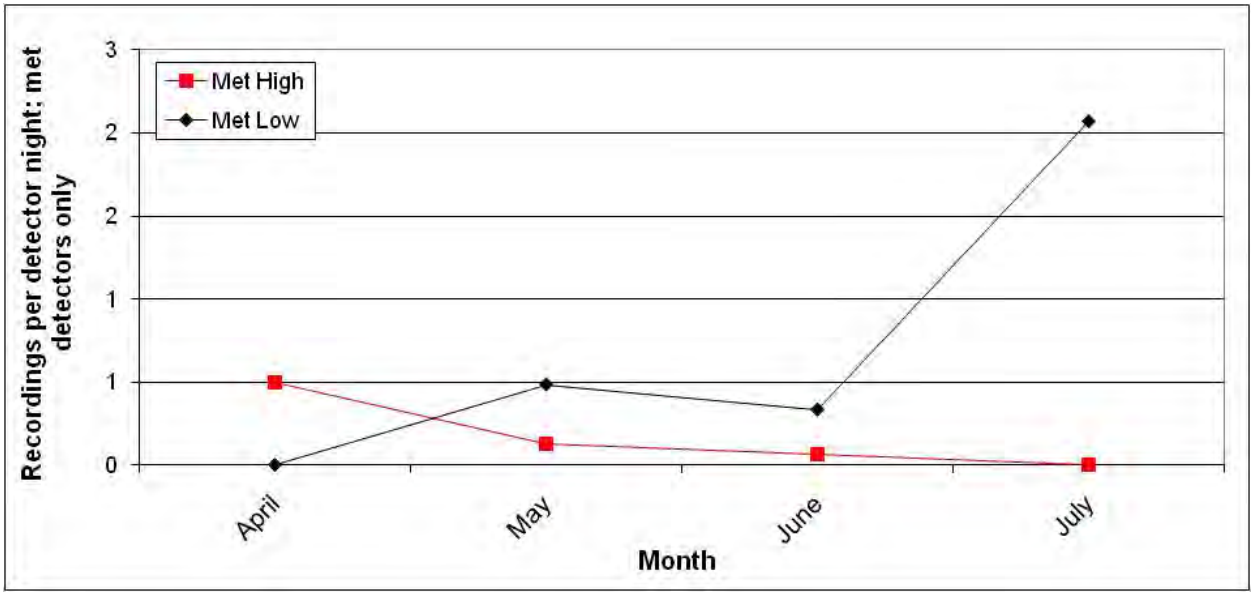

Figure 3-2. Monthly detection rates per detector at met tower detectors at Bull Hill, 2010

Table 3-1. Summary of bat detector field survey effort and results						
Location	**Dates Deployed**	**Calendar Nights**	**Detector-Nights***	**Recorded Sequences**	**Detection Rate ****	**Maximum Sequences recorded *****
Met High	April 15 to July 14	91 81		9	0.1	3
Met Low	April 15 to July 14	91 79		56	0.7	8
NE Tree	April 15 to July 14	91 91		711	7.8	121
Radar Tree	April 15 to July 14	91 91		1023	11.2	181
SE Tree	April 15 to July 14	91 47		250	5.3	57
SW Tree	April 15 to July 14	91 78		654	8.4	33
Overall Results		***546***	***467***	***2703***	5.8 --	
* One detector-night is equal to a one detector successfully operating throughout the night.						
** Number of bat echolocation sequences recorded per detector-night.						
*** Maximum number of bat passes recorded from any single detector for a detector-night.						

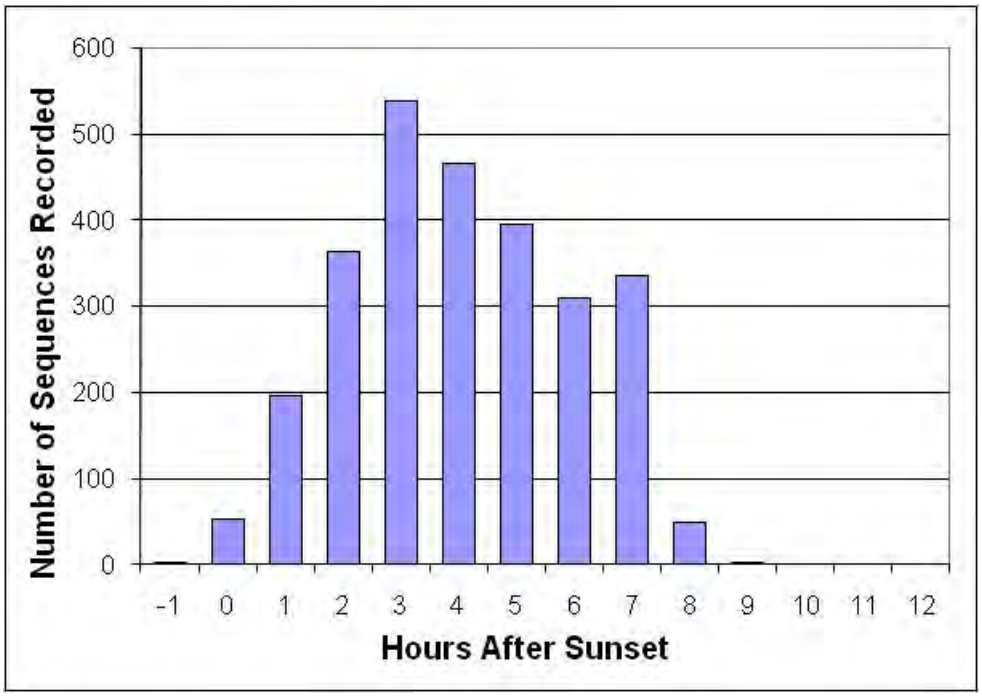

Figure 3-3. Hourly bat call sequence detections at the Bull Hill, 2010.

3.4.2 Species Composition

The met tower detectors recorded species from all guilds except the RBTB guild (Table 3-2). The unknown guilds represented the largest number of calls recorded by the both met tower detectors (n=47), followed by the MYSP guild (n=14). The tree detectors recorded calls from all five represented guilds, MYSP being the most frequently recorded (n=1350), followed by the UNKN guild (n=969). The unknown species guild can be broken down into low-frequency and high-frequency calls (Figure 3-4).

Table 3-2. Distribution of detections by guild for detectors at Bull Hill, Spring/Summer 2010.

Detector	Guild					Total
	BBSH	HB	MYSP	RBTB	UNKN	
Met High	1	0	1 0 7			9
Met Low	1	2	13 0 40			56
NE Tree	18	2	321	0	370	711
Radar Tree	190	7	599	7	220	1,023
SE Tree	18	3	77	1	151	250
SW Tree	33	30	353	10	228	654
Total Met Detections	2	2	14 0 47			65
Total Tree Detections 259		42	1350	18	969	2638
Met Detector Guild Compostion %	3.08% 3.08%		21.54%	0.00% 72	31%	--
Tree Detector Guild Compostion %	9.82% 1.59%		51.18%	0.68% 36	73%	--

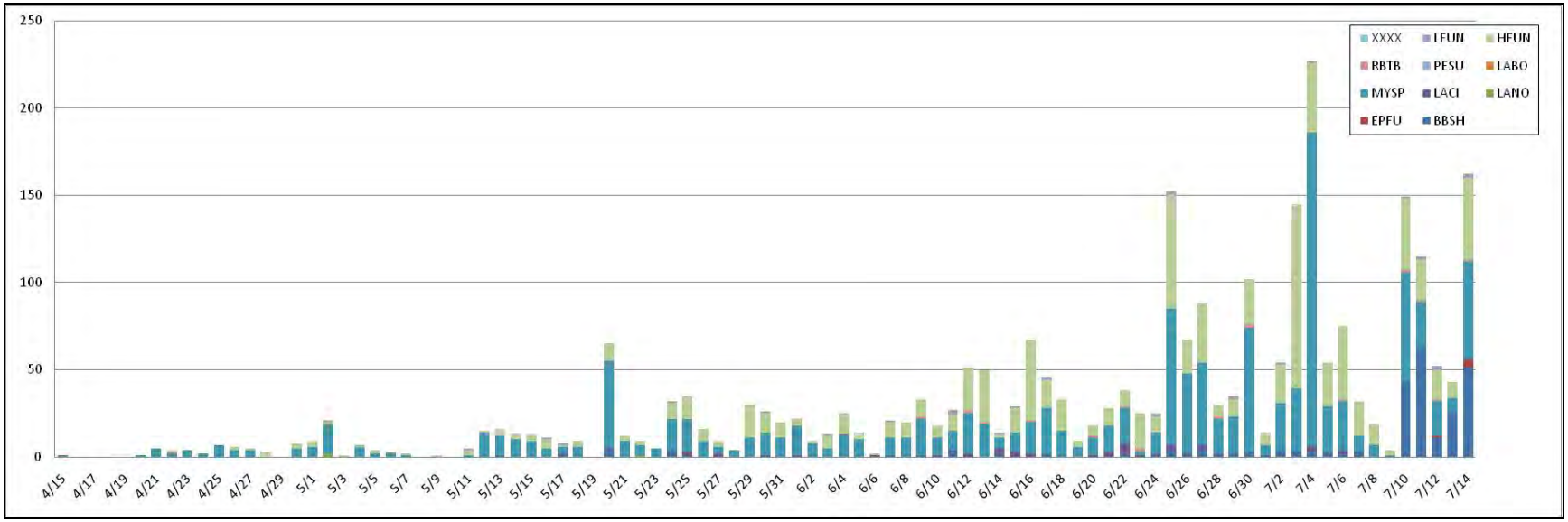

Figure 3-4. Total nightly bat call sequence detections at Bull Hill, 2010

Appendix B provides a series of tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Specifically, Appendix B Tables 1 through 6 provide information on the number of call sequences, by guild and suspected species, recorded at each detector and the weather conditions for that night. Analook files for all 2,703 recorded call sequences can be made available upon request.

3.5 DISCUSSION

Bat activity was variable among detector heights and locations during the spring and summer 2010 survey period, yet patterns in bat activity within the Project area emerged from this survey period. Nightly activity rates were lowest during the first few weeks of the survey period in April when nightly temperatures remained low. An increase in nightly bat activity corresponded with a seasonal increase in mean nightly temperatures recorded. Recent studies have found that bat activity patterns are influenced by weather conditions (Arnett *et al*. 2006, Arnett *et al*. 2008, Reynolds 2006). Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett *et al*. 2005).

The met tower detectors recorded an overall detection rate of 0.4 bat call sequences per detector night. Combined, the tree detectors recorded an overall detection rate of 8.6 call sequences per detector night. The largest overall peak in bat activity rates was recorded during July 4, 69 percent of which were MYSP calls recorded at the Radar Tree detector. It is important to note that detector location, height, and surrounding habitats can significantly affect detection rates.

The Radar Tree detector recorded the highest average monthly detection rate of all six detectors during the month of July, 2010 (36.9 bat call sequences per night), 84 percent of which were from the MYSP guild. When considering the level of activity documented by acoustic surveys, the numbers of recorded bat call sequences cannot be directly correlated with the number of bats in an area because acoustic detectors do not allow for differentiation between individuals.

Each file recorded by the six detectors was individually assessed to separate potential bat call sequences from static and other ambient noise resulting in 2,703 call files extracted. All calls were provisionally categorized into one of the five possible guilds; however some calls contained enough detail to be labeled to the species level. Several bat species of the northeast produce calls that exhibit unique characteristics. Such distinguishable details usually include the frequency and shape of a call. When a call file lacks sufficient detail to indentify species or in cases when the call has characteristics of one or more species, a guild labels is applied.

Certain species, such as the eastern red bat and hoary bat, have easily identifiable calls. Other species, such as the big brown bat and silver-haired bat, are difficult to distinguish acoustically. Similarly, certain members of the Myotis genus, such as the little brown bat, are far more common and have slightly more distinguishable calls than other species. A total of 1,364 Myotis

call sequences (50.5% of total call sequences recorded) were detected at the Project in spring, 2010. Both Myotis and RBTB calls fall within the range of the HFUN category and are often identified as such when less than five calls are recorded. During the spring, 2010 season, 1,364 Myotis calls were labeled to guild while only 18 RBTB calls were labeled to guild, which likely indicates that more of the 985 HFUN calls were from the Myotis guild than the RBTB guild.

The RBTB guild includes the tri-colored bat and eastern red bat. Only 18 call sequences, 0.7 percent of total call sequences recorded by detectors during the spring survey, belonged to the RBTB guild. None of these calls had enough detail to be identified as eastern red bats or tri-colored bats. Eastern red bats have relatively unique calls which span a wide range of frequency and have a characteristic hooked shape and variable minimum frequency. Tri-colored bats tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. Although both species do have distinct call characteristics their calls most often appear similar making differentiation difficult resulting in the RBTB classification.

The BBSH guild includes the big brown bat and silver-haired bat, both of which produce search-phase calls with minimum frequencies in the 25-30 kHz range. 261 call sequences from the BBSH guild composed 9.7 percent of all calls recorded during the spring 2010 survey period. Certain types of calls by each species are easily distinguishable from the other based on minimum frequency and call profile, but other calls in this range have overlapping characteristics and are difficult to distinguish. Eight of these calls were identified as big brown bats and three as silver-haired bats. One review of post construction mortality data from wind power sites in the eastern US found big brown mortality to occur less frequently than silver-haired bat mortality (Arnett et al, 2008).

The HB guild consists of the hoary bat, the largest bat species in the northeast. Forty-four (1.6%) call sequences recorded in the Project area belonged to the hoary bat. Hoary bat calls are generally distinguishable from all other species in the region and are characterized by highly variable minimum frequencies often extending below 20 kHz, and a hooked profile similar to the eastern red bat.

The height of a detector may determine the number of call sequences and the species composition it records; for example, long-distance migratory species are more likely to be recorded at detectors deployed above canopy height (Arnett et al. 2006). Detectors in and around canopy height likely detect foraging individuals passing by the detector multiple times, whereas much less concentrated foraging likely occurs within the recording zone of met tower detectors, possibly resulting in fewer foraging bats being recorded multiple times. Typically detectors deployed in met towers record a higher percentage of migratory species, (e.g., big brown bats and silver-haired bats) than tree detectors, which usually detect more Myotis and HFUN call sequences. However, only two of the calls recorded in met tower detectors were from the BBSH guild at the Project and only two calls were identified as hoary bats.

Results of acoustic surveys must be interpreted with caution. It is important to acknowledge that numbers of recorded bat call sequences cannot be correlated with the number of bats in an area because acoustic detectors do not allow for differentiation between individuals (Hayes 2000). Methods surrounding acoustic bat surveys are continually evolving, and it there is

currently little data aiding in the interpretation of number of calls per detector nights. Although interpretations are limited, the surveys represent a sample of activity and the general species groups that occur in the Project area, which are fairly typical when compared to these variables at other potential wind projects throughout the northeast.

4.0 Diurnal Raptor Surveys

4.1 INTRODUCTION

Three days of winter surveys and 12 days of spring season raptor migration surveys were conducted during 2010 at the Project. The primary purpose of the winter surveys was to document bald eagle (*Haliaeetus leucocephalus*) (a state-listed species of special concern) activity at or around Molasses Pond. All raptor species observed were documented.

The purpose of the spring raptor surveys to document the species that occur in the vicinity of the Project and to record the specific flight heights, flight path locations, and other flight behaviors of raptors within the Project area. Survey methodology and level of effort were discussed before and during the spring raptor migration surveys. During this initial agency meeting, MDIFW indicated raptor surveys should note all bald eagle, northern harrier (*Circus cyaneus*) (special concern), great blue heron (*Ardea herodias*) (special concern), and osprey (*Pandion haliaetus*), activity, as these species are suspected to occur in the vicinity of the Project area.

In the eastern United States, raptor migration tends to concentrate along the shores of large bodies of water including lakes and the Atlantic Coast (Kellogg 2007) as well as along ridgelines, where raptors take advantage of updrafts which form along the side slopes of ridges. Updrafts allow raptors to fly long distances with minimal exertion (Berthold 2001). Raptors also use thermals, which are pockets of warm, rising air that form as the ground's surface is heated by the sun, in order to minimize energy expenditure during migration movements (Bildstein 2006). Thus, raptor surveys were conducted from prominent locations on ridges inside the proposed Project area.

4.1.1 Study Area Description

For the purposes of this report, the 'study area' is considered the observable airspace as seen from the observation locations. The 'Project area' includes only those locations within the study area where turbines are to be located[6]. The Project area includes two separate turbine arrays on lower elevation hillsides: one on Bull Hill and one stretching across Heifer Hill and Beech Knoll (Figure 1-1). The observation locations during the winter surveys were performed from Sparrow Hill and spring 2010 surveys were performed from Bull Hill (Figure 1-1), both prominent

[6] Due to the change in turbine number and location on July 16, 2010, data collected during winter and spring migration surveys were reanalyzed to accurately report the number of birds observed within the Project area based on the updated turbine layout.

locations within the Project area. The view from Sparrow Hill provided an excellent 360 degree view. Accordingly, the observer had 100 percent visibility of all proposed turbine locations. The view from Bull Hill also provided an excellent 360 degree view. Accordingly, the observer had 100 percent visibility of all proposed turbine locations (Figure 1-1; Photo 4-1 and 4-2).

Photo 4-1. View of Molasses Pond from Sparrow Hill, the winter 2010 observation site.

Photo 4-2. View from Spring 2010 raptor survey location on Bull Hill.

The study area was categorized by the topographical positions which occur there (Figure 4-2). For clarification, locations within the Project boundary at Bull Hill include all topographical positions A, B, C, and D (Figure 4-1). However, proposed turbine locations at Bull Hill include the crests (A) and mid-slopes (B and C) of the Project ridges.

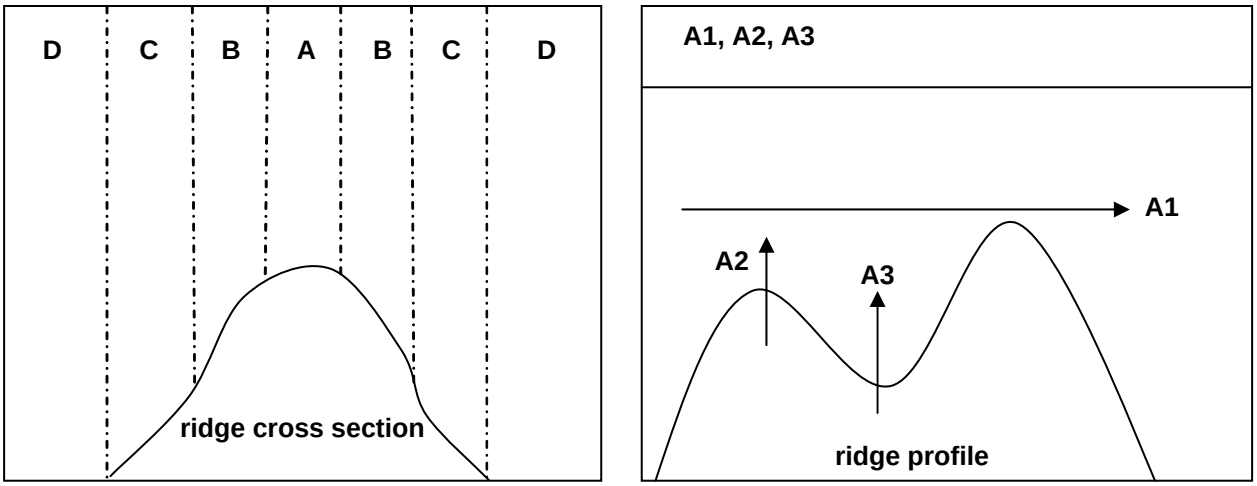

Figure 4-1. Raptor flight position categories in relation to the topography of the study area (codes apply to locations within and outside of Project area). A1) parallel to ridge, A2) perpendicular to ridge, A3) over saddle, B) flight path over upper slope of ridge, C) flight path over lower slope of ridge, and D) flight path over a valley.

For the purposes of data summary, the study area has been categorized into four separate regions: the Project area on Bull Hill, the Project area on Beech Knoll and Heifer Hills, ridges outside of the Project area, and valleys outside the Project area.

4.2 METHODS

4.3 RAPTOR DATA COLLECTION METHODS

4.3.1 Field Surveys

Field surveys were conducted on 3 days in winter 2010 and 12 days during the spring survey period[7]. Visual observation survey methods were based on modified Hawk Migration Association of North America (HMANA) methods (HMANA 2007). Surveys were conducted for seven consecutive hours between 9:00 am and 4:00 pm, during the peak hours of thermal development and raptor movement.

During surveys the observer scanned the sky and surrounding landscape by naked eye or with binoculars. Each raptor observation, or pass, was documented. Each time a bird was observed it was recorded, regardless of whether it was suspected to be a local bird observed previously. Therefore, daily count totals include all observations, or passes, of birds observed throughout a survey day[8]. Detailed information for each observation was recorded on standardized data sheets, including:

[7] Data regarding bald eagles are summarized for the 3 winter surveys in this report; all raptor data collected during the 3 winter surveys were combined and analyzed with data from the 12 spring migration survey.
[8] It should be noted that HMANA observers typically do not count birds suspected to be local or seen previously that day; therefore, this should be considered when comparing results between datasets.

- Observation date and time;
- Species [9], number of individuals, and age (if possible);
- The location of each bird depicted on a topographical map;
- The flight height[10] and behaviors observed in each of the topographical positions where birds occurred[11];
- The general flight direction of each bird; and
- An estimate of the length of time birds spent below maximum turbine height.

Additionally, observations of non-raptor species including water birds were documented by the observer. Passerine observations made during the raptor surveys were also recorded by the observer, however these data were not collected uniformly or systematically.

4.3.2 Weather Data

Wind direction, wind speed, and the development of thermals largely influence raptor flight behaviors and flight paths. Therefore, throughout each survey day, the observer recorded hourly weather conditions including wind speed and direction, temperature, sky condition, percent cloud cover, cloud type, and relative cloud height.

Specific seasonal weather conditions result in accentuated raptor migration movements. Atmospheric instability and updrafts are conditions that accompany low pressure systems and storms and raptors will move in advance of these conditions (Drennan 1981). Additionally, soaring on southerly winds is more efficient for northbound migrants (Drennan 1981). Raptor migration in the spring is most intense during the approach of a low pressure system and a cold front, and on days with southerly winds and rising air temperatures (Drennan 1981). In order to consider the atmospheric influences on raptor activity during the days that were sampled in spring 2010, regional surface weather map images were interpreted to determine the dates that daytime pressure systems (high, low, or none) moved through the region. Surface weather maps, prepared by the National Centers for Environmental Prediction, the Hydro-meteorological Prediction Center, and the National Weather Service, were downloaded daily for the majority of the survey window. The Surface Weather Maps show station data and the analysis for 7:00 am, EST.

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[9] Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, unidentified raptor.

[10] Nearby objects with known heights, such as met towers and trees, were used to estimate flight height.

[11] As individual birds traveled through or in the vicinity of the Project, all topographical position categories in which a bird occurred were recorded.

4.4 RAPTOR DATA ANALYSIS METHODS

Raptor observation data were summarized by survey day. Data analysis included a summary of:

- Daily and seasonal observation rates (raptors observed per hour);
- Total observations of the different species observed;
- Hourly observation totals;
- The percentage of birds observed in the study area which occurred specifically within the Project area;
- The percentage of birds suspected to be actively migrating;
- A summary of flight behaviors observed in the topographical positions of the different locations of the study area;
- The average minimum flight height of birds within each topographical position category; and
- For those birds observed within proposed turbine areas (topographical positions A, B, and C), the percentage of birds seen below 145 m (390').

The daily results of the winter and spring 2010 surveys were compared to the daily results of available regional raptor surveys. Survey results are available from the following sites: Bradbury Mountain, Pownal, ME; Barre Falls, Barre, MA; Pitcher Mountain, Stoddard, NH; Pilgrim Heights, North Truro, MA; and Plum Island, Newburyport, MA.

4.5 RESULTS

4.5.1 Weather Summary

Among survey days, the average hourly temperature was 12° C (53° F). Temperatures ranged from 3° C to 23° C (38 to 74° F). Sky conditions varied from clear to partly cloudy to overcast. There were 3 survey days which experienced periods of reduced visibility: a total of 8 hourly periods (out of 104 total hours; 8 percent) during which drizzle and rain showers reduced visibility. Wind direction was variable among survey days. Wind was predominantly from the west on 4 survey days, from the southwest on 3 survey days, from the south on 2 survey days, from the northeast on 2 survey days, from the northwest on 2 survey days, and variable on 2 survey days. Wind speeds ranged from 0 to 36 kilometers per hour (kph) (0 to 24 miles per hour [mph]).

Analysis of regional surface weather maps showed variable weather conditions during the survey periods. High pressure and fair weather existed throughout the region on seven survey days, while unsettled weather and frontal systems moved through during eight days. Days with highest passage rates occurred in early May during approaching and passing low pressure systems.

4.5.2 Raptor Data

A total of fifteen survey days were sampled between March 19 and May 23, resulting in a total of 104.25 survey hours[12]. A total of 55 raptor observations were made. The seasonal passage rate was 0.53 raptors/hour. Table 4-1 summarizes 2010 raptor migration survey results.

Table 4-1. A summary of the Spring 2010 survey effort and results for the Bull Hill Wind Project in Washington County, Maine

Range of survey dates		**3/19/2010 to 5/23/2010**	
No. survey days		**15 days**	
Total survey hours		**104.25**	
Total raptor species observed		**9**	
Raptor species observed		**State Listing**	**In Project area? (Y/N)**
(Common Name)	**(Scientific Name)**		
American kestrel	*Falco sparverius*		Y
bald eagle	*Haliaeetus leucocephalus*	Special Concern	N
broad-winged hawk	*Buteo platypterus*		Y
merlin	*Falco columbarius*		Y
northern harrier	*Circus cyaneus*	Special Concern	Y
osprey	*Pandion haliaetus*		N
red-tailed hawk	*Buteo jamaicensis*		N
sharp-shinned hawk	*Accipiter striatus*		Y
turkey vulture	*Cathartes aura*		Y
Total no. observations of raptors in study area		**55**	
Seasonal passage rate (raptor observation/hour)		**0.53**	
Total no. observations of raptors within Project area (percent of total observations in study area)		**15 (27%)**	
Total no. observations of raptors seen in turbine areas below max turbine height (145 m) (percent of total observations in Project area only)		**15 (100%)**	

Daily passage rates ranged from 0 (4/22, 5/21 and 5/23/2010) to 2.14 (5/5/2010) raptors/hour. Survey day totals ranged from 0 to 15 observations per day. The day with the highest passage, May 5 (n=15), was characterized by moderate northwest winds, mild temperatures, and excellent thermal development evidenced by fair weather cumulus clouds. Raptor activity during the spring 2010 surveys peaked in early May (Figure 4-2; Appendix C Table 1).

[12]. To see the raptor observations recorded during the 3 winter survey days separately, see Appendix C Table 1.

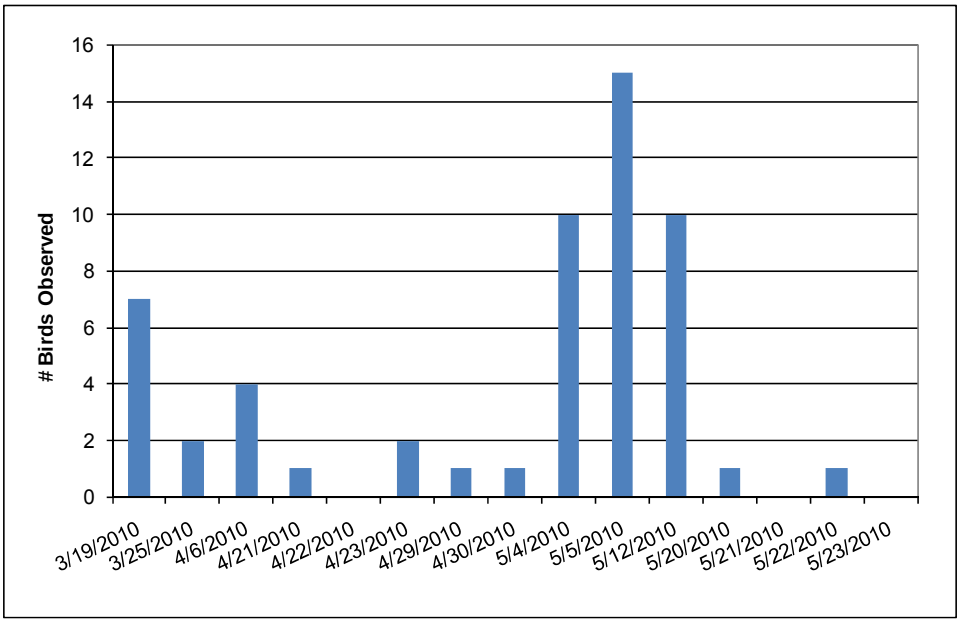


Figure 4-2. Survey totals of raptors observed during Spring 2010 surveys at the Bull Hill Wind Project.

There were nine species of raptors observed in the study area (not including the five unidentified individuals). The most common raptor species observed was broad-winged hawk (n=12; 22%). Other commonly observed species include turkey vulture (n=11, 20%), red-tailed hawk (n=6, 11%), and bald eagle (n=6, 11%) (Figure 4-3; Appendix C Table 1).

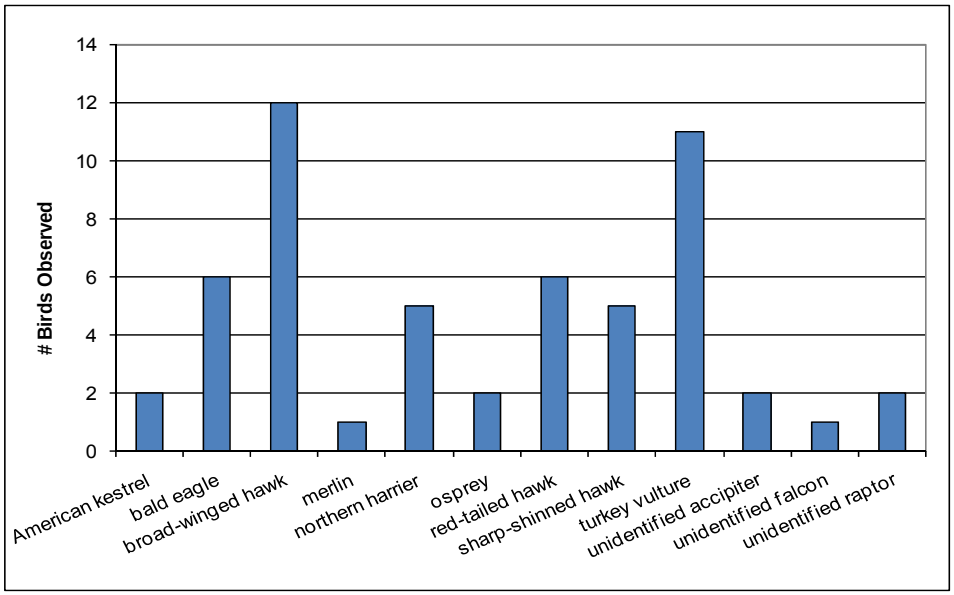


Figure 4-3. Number of observations of raptor species observed during Spring 2010 surveys at the Bull Hill Wind Project.

4.5.3 Hourly observations

Throughout the survey season, the majority of observations peaked in the morning hours between 9 am and 10 am and gradually decreased throughout the afternoon (Figure 4-4; Appendix C Table 2).

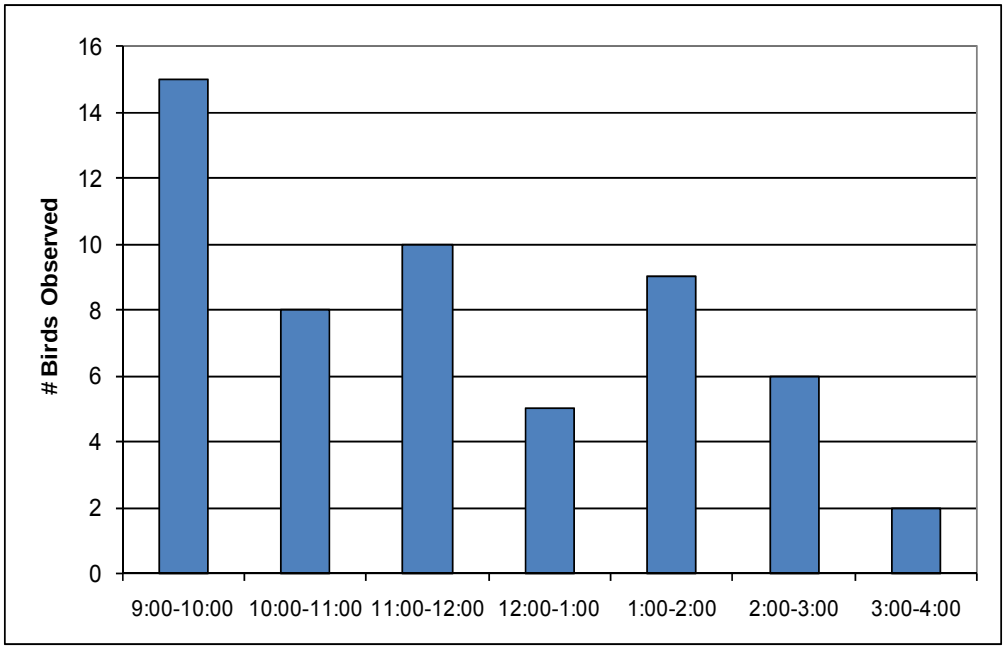


Figure 4-4. Number of observations of raptors per survey hour during Spring 2010 surveys at the Bull Hill Wind Project.

4.5.4 Raptor locations

Of the 55 total raptor observations made within the study area, 27 percent (n=15) occurred specifically within the Project area (Figure 4-5; Appendix C Table 3). Of the raptor observations within the Project area, all observations (n=15) occurred over Bull Hill (Figure 4-5; Appendix C Table 3).

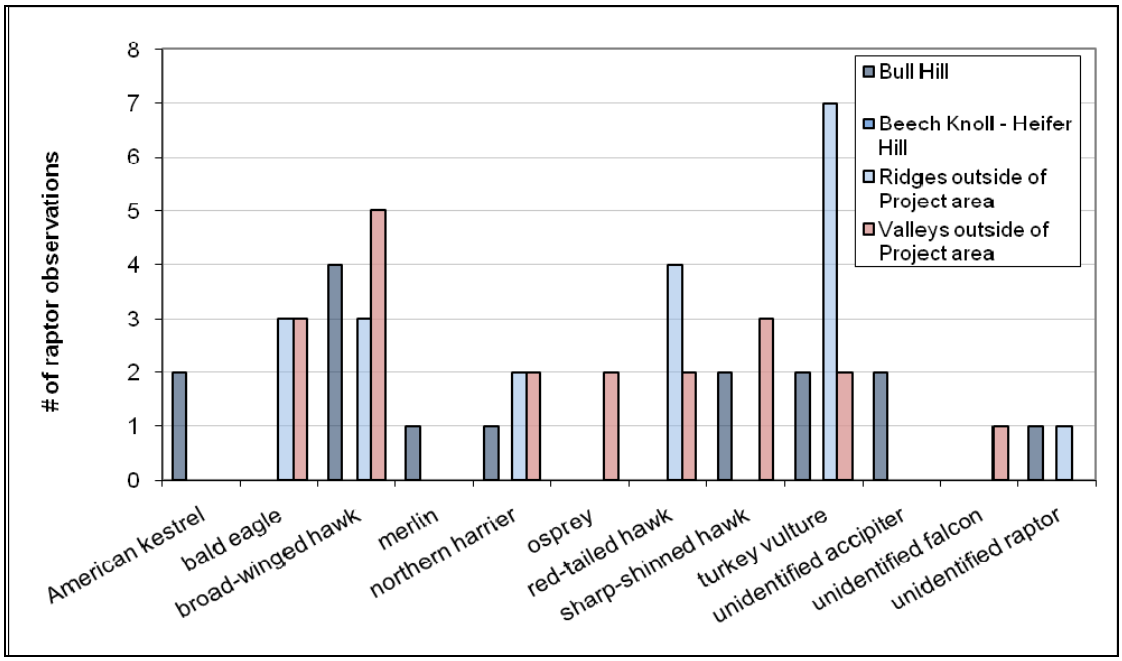
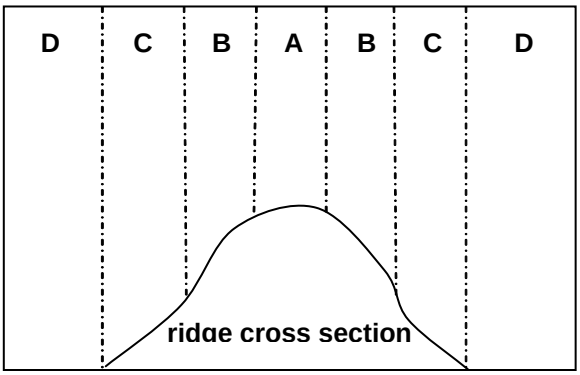


Figure 4-5. Number of observations of raptor species within different study area location categories during Spring 2010 surveys at Bull Hill Wind Project.

4.5.5 Raptor behaviors

Raptor behaviors observed in the topographical positions of the different study area location categories are summarized in Table 4-2. Note that there are more behavior observations than there were total raptors observed because some raptors exhibited multiple behaviors while passing through multiple topographical positions in the study area.



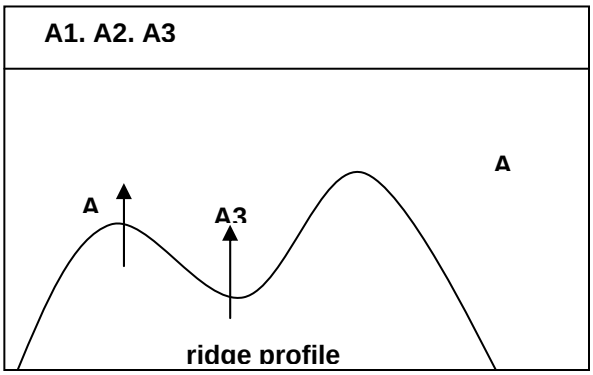


Table 4-2. Raptor behaviors summarized by location in study area and flight position during Spring 2010 at the Bull Hill Wind Project

Location in Study Area	Behavior	Soaring, Gliding						Powered Flight						Foraging Behaviors						Territorial or Courtship Behavior						Perched					
	Flight position where behavior observed	A1	A2	A3	B	C	D	A1	A2	A3	B	C	D	A1	A2	A3	B	C	D	A1	A2	A3	B	C	D	A1	A2	A3	B	C	D
	Bull Hill	7	0	0	3	2	2	5	1	0	3	2	0	2	0	0	1	0	0	2	0	0	0	0	0	2	0	0	0	0	0
	Little Bull Hill	2	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sparrow Hill	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Valley	1	0	0	6	8	14	0	0	0	3	2	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total behavior obs = 79	**11**	**1**	**0**	**10**	**10**	**17**	**5**	**1**	**1**	**7**	**4**	**3**	**3**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**

Raptors were considered actively migrating if their flight path was generally direct and in a northerly direction. Raptors were suspected to be stop-over or seasonally local birds if they were traveling in a non-direct manner and in a non-migratory direction, or if they exhibited perched or foraging flight behaviors. The raptors suspected to be actively migrating or not actively migrating are summarized in Table 4-3. Twenty-nine percent (n=16) of raptors observed during the spring 2010 surveys were suspected to be migrants based on the direction which they were flying (e.g. generally northward) and their flight behavior (i.e. powered flight). The majority of turkey vultures, the species most frequently observed during the surveys, were not actively migrating.

Table 4-3. Observations of raptors suspected to be actively migrating during Spring 2010 at the Bull Hill Wind Project

Species	actively migrating	not actively migrating	unknown
American kestrel	2	0	0
bald eagle	0	5	1
broad-winged hawk	8	4	0
merlin	0	1	0
northern harrier	1	4	0
osprey	0	2	0
red-tailed hawk	0	5	1
sharp-shinned hawk	2	2	1
turkey vulture	2	5	4
unidentified accipiter	0	0	2
unidentified falcon	1	0	0
unidentified raptor	0	1	1
Season Totals:	**16**	**29**	**10**

4.5.6 Flight heights

The average minimum flight heights of birds observed in the different topographical positions of the study area are summarized in Table 4-4 below.

Table 4-4. Number of observations and average flight heights for each position category for birds observed during Spring 2010 at the Bull Hill Wind Project

	A1) flight along or parallel to ridge	A2) crossed ridge	A3) flight crossed depression or saddle	B) upper slope	C) lower slope	D) over valley
No. of position observations (N=62)	11	4	3	14	11	19
Average minimum flight height (m)	57	86	150	74	36	225

Of the 55 raptor observations that occurred within the study area, 72 percent (n=40) were outside the project area. The remaining 15 observations took place in the Project area along ridges where turbines may be sited. Within these positions (flight positions A, B, and C), all (n=15; 100%) of observed flight heights occurred below the proposed maximum turbine height of 145 m for at least of portion of their flight (Figure 4-6; Appendix C Table 4).

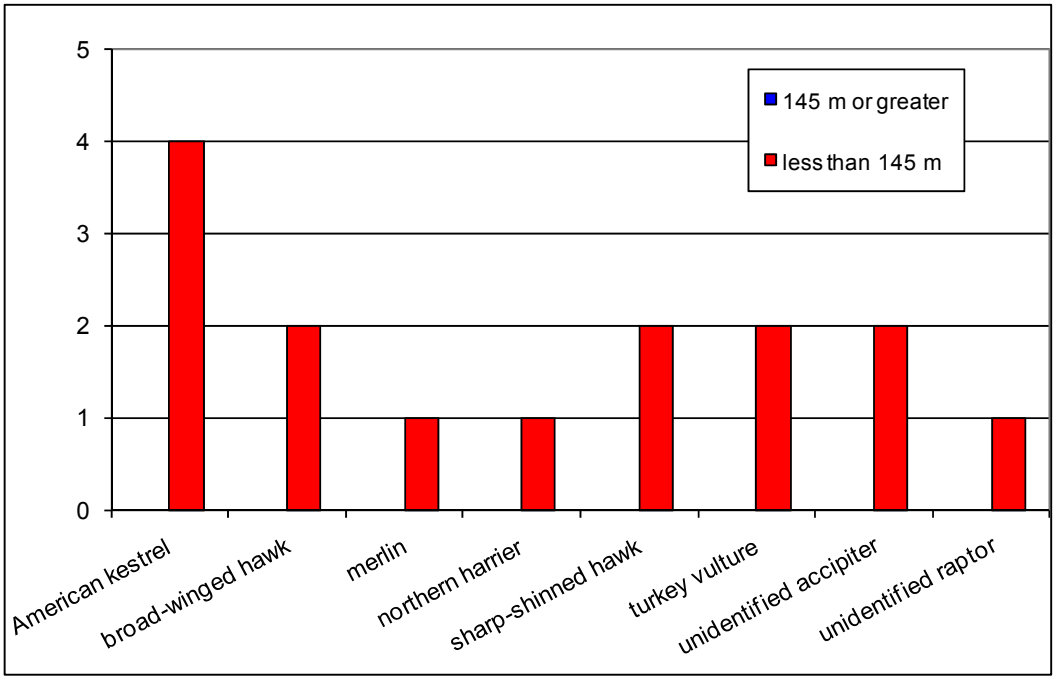


Figure 4-6. Number of observations of raptor species observed within Project area at heights above and below 145 m during Spring 2010 surveys at Bull Hill Wind Project.

4.6 SPECIAL CONCERN SPECIES

No state or federally endangered or threatened raptor species were observed during the surveys. Two raptor species of special concern were observed during both survey seasons: bald eagle and northern harrier. Two other species of interest were observed during the spring 2010 surveys: great blue heron (special concern) and osprey.

Five bald eagle observations were made during winter 2010 survey and one bald eagle observation was made during the spring raptor survey (additionally, one incidental bald eagle observation was made on the same day as the raptor survey, but outside the survey hours and outside the Project area). All eagle observations occurred outside the Project area. Four bald eagle observations occurred on one survey day in early spring (March 19): two adult eagles were observed in the same vicinity on two occasions at locations outside of the Project area, including a known nest location on Crimmins Island on Molasses Pond. On April 6, an adult eagle was seen as it was chased by a red-tailed hawk to the southwest of Sparrow Hill. On May 4, an adult eagle was seen soaring west high over Spectacle Pond.

Five northern harrier observations were made during spring 2010 raptor surveys, one of which occurred over Bull Hill within the Project area. On April 23, an adult female harrier was observed hunting a snake on the ground just outside the Project area on Bull Hill, then flew out over Little Bull Hill toward the Oxbow Heath. A second adult female, possibly the same individual was seen later that day crossing Little Bull Hill and roughly following the lakeshore to

the west. On May 4, a harrier was seen flying east over Spectacle Pond. On May 5, a harrier was seen flying in the Oxbow Heath vicinity and a second harrier—the only harrier seen in the Project area—was observed flying just over the treetops on the ridge of Bull Hill, flapping southeast, then back to the northwest.

There were two osprey observed on May 12 from Bull Hill: the birds were seen over valleys outside of the Project area. One great blue heron was observed outside of the Project area on May 5 flying southwest between Bull Hill and Little Bull Hill toward the French's Dam Meadow.

4.7 INCIDENTAL NON-RAPTOR OBSERVATIONS

Forty-five non-raptor avian species were observed incidentally during the winter and spring 2010 raptor surveys in the Project area, specifically within the viewshed shown on Figure 1-1. All non-raptor species identified by the observer were recorded on a separate datasheet. Passerine species were listed at the time they were seen or heard. Data were recorded for any waterbird seen or heard including the time it was observed, flight height, direction of flight, and location in the Project area. Among these species, six species are listed as state special concern: American redstart (*Setophaga ruticilla*), barn swallow (*Hirundo rustica*), black-and-white warbler (*Mniotilta varia*), chestnut-sided warbler (*Dendroica pensylvanica*), great blue heron (*Ardea herodias*), and white-throated sparrow (*Zonotrichia albicollis*) (Table 4-5).

Table 4-5. Non-raptor avian species observed incidentally during Spring 2010 raptor migration surveys at the Bull Hill Wind Project

Common Name	Scientific Name	Special Concern
Acadian flycatcher	*Empidonax virescens*	
American crow	*Corvus brachyrhynchos*	
American goldfinch	*Spinus tristis*	
American redstart	*Setophaga ruticilla*	Y
American robin	*Turdus migratorius*	
American woodcock	*Scolopax minor*	
barn swallow	*Hirundo rustica*	Y
black-and-white warbler	*Mniotilta varia*	Y
black-capped chickadee	*Poecile atricapillus*	
black-throated blue warbler	*Dendroica caerulescens*	
black-throated green warbler	*Dendroica virens*	
blue jay	*Cyanocitta cristata*	
blue-headed vireo	*Vireo solitarius*	
brown creeper	*Certhia americana*	
Canada goose	*Branta canadensis*	
chestnut-sided warbler	*Dendroica pensylvanica*	Y
common loon	*Gavia immer*	
common raven	*Corvus corax*	
common yellowthroat	*Geothlypis trichas*	
dark-eyed junco	*Junco hyemalis*	
downy woodpecker	*Picoides pubescens*	
eastern phoebe	*Sayornis phoebe*	
golden-crowned kinglet	*Regulus satrapa*	
great blue heron	*Ardea herodias*	Y
hairy woodpecker	*Picoides villosus*	
hermit thrush	*Catharus guttatus*	
herring gull	*Larus argentatus*	
house finch	*Carpodacus mexicanus*	
magnolia warbler	*Dendroica magnolia*	
mourning dove	*Zenaida macroura*	
northern flicker	*Colaptes auratus*	
ovenbird	*Seiurus aurocapilla*	
palm warbler	*Dendroica palmarum*	
pileated woodpecker	*Dryocopus pileatus*	
pine warbler	*Dendroica pinus*	
purple finch	*Carpodacus purpureus*	
ruby-crowned kinglet	*Regulus calendula*	
ruby-throated hummingbird	*Archilochus colubris*	
ruffed grouse	*Bonasa umbellus*	
song sparrow	*Melospiza melodia*	
unidentified gull	n/a	
unidentified passerines	n/a	
unidentified waterfowl	n/a	
white-breasted nuthatch	*Sitta carolinensis*	
white-throated sparrow	*Zonotrichia albicollis*	Y
wild turkey	*Meleagris gallopavo*	
winter wren	*Troglodytes troglodytes*	
yellow-rumped warbler	*Dendroica coronata*	

4.8 DISCUSSION

Of the 55 raptor observations made in the study area during the spring 2010 surveys, 27 percent of these observations occurred within the Project area. Of these birds within the Project area, all (100%) occurred over or along Bull Hill (where one of the two observation locations was positioned). It should be noted that the locations where raptors were observed in the study area are subject to observer bias. In general, birds in closer vicinity to the observer would be more visible to the observer than birds that occur at greater distances from the observer; whereas birds that traveled outside of the observer's view shed would have gone undetected. In this case, the fact that more raptor observations were made over Bull Hill than over the Beech Knoll/Heifer Hill area may be due to the fact that the raptor survey location was on Bull Hill, and observers more readily focused on raptors flying over this ridge.

The three winter survey days conducted at Sparrow Hill documented five bald eagle observations in the vicinity of Molasses Pond, none of which occurred within the Project area. The two spring aerial bald eagle nest surveys did not reveal any active nests in the Project area at the time of the surveys.

The survey effort and results of regional spring 2010 HMANA raptor surveys are available in Appendix C Table 5. The passage rate at the Project is lower than the rates reported at regional HMANA locations in Maine, New Hampshire, and Massachusetts. It should be noted that, when comparing the results of the Bull Hill surveys to the HMANA surveys, HMANA surveys typically do not count birds that are not actively migrating. The observations in this report are more inclusive, counting both migrating and non-migrating raptors. The Bull Hill passage rate for migrants only (0.25 raptors/hour) is considerably lower than the results at the other HMANA survey locations.

Raptor migration in the spring is most intense during the approach of a low pressure system and a cold front, and on days with southerly winds and rising air temperatures (Drennan 1981). Accordingly, days with the highest passage rates at the Project during the spring 2010 surveys occurred in early May during approaching and passing low pressure systems.

The flight paths of raptors observed at the Project varied between survey dates and were influenced by varying wind direction and weather. During raptor migration, flight pathways and flight heights along ridges, side slopes, and across valleys may vary seasonally, daily, or hourly. Raptors may shift and use different ridgelines and cross different valleys from year to year or season to season. Weather and wind are major factors that influence migration paths as well as flight heights. Wind strongly affects the propensity of raptors to congregate along 'leading lines' or topographic features (Richardson 1998). Wind, air temperature, and cloud cover influence the development of updrafts and thermals used by raptors while making long-distance flights.

The behaviors and flight heights of raptors observed in the different topographical positions of the study area were typical of actively migrating raptors as well as non-migrant raptors traveling between locations in the general area. Raptors observed were primarily commuting between resources in the area; few foraging behaviors were seen during the spring 2010 surveys.

Variations in flight heights among sites, and among survey days at a single site, are due to variable weather conditions and the particular flight behaviors of different raptor species. Typically, *accipiters* and falcons use up-drafts from side slopes to gain lift and, therefore, usually fly low over ridgelines. *Buteos* tend to use lift from thermals that develop over side slopes and valleys and tend to fly high during hours of peak thermal development. Raptors (*accipiters* in particular) typically fly lower than usual during windy or inclement conditions. Local birds may fly at lower altitudes while making small scale movements between foraging locations (Barrios and Rodriguez 2004). The relatively low average flight heights recorded at the Project may be due to the fact that more raptors at the Project were suspected to be local or commuting between resources rather than migrating.

Pre-construction raptor studies can provide baseline data regarding the species of raptor that occur in the study area and their general flight behaviors. At the Project, the number of raptors observed and the passage rates are comparable with, or below, those results documented at other raptor studies in the region (Appendix C Table 5).

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Appendix A

Radar survey results

Appendix A Table 1. Survey dates, results, level of effort, and weather - Spring 2010						
Date	**Sunset**	**Sunrise**	**Passage rate**	**Flight Direction**	**Flight Height (m)**	**% below 145 m**
4/20	19:23	5:40	453	62	163	55%
4/21	19:25	5:38	334	24	401	20%
4/22	19:26	5:37	528	32	357	33%
4/29	19:34	5:26	200	51	165	74%
4/30	19:36	5:24	879	38	164	68%
5/3	19:39	5:20	399	54	151	59%
5/4	19:41	5:19	646	35	177	54%
5/5	19:42	5:17	360	12	314	22%
5/6	19:43	5:16	350	57	158	56%
5/10	19:48	5:11	43	349	106	82%
5/11	19:49	5:10	747	50	220	35%
5/12	19:50	5:08	300	74	100	79%
5/13	19:51	5:07	383	63	115	79%
5/14	19:52	5:06	210	22	240	29%
5/18	19:57	5:02	421	68	216	35%
5/20	19:59	5:00	323	66	150	67%
5/21	20:00	4:59	546	49	319	24%
5/22	20:01	4:58	179	59	355	20%
5/23	20:02	4:57	117	53	309	19%
5/24	20:03	4:57	325	54	178	52%
Entire Season			**387**	**48**	**218**	**38%**

Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.														
Night of	Passage Rate (targets/km/hr) by hour after sunset										Entire Night			
	1	2	3	4	5	6	7	8	9	10	Mean	Median	Stdev	SE
4/20	289	450	9	900	668	718	525	461	279	229	453	455	264	83
4/21	511	350	207	211	411	407	311	254	271	407	334	330	100	32
4/22	393	575	739	1032	886	686	314	250	175	229	528	484	300	95
4/29	104	171	171	164	229	214	304	189	250	N/A	200	189	58	19
4/30	439	593	796	1057	1029	1050	1045	1018	882	N/A	879	1018	227	76
5/3	43	239	446	668	561	421	418	436	361	N/A	399	421	179	60
5/4	404	1486	971	911	629	657	279	239	239	N/A	646	629	419	140
5/5	200	336	475	279	264	318	464	450	457	N/A	360	336	103	34
5/6	125	357	446	414	479	446	382	336	164	N/A	350	382	125	42
5/10	75	0	29	50	18	25	14	14	161	N/A	43	25	49	16
5/11	107	371	821	739	1429	1104	914	643	596	N/A	747	739	389	130
5/12	146	500	336	311	279	229	282	350	264	N/A	300	282	97	32
5/13	11	393	464	629	789	593	289	204	71	N/A	383	393	263	88
5/14	96	221	257	171	193	143	182	343	479	16	210	188	129	41
5/18	89	343	446	579	489	739	543	357	204	N/A	421	446	198	66
5/20	46	232	475	514	482	375	336	407	43	N/A	323	375	180	60
5/21	136	364	364	696	811	875	725	593	346	N/A	546	593	252	84
5/22	104	300	382	275	268	125	46	79	29	N/A	179	125	128	43
5/23	43	325	157	193	107	89	36	57	50	N/A	117	89	95	32
5/24	118	257	314	375	396	436	354	393	283	N/A	325	354	97	32
Entire Season	**174**	**393**	**415**	**508**	**521**	**483**	**388**	**354**	**280**	**220**	**387**	**339**	**282**	**21**
0 indicates no targets counted for that hour										N/A indicates no data for that hour				

Appendix A Table 3. Mean Nightly Flight Direction		
Night of	**Mean Flight Direction**	**Circular Stdev**
4/20	62	39
4/21	24	59
4/22	32	77
4/29	51	42
4/30	38	40
5/3	54	35
5/4	35	43
5/5	12	58
5/6	57	41
5/10	349	113
5/11	50	36
5/12	74	46
5/13	63	30
5/14	22	47
5/18	68	53
5/20	66	47
5/21	49	31
5/22	59	58
5/23	53	53
5/24	54	44
Entire Season	**48**	**49**

Appendix A Table 4. Summary of mean flight heights by hour, night, and for entire season.

Night of	Mean Flight Height (m) by hour after sunset														% of targets below 145 meters
	1	2	3	4	5	6	7	8	9	10	Mean	Median	STDV	SE	
4/20	137	187	151	172	161	177	166	166	143	167	163	166	15	5	55%
4/21	203	384	9	408	518	500	451	383	Rain	363	358	384	160	53	20%
4/22	279	441	523	348	389	321	467	334	290	176	357	341	102	32	33%
4/29	552	165	127	134	98	106	94	108	102	N/A	165	108	147	49	74%
4/30	111	256	306	215	191	129	95	92	80	N/A	164	129	81	27	68%
5/3	136	166	175	154	180	132	145	125	150	N/A	151	150	19	6	59%
5/4	209	222	195	163	166	151	179	172	141	N/A	177	172	27	9	54%
5/5	211	261	307	345	334	320	387	353	312	N/A	314	320	52	17	22%
5/6	186	288	203	191	162	128	103	85	75	N/A	158	162	68	23	56%
5/10	63	78	131	179	76	165	--	96	61	N/A	106	87	46	16	82%
5/11	138	287	189	180	184	227	255	277	246	N/A	220	227	50	17	35%
5/12	142	155	101	92	96	77	64	82	89	N/A	100	92	30	10	79%
5/13	101	136	103	125	96	72	113	111	177	N/A	115	111	30	10	79%
5/14	181	269	221	244	263	261	299	215	205	N/A	240	244	37	12	29%
5/18	168	342	260	234	200	136	196	249	160	N/A	216	200	63	21	35%
5/20	148	169	191	126	134	119	144	114	202	N/A	150	144	31	10	67%
5/21	171	290	268	260	308	368	349	387	468	N/A	319	308	86	29	24%
5/22	331	455	424	368	331	362	350	293	280	N/A	355	350	57	19	20%
5/23	263	366	426	352	347	277	281	252	217	N/A	309	281	67	22	19%
5/24	160	218	191	164	154	148	187	165	216	N/A	178	165	26	9	52%
Entire Season	**195**	**257**	**246**	**223**	**219**	**209**	**228**	**203**	**190**	**213**	**217**	**186**	**109**	**8**	**38%**

-- indicates no targets counted for that hour N/A indicates no data for that hour

Appendix A Table 5. Summary of available avian spring radar survey results conducted at proposed (pre-construction) US wind power facilities in eastern US, using X-band mobile radar systems (2004-present)

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	(Turbine Ht) % Targets Below Turbine Height	Reference
Spring 2005									
Ellenberg, Clinton Cty, NY	40	n/a	Great Lakes plain/ADK foothills	110	n/a	30	338	(125 m) 20%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Sheldon, Wyoming Cty, NY	38	272	Agricultural plateau	112	6-558	25	422	(120 m) 6%	Woodlot Alternatives, Inc. 2006. A Spring 2005 Radar Survey of Bird Migration at the Proposed High Sheldon Wind Project in Sheldon, New York. Prepared for Invenergy.
Munnsville, Madison Cty, NY	41	388	Agricultural plateau	160	6-1065	31	291	(118 m) 25%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Munnsville Wind Project in Munnsville, New York. Prepared for AES-EHN NY Wind, LLC.
Sheffield, Caledonia Cty, VT	20	180	Forested ridge	166	12-440	40	552	(125 m) 6%	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
Stamford, Delaware Cty, NY	35	301	Forested ridge	210	10-785	46	431	(110 m) 8%	Woodlot Alternatives, Inc. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
Churubusco, Clinton Cty, NY	39	310	Great Lakes plain/ADK foothills	254	3-728	40	422	(120 m) 11%	Woodlot Alternatives, Inc. 2005. A Spring Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Marble River Wind Project in Clinton and Ellenburg, New York. Prepared for AES Corporation.
Prattsburgh, Steuben Cty, NY	20	183	Agricultural plateau	277	70-621	22	370	(125 m) 16%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windfarm Prattsburgh Project in Prattsburgh, New York. Prepared for UPC Wind Management, LLC.
Deerfield, Bennington Cty, VT	20	183	Forested ridge	404	74-973	69	523	(100 m) 4%	Woodlot Alternatives, Inc. 2005. Spring 2005 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
Jordanville, Herkimer Cty, NY	40	364	Agricultural plateau	409	26-1410	40	371	(125 m) 21%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar and Acoustic Survey of Bird and Bat Migration at the Proposed Jordanville Wind Project in Jordanville, New York. Prepared for Community Energy, Inc.
Franklin, Pendleton Cty, NY	21	204	Forested ridge	457	34-1240	53	492	(125 m) 11%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar and Acoustic Survey of Bird and Bat Migration at the Proposed Liberty Gap Wind Project in Franklin, West Virginia. Prepared for US Wind Force, LLC.
Clayton, Jefferson Cty, NY	36	303	Agricultural plateau	460	71-1769	30	443	(150 m) 14%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Clayton Wind Project in Clayton, New York. Prepared for PPM Atlantic Renewable.
Dans Mountain, Allegany Cty, MD	23	189	Forested ridge	493	63-1388	38	541	(125 m) 15%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Dan's Mountain Wind Project in Frostburg, Maryland. Prepared for US Wind Force.
Fairfield, Herkimer Cty, NY	40	369	Agricultural plateau	509	80-1175	44	419	(145 m) 16% [1]	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar Survey of Bird and Bat Migration at the Proposed Top Notch Wind Project in Fairfield, New York. Prepared for PPM Atlantic Renewable.
Spring 2006									
Kibby, Franklin Cty, ME (Range 1)	10	80	Forested ridge	197	6-471	50	412	(120 m) 22%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Deerfield, Bennington Cty, VT	26	236	Forested ridge	263	5-934	58	435	(100 m) 11%	Woodlot Alternatives, Inc. 2006. Spring 2006 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
Centerville, Allegany Cty, NY	42	n/a	Agricultural plateau	290	25-1140	22	351	(125 m) 16%	Mabee, T.J., J.H. Plissner, and B.A. Cooper. 2006a. A Radar and Visual Study of Nocturnal Bird and Bat Migration at the Proposed Centerville and Wethersfield Windparks, New York, Spring 2006. Report prepared for Ecology and Environment, LLC and Noble Environmental Power, LLC. July 2006.
Wethersfield, Wyoming Cty, NY	44	n/a	Agricultural plateau	324	41-907	12	355	(125 m) 19%	Mabee, T.J., J.H. Plissner, and B.A. Cooper. 2006a. A Radar and Visual Study of Nocturnal Bird and Bat Migration at the Proposed Centerville and Wethersfield Windparks, New York, Spring 2006. Report prepared for Ecology and Environment, LLC and Noble Environmental Power, LLC. July 2006.
Mars Hill, Aroostook Cty, ME	15	85	Forested ridge	338	76-674	58	384	(120 m) 14%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Radar, Visual, and Acoustic Survey of Bird Migration at the Mars Hill Wind Farm in Mars Hill, Maine. Prepared for Evergreen Windpower, LLC.
Chateaugay, Franklin Cty, NY	35	300	Agricultural plateau	360	54-892	48	409	(120 m) 18%	Woodlot Alternatives, Inc. 2006. Spring 2006 Radar Surveys at the Proposed Chateaugay Windpark in Chateaugay, New York. Prepared for Ecology and Environment, Inc. and Noble Power, LLC.
Howard, Steuben Cty, NY	42	440	Agricultural plateau	440	35-2270	27	426	(125 m) 13%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Howard Wind Power Project in Howard, New York. Prepared for Everpower Global.
Kibby, Franklin Cty, ME (Valley)	2	14	Forested ridge	443	45-1242	61	334	(120 m) n/a	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Kibby, Franklin Cty, ME (Mountain)	6	33	Forested ridge	456	88-1500	67	368	(120 m) 14%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Kibby, Franklin Cty, ME (Range 2)	7	57	Forested ridge	512	18-757	86	378	(120 m) 25%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Spring 2007									
Stetson, Washington Cty, ME	21	138	Forested ridge	147	3-434	55	210	(120 m) 22%	Woodlot Alternatives, Inc. 2007. A Spring 2007 Survey of Bird and Bat Migration at the Stetson Wind Project, Washington County, Maine. Prepared for Evergreen Wind V, LLC.
Cape Vincent, Jefferson Cty, NY	50	300	Great Lakes plain	166	n/a	34	441	(125 m) 14%	Western EcoSystems Technology, Inc. (WEST). 2007. Avian and Bat Studies for the Proposed Cape Vincent Wind Power Project, Jefferson County, NY. Prepared for BP Alternative Energy North America.
New Grange, Chautauqua Cty, NY	41	n/a	Great Lakes plain	175	n/a	18	450	(125 m) 13%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Laurel Mountain, Barbour Cty, WV	20	197	Forested ridge	277	13-646	27	533	(130 m) 3%	Stantec Consulting Services Inc. 2007. A Spring 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Laurel Mountain Wind Energy Project near Elkins, West Virginia. Prepared for AES Laurel Mountain, LLC.
Errol, Coos County, NH	30	212	Forested ridge	342	2 to 870	76	332	(125 m) 14%	Stantec Consulting Inc. 2007. Spring 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windpark in Coos County, New Hampshire by Granite Reliable Power, LLC. Prepared for Granite Reliable Power, LLC.
Villenova, Chautauqua Cty, NY	40	n/a	Great Lakes plain	419	22-1190	10	493	(120 m) 3%	Stantec Consulting Services Inc. 2008. A Spring 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Ball Hill Windpark in Villenova and Hanover, New York. Prepared for Noble Environmental Power, LLC and Ecology and Environment.
Roxbury, Oxford Cty, ME	20	n/a	Forested ridge	539	137-1256	52	312	(130) 18%	Woodlot Alternatives, Inc. 2007. A Spring 2007 Survey of Bird and Bat Migration at the Record Hill Wind Project, Roxbury, Maine. Prepared for Roxbury Hill Wind LLC.
Lempster, Sullivan Cty, NH	30	277	Forested ridge	542	49-1094	49	358	(125 m) 18%	Woodlot Alternatives, Inc. 2007.A Spring 2007 Survey of Nocturnal Bird Migration, Breeding Birds, and Bicknell's Thrush at the Proposed Lempster Mountain Wind Power Project Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
Spring 2008									
Lincoln, Penobscot Cty, ME	20	189	Forested ridge	247	40-766	75	316	(120 m) 13%	Stantec Consulting Services Inc. 2008.A Spring 2008 Survey of Bird and Bat Migration at the Rollins Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
Allegany, Cattaraugus Cty, NY	30	275	Forested ridge	268	53-755	18	316	(150 m) 19%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Oakfield, Penobscot Cty, ME	20	194	Forested ridge	498	132-899	33	276	(120 m) 21%	Stantec Consulting Services Inc. 2008.A Spring 2008 Survey of Bird and Bat Migration at the Oakfield Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
Hounsfield, Jefferson Cty, NY	42	379	Great Lakes island	624	74-1630	51	319	(125 m) 19%	Stantec Consulting Services Inc. 2008. A Spring 2008 Survey of Bird Migration at the Hounsfield Wind Project, New York. Prepared for American Consulting Professionals of New York, PLLC.
New Creek, Grant Cty, WV	20	n/a	Forested ridge	1020	289-2610	30	354	(130 m) 13%	Stantec Consulting Services Inc. 2008. A Spring 2008 Survey of Bird Migration at the New Creek Wind Project, West Virginia. Prepared for AES New Creek, LLC.
Tenney, Grafton Cty, NH	40	373	Forested ridge	234	35-549	77	321	(125m) 12%	Stantec Consulting Services Inc. 2008. Spring 2008 Radar Survey Report for the Groton Wind Project. Prepared for Groton Wind, LLC.
Rollins, Penobscot Cty, ME	20	189	Forested ridge	247	40 - 766	75	316	(120 m) 13%	Stantec Consulting. 2008. Spring 2008 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for First Wind, LLC.
Spring 2009									
Sisk (Kibby Expansion), Franklin Cty, ME	21	193	Forested ridge	207	50-452	28	293	(125m) 18%	Stantec Consulting Services Inc. 2009. Spring 2009 Nocturnal Migration Survey Report for the Kibby Expansion Wind Project. Prepared for TRC Engineers LLC.
Vermont Community Wind Farm, Orleans Cty, VT	15	90	Forested ridge	435	49-771	48	320	(130m) 22%	Stantec Consulting Services Inc. 2009. Spring and Summer 2009 Bird and Bat Survey Report. Prepared for Vermont Community Wind Farm, LLC.
Moresville, Delaware Cty, NY	30	275	Forested ridge	230	30-575	53	314	(125m)12%	Stantec Consulting Services Inc. 2009. 2009 Spring Nocturnal Radar Survey Report for the Moresville Energy Center. Prepared for Moresville Energy LLC.
Highland, Somerset Cty, ME (location 1)	21	192	Forested ridge	496	10-1262	47	287	(130.5m) 26%	Stantec Consulting Services Inc. 2009. Spring 2009 Ecological Surveys for the Highland Wind Project. Prepared for Highland Wind LLC
Highland, Somerset Cty, ME (location 2)	19	161	Forested ridge	511	8-1735	53	314	(130.5m) 23%	Stantec Consulting Services Inc. 2009. Spring 2009 Ecological Surveys for the Highland Wind Project. Prepared for Highland Wind LLC

Note:

[1] The percent targets below turbine height can be found in the addendum to the report "Effect of Top Notch (now Hardscrabble) Wind Project revision to turbine layout and model changes on the spring and fall 2005 nocturnal radar survey reports." Prepared August 26, 2009, by Stantec Consulting Services Inc.

Appendix B

Bat survey results

Appendix B Table 1. Summary of acoustic bat data and weather during each survey night at the Bull Hill Met High detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	1												0		
4/16/10	1												0		
4/17/10	0												0		
4/18/10	0												0		
4/19/10	0												0		
4/20/10	0												0		
4/21/10	0												0		
4/22/10	0												0		
4/23/10	0												0		
4/24/10	0												0		
4/25/10	0												0		
4/26/10	0												0		
4/27/10	1												0		
4/28/10	1									3			3		
4/29/10	1												0		
4/30/10	1												0		
5/1/10	1												0		
5/2/10	1			1									1		
5/3/10	1												0		
5/4/10	1												0		
5/5/10	1												0		
5/6/10	1												0		
5/7/10	1												0		
5/8/10	1												0		
5/9/10	1												0		
5/10/10	1												0		
5/11/10	1												0		
5/12/10	1												0		
5/13/10	1												0		
5/14/10	1												0		
5/15/10	1												0		
5/16/10	1												0		
5/17/10	1										1		1		
5/18/10	1												0		
5/19/10	1												0		
5/20/10	1												0		
5/21/10	1												0		
5/22/10	1												0		
5/23/10	1												0		
5/24/10	1										1		1		
5/25/10	1												0		
5/26/10	1									1			1		
5/27/10	1												0		
5/28/10	1												0		
5/29/10	1												0		
5/30/10	1												0		
5/31/10	1												0		
6/1/10	1												0		
6/2/10	1												0		
6/3/10	1												0		
6/4/10	1												0		
6/5/10	1												0		
6/6/10	1												0		
6/7/10	1												0		
6/8/10	1												0		
6/9/10	1												0		
6/10/10	1												0		
6/11/10	1												0		
6/12/10	1												0		
6/13/10	1												0		
6/14/10	1												0		
6/15/10	1					1							1		
6/16/10	1												0		
6/17/10	1												0		
6/18/10	1												0		
6/19/10	1												0		
6/20/10	1												0		
6/21/10	1												0		
6/22/10	1												0		
6/23/10	1												0		
6/24/10	1												0		
6/25/10	1												0		
6/26/10	1									1			1		
6/27/10	1												0		
6/28/10	1												0		
6/29/10	1												0		
6/30/10	1												0		
7/1/10	1												0		
7/2/10	1												0		
7/3/10	1												0		
7/4/10	1												0		
7/5/10	1												0		
7/6/10	1												0		
7/7/10	1												0		
7/8/10	1												0		
7/9/10	1												0		
7/10/10	1												0		
7/11/10	1												0		
7/12/10	1												0		
7/13/10	1												0		
7/14/10	1												0		
By Species		**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**5**	**2**	**0**	**9**		
By Guild		**1**			**0**	**1**	**0**			**7**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix B Table 2. Summary of acoustic bat data and weather during each survey night at the Bull Hill Met Low detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	0												**0**		
4/16/10	0												**0**		
4/17/10	0												**0**		
4/18/10	0												**0**		
4/19/10	0												**0**		
4/20/10	0												**0**		
4/21/10	0												**0**		
4/22/10	0												**0**		
4/23/10	0												**0**		
4/24/10	0												**0**		
4/25/10	0												**0**		
4/26/10	0												**0**		
4/27/10	1												**0**		
4/28/10	1												**0**		
4/29/10	1												**0**		
4/30/10	1												**0**		
5/1/10	1												**0**		
5/2/10	1					1				1	1		**3**		
5/3/10	1												**0**		
5/4/10	1												**0**		
5/5/10	1												**0**		
5/6/10	1										1		**1**		
5/7/10	1												**0**		
5/8/10	1												**0**		
5/9/10	1												**0**		
5/10/10	1												**0**		
5/11/10	1												**0**		
5/12/10	1												**0**		
5/13/10	1					1							**1**		
5/14/10	1												**0**		
5/15/10	1												**0**		
5/16/10	1					1				1			**2**		
5/17/10	1												**0**		
5/18/10	1												**0**		
5/19/10	1												**0**		
5/20/10	1					1							**1**		
5/21/10	1												**0**		
5/22/10	1												**0**		
5/23/10	1												**0**		
5/24/10	1												**0**		
5/25/10	1					2							**2**		
5/26/10	1												**0**		
5/27/10	1									2			**2**		
5/28/10	1												**0**		
5/29/10	1									2			**2**		
5/30/10	1									1			**1**		
5/31/10	1												**0**		
6/1/10	1					1							**1**		
6/2/10	1												**0**		
6/3/10	1												**0**		
6/4/10	1												**0**		
6/5/10	1												**0**		
6/6/10	1												**0**		
6/7/10	1	1											**1**		
6/8/10	1					1							**1**		
6/9/10	1												**0**		
6/10/10	1												**0**		
6/11/10	1												**0**		
6/12/10	1												**0**		
6/13/10	1									1			**1**		
6/14/10	1												**0**		
6/15/10	1					1							**1**		
6/16/10	1												**0**		
6/17/10	1												**0**		
6/18/10	1												**0**		
6/19/10	1												**0**		
6/20/10	1												**0**		
6/21/10	1												**0**		
6/22/10	1												**0**		
6/23/10	1												**0**		
6/24/10	1					1				1			**2**		
6/25/10	1									1			**1**		
6/26/10	1												**0**		
6/27/10	1												**0**		
6/28/10	1									1			**1**		
6/29/10	1												**0**		
6/30/10	1									1			**1**		
7/1/10	1									1			**1**		
7/2/10	1												**0**		
7/3/10	1									1			**1**		
7/4/10	1												**0**		
7/5/10	1									2			**2**		
7/6/10	1				2	2				2			**6**		
7/7/10	1									1			**1**		
7/8/10	1									3			**3**		
7/9/10	1												**0**		
7/10/10	1									4	1		**5**		
7/11/10	1									2			**2**		
7/12/10	1					1				1			**2**		
7/13/10	1												**0**		
7/14/10	1									7	1		**8**		
By Species		**1**	**0**	**0**	**2**	**13**	**0**	**0**	**0**	**36**	**4**	**0**	**56**		
By Guild		**1**			**2**	**13**	**0**			**40**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix B Table 3. Summary of acoustic bat data and weather during each survey night at the Bull Hill NE Tree detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	1					1							**1**		
4/16/10	1												**0**		
4/17/10	1												**0**		
4/18/10	1												**0**		
4/19/10	1												**0**		
4/20/10	1												**0**		
4/21/10	1					3							**3**		
4/22/10	1					1							**1**		
4/23/10	1					3							**3**		
4/24/10	1					2							**2**		
4/25/10	1					2							**2**		
4/26/10	1									2			**2**		
4/27/10	1					1							**1**		
4/28/10	1												**0**		
4/29/10	1												**0**		
4/30/10	1									1			**1**		
5/1/10	1					1							**1**		
5/2/10	1					11							**11**		
5/3/10	1									1			**1**		
5/4/10	1					1							**1**		
5/5/10	1									1			**1**		
5/6/10	1												**0**		
5/7/10	1												**0**		
5/8/10	1												**0**		
5/9/10	1												**0**		
5/10/10	1												**0**		
5/11/10	1												**0**		
5/12/10	1					1							**1**		
5/13/10	1	1				2				1			**4**		
5/14/10	1					2							**2**		
5/15/10	1					4							**4**		
5/16/10	1												**0**		
5/17/10	1												**0**		
5/18/10	1					2				1			**3**		
5/19/10	1												**0**		
5/20/10	1	1				11				1			**13**		
5/21/10	1					4				1			**5**		
5/22/10	1					2							**2**		
5/23/10	1					1							**1**		
5/24/10	1	4				9				2			**15**		
5/25/10	1		1			2							**3**		
5/26/10	1									3			**3**		
5/27/10	1					2							**2**		
5/28/10	1					1							**1**		
5/29/10	1					6				3			**9**		
5/30/10	1					5				3			**8**		
5/31/10	1					2				3			**5**		
6/1/10	1					2							**2**		
6/2/10	1					2				1			**3**		
6/3/10	1												**0**		
6/4/10	1					9				7			**16**		
6/5/10	1					3				1			**4**		
6/6/10	1												**0**		
6/7/10	1					2				2			**4**		
6/8/10	1					2				2			**4**		
6/9/10	1					14				5			**19**		
6/10/10	1					2				2			**4**		
6/11/10	1					6				6			**12**		
6/12/10	1					10				7			**17**		
6/13/10	1					5				7			**12**		
6/14/10	1												**0**		
6/15/10	1					3				3	1		**7**		
6/16/10	1					1				1			**2**		
6/17/10	1					5				5			**10**		
6/18/10	1					3				6			**9**		
6/19/10	1					1				1			**2**		
6/20/10	1				1	4				1			**6**		
6/21/10	1					1				1			**2**		
6/22/10	1					2				3			**5**		
6/23/10	1									17			**17**		
6/24/10	1					3				1	1	1	**6**		
6/25/10	1	4				6				13	2		**25**		
6/26/10	1					1				6			**7**		
6/27/10	1					10				14			**24**		
6/28/10	1	1			1	2				2			**6**		
6/29/10	1									4	2		**6**		
6/30/10	1					28				16			**44**		
7/1/10	1					1				1			**2**		
7/2/10	1	1				14				11			**26**		
7/3/10	1					24				97			**121**		
7/4/10	1					13				13			**26**		
7/5/10	1	1				12				13			**26**		
7/6/10	1					7				26			**33**		
7/7/10	1					6				13			**19**		
7/8/10	1					4				3			**7**		
7/9/10	1					1				1			**2**		
7/10/10	1	3				11				14			**28**		
7/11/10	1					9				4			**13**		
7/12/10	1	1				3				3			**7**		
7/13/10	1									1			**1**		
7/14/10	1					7				5	1		**13**		
By Species		**17**	**1**	**0**	**2**	**321**	**0**	**0**	**0**	**362**	**7**	**1**	**711**		
By Guild		**18**			**2**	**321**	**0**			**370**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix B Table 4. Summary of acoustic bat data and weather during each survey night at the Bull Hill Radar Tree detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	1												**0**		
4/16/10	1												**0**		
4/17/10	1												**0**		
4/18/10	1												**0**		
4/19/10	1												**0**		
4/20/10	1					1							**1**		
4/21/10	1					2							**2**		
4/22/10	1					1			1	1			**3**		
4/23/10	1					1							**1**		
4/24/10	1												**0**		
4/25/10	1					5							**5**		
4/26/10	1					4							**4**		
4/27/10	1												**0**		
4/28/10	1												**0**		
4/29/10	1												**0**		
4/30/10	1												**0**		
5/1/10	1					3							**3**		
5/2/10	1			1		4							**5**		
5/3/10	1												**0**		
5/4/10	1					4							**4**		
5/5/10	1					1							**1**		
5/6/10	1												**0**		
5/7/10	1									1			**1**		
5/8/10	1												**0**		
5/9/10	1									1			**1**		
5/10/10	1												**0**		
5/11/10	1					1				1	1		**3**		
5/12/10	1					5				1			**6**		
5/13/10	1					2							**2**		
5/14/10	1												**0**		
5/15/10	1					2				1			**3**		
5/16/10	1					2				1			**3**		
5/17/10	1									1			**1**		
5/18/10	1												**0**		
5/19/10	1												**0**		
5/20/10	1	1				17				1			**19**		
5/21/10	1					2				1			**3**		
5/22/10	1												**0**		
5/23/10	1					2							**2**		
5/24/10	1					1				2			**3**		
5/25/10	1				1	4				4			**9**		
5/26/10	1					2				1			**3**		
5/27/10	1												**0**		
5/28/10	1					1							**1**		
5/29/10	1					3				1			**4**		
5/30/10	1					4				1			**5**		
5/31/10	1					1							**1**		
6/1/10	1				1	9							**10**		
6/2/10	1												**0**		
6/3/10	1					3				2	1		**6**		
6/4/10	1					2				1			**3**		
6/5/10	1					2							**2**		
6/6/10	1				1								**1**		
6/7/10	1					2							**2**		
6/8/10	1					6				1			**7**		
6/9/10	1												**0**		
6/10/10	1				1	4				2			**7**		
6/11/10	1	1									2		**3**		
6/12/10	1					2				2			**4**		
6/13/10	1					6				3			**9**		
6/14/10	1					4							**4**		
6/15/10	1				2	2				7			**11**		
6/16/10	1									1			**1**		
6/17/10	1					9				1	2		**12**		
6/18/10	1					1							**1**		
6/19/10	1									1			**1**		
6/20/10	1					3			1	2			**6**		
6/21/10	1					10				5			**15**		
6/22/10	1												**0**		
6/23/10	1					1			2	2			**5**		
6/24/10	1					1				4			**5**		
6/25/10	1				1	55				46			**102**		
6/26/10	1					35				8			**43**		
6/27/10	1	2				21				7			**30**		
6/28/10	1					6			1	3			**10**		
6/29/10	1	1				17				5			**23**		
6/30/10	1					41			1	6			**48**		
7/1/10	1	1				3				2			**6**		
7/2/10	1	1				8				5			**14**		
7/3/10	1					7				2			**9**		
7/4/10	1	1				157				23			**181**		
7/5/10	1					1							**1**		
7/6/10	1	1				5				2			**8**		
7/7/10	1					1				2			**3**		
7/8/10	1					3				2			**5**		
7/9/10	1									1			**1**		
7/10/10	1	40				36				12			**88**		
7/11/10	1	58				13				9	1		**81**		
7/12/10	1	3				5			1	6			**15**		
7/13/10	1	24				4							**28**		
7/14/10	1	50	5			39				19			**113**		
By Species		**184**	**5**	**1**	**7**	**599**	**0**	**0**	**7**	**213**	**7**	**0**	**1023**		
By Guild		**190**			**7**	**599**	**7**			**220**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix B Table 5. Summary of acoustic bat data and weather during each survey night at the Bull Hill SE Tree detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	0												**0**		
4/16/10	0												**0**		
4/17/10	0												**0**		
4/18/10	0												**0**		
4/19/10	0												**0**		
4/20/10	0												**0**		
4/21/10	0												**0**		
4/22/10	0												**0**		
4/23/10	0												**0**		
4/24/10	0												**0**		
4/25/10	0												**0**		
4/26/10	0												**0**		
4/27/10	1												**0**		
4/28/10	0												**0**		
4/29/10	0												**0**		
4/30/10	0												**0**		
5/1/10	0												**0**		
5/2/10	0												**0**		
5/3/10	0												**0**		
5/4/10	0												**0**		
5/5/10	0												**0**		
5/6/10	0												**0**		
5/7/10	0												**0**		
5/8/10	0												**0**		
5/9/10	0												**0**		
5/10/10	1												**0**		
5/11/10	1									1			**1**		
5/12/10	1					5							**5**		
5/13/10	1					2				1			**3**		
5/14/10	1					3							**3**		
5/15/10	1					1				1			**2**		
5/16/10	1					1				2			**3**		
5/17/10	1					2							**2**		
5/18/10	1					1							**1**		
5/19/10	1												**0**		
5/20/10	1	1				1				1			**3**		
5/21/10	0												**0**		
5/22/10	0												**0**		
5/23/10	0												**0**		
5/24/10	0												**0**		
5/25/10	0												**0**		
5/26/10	0												**0**		
5/27/10	0												**0**		
5/28/10	0												**0**		
5/29/10	0												**0**		
5/30/10	0												**0**		
5/31/10	0												**0**		
6/1/10	0												**0**		
6/2/10	0												**0**		
6/3/10	0												**0**		
6/4/10	0												**0**		
6/5/10	0												**0**		
6/6/10	0												**0**		
6/7/10	0												**0**		
6/8/10	0												**0**		
6/9/10	0					2			1	3			**6**		
6/10/10	1					2				3			**5**		
6/11/10	1	2				1				3	1		**7**		
6/12/10	1				1	4				3			**8**		
6/13/10	1					4				12			**16**		
6/14/10	1	1				1				1			**3**		
6/15/10	1				1	1				1			**3**		
6/16/10	1					16				41			**57**		
6/17/10	1	1				3				6			**10**		
6/18/10	1					1				10			**11**		
6/19/10	1												**0**		
6/20/10	1												**0**		
6/21/10	1												**0**		
6/22/10	1												**0**		
6/23/10	1												**0**		
6/24/10	1	1			1	2				2			**6**		
6/25/10	1					1				5			**6**		
6/26/10	1	1				1				3			**5**		
6/27/10	1	1				4				6			**11**		
6/28/10	1					2							**2**		
6/29/10	1									1			**1**		
6/30/10	1	1											**1**		
7/1/10	1												**0**		
7/2/10	1	1								1	1		**3**		
7/3/10	1									3			**3**		
7/4/10	1		1							3			**4**		
7/5/10	1									3			**3**		
7/6/10	1					3				4			**7**		
7/7/10	1					1				1			**2**		
7/8/10	1									2			**2**		
7/9/10	1												**0**		
7/10/10	1					2				3			**5**		
7/11/10	1	3								6	1		**10**		
7/12/10	1		1			5				3			**9**		
7/13/10	1	2				2				3			**7**		
7/14/10	1	1				3				10			**14**		
By Species		**16**	**2**	**0**	**3**	**77**	**0**	**0**	**1**	**148**	**3**	**0**	**250**		
By Guild		**18**			**3**	**77**	**1**			**151**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix B Table 6. Summary of acoustic bat data and weather during each survey night at the Bull Hill SW Tree detector – Spring/Summer, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
4/15/10	0												**0**		
4/16/10	0												**0**		
4/17/10	0												**0**		
4/18/10	0												**0**		
4/19/10	0												**0**		
4/20/10	0												**0**		
4/21/10	0												**0**		
4/22/10	0												**0**		
4/23/10	0												**0**		
4/24/10	0												**0**		
4/25/10	0												**0**		
4/26/10	0												**0**		
4/27/10	0					3				1			**4**		
4/28/10	1												**0**		
4/29/10	1												**0**		
4/30/10	1					5				2			**7**		
5/1/10	1					2				3			**5**		
5/2/10	1					1							**1**		
5/3/10	1												**0**		
5/4/10	1					1				1			**2**		
5/5/10	1					1				1			**2**		
5/6/10	1					2							**2**		
5/7/10	1					1							**1**		
5/8/10	1												**0**		
5/9/10	1												**0**		
5/10/10	1												**0**		
5/11/10	1									1			**1**		
5/12/10	1					3							**3**		
5/13/10	1					4				2			**6**		
5/14/10	1					5				3			**8**		
5/15/10	1					2				2			**4**		
5/16/10	1					1				1	1		**3**		
5/17/10	1	1			1	2							**4**		
5/18/10	1					3				2			**5**		
5/19/10	1												**0**		
5/20/10	1	1			1	20				7			**29**		
5/21/10	1					3				1			**4**		
5/22/10	1			1		4				2			**7**		
5/23/10	1					2							**2**		
5/24/10	1					8				5			**13**		
5/25/10	1	1				11				9			**21**		
5/26/10	1					7				2			**9**		
5/27/10	1				2	2				1			**5**		
5/28/10	1					2							**2**		
5/29/10	1					2				13			**15**		
5/30/10	1				1	4				6	1		**12**		
5/31/10	1					8				6			**14**		
6/1/10	1					5				4			**9**		
6/2/10	1					6							**6**		
6/3/10	1					2				5			**7**		
6/4/10	1					2				4			**6**		
6/5/10	1					5				3			**8**		
6/6/10	1									1			**1**		
6/7/10	1					6				7	1		**14**		
6/8/10	1					2				6			**8**		
6/9/10	1	1				5				2			**8**		
6/10/10	1					2							**2**		
6/11/10	1				1	4							**5**		
6/12/10	1				1	7			2	12			**22**		
6/13/10	1					4			1	7			**12**		
6/14/10	1				4	1				1	1		**7**		
6/15/10	1					3				3			**6**		
6/16/10	1				2	1			1	3			**7**		
6/17/10	1	1				9				4			**14**		
6/18/10	1					10				2			**12**		
6/19/10	1					5				1			**6**		
6/20/10	1					3				3			**6**		
6/21/10	1				3	4				4			**11**		
6/22/10	1	2			6	18			1	6			**33**		
6/23/10	1				1	1				1			**3**		
6/24/10	1					5				1			**6**		
6/25/10	1				2	16							**18**		
6/26/10	1				1	9				1			**11**		
6/27/10	1	1			3	12				7			**23**		
6/28/10	1					10				1			**11**		
6/29/10	1	1				4							**5**		
6/30/10	1	2				2			1	3			**8**		
7/1/10	1					2				3			**5**		
7/2/10	1	1				5				5			**11**		
7/3/10	1	3				5				3			**11**		
7/4/10	1	3			1	10				1	1		**16**		
7/5/10	1	2				13				7			**22**		
7/6/10	1	1				11			1	8			**21**		
7/7/10	1	3				1				3			**7**		
7/8/10	1									2			**2**		
7/9/10	1									1			**1**		
7/10/10	1					14			1	8			**23**		
7/11/10	1	1				5			1	2			**9**		
7/12/10	1	7				6				4	2		**19**		
7/13/10	1					2				5			**7**		
7/14/10	1					7			1	6			**14**		
By Species		**32**	**0**	**1**	**30**	**353**	**0**	**0**	**10**	**221**	**7**	**0**	**654**		
By Guild		**33**			**30**	**353**	**10**			**228**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for the entire night; 0 = Non-operational for all or part of the night

Appendix C

Raptor Data Results

Appendix C Table 1. Daily total observations of raptor species and daily passage rates during Spring 2010 at the Bull Hill Wind Project

Species	3/19/2010	3/25/2010	4/6/2010	4/21/2010	4/22/2010	4/23/2010	4/29/2010	4/30/2010	5/4/2010	5/5/2010	5/12/2010	5/20/2010	5/21/2010	5/22/2010	5/23/2010	Entire Season
American kestrel									2							**2**
bald eagle	4		1						1							**6**
broad-winged hawk									2	9	1					**12**
merlin										1						**1**
northern harrier						2			1	2						**5**
osprey											2					**2**
red-tailed hawk	2	1	1				1				1					**6**
sharp-shinned hawk									1	2	1	1				**5**
turkey ulture v	1	1	2	1					2	1	3					**11**
unidentified accipiter											2					**2**
unidentified falcon									1							**1**
unidentified raptor								1						1		**2**
Daily Totals:	**7**	**2**	**4**	**1**	**0**	**2**	**1**	**1**	**10**	**15**	**10**	**1**	**0**	**1**	**0**	**55**

Appendix C Table 2. Hourly summary of raptor observations during Spring 2010 at the Bull Hill Wind Project

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	Grand Total
American kestrel	2							**2**
bald eagle		1	1		2	2		**6**
broad-winged hawk	8				3	1		**12**
merlin			1					**1**
northern harrier		2			1	1	1	**5**
osprey					2			**2**
red-tailed hawk		3	2				1	**6**
sharp-shinned hawk			4	1				**5**
turkey vulture	2	2	2	3	1	1		**11**
unidentified accipiter	2							**2**
unidentified falcon				1				**1**
unidentified raptor	1					1		**2**
Hourly totals	**15**	**8**	**10**	**5**	**9**	**6**	**2**	**55**

Appendix C Table 3. Total observations of raptor species at locations in the study area at the Bull Hill Wind Project, Spring 2010

	Inside Project area		Outside of Project area		
Species	**Bull Hill**	**Beech Knoll - Heifer Hill**	**Ridges**	**Valleys**	**TOTAL**
American kestrel	2	0	0	0	2
bald eagle	0	0	3	3	6
broad-winged hawk	4	0	3	5	12
merlin	1	0	0	0	1
northern harrier	1	0	2	2	5
osprey	0	0	0	2	2
red-tailed hawk	0	0	4	2	6
sharp-shinned hawk	2	0	0	3	5
turkey vulture	2	0	7	2	11
unidentified accipiter	2	0	0	0	2
unidentified falcon	0	0	0	1	1
unidentified raptor	1	0	1	0	2
Season Totals:	**15**	**0**	**20**	**20**	**55**

Appendix C Table 4. Number of individuals of species observed within Project boundary in proposed turbine areas (flight positions A, B, and C) above or below 145 m at the Bull Hill Wind Project, Spring 2010

Species	145 m or greater	less than 145 m	Total
American kestrel	0	4	4
broad-winged hawk	0	2	2
merlin	0	1	1
northern harrier	0	1	1
sharp-shinned hawk	0	2	2
turkey vulture	0	2	2
unidentified accipiter	0	2	2
unidentified raptor	0	1	1
Season Totals:	**0**	**15**	**15**

Appendix C Table 5. Summary of Regional Spring 2010 (March to May) Migration Surveys*

Site Number**	Location	Observation Hours	BV	TV	OS	BE	NH	SS	CH	NG	RS	BW	RT	RL	GE	AK	ML	PG	UA	UB	UF	UE	UR	MK	TOTAL	BIRDS/ HOUR
1	Bull Hill Wind Project; Washington County, Maine	104.25	0	11	2	6	5	5	0	0	0	12	6	0	0	2	1	0	2	0	1	0	2	0	**55**	0.5
2	Bradbury Mountain; Pownal, Maine	432.75	1	354	500	52	106	724	97	7	67	1746	292	0	0	450	44	3	10	5	3	0	13	0	**4474**	10.3
3	Barre Falls, Barre, MA	150.50	0	104	80	18	10	118	20	0	11	1101	66	0	0	31	1	0	0	0	0	0	13	0	**1573**	10.5
4	Pitcher Mountain; Stoddard, NH	23.25	0	28	3	1	2	5	1	2	2	50	8	0	2	4	0	0	0	1	0	0	8	0	**117**	5.0
5	Pilgrim Heights; North Truro, MA	280.00	10	794	174	19	13	527	39	2	15	331	155	0	0	119	72	26	1	3	3	0	2	7	**2312**	8.3
6	Plum Island; Newburyport, MA	121.33	0	18	27	0	39	133	9	0	0	0	0	0	0	305	88	5	5	1	6	0	4	0	**640**	5.3

* Data obtained from HMANA 2010.
** See map to right for site location.

Abbreviation Key:

BV - Black Vulture
TV - Turkey Vulture
UV - unidentified vulture
MK - Mississippi Kite
OS - Osprey
BE - Bald Eagle
NH - Northern Harrier
SS - Sharp-shinned Hawk
CH - Cooper's Hawk
NG - Northern Goshawk
RS - Red-shouldered Hawk
BW - Broad-winged Hawk
RT - Red-tailed Hawk
RL - Rough-legged Hawk
SW - Swainson's Hawk
GE - Golden Eagle
AK - American Kestrel
ML - Merlin
PG - Peregrine Falcon
UA - unidentified Accipiter
UB - unidentified Buteo
UF - unidentified Falcon
UE - unidentified Eagle
UR - unidentified Raptor

2010 Bald Eagle Evaluation

2010 Bald Eagle Evaluation

for the Bull Hill Project
In T16 MD, Maine

Prepared for

Blue Sky East Wind, LLC
179 Lincoln Street, Suite 500
Boston, MA 02111

Prepared by

Stantec Consulting Services Inc.
30 Park Drive
Topsham, ME 04086

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Appendix B White Sucker Spawning Assessment Results
Appendix C Eagle Activity Survey Results
Appendix D Summary of Best Available Information about Interactions between Bald Eagles and Wind Turbines

1.0 INTRODUCTION

In 2009 and 2010, Stantec Consulting (Stantec) completed bald eagle (*Haliaeetus leucocephalus*) nest surveys, sucker habitat assessment surveys, and eagle activity surveys in association with the proposed Bull Hill Wind Project (project) in T16 MD, Maine (Appendix A).

This report includes a summary of the methods used for each survey and a summary of the findings for those surveys.

2.0 EAGLE NEST AERIAL FLIGHT SURVEY

2.1 METHODS

Prior to the aerial survey conducted in spring 2010, Stantec reviewed information provided by the Maine Department of Inland Fisheries and Wildlife (MDIFW) regarding known active and historic eagle nest locations near the project area. The survey timing and methodology was consistent with Guidelines for Building and Operating Wind Energy Facilities in Maine (USFWS Maine Field Office, November 2009). Stantec also consulted with Charlie Todd of the MDIFW, who confirmed that the aerial survey was performed at an appropriate time of year and employed appropriate methods. In compliance with United States Fish and Wildlife Service (USFWS) National Bald Eagle Management Guidelines (May 2007), Stantec also notified Mark McCullough of the USFWS Maine Field Office that flights were planned in the area surrounding the project.

The survey consisted of low altitude passes from a single-engine aircraft, approximately 500 feet above ground level, along the shoreline of identified waterbodies within a 4-mile radius of proposed turbine locations for the project. This distance was used as recommended in the USFWS Maine Field Office Guidance (November 2007), which states that, “Four miles is an average distance that Maine bald eagles may be expected to travel.” The shorelines of the ponds and rivers were surveyed for active or historic eagle nest sites. Locations of new nests identified were recorded with a Global Positioning System receiver. Incidental observations of adult and juvenile bald eagles were also recorded.

Stantec conducted the aerial surveys in two phases. The first phase was conducted in two flights on April 13 and April 20, 2010, and was performed to identify new nests and to assess eagle nesting activity at known nest locations in the Project area. The second phase was conducted on May 28, 2010, to check the status of any active nests in the project area, and to perform a second search on areas where a nest was suspected but no nest was seen on the first flight.

The first phase included aerial surveys along the shoreline of seven lakes and ponds, and around numerous bogs, wetlands, and flowages within an approximately four-mile radius of the proposed turbine locations for the project. The lakes and ponds surveyed included Rocky Pond, Spectacle Pond, Molasses Pond, Scammon Pond, Abrams Pond, Webb Pond, and Narraguagus Lake (Appendix A). Webb Pond is located outside of the four-mile radius of the project area; however, it was surveyed because there is an historic eagle nest location on the pond.

2.2 EAGLE NESTS DOCUMENTED DURING AERIAL FLIGHT SURVEY

Stantec did not identify any active bald eagle nests in the project area during the 2010 surveys. Stantec located a known bald eagle nest on an island in Molasses Pond (MDIFW Nest #360), but the nest was not active. Two adult bald eagles were seen perched together on the western shore of the pond. A second location of potential nesting activity was seen on the island near the intact nest, which may have been an old nest or potentially the beginnings of a new nest. Stantec attempted to find the mapped bald eagle nest locations on Spectacle Pond (MDIFW #221A/B/C), Webb Pond (MDIFW Nest #511), Scammon Pond (MDIFW Nest #170A/B), and Abrams Pond (MDIFW Nest #170C), but no nests were identified. One adult bald eagle was observed on Rocky Pond flying along the western shore of the pond and then leaving the pond to the south. One adult bald eagle was also observed on Spectacle Pond flying along the eastern shore. No other bald eagles or nests were observed.

During the second flight, Stantec surveyed those waterbodies where adult bald eagles were seen during the first phase of flights, but no nests were observed. Stantec surveyed Rocky Pond, Spectacle Pond, and Molasses Pond and found no new active bald eagle nests.

3.0 WHITE SUCKER SPAWNING ASSESSMENT SURVEY

3.1 METHODS

At the request of MDIFW, Stantec conducted a white sucker (*Catostomus commersoni)* spawning assessment of the streams and rivers in the vicinity of the project area. The purpose of the survey was to determine if there are concentrations of spawning white suckers in the vicinity of the project area that could potentially be feeding areas for bald eagles and osprey (*Pandion haliaetus*). The objectives of the field survey were to: 1) survey the streams and rivers in the vicinity of the Project area for spawning white suckers; 2) record observations of bald eagles and osprey in the Project area; and 3) identify suitable spawning habitat in the streams and rivers associated with the Project.

3.2 RESULTS OF WHITE SUCKER ASSESSMENT SURVEY

No white sucker spawning was observed in any of the streams and rivers surveyed. Daytime water temperatures in the areas surveyed ranged from 44 to 56 degrees Fahrenheit, within the spawning range of the white sucker. In addition, no bald eagles or ospreys were observed during the three days of stream surveys (Appendix B).

4.0 RAPTOR MIGRATION SURVEY AND EAGLE ACTIVITY SURVEY

4.1 METHODS

Raptor migration and eagle activity surveys were conducted at two locations near each of the two turbine arrays in the project area in 2009 and 2010, including Sparrow Hill (summer 2009, winter 2010) and Bull Hill (fall 2009, spring 2010, fall 2010). Surveys were conducted during each seasonal period of the year (i.e., winter, spring, summer and fall). The specific goal of the summer surveys (August) was to characterize bald eagle activity in the vicinity of the project during the late-fledging period when both adults and that years' young are active in their breeding territories. Late winter/spring eagle activity surveys (March-April) targeted early eagle migration or resident eagle activity. Observations of other raptor species made during these periods were documented as well. The surveys in fall (September-October) and spring (April-May) sampled use and migration activity of all raptors in the project area.

Observation locations for both sites were positioned on ridge summits in areas with recent timber removal, allowing excellent 360 degree views of nearby project ridges, nearly 100 percent visibility of all proposed turbine locations in that array, and, to a lesser extent, the heaths and ponds in the valleys surrounding the project area. During surveys, a Stantec biologist scanned the sky and surrounding landscape with binoculars to search for eagles and other raptors. Surveys were conducted in a variety of weather conditions, although the majority of survey days were targeted for mostly clear days with good visibility. Surveys were conducted for at least seven hours per day, typically from 9 am to 4 pm, during the peak hours of thermal development and raptor movement. The flight paths and approximate flight height, including time directly over the project ridge, as well as age and behavior, were recorded for each eagle or raptor observed. For each observation, the horizontal flight path and vertical flight height were documented. The observations were summarized by survey day and for the entire survey period.

4.2 EAGLES DOCUMENTED DURING RAPTOR MIGRATION SURVEY 2009

In 2009, Stantec conducted 6 days (46 hours) of raptor migration surveys in summer and 12 days (87 hours) of raptor migration surveys in fall. Summer surveys included 3 days at Bull Hill and 3 days at Sparrow Hill from August 1 to August 27. Fall surveys were conducted at Bull Hill from September 2 to October 14.

During summer surveys, no bald eagles were observed. During fall surveys, three bald eagles were observed, only one of which, a sub-adult, was observed within the Project area (Appendix C).

For each observation, the horizontal flight path and vertical flight height were documented. Because each bird could be observed in multiple locations during their flight path, a total of three flight path locations were documented for the one eagle observed in the project area. This eagle, aged as a sub-adult IV (McCullough 1987), was observed crossing through the project area on October 14 moving north over Bull Hill at heights between 30 and 50 meters above ground level.

No bald eagles were observed on 15 of 18 days. The bald eagle passage rate in the project area was 0.0 eagles/observation hour in the summer and 0.01 eagles/observation hour in the fall.

4.3 EAGLES DOCUMENTED DURING RAPTOR MIGRATION SURVEY 2010

In 2010, Stantec conducted 15 days (104.25 hours) of raptor migration surveys in winter and spring. Winter surveys included 3 days at Sparrow Hill from March 19 to April 15, and spring surveys included 12 days at Bull Hill from April 15 to May 23. No bald eagles were observed within the project area. During winter surveys, five bald eagles observations were documented outside the project area, four of which occurred on one survey day in mid-March (March 19). During spring surveys, one bald eagle observation was documented outside the project area (Appendix C).

No bald eagles were observed on 12 of 15 days during winter and spring. The bald eagle passage rate in the project area was 0.0 eagles/observation hour in both winter and spring.

In 2010, Stantec also conducted 12 days (83 hours) of surveys in fall 2010 at Bull Hill from September 1 to October 12. One bald eagle was observed within the project area. This eagle was observed flying through the project area on October 6 crossing over Sugar Hill then flying southeastward at heights between 40 and 85 meters above ground level. During surveys, 10 other bald eagle observations were documented outside the Project area, five of which were documented over Spectacle Pond (Appendix C).

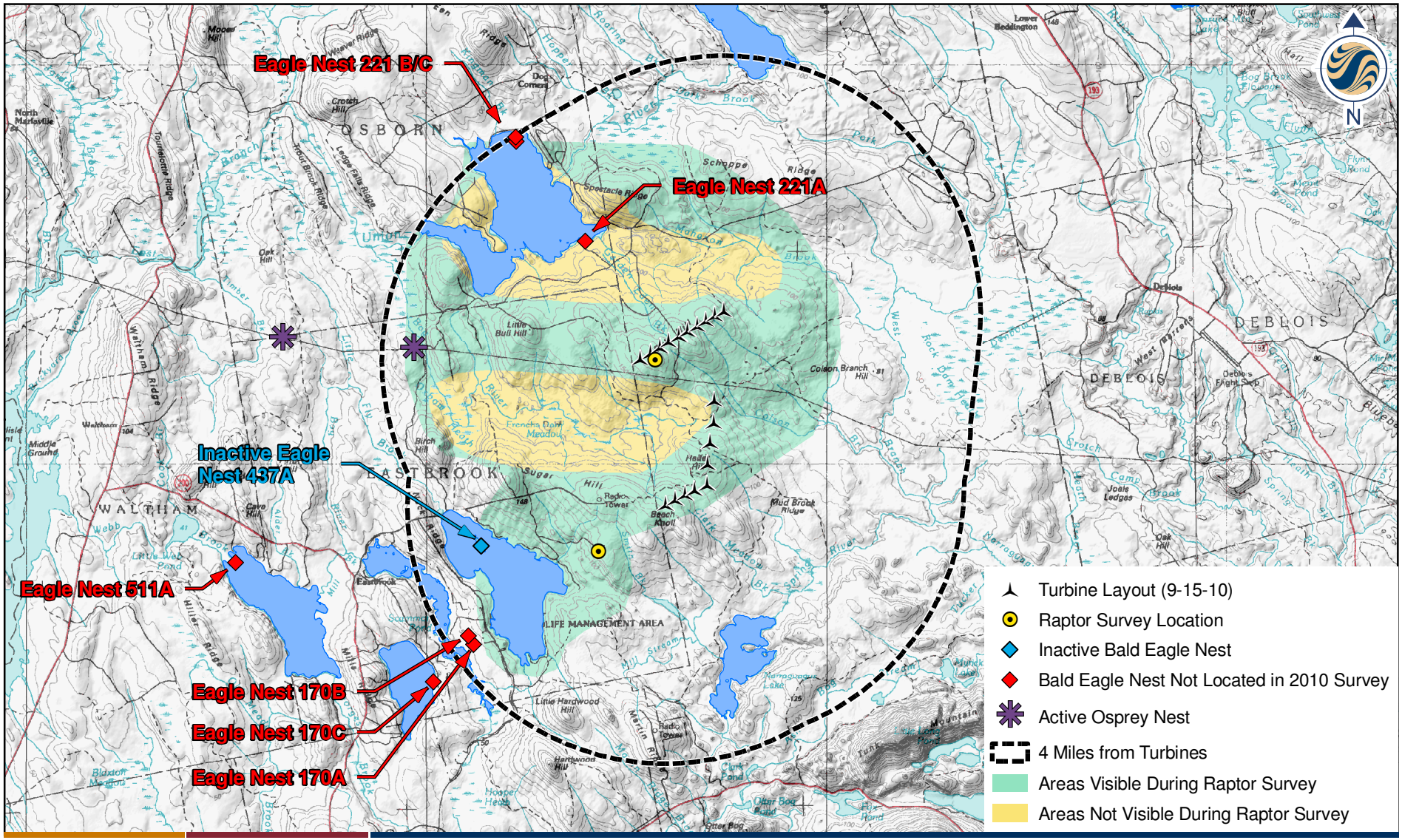
No bald eagles were observed on 5 of 12 days during fall. The bald eagle passage rate in the project area was 0.01 eagles/observation hour in fall.

5.0 CONCLUSION

Aerial nest surveys revealed no active bald eagle nest sites located within four miles of proposed turbine locations. Eagle activity surveys were conducted for a total of 45 days (320.5 hours) during one full year (winter, spring, summer, fall). During these surveys, a total of two bald eagle observations were documented in the project area.

The findings from these surveys should be interpreted within the context of the best available information about bald eagle interactions with wind projects (Appendix D). Post-construction studies and other literature on raptor collision mortality in the eastern United States have documented fewer than 40 raptor fatalities during 15,000 turbine searches, and only one report of bald eagle mortality related to a wind power project. This data suggests that the risk to bald eagles at properly sited modern wind facilities is low.

Appendix A
Survey Location Map



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0 2
Miles

Client/Project
Blue Sky East Wind, LLC
Bull Hill Wind Project
T16 MD, Maine

Figure No.
1

Title
Aerial and Visual Eagle Survey Locations

October 22, 2010

00500-F01-NestSpring2010.mxd

Appendix B
White Sucker Spawning Assessment Survey

Memo

To:	Brooke Barnes	From:	Michael Johnson
	Stantec		Stantec
File:	195600500	Date:	June 10, 2010

Subject: White Sucker Spawning Assessment for Bull Hill Wind Project, T16 MD, Maine

On May 11, 12, and 13, 2010, Stantec Consulting (Stantec) conducted a white sucker (*Catostomus commersoni)* spawning assessment of the streams and rivers in the vicinity of the Bull Hill Wind Project in T16 MD, Maine. The purpose of the survey was to determine if there are concentrations of spawning white suckers in the vicinity of the project area that are being targeted for foraging by bald eagles (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*). The objectives of the field survey were to: 1) survey the streams and rivers in the vicinity of the project area for spawning white suckers; 2) record observations of bald eagles and osprey in the project area; and 3) identify suitable spawning habitat in the streams and rivers associated with the project.

The white sucker is the second most common fish species in Maine lakes; it is more common in larger systems at lower elevations (PEARL, 2010). Preferred habitat consists of shallow lakes or shallow bays in deeper lakes (Langdon *et al.* 2006) and low to moderate grade streams (Twomey and Nelson 1984). White suckers are highly adaptable and found over a wide range of substrate types. Spawning occurs in the spring between early April and June when water temperatures reach 50 degrees Fahrenheit. Spawning typically occurs in rocky shallows of streams and rivers with gravel substrate and moderate currents. Lake residents will often make large spawning runs far up rivers. Eggs incubate in gravel substrates for a period of two weeks before hatching (Langdon *et al.* 2006).

Site Description

The project area consists of a series of coastal low elevation hills, including Bull Hill, Beech Knoll, and Heifer Hill. The project area is located between the Union River and Narraguagus River watersheds and contains several perennial streams. Sections of the following streams and rivers were surveyed as part of this assessment (Figure 1): Bog River, Union River, Colson Brook, Garden Eden Brook, Clark Meadow Brook, Mud Brook, Smith Brook, Roaring Brook, and an unnamed tributary to Spectacle Pond.

The streams closest to the project area include the upper sections of Colson Brook, Garden Eden Brook, Clark Meadow Brook, Mud Brook, Smith Brook, Roaring Brook, and an unnamed tributary to Spectacle Pond. These streams begin as small perennial streams with moderate slopes as they flow off the hills associated with the project area (Photo 1). The dominant substrate consists of boulders and cobble with lesser amounts of gravel and sand. These streams are generally narrow (less than 5 to 10 feet in width and shallow (less than 6 inches deep). The canopy cover in the upper sections of these streams is dense (70-100% shaded). The influence of beaver (*Castor canadensis*) activity increases as the gradients of the streams decrease. Beaver dams begin near the confluence of these streams with other streams, rivers and waterbodies (Photo 2). Some of these streams contain large beaver flowages (Photo 3).

The Bog River and the Union River are located further from the project area and consist primarily of slow moving backwaters (Figure 1). The survey focused on more restricted areas of riffle/run/pool habitat. These areas include a portion of the Bog River south of Little Bull Hill and the Union River below and above the confluence of Spectacle Pond (Figure 1). The riffle/run/pool habitat of Union River below the confluence of Spectacle Pond extends approximately 0.6 mile west of Spectacle Pond before entering a slow moving backwater associated with a large bog. The river in this section is 40 to 50 feet in width, contains a mix of boulder, cobble, gravel and sand substrate, a riffle/run/pool habitat,

and is approximately 3 feet deep (Photo 4). The Union River northeast of Spectacle Pond contains an approximately 0.3-mile section of riffle/run/pool habitat before entering slower moving water. This moderately sloping section of river contains mostly boulder and cobble substrate and some deep pools (over 5 feet) closer to Spectacle Pond (Photo 5). The section of the Bog River surveyed consists of approximately 0.8 mile of riffle/run/pool habitat between two large bogs (Photo 6) and is approximately 15 to 50 feet wide with depths to 2 feet in pools. There is a mix of boulder, cobble, gravel and sand substrate. Canopy cover along this section of river is variable, ranging from relatively open areas to closed canopy. The water in the river is tea colored coming out of the bog, and many of the rocks are covered with filamentous algae (Photo 7).

White Sucker Assessment

No white sucker spawning was observed in any of the streams and rivers surveyed. Daytime water temperatures in the areas surveyed ranged from 44° to 56° degrees Fahrenheit, within the spawning range of the white sucker. In addition, no bald eagles or ospreys were observed during the three days of stream surveys.

The smaller perennial streams associated with the project area are dammed by beavers in their lower reaches. These beaver dams impede any spawning movement of white sucker into the project area. In addition, the size and substrate of these streams is not suitable for large white sucker spawning movements. Substrates are generally dominated by boulders and cobble and not gravel, which is the preferred spawning substrate. The dense canopy cover along the sections of these streams associated with the project area also would restrict bald eagle and osprey foraging.

The Union River west of Spectacle Pond contains some suitable spawning habitat for white suckers (Photo 8 and 9). No spawning suckers were observed at the time of the survey. Suckers move upstream to spawn (Twomey and Nelson 1984), and suckers in Spectacle Pond are unlikely to move down river to this area. The section of the Union River northeast of Speckle Pond is dominated by boulder and cobble substrate and does not include suitable spawning habitat (Photo 5). The Bog River in the vicinity of the project area does contain some suitable spawning habitat (Photo 10). No white suckers were observed in the river here at the time of the survey. This section of river and the suitable spawning habitat it contains is relatively small and is not associated with a large waterbody from which suckers can migrate.

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Twomey, K.A. and P.C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: White Sucker. Fish and Wildlife Service. U.S. Department of Interior. Washington, DC.

Photo 1. Garden Eden Brook. This stream habitat is typical of the streams associated with the hills of the project area: moderate slope, boulder, and cobble substrate, shallow depths and dense canopy cover.

Photo 2. Colson Brook. Beaver dam associated with the lower reaches of the brook. Typical of the habitat associated with the lower reaches of the streams in the project area.

Photo 3. Clark Meadow Brook. Typical large beaver impoundment associated with the lower reaches of the streams in the project area.

Photo 4. The Union River west of Spectacle Pond.

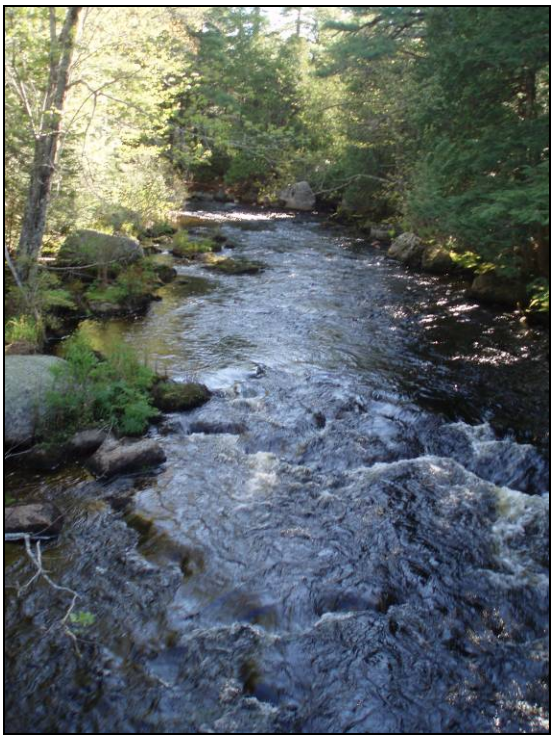

Photo 5. The Union River northeast of Spectacle Pond.

Photo 6. The Bog River.

Photo 7. The Bog River. Note filamentous algae on rocks.

Photo 8. Suitable spawning habitat in the Union River west of Spectacle Pond.

Photo 9. Suitable spawning substrate in the Union River west of Spectacle Pond.

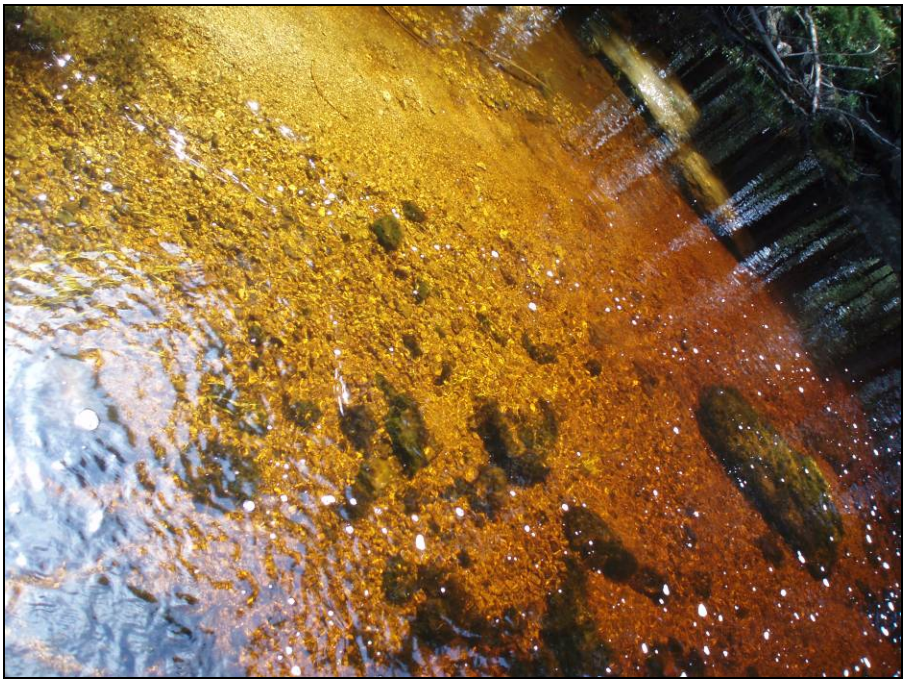

Photo 10. Suitable spawning substrate in the Bog River.

Appendix C
Summary of Survey Results

Appendix C. Eagle Data Summary from 2009 and 2010 Visual Field Surveys at Bull Hill, T16 MD, Maine.

								A1		A2		A3		B		C		D								
Date	Number of Individuals	Age (J, Sub-A or A)	Within project boundary (yes or no)	Minimum of all flight position heights	Maximum of all flight position heights	Behavior - LS, G, CS*	Behavior - PF**	min height (m) A1	max height A1 (m)	min height (m)A2	max height (m)A2	min height (m) A3	max height (m) A3	min height (m) B	max height (m) B	min height (m) C	max height (m) C	min height (m) D	max height (m) D	Actively migrating (yes/no)	Azimuth	Time spent over Project < 145 m (min:sec)	Notes			
10/14/2009	1	Sub-IV	YES	30	50	Y	Y			30				40		50				No	N	n/a	Crossed Bull Hill - flying pretty low, came close to raptor tower (~150'), then moved off to the N of the project area. Could clearly see that this bird had not reached adult plummage, some small white patches on body and small amount of dark feathers in head and tail.			
10/6/2010	1	A	YES	40	85	Y				40	60			40	60	75	85			Yes	SE	0:00	followed sugar hill then crossed ridge southward - Molasses Pond Bird?			
9/17/2009	1	Sub-A	NO	150	200	Y								150	200					Maybe	W					
10/2/2009	1	A	NO	70	70	Y										70				Maybe	NE					
3/19/2010	2	A	NO	125	250	Y	Y							125	250					No	NE					
3/19/2010	1	A	NO	125	200	Y	Y							125	200					No	NE					
3/19/2010	1	A	NO	150	300	Y												150	300	No	S					
4/6/2010	1	A	NO	10	10	Y										10	10			Maybe	SW					
5/4/2010	1	A	NO	200	250	Y												200	250	No	SW					
9/2/2010	1	A	NO	600	800	Y												600	800	No	NE					
9/15/2010	1	n/a	NO	400	1,000	Y												400	1000	No	SW					
9/15/2010	1	n/a	NO	200	600	Y												200	600	No	NE					
9/15/2010	1	n/a	NO	200	300	Y										200	300			No	NW					
10/4/2010	1	A	NO	600	700	Y												600	700	No	E					
10/5/2010	1	A	NO	250	300	Y												250	300	No	W					
10/9/2010	1	A	NO	20	150	Y												20	150	No	W					
10/9/2010	1	A	NO	30	100	Y												30	100	Yes	SW					
10/9/2010	1	n/a	NO	80	100	Y		80	100											No	NW					
10/12/2010	1	A	NO	100	350	Y												100	350	No	NE					

*LS: Linear Soaring

G: Gliding

CS: Circle Soaring

**PF: Powered Flight

Appendix D
Summary of Best Available Information about Interaction between Bald Eagles and Wind Turbines

Summary of Raptor and Bald Eagle Mortality at Existing Wind Facilities

Available information on the mortality of raptors, including eagles, from wind facilities include results of post-construction mortality surveys in the United States; comparison of site-characteristics of facilities with high numbers of fatalities in other countries; and results of surveys conducted pre- and post-construction at the same facilities.

The potential collision risk to bald eagles from wind facilities is influenced by the eagles' use of the ridgeline topography to catch updrafts for soaring, as well as potential crossing of the ridgeline during foraging. Outside of previous and ongoing studies at California's Altamont Pass, publicly-available studies of mortality at operating wind farms have consistently documented exceptionally low raptor mortality rates throughout North America. Conversely, the historic cause and effect of raptor mortality at Altamont is well documented (Smallwood and Thelander 2005, GAO 2005). Mortality rates found at onshore wind developments, outside of Altamont, documented 0 to 0.07 raptor fatalities/turbine/year from 2000-2004 (GAO 2005). A subsequent technical review of wind energy impacts by The Wildlife Society (TWS) (Arnett *et al.* 2007) documented a combined mean rate of 0.03 raptors per turbine at operating wind farms. Each of the studies incorporated in the TWS review integrated scavenger removal and searcher efficiency biases. At 14 wind projects in the United States (outside California), over 15,000 turbine searches have been conducted over a 15-year period. Less than 40 raptor fatalities have been reported (Table 3-1; 1994-2008), none of which were bald eagles (*Haliaeetus leucocephalus*).

Species found during the mortality searches were common to the area and occurred during both migratory and breeding seasons. Despite regular and ongoing reviews, there have not been any bald eagle fatalities reported at an operating wind facility in the United States (Erickson and Arnett 2008).[1],[2]

In addition to reported fatalities at sites in the United States, fatalities of related eagle species have been documented at several facilities outside the United States. As part of this review, Stantec investigated fatalities of eagle species closely related to the bald eagle, such as the sea eagle *(Haliaeetus albicilla)* and wedge-tailed eagle *(Aquila audax)*. Fatalities appear to be most common in settings that are inherently riskier than this Project area. For example, most of these facilities are located in coastal areas close to, and in one case, surrounding, high densities of breeding and resident eagles. Facilities in Norway, Australia, and Japan also include much larger numbers of turbines than are proposed at this project (Table 3-2).

[1] As of March 2010, two reports of bald eagle fatality have been documented in Canada associated with a wind facility. In November 2004, an adult bald eagle was recovered by facility personnel at the Castle River Wind Farm in southern Alberta. The cause of death was not determined, but the bird was found between two adjacent turbines. This facility includes 66 older-style turbines located in cultivated fields or heavily grazed native pasture; these turbines have a maximum height of 73 m, compared to 120 to 150 m for modern turbines, and are spaced 100-150 m apart, compared to 400-900 m for modern turbines. In June 2009, anecdotal reports of a fatality of a bald eagle were reported at a wind facility in Ontario. However, no information is currently publicly available for this incident. The facility includes 66 turbines and is within two miles of Lake Erie in a well-documented fall raptor migration corridor. A Hawk Watch site within 20 miles averages 37,000 raptors per fall season.

[2] Due to differences in turbine and monopole (tower) type, design, spacing, and rotor speed, along with differences in raptor use, the patterns of raptor fatality in California are considered unique among US installations, particularly when compared with results at facilities with modern turbine designs.

Table 3-1. Available raptor mortality data reported at wind farms in the U.S. (outside of California) from 1994-2009

Location	Habitat Type (# Turbines)	Study period	Search Interval	Number of fatalities and species	Dates of carcass discovery	Reference
Buffalo Ridge, MN	agricultural grassland (73)	1994-1995	30-50 weekly	0	n/a	Osborn *et al.* 2000
Buffalo Ridge, MN	agricultural grassland (138)	1996-1999	30 per 14 days	1 red-tailed hawk	n/a	Johnson *et al*. 2002
Searsburg, VT	forested ridge (11)	1997	11 total (4 per search) 2-6 days per month	0	n/a	Kerlinger 2002
Foote Creek Rim, WY	shrub-steppe grassland (69)	1998-2002	35 searched once every 2 weeks	1 northern harrier, 3 American kestrel, 1 short-eared owl	Northern harrier (4/19/99); American kestrel (5/12/99, 10/12/99, 7/19/00); short-eared owl (09/28/00)	Young *et al.* 2003
Vansycle, Umatilla County, Oregon	agricultural grassland (38)	1999	All turbines searched each 28-day period	0	n/a	Erickson *et al.* 2000
Stateline, WA/OR	agricultural grassland (454)	2001-2003	120-150 total	9 red-tailed hawk, 3 American kestrel, 1 ferruginous hawk, 1 Sawinson's hawk, 1 short-eared owl	Total raptor fatalities 2002: 1 in June, 2 in August, 2 in September, and 1 in October; 2003: 1 in May, 1 in June, 3 in July, 2 in October	Erickson *et al.* 2004
Somerset County, PA	agricultural grassland (8)	2000	n/a	0	n/a	Kerlinger 2006
Nine Canyon, WA	shrub-steppe grassland (37)	2002-2003	1 x 2 weeks	1 American kestrel, 1 short-eared owl	American kestrel (11/18/02), short-eared owl (4/7/03)	Erickson *et al.* 2003
Klondike, OR	shrub-steppe grassland (16)	2002-2003	1 x month	0	n/a	Johnson et al. 2003
Mountaineer, WV	forested ridge (44)	2003	2 x per week	1 red-tailed hawk, 2 turkey vultures	each between 04/04/03 - 04/27/03, 06/02/03 -06/24/03, 07/28/03 - 07/29/03, and 08/18/03 - 11/22/03	Kerns and Kerlinger 2004
Mountaineer, WV	forested ridge (44)	2004	22 daily, 22 weekly	1 sharp-shinned hawk, 1 turkey vulture	both between 07/31/04 - 09/11/04	Arnett *et al* 2005
Meyersdale, PA	forested ridgeline (20)	2004	10 daily, 10 weekly	0	n/a	Arnett *et al.* 2005
Top of Iowa, Iowa	agricultural grassland (89)	2004	26 every 3 days	1 red-tailed hawk	red-tailed hawk (4/01/04 - 12/10/04)	Koford *et al*. 2005
Buffalo Mountain, TN	open/shrubland (18)	2005	18 of 18 every week, every 2 weeks, or every 2-5 days	0	n/a	Fiedler *et al*. 2007
Kewaunee County, Wisconsin	agricultural grassland (31)	1999-2001		0	n/a	Howe *et al.* 2002
Maple Ridge, NY	woodland, agricultural grassland (120)	2006	10 every 3 days, 30 7 days, 10 daily	1 American kestrel	American kestrel (7/06)	Jain *et al*. 2007
Maple Ridge, NY	woodland, agricultural grassland (195)	2007	64 weekly	1 American kestrel, 5 red-tailed hawk	red-tailed hawk (1 found 8/07, 2 found 9/07) // (1 sharp-shinned hawk and 2 red-tailed hawk dates not reported)	Jain et al. 2008
Maple Ridge, NY	woodland, grassland, agricultural (120)	2008	64 weekly	1 American kestrel, 2 sharp-shinned hawk, 1 Cooper's hawk	n/a	Jain *et al.* 2009a
Mars Hill, ME	forested ridgeline (28)	2007	2 of 28 daily, 28 of 28 weekly, seasonal dog searches	0	n/a	Stantec 2008
Mars Hill, ME	forested ridgeline (28)	2008	28 of 28 weekly, seasonal dog searches	1 barred owl	barred owl (4/11/08)	Stantec 2009
Mt. Storm, WV	forested ridgeline (82)	2008	18 weekly, 9 daily	2 turkey vulture	9/25/2008 and 10/13/2008	Young *et al*. 2009
Lempster, NH	forested ridgeline (12)	2009*	4 daily	0	n/a	Tidhar 2009
Clinton, NY	agricultural, woodland (67)	2008	8 daily, 8 every 3-days, 7 every 7-days	1 broad-winged hawk	May	Jain et al. 2009b
Ellenburg, NY	agricultural, woodland (54)	2008	6 daily, 6 every 3-days, 6 every 7-days	1 broad-winged hawk	June	Jain et al. 2009c
Bliss, NY	agricultural, woodland (67)	2008	8 daily, 8 every 3-days, 7 every 7-days	3 red-tailed hawk, 1 sharp-shinned hawk	1 fatality in June, 1 fatality in August (2 incidental raptor dates not reported)	Jain et al. 2009d
Stetson, ME	forested ridgeline (38)	2009	19 weekly	1**	red-tailed hawk (7/27/09)	Stantec 2009b
Cohocton and Dutch Hill, NY	agricultural (50)	2009	5 daily, 12 weekly	1	sharp-shinned hawk (7/8/09)	Stantec 2009c
Munnsville, NY	agricultural (23)	2008	12 weely	2	red-tailed hawk (7/16 and 8/14)	Stantec 2009d

*Results of spring interim report, study period April 20 to June 1.

**Fatality was result of electrocution at a riser pole of the electrical collection system

Table 3-2. Comparison of known eagle mortality factors at wind facilities outside United States

Site	Landscape Conditions	Mortality	Site characteristics which influence mortality
Smola, Norway	coastal island	10 white-tailed sea eagles between 2005 and 2006	68 turbines located in area identified as International Bird Area with the highest density of white-tailed sea eagles in the world (300 individuals, 86 breeding pairs, 13-16 pairs within facility area prior to operation). The relatively small, off-shore island essentially lacks tree or shrub vegetation and consequently supports a high concentration of eagles which nest on the ground directly within the rows of turbine strings.
Tarifa, Spain	near the Straits of Gibraltar	2 short-tailed eagles over 1-year survey period (1993-1994)	Nearly 700 turbines (including lattice-tower models similar to Altamont) are located near a main point of migratory passage for several hundred thousand raptors annually.
Woolnorth, Tasmania	coastal bluff	14-18 wedge-tailed eagles between 2003 and 2008	62 turbines located on costal bluff and wedge-tailed eagle nests are located within 0.3 miles of turbines.
Starfish, Australia	coastal bluff	2 wedge-tailed sea eagles in 2004	23 turbines situated on a high coastal bluff
Hokkaido, Japan	coastal island	6 white-tailed sea eagles from 2004-2007	Almost 250 turbines are located in coastal area, along important migration route for sea eagles.

Note: This information is based on a literature review of mortality events from various sources. Mortality of white-tailed sea eagles has also been reported at facilities in Germany and Sweden, but very limited information is available; a request for further details has been submitted. Reports of other mortality were either not facility-specific or could not be substantiated thru an extensive search of news articles, peer-reviewed literature and general web searches.

There are currently three sites in the Northeast for which pre- and post-construction raptor survey data and mortality data are available: 1) Maple Ridge Wind Project in Lewis County, New York (pre-construction surveys formerly referred to site as Harrisburg; 2) Mars Hill Wind Project in Aroostook County, Maine; and 3) Lempster Wind Project in Sullivan County, New Hampshire. Post-construction raptor surveys were performed during the same year as mortality surveys in 2009 at the Stetson Wind Project in Penobscot and Washington Counties, Maine. Raptor avoidance behaviors were observed at this site.

At Maple Ridge, New York, pre-construction surveys in fall 1998 documented a total of 554 raptors during 68 total hours of survey from the beginning of September to October (seasonal passage rate of 8.1 birds/hour). The most commonly observed raptor species during the pre-construction surveys were turkey vulture (n=294) and American kestrel (n=84). There were two New York state-listed species observed, osprey (n=2) and northern harrier (n=52). The mean flight height of raptors was 48 meters (m)

(above ground level) (Cooper and Mabee 1999), which is below the rotor swept area of the turbines. Two years of post-construction mortality searches at Maple Ridge indicated relatively low raptor mortality, with an estimate of 0.07 American kestrels/turbine/year in 2006 (Jain et al. 2007), and an estimate of 0.41 red-tailed hawks per turbine per year in 2007 (Jain et al. 2008). No eagle fatalities were documented during post-construction surveys at the project.

At Mars Hill, Maine, pre-construction surveys in fall 2005 documented a total of 115 raptors during 42.5 hours of survey from the beginning of September to mid-October (the seasonal passage rate was 1.52 birds/hour); spring 2006 results included a total of 64 raptors during 60.25 hours of survey between mid April and late May (seasonal passage rate of 1.06 birds/hour). The most commonly observed raptor species during the fall surveys were sharp-shinned hawk (n=40) and red-tailed hawk (n=26) and, during the spring surveys, osprey (n=22) and turkey vulture (n=11). Maine state-listed species observed included peregrine falcon (n=2, fall), and bald eagle (n=8, fall; n=4, spring). The seasonal percentage of birds below the maximum rotor-swept height of 120 m was 42 percent in the fall and 48 percent in the spring (Woodlot 2005). Two years of concurrent raptor behavior, and post-construction fatality surveys at Mars Hill were subsequently conducted in 2007 and 2008 to help characterize raptor use of the site during active operations. These observations indicated a continued use of the project area by a variety of migrant and resident raptors, including bald eagle, with documentation of direct turbine avoidance. These observations, correlated with minimal raptor fatalities (one owl fatality in two years of study, and that could have been a natural winter kill during the severe 2007-2008 winter conditions), strongly suggest a low raptor collision risk despite continued use of the area by raptors (Stantec 2008, Stantec 2009). No eagle fatalities were documented during post-construction surveys at the project.

At Lempster, New Hampshire, pre-construction surveys in fall 2005 documented a total of 264 raptors during 80 hours of survey (the seasonal passage rate was 3.3 birds/hour). Spring 2006 results included a total of 102 raptors between mid April and late May (seasonal passage rate of 1.3 birds/hour). The most commonly observed raptor species during the fall surveys were broad-winged hawk (n=170) and sharp-shinned hawk (n=49). During the spring surveys, the most commonly observed raptor species were again broad-winged hawk (n=39) and sharp-shinned hawk (n=20). The seasonal percentage of birds below the maximum rotor-swept zone was 60 percent in the fall and 56 percent in the spring (Woodlot 2007). One year of post-construction fatality surveys at Lempster were subsequently conducted in 2009 to determine the estimates of the overall annual mortality rate of the project. This monitoring did not cover raptor use of the project area after construction; however, it did document species specific fatalities with adjustments for searcher efficiency and scavenger removal rates (Tidhar 2009). No raptor fatalities were documented during 2009 post-construction surveys at the project.

At Stetson, Maine, post-construction raptor surveys occurred in conjunction with the post-construction mortality surveys. A total of 79 raptors (34 in spring; 45 in fall) during 70 hours of survey were observed for both spring and fall survey seasons (Stantec 2009b). The seasonal passage rate was 1.13 birds/hour. The most commonly observed raptor species were red-tailed hawk (n=26) and turkey vulture (n=19). The seasonal percentage of birds below the maximum turbine height was 67 percent for the spring and fall surveys combined. During post-construction mortality surveys, one red-tailed hawk was found; however, it was electrocuted by a riser pole of the electrical collection system. No raptor fatalities were documented under turbines.

Flight behaviors

Available information on the flight behavior of eagles and interaction with wind turbines includes results of behavior surveys conducted at multiple facilities, reported avoidance rates, and evaluation of factors that contribute to specific flight behaviors.

At proposed (and now existing) wind facilities in the east, it has generally been the trend that the majority of raptors observed have been below the height of the proposed turbines; the range of birds below the maximum height of the towers has been between 9 to 89 percent (Stantec 2009). Despite relatively low flight heights of raptors observed, studies have also documented high turbine collision avoidance behaviors at modern wind facilities (Whitfield and Madders 2006, Chamberlain *et al.* 2006). These

studies found that because most raptors are diurnal, raptors may be able to visually, as well as acoustically, detect turbines during periods of fair weather. Additionally, periods of intensified raptor movements, such as during peak migration days, are often associated with the clear weather conditions that follow certain frontal systems.

During spring and fall raptor surveys at the Stetson Wind Project, a total of 69 raptors were observed in the Project area; 46 of these birds were documented flying below maximum turbine height. Of those 46 birds, 54 percent of birds (n=25) occurred within 51 to 100 m from the turbines. Of these birds within turbine areas at heights below 119 m, 39 birds exhibited no observable reaction to turbines as they occurred over the Project ridge. Only two raptors observed during migration surveys exhibited turbine-avoidance behaviors: a turkey vulture and a sharp-shinned hawk, both on April 27. Incidental observations of raptors during the mortality survey included additional instances of raptor turbine-avoidance behaviors. Out of 47 incidental observations, 7 raptors exhibited turbine-avoidance behaviors. For these 7 observations, raptors made slight changes to their flight paths as they approached spinning turbines. For all 9 observations of turbine-avoidance behaviors, including observations made during migration surveys and incidental observations, the turbines closest to these birds were spinning. No raptors observed came into contact with the turbines (Stantec 2009b).

While the ability of raptors to avoid turbines likely depends on a variety of factors, limited studies have attempted to quantify or estimate raptor avoidance rates, either through on-site observation or modeling. Birds presumably avoid encountering turbines by seeing the blades or detecting the motion of spinning blades, or by acoustically detecting them (Dooling 2002). Avian turbine avoidance rates have been calculated, using a model developed by Whitfield and Madders (2006) known as the “Band Model,” at several existing wind farms in the U.S. where mainly geese and raptor species were estimated to have avoidance rates greater than 95 percent (Fernley et al. 2006). Vultures, while often common in and around wind facilities, have also collided with turbines infrequently (NRC 2007). Golden eagles were reported to have an estimated turbine avoidance rate of 99.5 percent during surveys at a U.S. facility (Chamberlain et al. 2006).

Bald eagle observations have regularly been documented at operational facilities during raptor surveys. Results are available from surveys conducted at five operational facilities. At Buffalo Ridge, Minnesota, 51 bald eagle observations were documented during four years of monitoring, primarily during spring migration. Direct observations of turbine avoidance behavior by raptors were made by researchers documenting movement patterns and flight behaviors of birds at the Buffalo Ridge facility in Minnesota. Birds seen flying through turbine strings often adjusted their flight when turbine blades were rotating and typically made no adjustments when turbines were not operating, supporting the theory that birds can detect blade movement by sight or sound. American kestrels were often seen at the height of the rotors and within 15 m (50 feet [’]) of turbines. However, no kestrels were found during four years of fatality searches at this site. Buteos were often observed at the height of the rotors, but were infrequently seen within 31 m (100’) of the towers. No buteo morality was reported at this facility (Osborn *et al.* 1998). No bald eagle fatalities were reported at any project in the U.S.

At Foote Creek Rim, Wyoming, three bald eagle nests are located within 10 miles of the project and post-construction observations documented 43 bald eagle observations during use surveys. In addition, at the Foote Creek Rim facility, 30 golden eagle nests were found within 10 miles of the project and over 2000 golden eagle observations recorded, yet no eagle fatalities were documented during a four-year period (Young et al. 2003).

At Erie Shores, Ontario, adults and juvenile eagles were seen perched within 200 m of active turbines and on a few occasions they were observed flying closer than 100 m of rotating blades. Over the course of two years, bald eagles were noted flying past active turbines within 300 m on about 170 occasions. Most of these were along the Lake Erie shore, where they routinely soared past at less than 200 m away but during 5-6 occasions they were observed less than 50 m of turning blades. A 2008 use study included over 3000 observations of raptors passing within 300 m of the turbine, including 170 bald eagle observations (James 2008).

At Mars Hill, Maine, post-construction monitoring results have demonstrated that migrant and resident raptors continue to use the Project area. Surveys also documented direct turbine avoidance by eagles, very similar to the behavior observed at Buffalo Ridge. Two years of post-construction monitoring were conducted in 2007 and 2008. No bald eagle fatalities have been documented in nearly three years of operation (Stantec 2009). At Lempster, New Hampshire, operation started in winter 2009. Post-construction fatality monitoring is ongoing; to date, no bald eagle fatalities have been documented.

The fact that post-construction studies have shown very few raptors being killed by turbines, and that fatalities are distributed between breeding and migration seasons, demonstrates the difficulty in determining which specific factors (e.g., flight behaviors, other seasonal behaviors, weather conditions, prey abundance and availability, raptor density) may cause raptors to collide with wind turbines at a given site. It may be more apparent why they are generally avoiding turbines. Raptor mortality from operational wind facilities in the United States may be low due to the life history characteristics of raptors. In the northeast, migrating raptor species (not including owls) are diurnal animals, they are active almost entirely during daylight hours (Wheeler 2003) and their preferred prey species are generally small to medium-sized mammals, fish, and birds, which are hunted from hundreds of feet away. It requires excellent vision to hunt and capture small prey at these distances. The day-time habits and good vision of raptors may allow them to see turbines and avoid them (Chamberlain 2006) and eagles are less likely to fly during periods of high winds. This behavior has been confirmed by direct observations of raptors at some operating wind projects in the U.S. (Chamberlain 2006, Stantec 2008, 2009).

Nest Displacement

Limited data exist regarding raptor displacement from wind farms in the eastern United States. Data from existing facilities in the west and upper mid-west indicate that raptors continue to use the area surrounding wind developments although breeding habitat displacement was observed at a wind farm in Minnesota and at a wind farm in Ontario.

For three years after construction of a facility in Wyoming, a pair of golden eagles successfully nested within 0.8 km (0.5 mi) of the facility (NRC 2007). A Swainson's hawk nested within 0.8 km of a wind farm in Oregon (NRC 2007). Golden eagle breeding territories were monitored in 2000 and 2005 at a facility in California, and the same nesting territories were used during both years (NRC 2007). Within 2 miles of the Stateline facility in Oregon and Washington, raptor density remained unchanged during a two year post-construction study (NRC 2007).

After development of the Buffalo Ridge Wind Farm, raptors continued to nest in the area surrounding the Project; however, no nests were found in similar habitats within the 32 sq. km (19.9 sq. mi) facility (NRC 2007). Observed raptors, however, continued to use the Project area while foraging or flying. American kestrels were often seen flying within 15 m (49.2') of turbines (Osborn *et al.* 1998). However, buteos were infrequently seen within 31 m of the towers (Osborn *et al.* 1998). At a facility in Ontario, a pair of bald eagles nested in a wooded area within the project boundary, approximately 400 m from the turbine site. During turbine construction during winter, the pair moved to a new nest approximately 900 m from the turbine site. The pair was observed flying in the wind facility during all seasons and successfully raised two eaglets. During the next year, a pair returned to occupy the new nest but it failed early for unknown reasons. In the third year, the pair rebuilt and reoccupied the original nest. There were also 2 Cooper's hawk nests within 180 m of turbines and 1 red-tailed hawk nest within 60 m of turbine construction (James 2008).

In 7 of the 10 states with the highest megawatts of developed wind energy, there are over 150 bald eagle breeding pairs, and in one case, over 1000 (Table 3-3).

Table 3-3. Estimated Bald Eagle Breeding Pairs in the ten states with the highest installed wind capacity

State	Megawatts of installed wind generation capacity	# of breeding pairs of bald eagles	# of bald eagle fatalities attributed to wind turbines
Texas	7907	156	0
Iowa	2883	200	0
California	2653	200	0
Minnesota	1803	1312	0
Washington	1479	848	0
Oregon	1363	470	0
New York	1261	110	0
Colorado	1068	42	0
Kansas	1014	23	0
Illinois	915	100	0
Maine	104	414	0

Sources: AWEA installed wind capacity; USFWS, April 2007; Erickson and Arnett 2008

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