Bird and Bat Risk Assessment: A Weight-of-Evidence Approach to Assessing Risk to Birds and Bats at the Proposed Groton Wind Project, Groton, New Hampshire

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Executive Summary

An Ecological Risk Assessment was performed by Stantec Consulting Inc. (Stantec), in fall 2009 to evaluate potential impacts to avian and bat resources from both the construction and operation of the proposed Groton Wind Project (the Project) on Tenney and Fletcher Mountains in Groton New Hampshire, to be constructed by Groton Wind, LLC (Groton Wind). The assessment used information from literature review, agency consultation, regional surveys and databases, and on-site field surveys to characterize use of the Project area by raptors, nocturnally migrating passerines, breeding birds, and bats. Field surveys used in preparing the risk assessment included: acoustic bat surveys and peregrine surveys conducted in 2006, nocturnal radar surveys conducted in spring and fall 2008, raptor migration surveys conducted in spring and fall 2009; breeding bird surveys conducted in spring/summer 2009; Peregrine use survey conducted in late summer/early fall 2009, and acoustic bat surveys between August and October 2009. Detailed descriptions of methods and results of these surveys are provided in separate seasonal survey reports (Stantec 2006 Summer and Fall Wildlife Survey Letter Report; Spring 2008 Radar Survey Report, Fall 2008 Radar Survey Report, 2009 Spring, Summer, and Fall Avian and Bat Survey Report, and 2009 Summer and Early-Fall Peregrine Falcon Use Survey Report). Work scopes and levels of effort for field surveys were determined based on Stantec's experience conducting these types of surveys at proposed wind projects in the northeast as well as consultation with the New Hampshire Fish and Game Department (NHFGD), US Fish and Wildlife Service (USFWS), and New Hampshire Audubon.

A qualitative weight-of-evidence technique was used in this risk assessment, as it is currently not possible to quantitatively assess risk to birds and bats in the pre-construction phase, given the existing technology and methodologies available. Using this technique, the results of field surveys, regional data, and literature review were evaluated for their indication of risk to birds and bats from direct and indirect impacts. The strengths and weaknesses of each source of data were also evaluated to assign a level of confidence or certainty to the assessment of risk derived from each type of data.

While statements of risk included in this report are made with some uncertainty, results from the weight-of-evidence assessment provide a thorough summary of the current understanding of potential risks to raptors, nocturnally migrating passerines, breeding birds, and bats. The document is organized around these four species groups. Each is addressed separately within the results and discussion sections.

Potential impacts to raptors are expected to be minor, based on the finding that very few raptors have collided with turbines at existing facilities throughout the country (with the exception of older facilities in California, such as Altamont Pass Wind Resource Area), and relatively low numbers of raptors appear to pass over the Project area during the spring and fall migration periods. While the Project area does not appear to support nesting eagles, both golden eagles (*Aquila chrysaetos*) and bald eagles (*Haliaeetus leucocephalus*) appear to be occasionally present in the vicinity of the Project area during the spring and fall migration periods. However, based on publicly-available post-construction surveys, eagles have not been documented to collide with wind turbines at New England projects.

Nocturnally migrating passerines were observed to migrate through the Project area in relatively low to moderate numbers, although the vast majority of individuals were flying at a height high above the proposed turbines, and a relatively small percentage of individuals passed below the turbine height. Among the categories of birds discussed in this document, nocturnally migrating passerines are expected to be vulnerable to collision, given their apparent abundance during spring and fall migration and results of post-construction mortality monitoring at existing wind projects. However, it is expected that collision rates at this project will be more similar to operational projects in New England where mortality has been relatively low.

Potential impacts to breeding birds are expected to be minimal. While collision mortality has been documented for breeding birds at existing facilities, birds seem to be less prone to collision during the breeding season than during the spring and fall migration. Indirect impacts to breeding birds associated with habitat conversion are expected to cause limited shifts in species distribution and abundance and are expected to affect certain species more than others. Breeding bird habitat currently within the Project area consists of a mosaic of second growth and successional forest with a history of timber harvests for commercial forest management. While many of the species documented at the Project are often found in fragmented habitats, certain forest interior species may be indirectly impacted by the Project. However, overall indirect impacts to breeding birds are expected to be minimal, and the type of clearing associated with the Project is not expected to dramatically alter the breeding bird community in the Project area. Furthermore, no federally or state listed threatened or endangered species were observed in the project area, during breeding bird surveys.

Results of the risk assessment suggest that potential impacts to bats consist largely of collision mortality, particularly during the fall migration season. While collision mortality has been documented at operational wind facilities during summer, and bats likely reside within the Project area between early spring and late fall, bats seem most vulnerable to collision during the fall migration period based on results from post-construction surveys at existing facilities. Long distance migratory species are expected to be more vulnerable to collision mortality than other species based on these post-construction studies. These species were well represented in the results of on-site acoustic surveys, particularly at rotor-height detectors. This finding, combined with the fact that long-distance migratory bat species have comprised the majority of fatalities at several operational facilities, suggests that long-distance migratory bat species may be the group of bats most vulnerable to collision mortality. However, it is expected that collision rates at this project will be more similar to operational projects in New England where bat mortality has been relatively low To date, post construction mortality surveys in the northeast, including new England, have documented a greater proportion of long distance migratory bat fatalities, particularly silver-haired bats (*Lasionycteris noctivagans)* and hoary bats (*Lasiurus cinereus)* than those species that tend to migrate shorter distances, such as *myotis* species. Although rates of collision have been low in New England relative to other projects outside of New England, these projects have also documented the majority of collision impacts during the fall migratory season. Impacts are expected to be greatest during the fall migratory season, based on the timing of acoustic activity at the Project as well as patterns observed at operational sites.

Overall, the impacts to birds and bats expected at the Project are not unique to this Project, but similar to those generally associated with wind power in the eastern United States, but more similar to those in New England. Habitats at the Project are typical of lands managed for industrial timber harvests and consist of mixed age classes of hardwood forest with red spruce along portions of the summits, and the topography of the site is also typical of the region. Potential ecological impacts are expected to be within the range of those documented at existing wind facilities in the east particularly those in New Hampshire and Maine, which have been shown to be relatively low. Nocturnally migrating songbirds and bats are expected to be the most vulnerable to collision mortality at the Project, especially during the fall migration period when passage rates were greatest based on results the field surveys. Resident threatened or endangered bird species were not documented breeding in the Project area. Although some T& E species were observed during raptor migration surveys as they migrated through the Project vicinity, they were observed infrequently and for short periods of time. Impacts to T & E species are not expected to occur.

Table of Contents

Tables

Figures

Appendices

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1.0 Introduction

Potential ecological impacts to birds and bats associated with wind projects can be divided into two primary categories: direct impacts involving collision mortality with turbine blades, towers, and associated structures, and indirect impacts such as habitat loss and displacement from areas containing turbines. In an effort to assess potential impacts to birds and bats at the proposed Groton Wind Project (the Project) located on Tenney and Fletcher Mountains in Groton, New Hampshire, Groton Wind, LLC (Groton) and its consultants developed a proposed work plan for avian and bat studies (Iberdrola 2009) with the US Fish and Wildlife Service (USFWS) and NHFGD in spring 2009 (Appendix A). The work plan was developed by Groton Wind based on two previous documents: Iberdrola Renewables Avian and Bat Protection Plan (ABPP), which the USFWS has endorsed, and the Groton Wind Farm Groton Phase 1 Avian Risk Assessment (ARA), which was produced by Curry & Kerlinger. The work plan was submitted to the NHFGD and USFWS for feedback and comment of which were subsequently incorporated. Following the details of the proposed scope of work, Stantec Consulting (Stantec) and New Hampshire Audubon conducted a variety of field surveys for birds and bats in the Project area. Including selected surveys completed prior to 2009, Stantec conducted surveys between 2006 and 2009. Methods, results, and discussion of each survey are summarized in detail in the seasonal survey reports (Stantec 2006 Summer and Fall Wildlife Survey Letter Report [Stantec 2006]; Spring 2008 Radar Survey Report [Stantec 2008a], Fall 2008 Radar Survey Report [Stantec 2008b], 2009 Summer and Early-Fall Peregrine Falcon Use Survey Report [Stantec 2009a], and 2009 Spring, Summer, and Fall Avian and Bat Survey Report [Stantec 2009b]). Following analysis of the results of on-site field surveys, Stantec reviewed available information regarding the abundance, distribution, and species composition of birds and bats in the Project area, synthesized this information with results of on-site surveys, reviewed known patterns of collision mortality at wind farms for each group, and finally incorporated this information into this risk assessment.

The purpose of this document is to provide a summary of information obtained from literature review, agency consultation, and site-specific pre-construction field surveys to evaluate potential impacts to birds and bats from construction and operation of the Project. The document is organized around four primary categories, which are further divided into sections discussing particular species and/or guilds within the group. The primary categories discussed in this assessment are raptors, nocturnally migrating passerines, breeding birds, and bats.

Unlike traditional ecological risk assessments, in which a stressor is present in a measurable quantity and potential effects of this stressor on various species or communities have been described, risk assessments for wind energy involve a stressor that is not yet present in the landscape (wind turbines), and, therefore, cannot predict risk in a quantitative manner. However, the risk assessment approach provides a framework for systematic analysis and standardized documentation that elucidates the factors considered in the evaluation process. This document will serve as a screening-level, modified ecological risk assessment (ERA) and follows a conservative, qualitative approach to predicting levels of risk to various bird and bat species. This approach uses a weight-of-evidence (WOE) approach that simultaneously evaluates multiple, diverse survey methods and considers the strengths and weaknesses of each. Level of risk for each species or group evaluated is predicted by taking into account its abundance in the Project area, the likelihood of exposure to wind turbines, and patterns of impact to the particular species or group, as documented at existing wind projects. The WOE approach was selected for this risk assessment because it is well suited to make the most appropriate use of a variety of types of data with ranging quality and applicability, and was identified as a frequently used method in a draft document prepared by the National Wind Coordinating Committee (NWCC) on the applicability of ERA to wind projects (Kunz 2007b).

Although risk assessments have not typically been included as part of the permitting process for wind projects in New England, Groton Wind proposed a formal risk assessment as part of the work plan, which was submitted to NHFGD and USFWS. No comments were received back from the agencies regarding the methodology proposed for the Risk Assessment. However, the WOE approach has been used by Stantec to assess risk at one project in New England (Rollins Wind Project, Maine) and two projects in the Mid-Atlantic (Laurel Mountain and New Creek, both in West Virginia) (Stantec 2009c, Stantec 2008d, and Stantec 2008e). This approach has been accepted by the regulatory agencies in those states. Although, this assessment is slightly different than used at other projects in New Hampshire in the past, it provides a standardized approach to assessing risk to birds and bats from the project by incorporating a variety of lines of evidence and the strengths and weaknesses of them. Overall, it provides descriptions of each line of evidence used and the process in which conclusions of risk were reached.

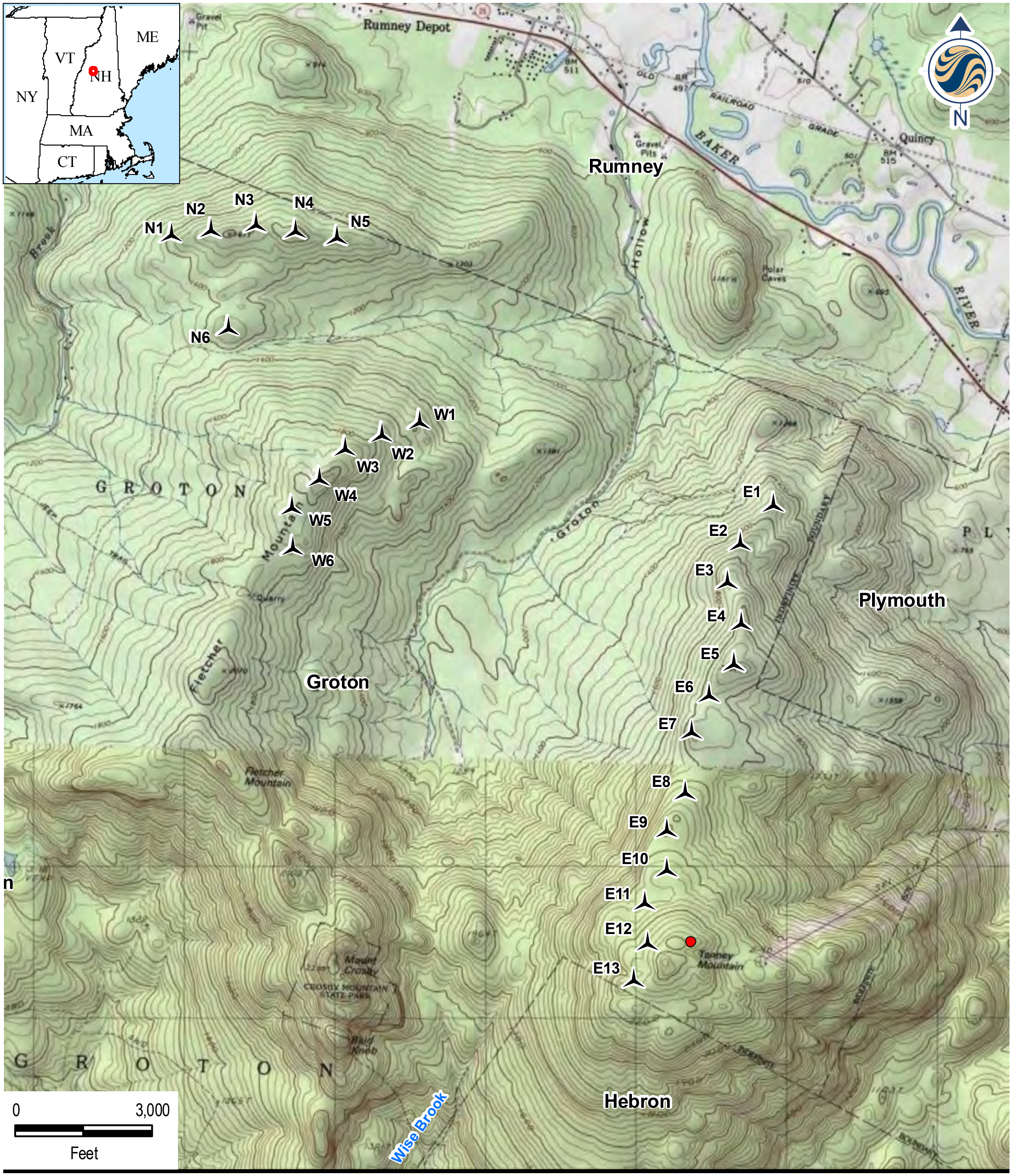
1.1 PROJECT AREA DESCRIPTION

The Project is located in Grafton County, New Hampshire within the Sunapee Uplands subsection as characterized by Sperduto and Nichols 2004 in *Natural Communities of New Hampshire*. This subsection of New Hampshire is classified by its moderate topography consisting of granite hills and peaks of shallow, nutrient poor soils interspersed with small lakes and narrow stream valleys (Sperduto and Nichols 2004).

More specifically, the Project is located on Tenney Mountain and the northwest extension of Fletcher Mountain in Groton, New Hampshire. Both Tenney and Fletcher mountains are oriented northeast/southwest, the northwest extension is oriented east to west. The peaks range in elevation from 427 m (1401’) to 689 m (2260’). Due to its moderate elevation, the dominant tree species in the Project area include sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis)*, and American Beech (*Fagus grandifolia*), which are typical of northern hardwood – conifer forests. This forest community is the most common in the northern half of the State of New Hampshire. Some small pockets of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are present, but are limited to the ridge summits. Common understory species include regenerating canopy species (e.g., sugar maple, yellow birch, and American beech), hobblebush (*Viburnum lantanoides*), striped maple (*Acer pensylvanicum*), and white birch (*Betula papyrifera*).

As proposed, the majority of the Project site (the northern two-thirds of Tenney Mountain) is located on lands owned by Green Acres Woodlands and managed by FORECO, a local forest management company. The Fletcher Mountain portion of the Project area is on lands owned by Yankee Forest and managed by Wagner Forest Management, and the Smith Family. Both Green Acre Woodlands and Yankee Forest actively manage these lands for commercial forestry products. Consequently, human disturbances are evident across the majority of the Project site. Historically and presently, the land within and surrounding this area, including the summits of the ridgeline, has been used for commercial timber production. This is evident by the recent and past cuts as well as the presence of a network of haul roads that extend through the site. These forest management operations have resulted in a variation of forest age classes. Crosby Mountain State Park is located south of the Fletcher Mountain portion of the Project area. The 230-acre Park includes Jericho Lake and Mount Crosby (elevation 676 m [2,218 ft]). The Tenney Mountain downhill ski area abuts the Project area on the southeast side of the ridge, and includes approximately 48 cleared ski trails. At this location, trails and maintenance roads provide access to the summit for servicing ski trails and chairlifts. A communication tower is also adjacent to the Project area on the summit of Tenney Mountain. The southern summit is the highest point of elevation within the Project area and is evidenced by a greater frequency of red spruce and balsam fir than the side slopes of the Project area ridgelines.

For the purposes of describing breeding bird, raptor, and bat activity within the Project area, the Project area refers to the proposed turbine areas as depicted in Figure 1-1 and does not include the lowlands where access roads, transmission corridors, and the substation are to be located.



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Legend

- Communication Tower
- Turbine Location (10-26-2009)

Client/Project

Groton Wind Project
Groton, New Hampshire

Figure No.
1-1

Title
Project Area Location Map
November 30, 2009

00299-F001-Locus.mxd

2.0 Methods

2.1 INFORMATION REVIEW

For each avian and bat species group discussed in this ERA, Stantec reviewed available sources of data on distribution, abundance, and species composition in the vicinity of the Project area. These included online databases, literature review, agency consultation, regional survey data, and the Groton Phase I Avian Risk Assessment for the Groton Wind Project authored by Curry and Kerlinger in 2008. The quantity and relevance of these data varied by species group and included sources such as results of Christmas Bird Counts (CBC), Breeding Bird Survey (BBS) routes, the Cornell Lab of Ornithology and National Audubon Society's online checklist program (eBird), results of Hawk Migration Association of North America (HMANA) counts, known habitat associations of various species, and literature regarding distribution and abundance of various species. Specific types of information used for each group are identified in the corresponding results sections of this report.

2.2 FIELD SURVEYS

A variety of on-site field surveys were conducted in the Project area between July 2006 and October 2009. Surveys were conducted primarily during the spring and fall migration periods, and included nocturnal marine radar surveys, breeding bird surveys, spring and fall raptor migration surveys, acoustic bat surveys, and a summer peregrine falcon (*Falco peregrinus*) survey. Dates of various field surveys conducted in the Project area are summarized in Table 2-1.

Table 2-1. Timing and level of effort for avian and bat field surveys conducted in the Project area

Survey Type	Range of Dates	# Survey Days (or nights)	# Locations Sampled	Source
Fall 2006 Acoustic Bat Survey	7/27/06 to 10/16/06	69	3 detectors	Stantec 2006 Summer and Fall Wildlife Survey Letter Report (Stantec 2006)
Summer/Early-Fall 2006 Pilot Peregrine Falcon Surveys	6/23/06 to 9/23/06	4	1 aerie location	Stantec 2006 Summer and Fall Wildlife Survey Letter Report (Stantec 2006)
Spring 2008 Nocturnal Radar Survey	4/17/08 to 6/1/08	40	1 radar location	Spring 2008 Radar Survey Report (Stantec 2008a)
Fall 2008 Nocturnal Radar Survey	8/14/08 to 10/10/08	45	1 radar location	Fall 2008 Radar Survey Report (Stantec 2008b)

2009 Breeding Bird Survey	6/10/09 to 6/27/09	2 rounds of surveys, 6 days total	21 point-count locations	2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b)
Spring 2009 Raptor Migration Survey	3/26/09 to 5/23/09	11 days	2 locations surveyed simultaneously	2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b)
Fall 2009 Acoustic Bat Survey	8/11/2009 to 10/22/09	466 nights	8 detectors	2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b)
Fall 2009 Raptor Migration Survey	8/24/09 to 10/26/09	10 days	2 locations surveyed simultaneously	2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b)
2009 Summer/Early-Fall Peregrine Falcon Surveys	6/23/09 to 9/10/09	20 days	4 locations surveyed simultaneously	2009 Summer and Early-Fall Peregrine Falcon Use Survey Report (Stantec 2009a)

Methods and work scopes for surveys conducted in the Project area were based on a combination of standard methods within the wind power industry for pre-construction surveys, input and guidance from the New Hampshire Audubon Society (NH Audubon), and NHFGD. Surveys were consistent with several other studies conducted recently in the state and the Northeast region including the only two operational or permitted projects in NH. This document has been prepared at the request of Groton Wind, LLC, and serves as an overall synthesis of survey results and available information from other publicly available surveys at proposed or existing wind projects in the eastern United States. Detailed descriptions of the survey methods and results of surveys included in Table 2-1 are summarized in corresponding survey reports, but are not included in this document.

Although Stantec did not conduct formal habitat surveys as part of its fieldwork, this risk assessment includes general information about habitat types present within the project area. This information was obtained during on-site radar, raptor, breeding bird, and acoustic bat surveys, which involved hiking and/or driving throughout most of the project area. Additional information was gained through a review of a formal habitat assessment conducted by VHB for the Project dated November 2009. Throughout this report, “habitat characterizations” refer to information recorded by Stantec during fieldwork in the Project area between 2006 and 2009, and are limited to general, qualitative observations.

2.3 RISK ASSESSMENT

Information gathered for each primary category (raptors, nocturnally migrating passerines, breeding birds, and bats) during the information review process and on-site field surveys was incorporated into this risk assessment. Although risk assessments used in different fields of study are variable in scope and focus, they often share a common framework with consistent terms used to describe key concepts. Because these terms can be technically complex, the following outlines vocabulary used to describe key components of this risk assessment.

Weight-of-Evidence (WOE) is the process by which multiple measurement endpoints are related to an assessment endpoint to evaluate risk. An **assessment endpoint** is a "…quantitative or quantifiable expression of the environmental value considered to be at risk…" from a given stressor (Suter 1993) (e.g., the potential collision mortality of a species, or potential loss of habitat for a species). **Measurement endpoints** are the methods used to estimate the effects of exposure on an assessment endpoint (e.g., literature review and nocturnal radar surveys, and literature review and breeding bird surveys, respectively, for the examples provided). **Potential stressors** evaluated at wind facilities can include moving or stationary turbine blades, monopoles, habitat removal and fragmentation, behavioral effects, or human activity leading to disturbance, among others (Leddy *et al.* 1999). Specific measurement endpoints, assessment endpoints, and stressors for each species category are identified in corresponding subsections of the results section.

A WOE model is a central component of the Ecological Risk Assessment that takes into account the strengths and weaknesses of different measurement endpoints. Within this model, lines of evidence that yield high quality, relevant data for a particular ERA are assigned more "weight" than lines of evidence that may be less relevant, or less accurate. This approach is particularly well-suited for an ERA involving multiple measurement endpoints with varying degrees of relevance to particular assessment endpoints, which is typically the case with pre-construction surveys at proposed wind projects. The WOE approach will not eliminate discrepancies in the quality or relatedness of the sources of data, but rather evaluates each source of data in a systematic manner. Professional judgment, along with scientific knowledge and technical expertise, are applied in the evaluation of multiple lines of evidence pertaining to a specific assessment endpoint. The WOE model provides a comprehensive strategy for integrating disparate assessment methods into a cohesive framework that facilitates the interpretation of results.

The procedure used in this risk assessment was modeled after the method developed by the Massachusetts Weight-of-Evidence Workgroup (hereafter workgroup), an independent *ad hoc* group of ecological risk assessors from both government and private sectors (Massachusetts Weight-of-Evidence Workgroup 1995). The workgroup drafted a guidance document to provide standardized terminology and methodology for implementing a WOE approach. This document, as well as the U.S. Environmental Protection Agency's (USEPA) Framework for Ecological Risk Assessment (USEPA 1992), serve as the basis for the approach used to assess risk to bats and birds from the development and operation of the proposed Project.

The WOE approach followed in this document was organized around four primary processes. First, assessment and measurement endpoints were defined for each species category to best address potential impacts within that category and allow for discussion of risk to certain subgroups separately. For example, potential impacts to Threatened and Endangered (T&E) bird species was treated as a separate assessment endpoint from risk of collision to non-listed bird species within the bird section. Measurement endpoints typically consisted of each type of data available or survey conducted on-site to address a particular assessment endpoint. In some cases, certain similar types of information, such as a variety of types of regional information on abundance of breeding birds, were combined into a single measurement endpoint.

Second, weight was assigned to each measurement endpoint, based on a series of ten criteria considered equally important in evaluating measurement endpoints (Massachusetts Weight-of-Evidence Workgroup 1995). The ten attributes are divided into three categories: 1) strength of association between assessment and measurement endpoints; 2) data quality; and 3) study design and execution (Table 2-2). Each measurement endpoint was scored according to each of the ten attributes, resulting in an overall score of high, medium, or low based on broadly applicable, non-overlapping criteria based on those presented in a document prepared by the WOE workgroup (Massachusetts Weight-of Evidence Workgroup 1995). These criteria are identified in Table 2-3. While the criteria contained in Tables 2-2 and 2-3 are more appropriate for use in traditional risk assessments involving stressors present in a system in a measurable quantity, they were applied to the endpoint pairs used in this risk assessment as appropriately and consistently as possible.

Third, each measurement endpoint was evaluated with respect to its indication of risk of harm and the magnitude of this risk. Indication of risk of harm for each measurement/assessment endpoint pair was described as “yes” (potential impact exists), “no” (potential impact does not exist), or “undetermined.” For endpoint pairs where a potential impact was determined to exist, the magnitude of response was characterized has “high,” “moderate,” or “low,” depending on the predicted severity of impact.

Finally, the level of concurrence among measurement endpoints was evaluated to determine whether or not various measurement endpoints generally predicted similar levels and magnitudes of risk. This was done by plotting each measurement endpoint on a matrix, the columns of which present the weights assigned in the first step, and the rows of which present the likelihood of risk based. Agreements or divergences among measurement endpoints are readily observed using this matrix, enabling interpretation of the results of various survey methods with respect to particular assessment endpoints. Within this report, assessment and measurement endpoints are identified and evaluated in the results section, and the remainder of the steps previously described are contained in the discussion section, organized by the four species categories in both sections.

Table 2-2. Definitions of attributes used to determine the "weight" of measurement endpoints (Massachusetts Weight-of-Evidence Workgroup 1995)

	Attributes	Measurement Endpoint
I. Strength of Association between Measurement and Assessment Endpoints		
1	Degree of Biological Association	The extent to which the measurement endpoint is representative of, and correlated with, or applicable to the assessment endpoint. Biological linkage is based on known biological processes; similarity of effect, target organism, mechanism of action, and level of ecological organization.
2	Stressor/Response	The ability of the endpoint to demonstrate effect from exposure to the stressor and to correlate effects with the degree of exposure. As such, this attribute also takes into consideration the susceptibility of the receptor and the magnitude of effects observed.
3	Utility of Measure	This attribute relates the ability to judge results of the survey against well-accepted standards, criteria, or objective measures. As such, the attribute describes the applicability, certainty, and scientific basis of the measure, as well as the sensitivity of a benchmark in detecting environmental harm.
II. Data Quality		
4	Data Quality	The degrees to which data quality objectives are designated that are comprehensive and rigorous, as well as the extent to which they are met. Data quality objectives should clearly evaluate the appropriateness of data collection and analysis practices. If any data quality objectives are not met, the reason for not meeting them and the potential impact on the overall assessment should be clearly documented.
III. Study Design and Execution		
5	Site Specificity	The extent to which biological data, environmental conditions, or habitat types used in the measurement endpoint reflect the site of interest.
6	Sensitivity	The ability to detect a response in the measurement endpoint, and the ability to discriminate between responses to a stressor and those resulting from natural or design variability and uncertainty.
7	Spatial Representativeness	The degree of compatibility or overlap between the locations of measurements or samples, locations of stressors, and locations of ecological receptors and their potential exposure.
8	Temporal Representativeness	The degree of temporal overlap between the measurement endpoint (when data were collected) and the period during which effects of concern would be likely to be detected. Also linked to this attribute is the number of measurement or sampling events over time and the expected variability over time.
9	Quantitative Measure	This attribute relates to whether magnitude of response can be assessed objectively or subjectively, and whether the results can be tested for both biological and statistical significance.
10	Standard Method	The extent to which the study follows standard protocols recommended by a recognized scientific authority for conducting the method correctly. Examples of standard methods are study designs repeatedly published in the peer reviewed scientific literature. This attribute also reflects the suitability and applicability of the method to the endpoint and the site, as well as the need for modification of the method.

Table 2-3. Criteria for qualitatively ranking measurement endpoints (Massachusetts Weight-of-Evidence Workgroup 1995)

Attribute		Measurement Endpoint Ranking Criteria		
		LOW	**MEDIUM**	**HIGH**
1	**Biological linkage between measurement endpoint and assessment endpoint**	Biological processes link the measurement endpoint to the assessment endpoint only indirectly, yielding a weak correlation between the assessment and measurement endpoints	Measurement and assessment endpoints are directly linked and the adverse effect, target organism, and mechanism of action are the same for both endpoints; however, the levels of ecological organization differ	Assessment endpoint is directly measured and, therefore, is equivalent to the measurement endpoint
2	**Correlation of stressor to response**	Endpoint response to stressor has not been demonstrated in previous studies but is expected based upon demonstrated response to similar stressors	In previous studies, endpoint response to stressor has been demonstrated, but response is not correlated with magnitude of exposure	Statistically significant correlation is demonstrated
3	**Utility of measure for judging environmental harm**	Measure is developed by the investigator (i.e., personal index) and has limited applicability and certainty, the scientific basis is weak, and the benchmark is relatively insensitive	Measure is well accepted and developed by a third party but has either limited applicability or certainty, or the scientific basis is weak, or the benchmark is relatively insensitive	Measure is well accepted and developed by a third party and has very high levels of certainty and applicability, as well as a very strong, scientific basis and benchmark is very sensitive
4	**Quality of data**	Three or more study objectives are not met, the level of error is large, and the data collected is not appropriate to address the assessment endpoint	One study objective is not met, the level of error is moderate, and the data collected is only moderately appropriate to address the assessment endpoint	All study objectives are met, the level of error is low to none, and the data collected appropriately addresses the assessment endpoint
5	**Site Specificity**	Only one or two of the six factors (i.e., data, media, species, environmental conditions, benchmark, habitat type) is derived from or reflects the site	Four of the six factors (i.e., data, media, species, environmental conditions, benchmark, habitat type) are derived from or reflect the site	All six factors (i.e., data, media, species, environmental conditions, benchmark, habitat type) are derived from or reflect the site (i.e., both data and benchmark reflect site conditions)
6	**Sensitivity of the measurement endpoint for detecting changes**	Measurement endpoint can detect only very large and obvious changes in response to stressor	Measurement endpoint can detect moderate level changes in response to stressor	Measurement endpoint is very sensitive and can detect very minute and subtle changes in response to stressor
7	**Spatial representativeness**	The locations of two of the following subjects overlap spatially only to limited extent: study area, sampling/measurement site, stressors, receptors, and points of potential exposure	The locations of three of the following subjects overlap spatially: study area, sampling/measurement site, stressors, receptors, and points of potential exposure	The locations of five of the following subjects overlap spatially: study area, sampling/measurement site, stressors, receptors, and points of potential exposure
8	**Temporal representativeness**	Measurements are collected during a season different from when effects would be expected to be most clearly manifested; AND A single sampling or measurement event is conducted; AND High variability in that parameter is expected over time	Measurements are collected during the same period that effects would be expected to be most clearly manifested; AND A single sampling or measurement event is conducted; AND Moderate variability in that parameter is expected over time	Measurements are collected during the same period that effects would be expected to be most clearly manifested; AND EITHER [two sampling events are conducted and variability is low OR multiple sampling events are conducted and variability is moderate to high]
9	**Quantitativeness**	Results are qualitative and are subject to individual interpretation	Results are quantitative, but data are insufficient to test for statistical significance	Results are quantitative and may be tested for statistical significance; such tests clearly reflect biological significance
10	**Use of a standard method**	Method has never been published AND methodology is not an impact assessment, field survey, toxicity test, benchmark approach, toxicity quotient, or tissue residue analysis	A standard method exists, but its suitability for this purpose is questionable, and it must be modified to be applicable to site specific conditions	A standard method exists and is directly applicable to the measurement endpoint and it was developed precisely for this purpose and requires no modification OR the methodology is used in three or more peer-reviewed studies

3.0 Results

3.1 RAPTORS

3.1.1 Information Review

In addition to the results of on-site field surveys, available information regarding the species composition, abundance, and migratory patterns of raptors in the vicinity of the Project area include the results of surveys conducted at the closest HMANA observation points to the Project, the results of regional bird surveys (including US Geological Survey (USGS) breeding bird survey and Audubon Christmas Count survey), information provided through agency consultations, the Groton Phase I Avian Risk Assessment for the Groton Wind Project authored by Curry and Kerlinger in 2008, nesting information for local breeding peregrine falcon, telemetry data for eagles, and regional information on the distribution of raptors.

Spring 2009 regional raptor migration data were obtained from the five closest HMANA observation points to the Project area with available survey data and include Barre Falls, Massachusetts; Plum Island, Newburyport, MA; Pilgrim Heights, North Truro, MA; Poquonock, Connecticut; and Bradbury Mountain, Pownal, Maine. Fall 2009 regional raptor migration data were obtained from the six closest HMANA observation points to the Project area with available survey data and include Barre Falls, MA; Poquonock, Connecticut; Interlakes Elementary School, New Hampshire; Little Blue Job, NH; Little Round Top; NH; and Pack Monadnock, NH. These results were used to provide comparisons to surveys conducted at the Project site.

The North American USGS Breeding Bird Survey (BBS) provided a composition of species that breed in the vicinity of the Project and region, as well as the relative abundance of these species. Although the methods of these surveys typically focus on breeding passerines, information on breeding raptors were obtained from BBS data compiled between 1966 and 2009. This survey is a national survey that is conducted annually by volunteers since its inception in 1966. Each year volunteers drive the same breeding bird survey routes for replication and to track the status and trends of North American bird populations. Along each 40 km (24.5 mi) survey route, 50 stops are located approximately 0.8 km (0.5 mi) miles apart. At each stop a three minute point count is conducted. During the count, all birds seen or heard within 0.4 km (0.25 mi) miles are documented. Breeding bird survey routes are conducted at the peak of the breeding period, typically in June depending on the region. The closest breeding bird survey route to the Project is in Wilmot, NH approximately 20 miles south (Figure 3-5). The habitat along this route is predominantly deciduous forest, also containing segments of pasture/hay fields, and mixed forest. Data were obtained from this route from 1966 to 2009 and is provided in Appendix B, Table 1.

The Audubon Christmas Bird Count (CBC) was developed to monitor the status and distribution of birds in the Western Hemisphere. The CBC occurs during early winter, typically from December 14 to January 5. Each year a series of count circles are surveyed across the western hemisphere in which approximately 10 observers cover a 24 km (15 mi) diameter count circle over a period of 24 hours. The same count circle is surveyed each year and a count circle does not overlap with another count circle. Only birds detected within the count circle are recorded. The nearest CBC count to the Project is centered in Baker Valley, approximately 1.2

miles northeast of the Project, and includes all of the Project area within its boundary. Data for the Baker Valley CBC are available for years 2000 through 2009 (Figure 3-5; Appendix B, Table 2).

The Groton Phase I Avian Risk Assessment for the Project was authored by Curry and Kerlinger, L.L.C in June 2008. The purpose of the Groton Phase I Risk Assessment was to determine potential collision and displacement risk to birds due to the Project (impacts were not assessed for bats). The risk assessment involved a site visit for a habitat evaluation, a regional bird survey database review, a literature review, and written consultation with wildlife agencies for special-interest species.

Also available are the results of 25 post-construction mortality studies conducted at 20 different locations throughout the U.S. (outside of California) (Osborn *et al.* 2000, Johnson *et al*. 2002, Kerlinger 2002, Young *et al.* 2003, Erickson *et al.* 2000, Erickson *et al.* 2004, Kerlinger 2006, Erickson *et al.* 2003, Johnson *et al*. 2003, Kerns and Kerlinger 2004, Arnett *et al.* 2005, Koford *et al*. 2005, Fiedler *et al*. 2007, Howe *et al.* 2002, Jain *et al*. 2007, Jain *et al*. 2008, Jain *et al.* 2009a, Stantec 2008, Stantec 2009, Young *et al*. 2009, Tidhar 2009, Jain *et al.* 2009b, Jain *et al.* 2009c, Jain *et al.* 2009d). These studies provide information regarding the numbers of individuals and species of raptors that have been involved with collisions at wind farms (Appendix B, Table 3).

3.1.2 Field Surveys

On-site field surveys to document raptor activity in the Project area consisted of one spring migration season, one fall migration season, and one summer/early-fall season of peregrine falcon surveys (an additional summer/early-fall season was surveyed; however, this pilot study included only 4 days of sampling in 2006 from an observation location outside of the Project area at a nearby peregrine falcon aerie on Rattlesnake Mountain) (Table 3-1). The spring 2009 migration surveys were conducted from two different observation locations overlooking the Project area; the fall 2009 migration surveys were conducted from one location within the Project area and one location overlooking the Project area; and the summer/early-fall peregrine falcon surveys were conducted from two nearby peregrine falcon aerie locations, from one location within the Project area, and one location over-looking the Project area (Figure 3-1). Detailed descriptions of the methods and results of these surveys are included in the respective field reports (Woodlot 2006, Stantec 2009a, Stantec 2009b).

3.1.3 Risk Assessment Endpoints

Two assessment endpoints were chosen for the evaluation of risk to raptors associated with the Project: (1) potential collision mortality of raptors, including resident and migrating individuals, and (2) potential habitat loss or displacement of raptors from the Project area. Five measurement endpoints were identified for these assessment endpoints as specified in Table 3-1. Measurement endpoints consisted of literature review (1a and 2a), results of spring and fall raptor field surveys (1b), summer/early-fall peregrine falcon surveys (1c), and results of a general habitat characterization (2b). Literature review included a review of information on interactions between raptors and wind turbines, collision mortality data from operational wind projects, and information on the distribution of raptors (including RTE species) in the vicinity of the Project area.

<table>
<caption>Table 3-1. Assessment and measurement endpoints used to assess risk to raptors at the Groton Wind Project</caption>
<tr><th colspan="2">Assessment Endpoint</th><th colspan="2">Measurement Endpoints</th><th>Measurement Endpoint Response</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Potential collision mortality of resident and migratory raptors</td><td>1a</td><td>Literature Review</td><td rowspan="2">Review literature regarding interactions between raptors and turbines and collision mortality results from other sites. Document species composition, abundance, and flight patterns of raptors in the Project area and surrounding area.</td></tr>
<tr><td>1b</td><td>Raptor Migration Surveys and Regional Bird Surveys</td></tr>
<tr><td>1c</td><td>Summer/Early-Fall Peregrine Falcon Surveys</td><td>Document flight and foraging patterns of resident breeding and fledgling peregrine falcons from two nearby nest sites.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Potential habitat loss or displacement of raptors from the Project area</td><td>2a</td><td>Literature Review</td><td rowspan="2">Characterize available habitat pre-construction, and the types of habitat loss/conversion resulting from construction.</td></tr>
<tr><td>2b</td><td>General Habitat Characterization</td></tr>
</table>

Each measurement/assessment endpoint pair was assigned a weight based on the attributes and criteria described in the methods section. Overall, the measurement endpoints were evaluated as medium to low weight-of-evidence (Table 3-2). However, the relatively low scoring of measurement endpoints used in the risk assessment is not a result of insufficient pre-construction data, which provided a thorough characterization of migration activity of raptors through the Project area. Instead, the uncertainty stems from the lack of understanding of the connection between pre-construction surveys and rates of mortality once facilities become operational. Moreover, the stressor is not yet present in the landscape. It is important to note that additional pre-construction surveys would not necessarily increase the rankings of these attributes or the ability to accurately predict risk to raptors, specifically because additional field survey data would not further understand the link between pre-construction and post-construction conditions until the Project is constructed.

To date, wind power facilities in New England have documented low mortality rates during post-construction surveys making correlations between pre- and post-construction surveys difficult. However, the operational Lempster Wind Project nearby which is similar in elevation and habitat to the Groton Wind Project may provide useful insight as to potential impacts to raptors from the Groton Project by comparing the pre-construction data between the two.

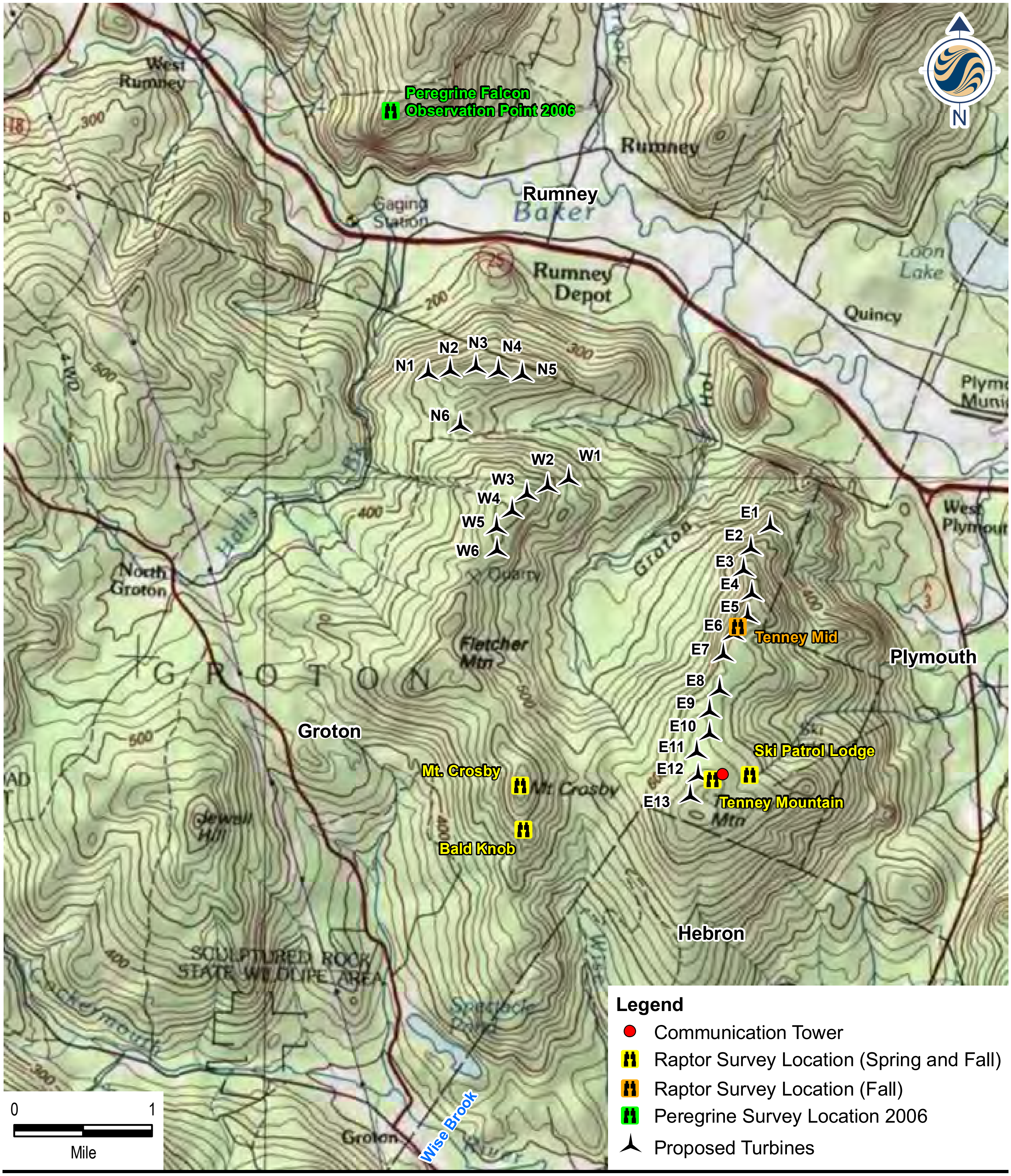

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Figure No.
3-1

Title
Raptor Survey Location Map
November 30, 2009

00299-F003-1-Raptor.mxd

Table 3-2. Weight-of-evidence evaluation of measurement endpoints used to evaluate risk to raptors at the Groton Wind Project

Attributes	Measurement Endpoints: Collision mortality 1a Literature Review	Collision mortality 1b Raptor Migration Surveys and Regional Bird Surveys	Collision mortality 1c Summer/early-fall Peregrine Falcon Surveys	Indirect Impacts 2a Literature Review	Indirect Impacts 2b Habitat Characterization	Rationale
II. Strength of Association between Assessment and Measurement Endpoint						
Degree of Biological Association	Medium	Medium	Medium	Medium	Medium	Literature review can directly characterize patterns in collision mortality and indirect displacement at existing wind farms only. Pre-construction raptor surveys can document species composition and behavior of raptors, although these results can only be used indirectly to characterize risk of collision or indirect impacts, as relationships between pre-construction surveys and post-construction surveys have not been established.
Stressor/Response	Medium	Medium	Medium	Medium	Medium	Increased exposure to wind turbines presumably increases risk of collision, although the mechanisms explaining collision mortality remain ambiguous. However, patterns in collision mortality, raptor avoidance capabilities, and indirect impacts will likely be similar between sites, so as more information is gathered, this relationship will become stronger, for at least some species.
Utility of Measure	Medium	Medium	Medium	Medium	Medium	The methods used for raptor migration surveys and habitat surveys (and the literature that reports their results) are well accepted and developed by a third party, but they have limited applicability and are relatively insensitive for determining risk.
II. Data Quality						
Data Quality	Medium	Medium	High	Medium	Medium	Raptor surveys and aerial nesting surveys are appropriate tools to characterize the population of raptors in the Project area. Although surveys were conducted in a rigorous manner, results of these types of ecological surveys are inherently subject to uncertainty and require extrapolation to relate to the assessment endpoints.
III. Study Design						
Site Specificity	Low	High	High	Low	High	Raptor migration and habitat surveys provide highly site-specific data that could provide means for comparison of pre- and post-construction results. Literature review of mortality surveys at other sites has uncertain applicability to the exposure site. Habitat characterizations directly measure loss/conversion at the site of interest and lit review of habitat loss at other areas is probably moderately applicable.
Sensitivity	Low	High	High	Low	Medium	Raptor surveys can detect subtle changes in the species composition, relative abundance, and behavior of raptors in the Project area provided that surveys are conducted on a regular basis using the same methods. Habitat characterizations can detect moderate level changes in raptor habitat from measuring loss/conversion.
Spatial Representativeness	Low	High	High	Low	Medium	Raptor surveys were conducted from two sites in or near the Project area, and summer peregrine surveys were conducted from four locations simultaneously. Habitat characterizations were general, focusing on dominant conditions and major losses/conversions expected.
Temporal Representativeness	N/A	High	High	N/A	Medium	Raptor surveys took place during the active spring and fall migration periods, and occurred throughout most of the migration period. Summer peregrine surveys took place throughout the incubation and fledgling stages.
Quantitative Measure	Low	Low	Low	Medium	Low	The magnitude of response to the stressor can not be tested statistically for pre-construction raptor surveys, because the exposure has not yet occurred. Statistical tests, such as those used in spatial statistics in GIS analysis of fragmentation or connectivity, could be conducted and applied to a predictive model of impact to raptor habitat.
Standard Method	N/A	Medium	Medium	N/A	Medium	A standard method exists for conducting raptor migration surveys, but its applicability to predicting risk is questionable. Methods for habitat characterizations are well documented and application to evaluating loss/conversion of bat habitat could be standardized.
Overall Endpoint Value*	Low/Medium	Medium/High	Medium/High	Low/Medium	Medium	

* Overall endpoint value was determined by determining the number of attributes ranked as "low", "medium", and "high" for each measurement endpoint.

3.2 NOCTURNALLY MIGRATING PASSERINES

3.2.1 Information Review

Nocturnal migrants consist primarily of migrating passerines. Although various species of migratory bats also migrate at night, potential impacts to migratory bats are discussed separately in sections 3.4 and 4.4. Little information is available on regional patterns, numbers, and species composition of nocturnally migrating passerines. However, general literature exists on behavior of migrating birds with respect to topography, seasonal timing, and general migration routes. Also, an increasing amount of information from radar surveys conducted at proposed wind projects is becoming publicly available and provides general information on flight heights and passage rates on a somewhat more specific level. Several entities have conducted numerous radar surveys at proposed wind projects throughout the east between 2004 and 2009 (Table 2-1 in the Spring 2008 Radar Survey Report and Appendix A Table 5 in the Fall 2008 Radar Survey Report). Results of these surveys were compared to those from the Project area to provide context, and to characterize overall anticipated migration patterns in the vicinity of the Project. Additionally, the Groton Phase I Avian Risk Assessment by Curry and Kerlinger was reviewed.

Also available are the results of 25 post-construction mortality studies conducted at 20 different locations throughout the U.S. (outside of California) (Osborn *et al.* 2000, Johnson *et al*. 2002, Kerlinger 2002, Young *et al.* 2003, Erickson *et al.* 2000, Erickson *et al.* 2004, Kerlinger 2006, Erickson *et al.* 2003, Johnson *et al*. 2003, Kerns and Kerlinger 2004, Arnett *et al* 2005, Koford *et al*. 2005, Fiedler *et al*. 2007, Howe *et al.* 2002, Jain *et al*. 2007, Jain *et al*. 2008, Jain *et al.* 2009a, Stantec 2008, Stantec 2009, Young *et al*. 2009, Tidhar 2009, Jain *et al.* 2009b, Jain *et al.* 2009c, Jain *et al.* 2009d). These studies provide information regarding the numbers of individuals and species of nocturnally migrating passerines that have been involved with collisions at wind farms (Appendix B, Table 4).

3.2.2 Field Surveys

Nocturnal marine radar surveys were conducted in the Project area during spring and fall 2008, from a meteorological tower clearing near the high point of Tenney Mountain (Figure 3-2). At this location the radar had unobstructed views of the surrounding airspace within the radar's range. During the spring survey, 40 nights were surveyed between April 17 and June 1, 2008 and during the fall survey, 45 nights were surveyed between August 14 and October 10, 2008. An X-band, 12 kilowatt (kW) marine radar unit mounted on an 8 meter fixed platform was used in the same location for both surveys, which were conducted using the same methodology. Detailed summaries of survey methods and results are included in the seasonal radar survey reports (Spring 2008 Radar Survey Report and Fall 2008 Radar Survey Report). Mean hourly and nightly passage rates, flight direction, and flight heights were determined for the duration of each survey. In addition to radar surveys general notes on suitability of habitats within the Project area as stopover habitat for migrating passerines as well as incidental observations of migratory flocks were taken during on-site field surveys.

3.2.3 Risk Assessment

A single assessment endpoint was chosen for the evaluation of risk to nocturnally migrating passerines associated with the Project: potential collision mortality of nocturnally migrating passerines. Potential indirect impacts to nocturnally migrating passerines, such as loss of stopover habitat, are discussed under indirect impacts to breeding birds. Because sufficient data do not exist to characterize patterns of nocturnal migration within the Project area on a species-specific or even guild-specific level, risk is discussed for nocturnal migrants as a group. Measurement endpoints were identified for each assessment endpoint as specified in Table 3-3. Measurement endpoints consisted of literature review (3a) and results of spring and fall nocturnal radar surveys (3b). Literature review included a review of information on interactions between nocturnally migrating passerines and wind turbines, collision mortality data from operational wind projects including the Lemspter Wind Project in Lempster, NH, and information on general migration patterns in the vicinity of the Project area.

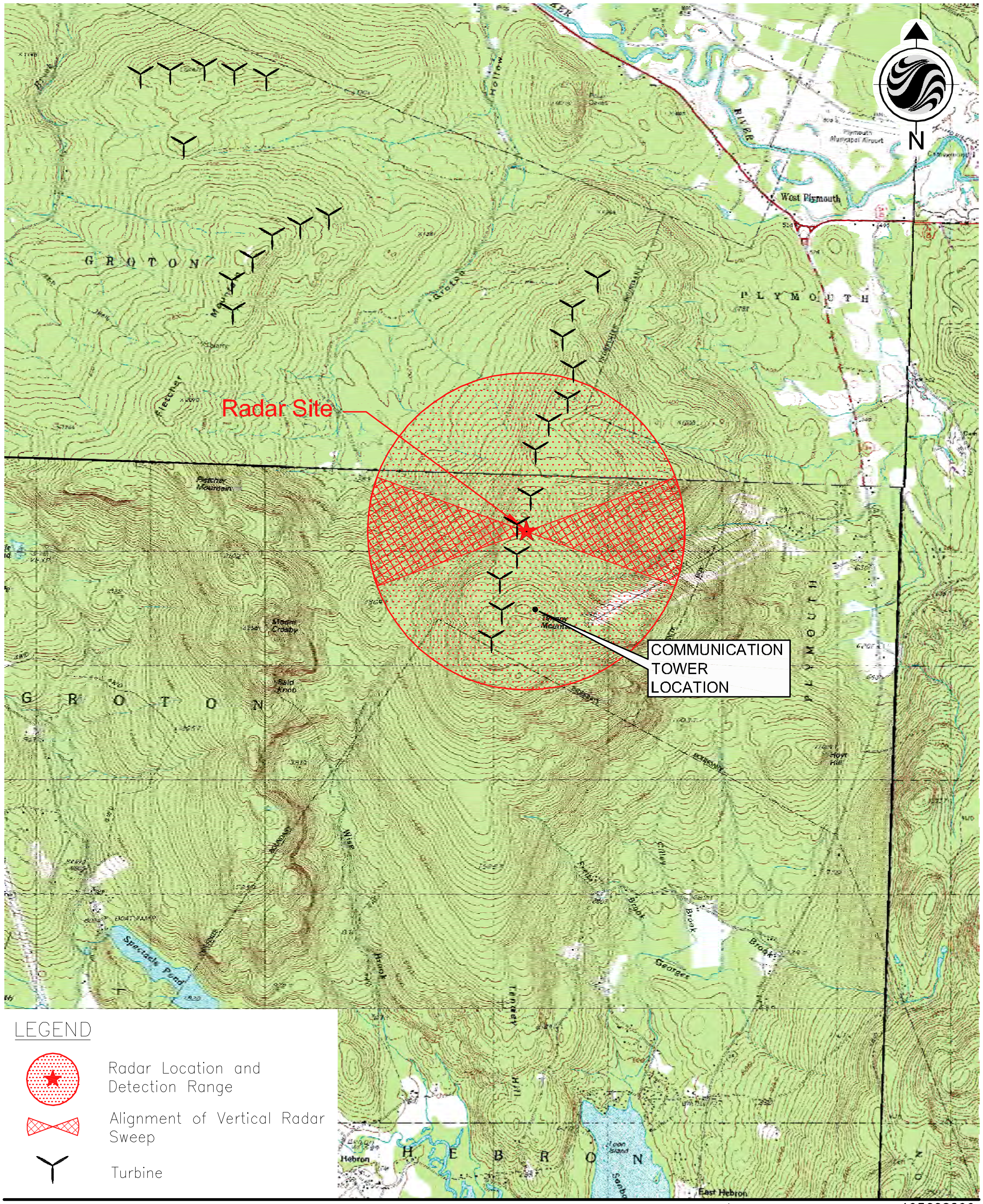

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Figure No.
3-2

Title
Radar Location Map

November 30, 2009

Table 3-3. Assessment and measurement endpoints used to assess risk to nocturnally migrating passerines at the Project				
Assessment Endpoint		**Measurement Endpoints**		**Measurement Endpoint Response**
3	Potential collision mortality of nocturnally migrating passerines	3a	Literature Review	Review literature regarding interactions between nocturnal migrants and turbines and collision mortality results from other sites. Document flight patterns of nocturnal migrants above the Project area during spring and fall migration periods.
		3b	On-site Radar Surveys	

Each measurement/assessment endpoint pair was assigned a weight based on the attributes and criteria described in the methods section. Overall, the measurement endpoints were evaluated as medium to low weight-of-evidence (Table 3-4). However, the relatively low scoring of measurement endpoints used in the risk assessment is not a result of insufficient pre-construction data, which provided a thorough characterization of nocturnal migration activity in the Project area. Instead, the uncertainty stems from the lack of understanding of the connection between pre-construction surveys and rates of mortality once facilities become operational. Moreover, the stressor is not yet present in the landscape. It is important to note that additional pre-construction surveys would not necessarily increase the rankings of these attributes or the ability to accurately predict risk to nocturnally migrating passerines, specifically because additional field survey data would not further detail the link between pre-construction and post-construction conditions until the Project is constructed.

Based on post-construction surveys in New England, pre-construction passage rates and post-construction mortality have a tenuous relationship. Low numbers of nocturnal migrant fatalities reported at post-construction sites in New England make correlation with pre-construction rates difficult. For example, if pre-construction passage rates are higher at one project than another it does not equate to higher risk of mortality at that Project. In the case of the Lempster Wind Project, pre-construction passage rates were near the higher end of the range of other studies conducted in the northeast during the fall season, and post construction mortality surveys documented very low bird mortality. Nevertheless, nearby operational facilities such as the Lempster Wind Project which is similar in elevation and habitat to the Groton Wind Project, may provide useful insight as to potential impacts to nocturnally migrating passerines from the Groton Project by comparing the pre-construction data between the two sites. At the very least these types of pre-construction comparisons allow for the identification of sites that may be an anomaly which may lead to a greater risk of impact.

Table 3-4. Weight-of-evidence evaluation of measurement endpoints used to evaluate risk to nocturnal migrants

Attributes	Measurement Endpoints Collision mortality 3a Literature Review	 3b Spring and Fall Radar Surveys	Rationale
II. Strength of Association between Assessment and Measurement Endpoint			
Degree of Biological Association	Medium	Medium	Pre-construction radar surveys can document flight patterns and passage rates of nocturnal migrants through the Project area, although these results can only be used indirectly to characterize risk of collision or indirect impacts, as relationships between pre-construction surveys and post-construction surveys have not been established. Literature review can directly characterize patterns in collision mortality and indirect displacement at existing wind farms only.
Stressor/Response	Medium	Medium	Increased exposure to wind turbines presumably increases risk of collision, although the mechanisms explaining collision mortality remain ambiguous. However, patterns in collision mortality, avoidance behavior, and indirect impacts will likely be similar between sites, so as more information is gathered, this relationship is expected to become stronger.
Utility of Measure	Medium	Medium	The methods used for radar surveys and habitat characterizations (and the literature that reports their results) are well accepted and developed by a third party, but they have limited applicability and are relatively insensitive for determining risk.
II. Data Quality			
Data Quality	High	High	Radar surveys provide an appropriate means to characterize migration patterns of nocturnal migrants in the Project area, and surveys were conducted in a rigorous manner. However, results of these types of ecological surveys are inherently subject to uncertainty and require extrapolation to relate to the assessment endpoints.
III. Study Design			
Site Specificity	Low	High	Radar and habitat characterizations provide highly site-specific data that could provide means for comparison of pre- and post-construction results. Literature review of mortality surveys at other sites has uncertain applicability to the exposure site. Habitat characterizations directly measure loss/conversion at the site of interest and literature review of habitat loss at other areas is probably moderately applicable.
Sensitivity	Low	High	Radar surveys can detect relatively subtle changes in the flight patterns and passage rates of nocturnal migrants, which could be used to assess effects of wind turbines on migration provided that pre- and post-construction surveys were conducted in a suitable manner.
Spatial Representativeness	Low	Medium	Although radar surveys were conducted from only one site in the Project area, a general understanding of patterns in migration of nocturnal migrants suggests that patterns would be relatively uniform throughout the Project area. Habitat characterizations were general, focusing on dominant conditions and major losses/conversions expected.
Temporal Representativeness	N/A	High	Radar surveys took place during a representative sample of the spring and fall migration periods, accurately characterizing the range of migration activity.
Quantitative Measure	Low	Low	The magnitude of response to the stressor can not be tested statistically for pre-construction radar surveys, because the exposure has not yet occurred. Statistical tests, such as those used in spatial statistics in GIS analysis of fragmentation or connectivity, could be conducted and applied to a predictive model of impact to habitat for nocturnal migrants.
Standard Method	N/A	Medium	A standard method exists for conducting radar migration surveys, but its applicability to predicting risk is questionable. Methods for habitat characterizations are well documented and application to evaluating loss/conversion of bat habitat could be standardized.
Overall Endpoint Value*	Low/Medium	Medium	

* Overall endpoint value was determined by determining the number of attributes ranked as “low”, “medium”, and “high” for each measurement endpoint.

3.3 BREEDING BIRDS

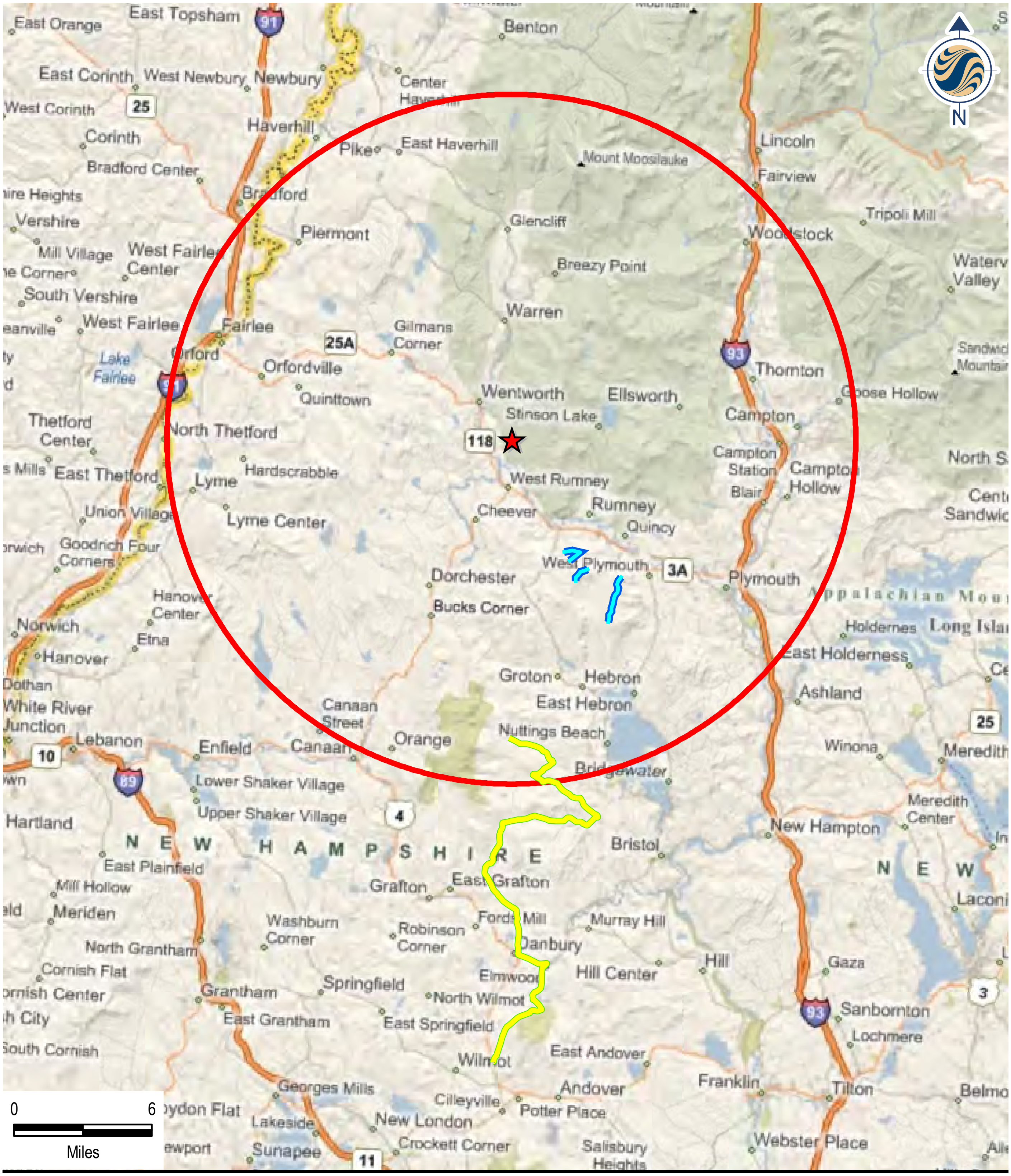
3.3.1 Information Review

A variety of sources of data exists on the distribution and abundance of birds in the vicinity of the Project and is described below. These sources include:

- USGS Breeding Bird Survey (1966-2009; Figure 3-3);
- Audubon Christmas Bird Count (2000-2009; Figure 3-3);
- Audubon Important Bird Areas (IBA);
- the Cornell Lab of Ornithology and National Audubon Society (eBird: 2009);
- New Hampshire Fish and Game (NHF&G) Non-game and Endangered Species Program and New Hampshire Partners in Flight (PIF) Priority Species Lists;
- Life history behavioral information (Birds of North America Online [BNA])
- Groton Phase I Avian Risk Assessment for the Groton Wind Project by Curry and Kerlinger (2008)

As described previously in section 3.1.1, the North American USGS Breeding Bird Survey (BBS) provides a composition of species that breed in the region, as well as the relative abundance of these species. Data on breeding birds were compiled from 1966 through 2009 for the Wilmot, NH route, the BBS route nearest the Project, approximately 6 miles to the south (Figure 3-4).

The BBS was developed as an index to show changes in North America bird populations over multiple years. Survey routes were randomly positioned within regions in order to account for species that occur in representative habitats. Along each 40 km (24.5 mi) survey route, there are 50 stops located approximately 0.8 km (0.5 mi) miles apart. A three minute point count is conducted at each stop. During the count, all birds seen or heard within 0.4 km (0.25 mi) miles are documented. BBS routes are surveyed during the peak of the breeding period, typically in June but depending on the region. As mentioned previously, the closest BBS route to the Project is in Wilmot, NH (Figure 3-4). The habitat along this route is predominantly deciduous forest, as well as segments of pasture/hay fields, and mixed forest. Data are available for this route from 1966 through 2009 (Appendix B, Table 1).



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Legend

- Christmas Bird Count Site
- Christmas Bird Count Area
- Breeding Bird Survey Route
- Turbine String

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Groton Wind Project
Groton, New Hampshire

Figure No.

3-3

Title

Regional Bird Survey Location Map
November 30, 2009

00299-F003-3-Regional-Bird-Survey-Map.mxd

As previously described in Section 3.1.1, the Audubon Christmas Bird Count (CBC) was developed to monitor the status and distribution of birds in the Western Hemisphere. The nearest CBC count to the Project is centered in Baker Valley, approximately 1.2 mi northeast of the Project, and includes all of the Project area within its boundary. Data for the Baker Valley count are available for years 2000 through 2009 (Figure 3-3; Appendix B, Table 2). Although the CBC provides a composition of mainly non-migratory species that remain in the region in the early winter, the information can be helpful in assessing potential impacts to breeding birds as well, as certain species remain in the Project area year-round.

The Cornell Bird Laboratory and the National Audubon Society developed an online checklist tool known as eBird to store avian abundance and distribution data collected by amateur and professional bird watchers across the country (http://ebird.org/content/ebird/about). Data submissions are available in real-time as they are submitted and can be accessed in many different forms by species, region, high counts, arrival/departure dates and more. For the purposes of comparison, 2009 data from Grafton County was downloaded for the dates Jan 1 – November 23. Whereas CBC, BBS, and BBA surveys are season-specific, the data submitted to eBird is annual and often includes migrant or incidental species that may be seasonally abundant but not documented from other survey types.

The New Hampshire Fish and Game (NHF&G) Nongame and Endangered Species Program maintains an inventory of species in the state that are considered rare, threatened, endangered, or species of special concern in the state (NH F&G http://www.wildlife.state.nh.us/Wildlife/Nongame/endangered_list.htm). The New Hampshire Partners in Flight Working Group (NH PIF) maintains an inventory of species that are considered rare or priority species in the state (http://www.anselm.edu/homepage/jpitocch/NHPIF2.html). These inventories combine to create a list of rare, threatened, or endangered (RTE) species found in the state of New Hampshire. RTE species that occurred either in the Project area during on-site field surveys, or were detected in the region during the USGS BBS or Audubon CBC surveys and are on the NHF&G or NH PIF lists, are included in Appendix B, Table 5.

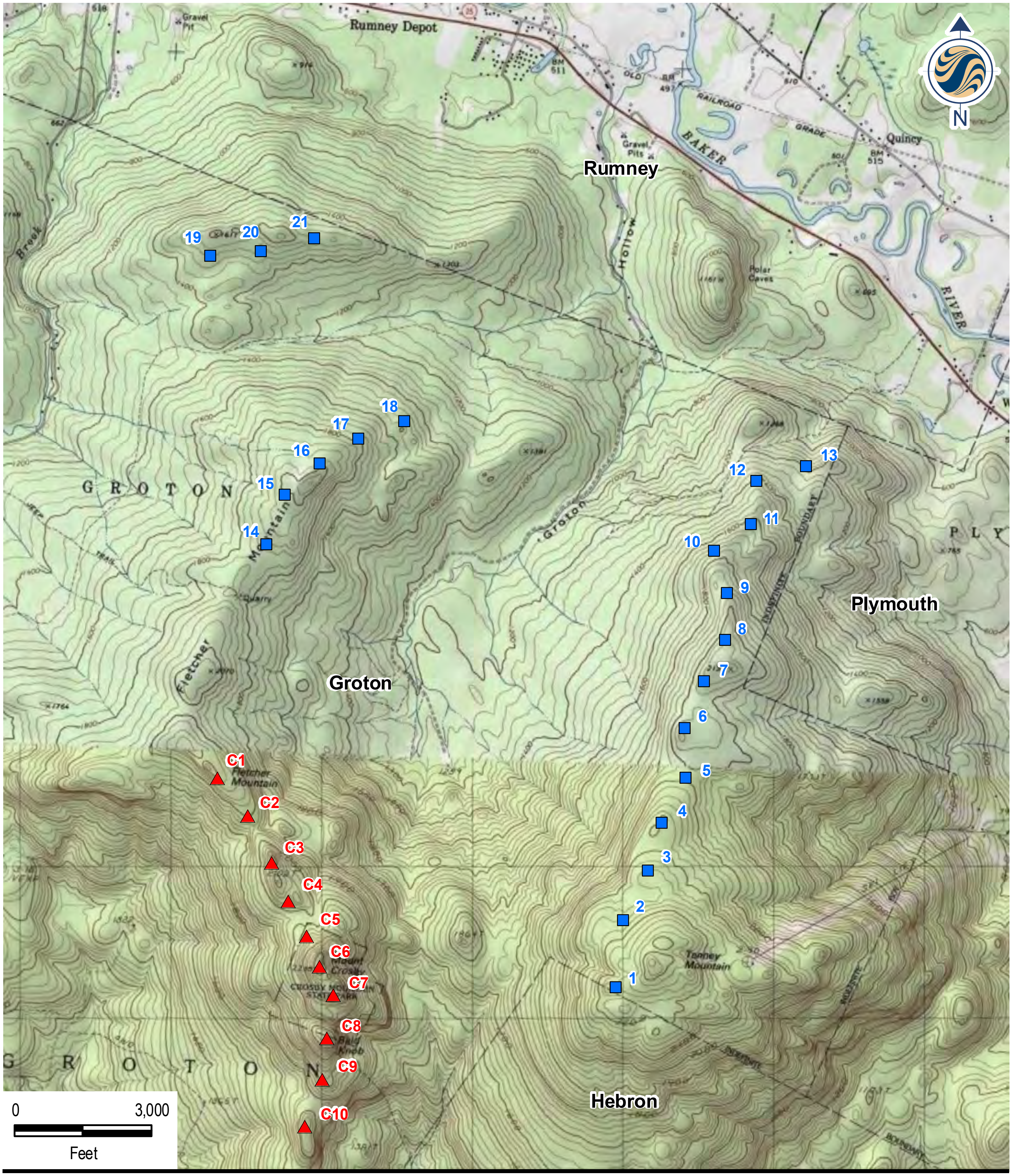
For certain species within the Project area, natural history information was obtained to help assess potential levels of direct and indirect risk associated with the Project. These data were obtained from a variety of sources, including literature reported in the Birds of North America Online (2009) and other species-specific literature, and are included in relevant sections of the discussion. The above sources of data were used, in combination with results of field surveys, to characterize the overall breeding bird population within the Project area and immediate vicinity.

3.3.2 Field Surveys

Field surveys for breeding birds within the Project area consisted of two rounds of BBS point counts according to a modified USGS survey protocol. These surveys consisted of 21 10-minute point counts distributed throughout the Project area and an additional 10 10-minute counts distributed over a nearby ridge (Bald Knob and Mt. Crosby) designated as a control site. Each survey location was sampled during two survey periods, one in mid-June (June 10 ,11, and 16) and one in late June (June 17, 18, and 27) (Figure 3-4). On-site BBS also included documentation of incidental observations made outside of the official point count periods but during on-site visits. A detailed summary of the methods and results of these surveys can be found in the 2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b), along with the complete list of species detected in the Project area during the BBS (Appendix A, Tables 1 through 6 in the 2009 Avian and Bat Survey Report [Stantec 2009b]). In addition to on-site BBS, habitat surveys were conducted periodically between spring and fall, 2009. These included overall documentation of the types and relative amounts of breeding bird habitat within the Project area. Habitat characterizations, consisting of qualitative notes made during on-site field surveys, also contributed to the risk assessment.

3.3.3 Risk Assessment Endpoints

Two assessment endpoints were chosen for the evaluation of risk to breeding birds associated with the Project: potential collision mortality of breeding birds (assessment endpoint 4), and; potential indirect impacts (habitat loss, displacement) to breeding birds (assessment endpoint 5). When possible, potential impacts to individual species or guilds are discussed for each assessment endpoint. Measurement endpoints were identified for each assessment endpoint as specified in Table 3-5. Measurement endpoints consisted of results of literature review (4a and 5a), on-site and regional breeding bird surveys (4b), and habitat characterizations 5b). Literature review included a review of information on interactions between breeding birds and wind turbines, collision mortality data from operational wind projects, and information regarding potential effects of habitat loss and conversion on breeding birds.



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00299-F003-4-BBS-Survey-Location-Map.mxd

Legend

BBS Points

- ■ 1-21
- ▲ C1-C10

Client/Project

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Groton Wind Project
Groton, New Hampshire

Figure No.

3-4

Title

Breeding Bird Survey Location Map
November 30, 2009

Table 3-5. Assessment and measurement endpoints used to assess risk to breeding birds				
Assessment Endpoint		**Measurement Endpoints**		**Measurement Endpoint Response**
4	Potential collision mortality of breeding birds	4a	Literature Review	Review literature regarding interactions between breeding birds and turbines and collision mortality results from other sites. Document species diversity, relative abundance, and distribution of breeding birds in the Project area.
		4b	On-site and Regional Bird Surveys	
5	Potential indirect impacts to breeding birds	5a	Literature Review	Determine how habitat loss/conversion may impact breeding bird abundance and distribution in the Project area.
		5b	Habitat Characterization	

Each measurement/assessment endpoint pair was assigned a weight based on the attributes and criteria described in the methods section. Overall, the measurement endpoints were evaluated as medium to low weight-of-evidence (Table 3-6). However, the relatively low scoring of measurement endpoints used in the risk assessment is not a result of insufficient pre-construction data, which provided a thorough characterization of the population of breeding birds in the Project area. Instead, the uncertainty stems from the lack of understanding of the connection between pre-construction surveys and rates of mortality or displacement behavior once facilities become operational. Moreover, the stressor is not yet present in the landscape. It is important to note that additional pre-construction surveys would not necessarily increase the rankings of these attributes or the ability to accurately predict risk to breeding birds, specifically because additional field survey data would not further understanding of the link between pre-construction and post-construction conditions until the Project is constructed. However, one season of breeding bird surveys provide the opportunity to determine if T&E species or their habitats are present at the project area and provide a baseline data set for assessing potential post construction changes in the breeding bird community. This data is also useful for comparing pre-construction survey data from similar projects and habitats that have been developed and also conducted post construction mortality studies to get a better perspective of potential impacts to breeding birds.

Table 3-6. Weight-of-evidence evaluation of measurement endpoints used to evaluate risk to breeding birds

Attributes	Measurement Endpoints				Rationale
	Collision Mortality		Indirect Impacts		
	4a Literature Review	4b On-site and Regional Bird Surveys	5a Literature Review	5b Habitat Characterization	
I. Strength of Association between Assessment and Measurement Endpoint					
Degree of Biological Association	Medium	Medium	Medium	Medium	Literature review can directly characterize patterns in collision mortality and indirect displacement at existing wind farms only. Pre-construction breeding bird surveys can document species composition and relative abundance of breeding birds in the Project area, although these results can only be used indirectly to characterize potential risk of collision or indirect impacts, as relationships between pre-construction surveys and post-construction surveys have not been established.
Stressor/Response	Medium	Medium	Medium	Medium	Increased exposure to wind turbines presumably increases risk of collision, although the mechanisms explaining collision mortality remain ambiguous. However, patterns in collision mortality and indirect impacts will likely be similar between sites, so as more information is gathered, this relationship is expected to become stronger.
Utility of Measure	Medium	Medium	Medium	Medium	The methods used for breeding bird surveys and habitat characterizations (and the literature that reports their results) are well accepted and developed by a third party, but have limited applicability and are relatively insensitive for determining risk.
II. Data Quality					
Data Quality	High	High	High	High	Breeding bird surveys provide an appropriate means to characterize the breeding bird population in the Project area, and surveys were conducted in a rigorous manner. However, results of these types of ecological surveys are inherently subject to uncertainty and require extrapolation to relate to the assessment endpoints.
III. Study Design					
Site Specificity	Low	High	Medium	High	Literature review of mortality surveys at other sites has uncertain applicability to the exposure site. Breeding bird and habitat characterizations provide highly site-specific data that could provide means for comparison of pre- and post-construction results. Habitat characterizations directly measure loss/conversion at the site of interest and literature review of habitat loss at other areas is probably moderately applicable.
Sensitivity	Low	High	Low	Medium	Breeding bird surveys can detect changes in species composition and abundance of breeding birds over time, which could be used to assess indirect impacts of the wind Project provided that pre- and post-construction surveys were conducted in a suitable manner. Habitat assessments can detect moderate level changes in breeding bird habitat from measuring loss/conversion.
Spatial Representativeness	Low	High	Low	Medium	Breeding bird surveys were conducted throughout the Project area in a variety of representative habitats. Habitat charcterizations were general, focusing on dominant conditions and major losses/conversions expected.
Temporal Representativeness	N/A	High	N/A	N/A	On-site field surveys took place at two time periods during the active breeding season of birds. Regional surveys include data from multiple years of surveys.
Quantitative Measure	Low	Low	Medium	Low	The magnitude of response to the stressor can not be tested statistically for pre-construction breeding bird surveys, because the exposure has not yet occurred. Statistical tests, such as those used in spatial statistics in GIS analysis of fragmentation or connectivity, could be conducted and applied to a predictive model of impact to habitat for nocturnal migrants.
Standard Method	N/A	Medium	N/A	Medium	A standard method exists for conducting breeding bird surveys, but its applicability to predicting risk is questionable. Methods for habitat characterizations are well documented and application to evaluating loss/conversion of bat habitat could be standardized.
Overall Endpoint Value*	Low/Medium	Medium/High	Low/Medium	Medium	

* Overall endpoint value was determined by determining the number of attributes ranked as “low”, “medium”, and “high” for each measurement endpoint.

3.4 BATS

3.4.1 Information Review

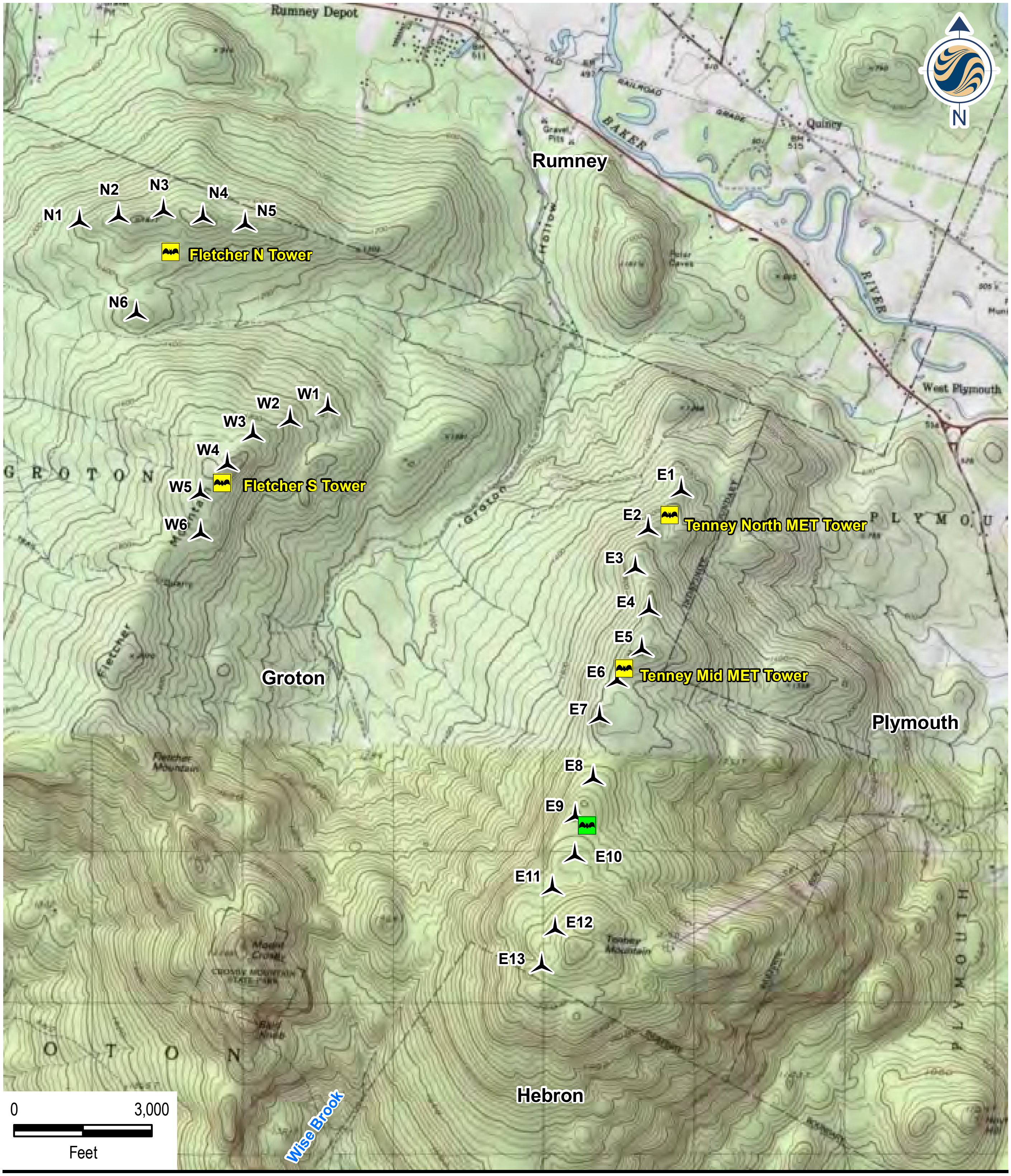
Sources of information relating to the abundance and distribution of bats in the northeast, particularly New Hampshire are limited. Stantec reviewed literature on the overall distribution of species in the east, with the understanding that these types of data are rarely specific enough to draw conclusions on a site-specific basis. Qualitative habitat information gathered during field surveys at in the Project area, such as landscape cover, forest structure, distribution and type of wetlands, presence of caves, and topography was used to characterize the overall suitability of the Project area for bats.

3.4.2 Field Surveys

On-site field surveys for bats at in the Project area consisted of two seasons of summer/fall acoustic monitoring (Table 2-1). Year 2006 acoustic bat surveys involved 3 detectors mounted in one met tower, and year 2009 acoustic surveys involved 8 detectors mounted in two met towers and two temporary towers (Figure 3-5). Detailed descriptions of the survey design, methods, and results of these surveys are included in the 2009 Spring, Summer, and Fall Avian and Bat Survey Report (Stantec 2009b). Further acoustic monitoring will be conducted during the spring and summer of 2010 to sample the spring migration season and summer resident period.

3.4.3 Weather Data Analysis

Results from the limited number of available mortality studies suggest that relationships may exist between rates of bat collision mortality and weather variables such as wind speed and temperature, either because these variables directly affect bat behavior, or because they affect distribution and abundance of prey (Kunz *et al.* 2007a). To address this relationship, patterns in weather variables were compared to bat activity levels recorded in the Project area during summer/fall 2009. Nightly and hourly summaries of weather variables in the Project area were similar to one another throughout the monitoring period (Tables 3-7 and 3-8), and were separated by month and averaged for an overall total. During the 2009 acoustic bat survey period, 71 percent of nights in August (66% of hours) had mean wind speeds ≤ 6 m/s, a wind speed below which bat mortality appears to be higher based on several recent studies (Arnett *et al*. 2008). This decreased to 57 percent of nights (49% of hours) in September, and decreased further to 47 percent of nights (44% of hours) during October. Overall, 57 percent of nights (52% of hours) in the total survey period had mean wind speeds ≤ 6 m/s.



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Legend

- 2009 Bat Detector
- 2006 Bat Detector
- Proposed Turbines

Client/Project

Groton Wind LLC
Groton Wind Project
Groton, New Hampshire

Figure No.

3-5

Title

Bat Acoustic Survey Location Map
November 30, 2009

00299-F003-5-Bat-Acoustic-Survey-Location-Map.mxd

During August, 71 percent of nights (73% of hours) had mean temperatures ≥ 14 °C. This decreased to 29 percent of nights (30% of hours) during September, and dropped to 0% of nights and hours during October. Overall, 29 percent of nights and 30% of hours in the total survey period had mean temperatures ≥ 14 °C (Tables 3-7 and 3-8).

Table 3-7. Percent of nights with given weather conditions between August and October, 2009

Date range	Wind speed (m/s)			Temperature (°C)		
	<4	<6	<8	>12	>14	>16
August 11-31	43%	71%	76%	76%	71%	71%
September 1-30	18%	57%	71%	50%	29%	11%
October 1-30	7%	47%	70%	0%	0%	0%
Total survey	20%	57%	72%	38%	29%	23%

Table 3-8. Percent of night-time hours with given weather conditions between August and October, 2009

Date range	Wind speed (m/s)			Temperature (°C)		
	<4	<6	<8	>12	>14	>16
August 11-31	38%	66%	79%	78%	73%	67%
September 1-30	18%	49%	72%	49%	30%	12%
October 1-30	20%	44%	68%	0%	0%	0%
Total survey	24%	52%	72%	38%	30%	22%

The amount of time when both wind speed and temperature met certain values was also similar between nightly and hourly summaries, and was generally lower than calculations made on only a single weather condition (Tables 3-9 and 3-10). During August, 57 percent of nights (52% of hours) had mean wind speeds ≤ 6 m/s *and* mean temperatures ≥ 14 °C. This decreased to 20 percent of nights and hours during September, and 0 percent of nights and hours in October. Overall, 22 percent of nights (21% hours) in the total survey period had mean wind speeds ≤ 6 m/s *and* mean temperatures ≥ 14 °C.

Table 3-9. Percent of nights with given weather conditions between August and October, 2009						
Temp (°C)	Wind speed (m/s)					
	≤4		≤6		≤8	
≥12	August:	33%	August:	57%	August:	62%
	September:	10%	September:	33%	September:	37%
	October:	0%	October:	0%	October:	0%
	Total:	12%	Total:	27%	Total:	30%
≥14	August:	33%	August:	57%	August:	62%
	September:	7%	September:	20%	September:	23%
	October:	0%	October:	0%	October:	0%
	Total:	11%	Total:	22%	Total:	25%
≥16	August:	33%	August:	57%	August:	62%
	September:	3%	September:	7%	September:	7%
	October:	0%	October:	0%	October:	0%
	Total:	10%	Total:	17%	Total:	19%

Table 3-10. Percent of night-time hours with given weather conditions between August and October, 2009						
Temp (°C)	Wind speed (m/s)					
	≤4		≤4		≤4	
≥12	August:	29%	August:	53%	August:	63%
	September:	12%	September:	32%	September:	39%
	October:	0%	October:	0%	October:	0%
	Total:	12%	Total:	25%	Total:	31%
≥14	August:	29%	August:	52%	August:	61%
	September:	6%	September:	20%	September:	24%
	October:	0%	October:	0%	October:	0%
	Total:	10%	Total:	21%	Total:	25%
≥16	August:	29%	August:	48%	August:	56%
	September:	2%	September:	7%	September:	9%
	October:	0%	October:	0%	October:	0%
	Total:	8%	Total:	15%	Total:	18%

3.4.4 Risk Assessment Endpoints

Two assessment endpoints were chosen for the evaluation of risk to bats associated with the project: potential collision mortality of bats (assessment endpoint 6); and potential loss of habitat or displacement (assessment endpoint 7). These endpoints were chosen so as to separately evaluate risk of collision mortality to both threatened and endangered and non-endangered bat species, and indirect habitat loss associated with the Project. Measurement endpoints were identified for each assessment endpoint as specified in Table 3-11. Measurement endpoints consisted of results of literature review (6a, 7a), on-site acoustic bat surveys (6b), a habitat assessment (7b), and analysis of weather data (6c). Literature review included a review of information on interactions between bats and wind turbines, collision mortality data from operational wind projects, information on the distribution of bat species (including RTE species) in the vicinity of the project area, including maternity colonies and hibernacula, and information regarding the effects of habitat loss and conversion on bats.

Table 3-11. Assessment and measurement endpoints used to assess risk to bats at the Groton Wind Project

Assessment Endpoint		Measurement Endpoints		Measurement Endpoint Response
6	Potential collision mortality of bats	6a	Literature Review	Measure species composition and relative abundance, and determine activity patterns of bats in the Project area. Relate these to known patterns of collision mortality from operational sites. Document patterns in weather and relate these to patterns of collision mortality from operational sites.
		6b	Acoustic Bat Surveys	
		6c	Weather Analysis	
7	Potential habitat loss or displacement of bats from the Project area	7a	Literature Review	Document available habitat pre-construction, and potential effects of habitat loss.
		7b	Habitat Characterization	

Each measurement/assessment endpoint pair was assigned a weight based on the attributes and criteria described in the methods section. Overall, the measurement endpoints were evaluated as medium to low weight-of-evidence (Table 3-12). However, the relatively low scoring of measurement endpoints used in the risk assessment is not a result of insufficient pre-construction data, which provided a thorough characterization of bat activity in the Project area. Instead, the uncertainty stems from the lack of understanding of the connection between pre-construction surveys and rates of mortality and displacement once facilities become operational. Moreover, the stressor is not yet present in the landscape. It is important to note that additional pre-construction surveys would not necessarily increase the rankings of these attributes or the ability to accurately predict risk to bats, specifically because additional field survey data would not further understanding of the link between pre-construction and post-construction conditions until the Project is constructed. However, acoustic bat surveys provide the opportunity to document bat activity levels and general species composition at the project area and relative to other projects and is useful for comparing pre-construction survey data from similar projects and habitats that have been developed and also conducted post construction mortality studies.

Table 3-12. Weight-of-evidence evaluation of measurement endpoints used to evaluate risk to bats

Attributes	Measurement Endpoints					Rationale
	Collision Mortality			Indirect Impacts		
	6a Literature Review	6b On-site Acoustic Field Surveys	6c Weather Analysis	7a Literature Review	7b Habitat Characterization	
I. Strength of Association between Assessment and Measurement Endpoint						
Degree of Biological Association	Medium	Low	Low	Medium	Medium	Literature review can directly characterize patterns in collision mortality and indirect displacement at existing wind farms only. Pre-construction acoustic surveys can document species composition and bat activity patterns, although these results can only be used indirectly to characterize risk of collision or indirect impacts, as relationships between pre-construction surveys and post-construction surveys have not been established.
Stressor/Response	Medium	Medium	Low	Medium	Medium	Increased exposure to wind turbines presumably increases risk of collision, although the mechanisms explaining collision mortality remain ambiguous. Relationships between weather variables and collision rates have been identified as potentially explaining variability in rates of collision morality. However, patterns in collision mortality and indirect impacts will likely be similar between sites, so as more information is gathered, this relationship will become stronger, for at least some species.
Utility of Measure	Medium	Medium	Medium	Medium	Medium	The methods used for acoustic bat surveys (and the literature that reports their results), and weather documentation are well accepted and developed by a third party, but they have limited applicability and are relatively insensitive for determining risk.
II. Data Quality						
Data Quality	Medium	Medium	Medium	Medium	Medium	The objectives of documenting activity patterns of bats were met by acoustic surveys. However, results of these types of ecological surveys are inherently subject to variation and require extrapolation to relate to the assessment endpoints.
III. Study Design						
Site Specificity	Low	High	High	Medium	High	Acoustic surveys provide site-specific data that could provide means for comparison of pre- and post-construction results. Literature review of post-construction mortality surveys at other sites has uncertain applicability to the exposure site. Habitat characterizations directly address loss/conversion at the site of interest and literature review of habitat loss at other areas is probably moderately applicable.
Sensitivity	Low	Low	High	Low	Medium	Acoustic surveys can detect slight changes in activity levels, although these changes would not necessarily be correlated to the stressor. Habitat characterizations can detect moderate level changes in bat habitat from measuring loss/conversion.
Spatial Representativeness	Low	Medium	High	Low	Medium	Acoustic surveys were conducted at four locations and characterized broader patterns in activity. Habitat characterizations were general, focusing on dominant conditions and major losses/conversions expected.
Temporal Representativeness	N/A	Medium	High	N/A	N/A	Acoustic surveys sampled the entire fall migration period, sampling a large portion of the season in which bat mortality is expected to be highest.
Quantitative Measure	Low	Low	Medium	Medium	Medium	The magnitude of response to the stressor can not be tested statistically for acoustic surveys, because the exposure has not yet occurred. Statistical tests, such as those used in spatial statistics in GIS analysis of fragmentation or connectivity, could be conducted and applied to a predictive model of impact to bat habitat.
Standard Method	N/A	High	High	N/A	Medium	Fairly standardized methods exist for acoustic surveys, but they are only moderately applicable to assessing exposure. Similarly, standard methods exist for collection of weather data, but not for relating these data to risk of bat collision mortality. Methods for habitat characterizations are well documented and application to evaluating loss/conversion of bat habitat could be standardized.
Overall Endpoint Value*	Low/Medium	Medium	Medium/High	Low/Medium	Medium	* Overall endpoint value was determined by determining the number of attributes ranked as “low”, “medium”, and “high” for each measurement endpoint.

4.0 Discussion

4.1 RAPTORS

4.1.1 Raptor Collision Mortality (Assessment Endpoint 1)

4.1.1.1 Literature Review (Measurement Endpoint 1a)

Regional Migration Patterns

New Hampshire is located within the "Eastern Continental Hawk Flyway[1]," which extends from the Canadian Maritimes south to eastern Florida and, at its widest, measures the width of North Carolina and Tennessee. Within this large area, raptors tend to concentrate along linear ridges, in which atmospheric conditions create deflective updrafts or "thermals" that raptors can use to fly long distances with minimal energy exertion. (Berthold 2001) The geography of the area where the Project is located is characterized by moderate topography consisting of granite hills and peaks interspersed with small lakes and narrow stream valleys (Sperduto and Nichols 2004). The Project ridges are among a series of ridges that occur in the immediate area. Updrafts are formed along the side slopes of ridges which raptors use in order to fly long distances with minimal exertion (Berthold 2001). In the Eastern Continental Hawk Flyway, raptor migration also tends to concentrate along the shores of large bodies of water including lakes as many species of raptor avoid crossing large bodies of water (Kellogg 2007).

Regional Raptor Species

Fifteen species of raptors are expected to occur in New Hampshire during the breeding and/or migration periods based on their normal geographic range. These species are turkey vulture (*Cathartes aura*), osprey (*Pandion halaeetus*), bald eagle (*Haliaeetus leucocephalus*), northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern goshawk (*Accipiter gentilis*), red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), red-tailed hawk (*Buteo jamacensis*), rough-legged hawk (*Buteo lagopus*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), merlin (*Falco columbarius*) and peregrine falcon (*Falco peregrinus*)[2].

Results of Regional Bird Surveys

The most commonly observed raptors at regional HMANA sites during spring and fall migration were broad-winged hawks, which constituted the majority of many large migration days at hawk watch sites in mid September. The greatest peak in overall migration of raptors occurred in September, concurrent with the peak in fall broad-winged hawk migration. The greatest levels of raptor migration activity during the spring were documented at Bradbury Mountain, Maine,

[1] The Eastern Continental Flyway includes the Maritime Provinces; New England; New York (south and east of a line from Jamestown to Utica to the north end of Lake Champlain); Pennsylvania (all except Erie County); Mid-Atlantic States through Georgia, West Virginia, Kentucky and Tennessee; Florida east of a line from Lake Seminole south to Apalachicola (Kellogg 2007).

[2] While turkey vultures 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.

Plum Island, Newburyport, MA, and Barre Falls, MA. The highest levels of activity during the fall were documented at Barre Falls, MA, Little Round Top, NH, and Pack Monadnock, NH. During the timeframe when seasonal migration surveys were conducted at the Project, mean hourly hawk observation rates at regional hawk watch sites varied between 3.78 (Poquonock, CT) and 9.30 (Bradbury Mountain, ME) birds per hour in spring, 2009, and 2.9 (Little Blue Job, NH) and 22.27 (Barre Falls, NH) birds per hour in fall, 2009 (Appendix B Table 1 in the 2009 Spring and Fall survey report).

The USGS BBS Wilmot, New Hampshire survey route documented the occurrence of four species of raptor and one owl during breeding seasons from 1966 to 2009: broad-winged hawk, northern harrier, red-shouldered hawk, sharp-shinned hawk, turkey vulture, and barred owl (Appendix B, Table 1).

The Audubon Christmas Bird Count survey documented the occurrence of 6 species of raptor and one owl from 2000 to 2009: bald eagle, Cooper's hawk, Northern goshawk, red-tailed hawk, rough-legged hawk, sharp-shinned hawk, and barred owl (Appendix B, Table 2).

Consultation with State Agencies

During a preliminary meeting to discuss the scope of work for field surveys to be conducted for the Project, New Hampshire Fish and Game recommended that a peregrine falcon survey be conducted, in consultation with NH Audubon, to investigate peregrine falcon activity in the area at the end of the breeding season, during the time the fledglings are dispersing from nest sites.

Local Peregrine Falcon Breeding Information

Peregrine falcons are listed as threatened in New Hampshire, recently down-listed from endangered. Peregrine falcon nests (aeries) are typically located on cliffs or anthropogenic structures such as bridges and tall buildings. Peregrine falcons are known to breed at two aerie locations in the vicinity of the Project: The Bear Mountain aerie is approximately 5 miles south of the Project area and the Rattlesnake Mountain aerie is approximately 2 miles north of the Project area. Peregrine falcons have been documented at the Rattlesnake Mountain aerie during the breeding season for the past 16 years (since 1994), and have been confirmed to be actively breeding there for 15 years (since 1995) (NH Audubon pers. comm.). The falcons have had a historic presence at the aerie since at least 1955 (NH Audubon pers. comm.). Peregrine falcons have had a documented presence at the Bear Mountain aerie during the breeding season for the past 4 years (since 2006), and have been confirmed to be breeding at the site for the past 3 years (since 2007); however, their historic presence at the site is unknown (NH Audubon pers. comm.). During the 2009 breeding season, the Bear and Rattlesnake mountain aeries successfully fledged 4 and 3 young, respectively (NH Audubon, unpub. data).

Regional Eagle Telemetry Data

An intensive eagle migration survey was recently initiated by the National Aviary in conjunction with Powdermill Avian Research Center and a number of other non-profit institutions. Eagles were captured either in their winter ranges in the mid-Atlantic states or in their summer ranges in northern Canada and were fitted with satellite transmitters to track their movements during migration. The data are currently publicly available in rough form and provide some insight into the specific flight paths, timing of occurrence, and behavior patterns of golden and bald eagles.

At present, the study has data for 10 actively tracked golden eagles. The time periods of available data vary among individual birds and include winter 2007, spring 2008, fall 2008, and spring and summer 2009 (National Aviary 2009). Available data exist for 7 actively tracked bald eagles. The time periods of available data vary among individuals and include Fall 2007, summer and fall 2008, and spring and summer 2009 (National Aviary 2009).

Although the resolution of the publicly available telemetry data from the eagle tracking project does not permit determination of whether eagles flew directly over the Project area, 5 of the 10 tracked golden eagles occurred at locations along the Appalachian Mountain chain either during their migration or over-wintering periods (Figure 4-1; National Aviary 2009). Specifically golden eagle number 603 occurred at some location over central New Hampshire as it migrated from its breeding grounds in Canada to its wintering grounds in West Virginia between September 3, 2008 and October 16, 2008 (Figure 4-1; National Aviary 2009). Four of the tracked bald eagle occurred at locations over New Hampshire either during their late-summer/early fall dispersal, spring northbound migration, or southbound fall migration (Figure 4-2; National Aviary 2009). In particular, bald eagle number 63 occurred over south-central New Hampshire during its southbound migration at some point between September 16 and September 20, 2007 (Figure 4-2; National Aviary 2009).

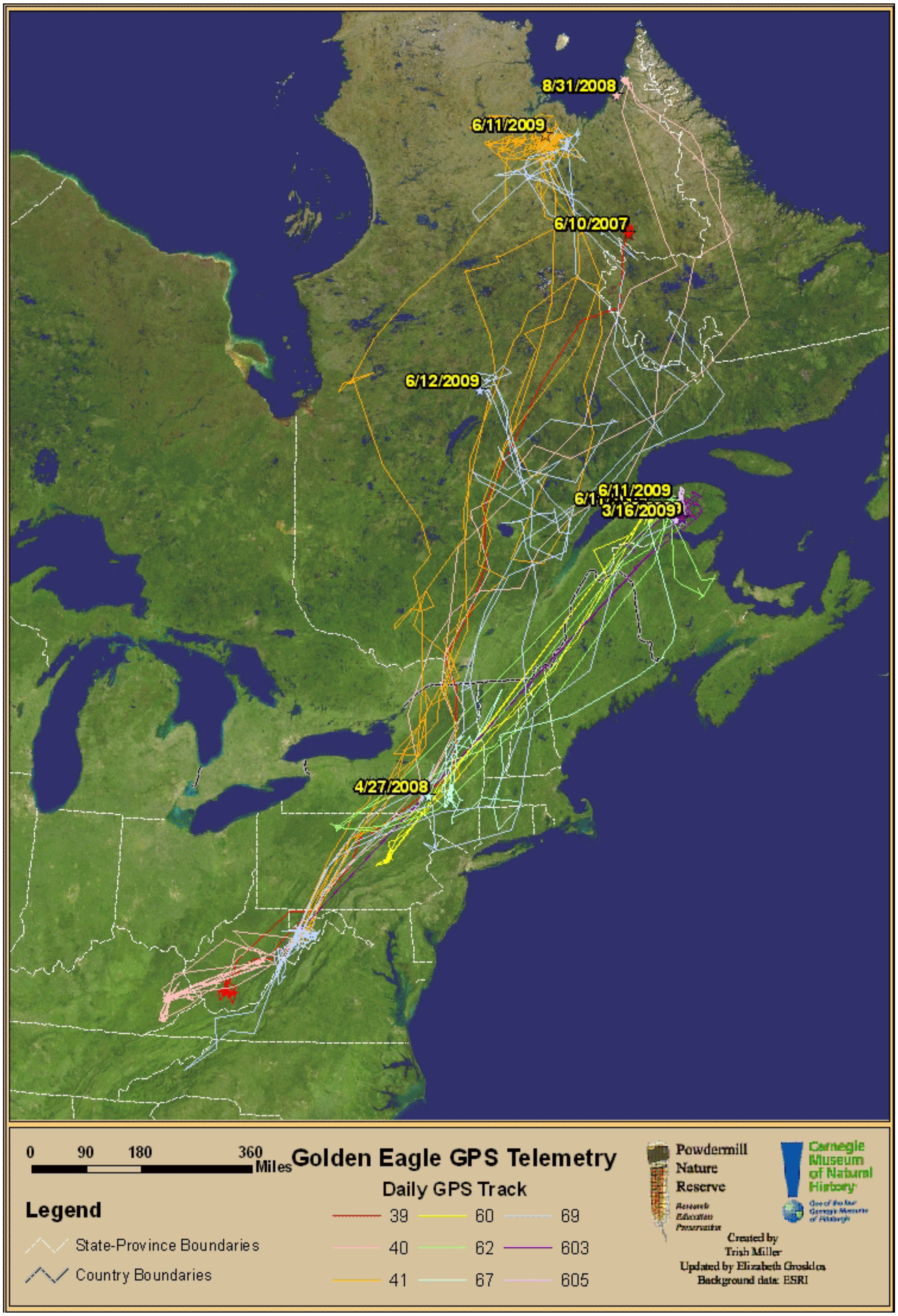


Figure 4-1. Static map of telemetry locations for golden eagles tracked by the National Aviary between fall 2006 and summer 2009 (National Aviary 2009)

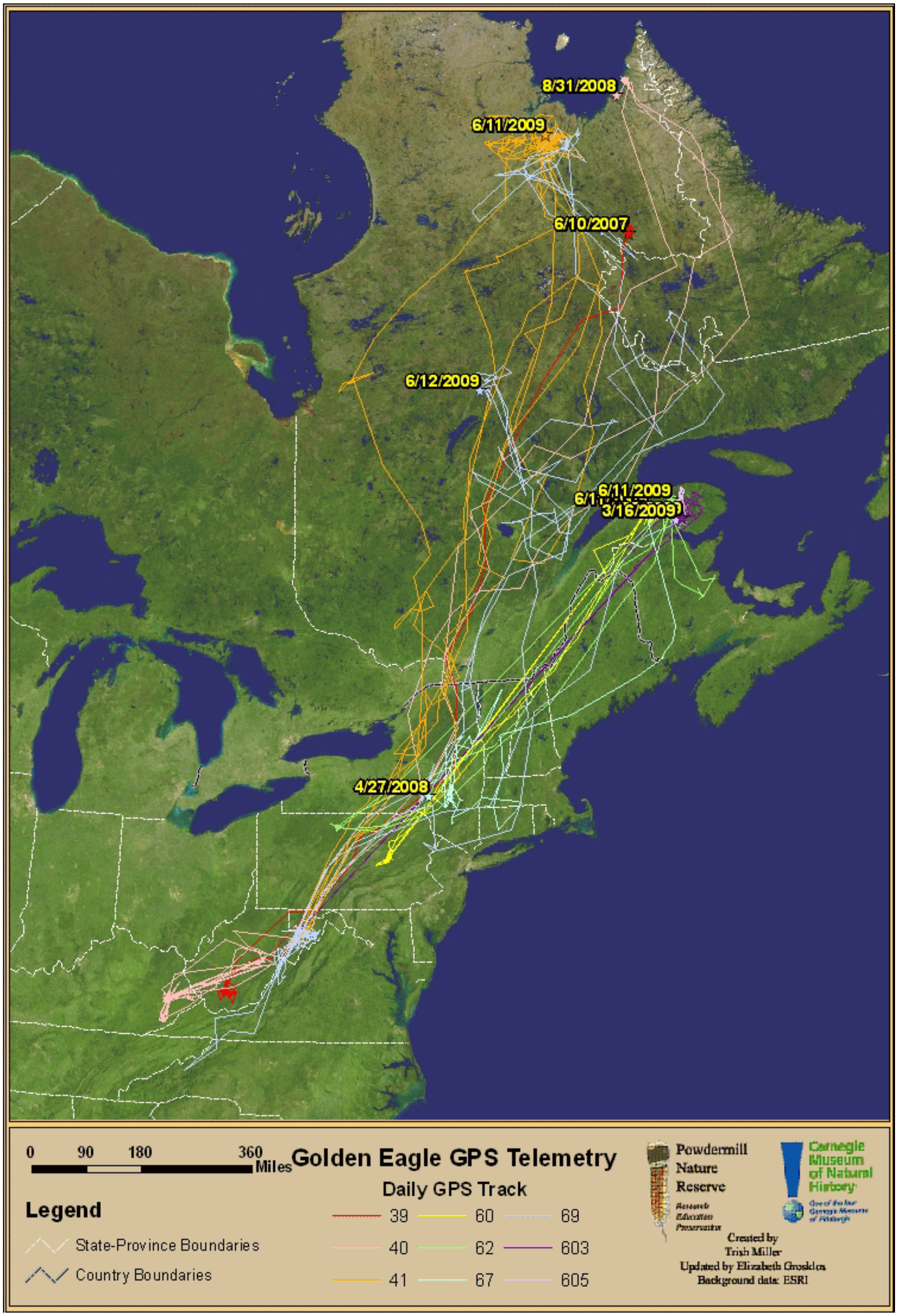


Figure 4-2. Static map of telemetry locations for bald eagles tracked by the National Aviary between fall 2006 and summer 2009 (National Aviary 2009)

Raptor Mortality Data

The fatality of raptors at California wind farms was the catalyst for investigations of the effects of wind energy projects on birds. The high rates of raptor mortality that have been found in California, particularly at Altamont Pass, are attributable to at least five factors: high raptor density; high prey density; high turbine density; short lattice towers; and fast spinning blades that appear to blur at high wind speeds. The combination of these factors is unique to older projects within parts of California, although not all projects within that state include all of these factors.

Modern projects that have been constructed within the last 5 to 10 years have significantly different characteristics than those found specifically at Altamont Pass and other California developments with high raptor density. In general, newer sites are within areas with much lower raptor density and probably lower prey densities (Erickson *et al*. 2002). Additionally, newer facilities have widely spaced turbines, smooth tubular towers, and blades that spin slowly enough to remain visible even at high wind speeds. These factors are thought to have contributed to lower rates of raptor mortality in the east than those documented in California. Several recent studies conducted in the U.S., outside of California, have documented relatively low raptor mortality with less than 50 total raptor and owl fatalities documented by 25 studies at 20 different locations throughout the U.S. (Appendix B, Table 3) for a total of 1,718 turbines. This compares with more than one hundred raptor mortalities documented per year at Altamont Pass and overall estimates of thousands killed annually at that facility. Furthermore, pre-construction surveys conducted at the now operational Lempster Wind Project documented an overall season passage rate of 3.3 birds/hour in fall 2005 and an overall passage rate of 1.3 birds/hour in spring 2006. These results compared to those documented at the Groton Wind Project (see section 4.1.1.2) were lower; however simultaneous surveys with two observers were not conducted at the Lempster Wind Project. Although survey effort varied between the two Projects, the overall spring and fall passage rates were similar and the greatest passage rates at both sites were observed during the fall migration season. No raptor fatalities were documented at the Lempster Wind Project during searches conducted between April 15 and June 1, 2009 (Tidhar 2009).

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). However, limitations to these calculations include failure to account for differences among bird flight patterns and behaviors under a range of conditions, and to a general lack of information and data about avoidance behaviors of birds (Chamberlain *et al.* 2006).

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. The Project area at Buffalo Ridge consists of upland prairie, prairie wetlands, agricultural land, woodlands, and forested ravines. 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') of turbines. However, no kestrels were found during 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). Breeding passerines were believed to be at a decreased risk of collision with the turbines at the Buffalo Ridge facility because most flights occurred below blade height (Osborn *et al*. 1998).

Due to the overlap in occurrence of seasonally local and migrant raptors at study locations, it is difficult to determine if the raptor fatalities reported in Appendix B, Table 3 occurred during localized movements or during long-distance migration movements. Available carcass discovery dates indicate that collision events could occur during both breeding and migration seasons (Appendix B, Table 3). Overall, literature review suggests that, while a variety of raptors are present in the Project area during spring and fall migration, as well as during the breeding season, the likelihood of raptor collision morality at the Project will be low, given the low overall rates of collision mortality observed at other sites in the U.S., outside of California (Appendix B, Table 3).

Due to the specific concern for risk of Project related impacts to peregrine falcon, additional turbine collision mortality data specific to peregrine falcon is included here. Peregrine are among species involved with collisions at the Altamont Pass Wind Resource Area in California (Jones and Stokes 2009). However, the Altamont Pass Wind Resource area has unique topographical features, differences in the abundance of raptors and prey species, as well as out-dated turbine design features which are not characteristic of modern wind farms in the eastern U.S. Peregrine falcon turbine collisions have also been documented at small wind farms located in wetland settings: a peregrine falcon collision was documented at a wind farm located in wetlands in Atlantic City, New Jersey (NJDEP 2009), and another fatality was documented at a wind farm located in a bog on the Orkney Islands, Scotland (Kingsley and Whittam 2001).

Curry and Kerlinger suggest in the Groton Phase I Avian Risk Assessment that the number of raptor fatalities due to the Project would be expected to be small and to primarily involve seasonally local species verses migrating raptors. For listed raptor species that may occur in the Project area, Curry and Kerlinger expect low risk of collision because peregrine falcon would hunt primarily over Baker River Valley and would only occasionally occur along the ridge; and Cooper's hawk would typically forage within forest canopy and along forest edges, and would mainly remain below the rotor zone.

4.1.1.2 On-site Field Surveys (Measurement Endpoint 1b)

Of the fifteen species of raptors expected to occur in New Hampshire, 11 and 14 were observed during on-site raptor migration surveys in spring and fall 2009, respectively. The only species expected to occur in the region that was not observed on-site during the 2009 surveys was rough-legged hawk. The summer/early-fall peregrine falcon surveys documented 14 of 15 species expected to occur in the area; again, rough-legged hawk was the only species not observed during these surveys. Two state endangered raptor species were observed during the

2009 field surveys: golden eagle and northern harrier (Stantec 2009a, Stantec2009b). Two state threatened raptor species were observed: peregrine falcon and bald eagle (Stantec 2009a, Stantec 2009b). The individual field reports provide the dates, number of individuals, locations of occurrence, and flight behaviors of each of the state listed species observed.

Species observed most frequently during the spring and fall migration surveys included broad-winged hawk, red-tailed hawk, and turkey vulture. Turkey vultures and red-tailed hawks accounted for 57 and 19 percent of observations during spring migration surveys. Broad-winged hawks and red-tailed hawks accounted for 47 and 14 percent of all observations during fall migration surveys. During the summer and early-fall peregrine falcon surveys, broad-winged hawk, turkey vulture, and red-tailed hawks were the most frequently observed species from the two Project observation locations (either within or over-looking the Project area), while broad-winged hawk, turkey vulture, red-tailed hawk, and peregrine falcon were the most frequently observed species at the aerie observation locations.

The spring passage rate (1.41 birds per hour [birds/hr]) at the Project was low in comparison to rates reported at HMANA observation locations which ranged from 3.78 to 9.30 birds/hr (Appendix B Table 1 in the 2009 Spring, Summer and Fall Avian and Bat Survey Report). The fall passage rate (4.35 birds/hr) was low compared to the fall HMANA observation rates which ranged from 2.9 to 22.27 birds per hour (Appendix B, Table 1 in the 2009 Spring, Summer and Fall Avian and Bat Survey Report). The passage rates detected from the four observation locations during the summer/early-fall peregrine falcon surveys include multiple observations of individual birds that were suspected to be seasonally local. For example, 5 percent of raptor observations made from Bald Knob during the peregrine falcon surveys were of birds suspected to be seasonally local (the migrant or local bird status of 58 percent of all raptor observations was undetermined); 7 percent of raptor observations made from Tenney Mountain were of birds suspected to be seasonally local (the migrant or local status of 63 percent of observed raptors was unknown) (2009 Summer/Early-Fall Peregrine Falcon Use Survey Report). Due to the timing of peregrine falcon surveys (outside of the migration period), these passage rates are not comparable to the HMANA survey passage rates documented during migration periods. However, the early-fall migration period experienced relatively more migrant activity, particularly for broad-winged hawks. It should be noted that there is over-lap in the timing of fall 2009 raptor migration surveys and the 2009 early-fall peregrine falcon surveys; therefore, some of the migrant activity documented during peregrine surveys is also accounted for in the raptor section of the 2009 Spring, Summer and Fall Avian and Bat Survey Report.

During the 2009 spring raptor migration surveys, at total of 76 (43 percent) of all raptors observed were seen within the Project area. Twenty-five percent of these 76 birds were at flight heights within the proposed rotor zone. During the 2009 fall raptor migration surveys, a total of 417 (59.9 percent) of all raptors observed were seen within the Project area. Thirty-three percent of these 417 birds were at flight heights within the proposed rotor zone (Stantec 2009b). During the 2009 peregrine falcon surveys, 254 observations of raptors (48 percent of all observations), as seen from Bald Knob, occurred within the Project area. Sixty-nine percent of these 254 observations occurred within the proposed rotor zone. Three hundred and seventy raptor observations (87 percent of all observations), as seen from Tenney Mountain, occurred at some location over the Project area. Fifty-four percent of these raptor 370 observations occurred within the proposed rotor zone (Stantec 2009a).

The 2006 peregrine falcon surveys were conducted from Rattlesnake Mountain where the peregrine falcon nest failed that year. On two occasions, a falcon was observed over the lower slopes of Fletcher Mountain (after leaving the aerie and crossing route 25); during the surveys, peregrines were repeatedly seen flying over the Baker River Valley and along Rattlesnake Mountain's south-facing cliffs (Woodlot 2006). During the 2009 peregrine falcon use surveys, four peregrine falcons were observed from Bald Knob; however, each of these observations was of birds occurring outside of the Project area. There were four observations of peregrine falcons made from Tenney Mountain; three of these observations were of birds within the Project boundary. The three birds observed within the Project boundary were seen at flight heights within the rotor zone of the proposed turbines (2009 Peregrine Falcon Use Survey Report).

Spring and fall raptor surveys (Measurement endpoint 1b) documented low to moderate numbers of migrating raptors above the Project area, but relatively high percentages of raptors flying below the height of the proposed turbines. The summer/early fall peregrine falcon surveys documented low to moderate numbers of seasonally local and migrant raptors at locations above the Project area, and relatively high percentages of raptors flying below the height of the proposed turbines. While pre-construction surveys do not provide the necessary information to predict risk of collision mortality, field surveys do indicate the potential for exposure of raptors to wind turbines at the Project. However, the relatively low numbers of raptors within the Project area overall suggests a low likelihood of impact, especially when considered in light of the results of mortality surveys conducted in the U.S. (outside of California), which have documented very low rates of raptor collision mortality (Table 4-1). Few peregrine falcon fatalities have been documented among available studies. However, the landscape settings of wind farms where peregrine falcons have been known to be involved with turbine collisions are different than the landscape setting of the Project. For example, the Altamont Pass Wind Resource Area is located in open uplands and the New Jersey and Scotland facilities are in and around wetlands which are areas that would likely be more utilized by peregrine falcons than the Groton Wind Project which is located on forested ridgelines.

Table 4-1. Evaluation of risk of impacts to raptors at Groton Wind Project

Assessment Endpoint		Measurement Endpoints		WOE Score	Risk of Impact	Magnitude of Impact	Rationale
1	Potential collision mortality of resident and migratory raptors	1a	Literature Review	Low/ Medium	Yes	Low	Low rates of raptor collision mortality observed at wind facilities in the U.S. (outside of California).
		1b	Raptor Migration Surveys and Regional Bird Surveys	Medium/High	Yes	Low	Several species of raptor, including state-listed species, present in and around Project area during migration, although rates of raptor migration are low relative to other sites. On-site BBS surveys did not document breeding raptors but regional surveys indicate several raptors that breed or over-winter in the region.
		1c	Summer/Early-Fall Peregrine Falcon Surveys	Medium/High	Yes	Low	There were three peregrine falcons observations which occurred within the Project area and within the proposed rotor zone. Survey results indicate peregrine falcon do occur in the Project area but at a low frequency.
2	Potential habitat loss or displacement of raptors from the Project area	2a	Literature Review	Low/ Medium	Yes	Low	Displacement of raptors documented at certain operational wind facilities, raptors continue to forage and nest within other facilities indicating the potential for impacts but a low magnitude of impact.
		2b	Habitat Characterization	Medium	Yes	Low	There are no state-listed raptor species known to breed within the Project area. Habitat impacts to raptor species in general would be similar to existing impacts in Project area.

4.1.2 Indirect Impacts (Assessment Endpoint 2)

In addition to direct impacts, indirect impacts to raptors such as habitat loss or displacement may result from development of the Groton Wind Project. Impacts may include displacement from the direct development area due to loss of habitat, and for certain species, displacement from areas with increased edge habitat or forest fragmentation. Other species may benefit from the creation of forest edge, which may provide preferred foraging habitat. Species that are sensitive to human presence and construction or maintenance activities may also be displaced. Displacement may result in loss of habitat or decreased breeding success. Certain raptor species would be expected to be more susceptible to displacement impacts or loss of breeding habitat than others. The potential indirect impacts to raptors is dependent on species' use of the Project area, the availability of suitable breeding or foraging habitat on-site, and species' tolerance for human disturbances.

4.1.2.1 Literature review (Measurement Endpoint 2a)

Limited data exist regarding raptor displacement from wind farms in the east. However, data from existing facilities in the west and upper mid-west can be used to extrapolate potential behavioral patterns for similar species in the east. 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).

The majority of available studies conducted in the U.S. indicate that raptors continue to use the area surrounding wind developments. However, breeding habitat displacement was observed at a wind farm in Minnesota. 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).

Based on these results, the potential for indirect impacts to raptors exists at modern wind facilities, although the magnitude of impacts appears to be low (Table 4-1). In addition to displacement, creation of edge habitat and clearing for turbine pads will likely create foraging habitat for certain raptor species, although this is not expected to have a significant effect on the distribution of raptors.

In the Groton Phase I Avian Risk Assessment, Curry and Kerlinger indicate that subtle effects to raptors associated with disturbance and displacement could occur. Although a small percentage of forest-interior habitats would be removed when developing the Project, impacts are expected to be similar to current timber harvest activities which could currently have the same type of effect on raptor breeding habitat even if the Project were not constructed. Disturbances could occur for raptors nesting in the vicinity of construction sites; however, habituation was observed at the Erie Shores Wind Farm for bald eagle, Cooper's hawks and red-tailed hawk and Curry and Kerlinger expect that habituation will occur for some raptor species nesting in vicinity of Project.

4.1.2.2 Habitat Characterization (Measurement Endpoint 2b)

Due to its moderate elevation, the dominant tree species in the Project area include sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis)*, and American Beech (*Fagus grandifolia*), which are typical of northern hardwood – conifer forests. This forest community is the most common in the northern half of the State of New Hampshire. Some small pockets of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are present, but are limited to the ridge summits. Common understory species include regenerating canopy species (e.g., sugar maple, yellow birch, and American beech), hobblebush (*Viburnum lantanoides*), striped maple (*Acer pensylvanicum*), and white birch (*Betula papyrifera*). The majority of the Project site (the northern two-thirds of Tenney Mountain) is located on lands owned by Green Acres Woodlands and managed by FORECO, a local forest management company. The Fletcher Mountain portion of the Project area is owned and managed by Wagner Forest Management. Both companies actively manage these lands for commercial forestry products. Consequently, human disturbances are evident across the majority of the Project site. Historically and presently, the land within and surrounding this area, including the summits of the ridgeline, has been used for commercial timber production. This is evident by the recent and past cuts as well as the presence of a network of haul roads that extend through the site. These forest management operations have resulted in a variation of forest age classes.

Habitat exists for some species of breeding and over-wintering raptors including sharp-shinned hawk, Cooper's hawk, and red-shouldered hawk; however, it does not provide the preferred breeding habitat of state-listed species such as northern harrier (state endangered), bald eagle (state threatened), or peregrine falcon (state threatened). No raptors were detected on-site during the spring 2009 breeding bird surveys. However, initiation of breeding is typically earlier for raptors than for other avian groups like passerines, and raptors may be more easily detected early in their breeding season when establishing breeding territories. Therefore, it is possible that breeding raptors were not detected during breeding bird surveys. Several species of raptor were however detected during regional bird surveys conducted during the breeding season and during the winter.

The development of new access roads and clearings for the turbine lay-down areas will result in forest disturbance. However, as this type of habitat disturbance is already present in the Project area, in the form of existing logging areas on Fletcher and Tenney Mountains, and the access roads, clearings, and transmission lines associated with the ski trails and telecommunication tower on Tenney Mountain. The composition of raptor species that may occur in the Project area is not expected to change dramatically after the proposed development, based on the fact that the Project infrastructure will affect only a very small percentage of available habitat. Whereas species categorized as "forest interior" species could be more sensitive to development of the Project, the majority of available habitat is currently disturbed and subject to some level of human presence and activity.

Species including red-tailed hawk benefit from the creation of cleared areas near woodlands (Preston and Beane 1993). The creation of roads at the proposed Project site may increase foraging habitat for such species. However, the presence of operating turbines or maintenance personnel may discourage more sensitive species such as red-shouldered hawk from breeding or foraging in the area immediately surrounding the turbines.

Magnitude of indirect impacts associated with breeding or over-wintering habitat loss or displacement from habitat is anticipated to be low for raptors based on the results of the habitat characterization (Measurement Endpoint 2b), as the Project will result in a relatively small amount of habitat loss relative to the landscape (Table 4-1).

4.1.3 Conclusions

Whereas available data do not necessarily allow for an accurate prediction of collision rates, timing of collisions, and species involved, the overall lack of raptor mortalities documented at existing facilities suggests very low risk of impact to this species group. Reasons for this low potential impact are not completely understood, but potentially related to the large size of modern turbines and slow-moving blades, which are likely more easily avoided by diurnally active raptors than the older generation, fast-spinning turbines used at the Altamont Pass. Anecdotal observations of raptors avoiding turbines suggest that raptors are generally able to detect and avoid them, and that collisions are unusual.

Post-construction studies and other literature on raptor collision mortality in the U.S. (outside of California) (measurement endpoint 1a) have documented very few raptor fatalities, and suggest that raptors are not vulnerable to impacts associated with collision mortality at modern wind facilities. In particular, the nearby Lempster Wind Project which is similar in elevation and habitat did not document any raptor fatalities during 2009 post construction surveys. On-site raptor surveys (measurement endpoint 1b) documented low to moderate numbers of raptors passing through the Project area during spring and fall migrations, indicating a potential for collision events to occur, although low numbers of raptors observed suggest a low magnitude of impacts (Table 4-1). The two measurement endpoints addressing potential indirect impacts to raptors at the Project both indicated a potential for impact, as any type of habitat modification or land clearing can be expected to affect the distribution and species composition of raptors in the immediate area, but a low magnitude of impact, as the amount of land clearing associated with the Project will be minimal in comparison to the amount of available habitat and will result in habitat alterations similar to those already present in the landscape (Table 4-1).

Field surveys and literature review did not document anything particular about the Project area that would suggest an increased risk to raptors posed by the site, other than the location of the Project within a system of parallel ridges in a region of the country through which large numbers of raptors migrate. Additionally, peregrine falcons nest at two sites within 5 miles of the Project, although this does not necessarily indicate risk of direct or indirect impacts. However, raptor migration surveys at the Project documented low levels of migration relative to other hawk watch sites, suggesting that the Project itself does not appear to be a point of concentration during migration. During peregrine falcon surveys, peregrines were documented within the Project area but at a very low frequency of occurrence and for very short periods. Overall, the measurement endpoints indicated a potential risk of direct and indirect impacts, as raptors do migrate through the Project area, peregrine falcon do occur in the Project area, and the Project will result in a certain amount of forest clearing, but the magnitudes of impact would be low (Table 4-3).

Table 4-2. Concurrence among measurement endpoints for raptors at the Groton Wind Project

Increasing Evidence of Risk	Evidence of Impact?/ Magnitude?	Weighting Factors				
		Low	Low/ Medium	Medium	Medium/ High	High
	Yes / High					
	Yes / Moderate					
	Yes / Low		**1a, 2a**	**2b**	**1b, 1c**	
	No					
	Undetermined					
	Increasing Confidence or Weight					
1a	Literature Review (Potential collision mortality of raptors)					
1b	Raptor Migration and Regional Bird Surveys (Potential collision mortality of raptors)					
1c	Summer/Early-Fall Peregrine Falcon Surveys (Potential collision mortality of peregrines)					
2a	Literature Review (Indirect impacts to raptors)					
2b	Habitat Characterization (Indirect impacts to raptors)					

4.2 NOCTURNALLY MIGRATING PASSERINES

4.2.1 Information Summary

Many small birds, including rails, shorebirds, flycatchers, sparrows, orioles, thrushes, warblers, vireos, as well as many waterfowl, migrate nocturnally (Zimmerman 1998). The majority of nocturnal migrants in eastern North America are warblers, sparrows, thrushes, grosbeaks, and tanagers (Farnsworth 2004). Many species migrate diurnally including waterfowl, loons, gulls, raptors, swallows, nighthawks, and swifts. Some birds, including wading birds, migrate both day and night (Zimmerman 1998).

The peak in bird density in the sky at night generally occurs before midnight (Farnsworth 2004, Zimmerman 1998) and gradually decreases until sunrise (Zimmerman 1998). Most migrants fly at high altitudes, possibly to take advantage of favorable following winds, to prevent overheating, to navigate over landscape features, to fly over fog or clouds, or to avoid physical barriers (Zimmerman 1998). Some birds, including waterfowl and shorebirds, are known to fly at elevations greater than 6,000 m (20,000’) (Zimmerman 1998, Sibley 2001). Whereas previous studies suggested that most small birds migrate at altitudes between 150 and 300 m (492 and 984’) (Zimmerman 1998) and that the majority of passerines migrate at altitudes between 90 and 610 m (295 and 2000’) (Kerlinger 1995 cited in NRC 2007), numerous radar surveys conducted in recent years at proposed wind projects suggest that flight height of nocturnally migrating passerines is relatively constant, and takes place at high altitudes, with mean values for flight heights generally ranging between 300 m and 600 m (985 and 1969’) above ground level for entire survey periods (Table 2-1 in the Spring 2008 Radar Survey Report and Appendix A Table 5 in the Fall 2008 Radar Survey Report). Recent radar studies also indicate that approximately 10 percent of migrants fly below 125 m, the maximum height of most modern wind turbines (NRC 2007). Long-distance migrants typically migrate at higher elevations than short-distance migrants. Some shorebird and waterfowl species make non-stop flights between the breeding and wintering grounds, while more short distant migrants make stop-overs at locations along their migration route to rest and forage. Passerines typically reach peak altitudes just before midnight, and gradually decrease in altitude until sunrise.

Most species travel along 'broad fronts' during migration in the region. The width of many species' migration corridors may be similar to the width of their breeding range (typically over 3219 km [2000 mi] east to west) (Zimmerman 1998). A study in Europe suggests that species with a broad east-to-west breeding range will cross all topographical features during migration including lakes, river valleys, and mountains (NRC 2007). Many waterfowl follow interior migration paths across North America as they travel to their wintering grounds along the Atlantic Coast from their breeding grounds in Canada. Some waterfowl travel southeast from central Canada, crossing the Great Lakes, New York, and Pennsylvania before reaching their coastal destinations. Certain species travel to and from breeding grounds along elliptical or circular migration routes, potentially to take advantage of seasonal wind conditions (Zimmerman 1998). For example, some species may occur along the eastern coast in the fall and then within the interior during migration in the spring.

During the fall, the largest movements of migrants usually occur following the passage of a cold front. Low pressure systems in the spring are associated with large migration movements (Zimmerman 1998). Species will migrate in overcast conditions that are characterized by favorable tailwinds. When weather conditions result in lower flight altitudes, birds may be at increased risk of collision with man-made structures (NRC 2007). Birds will continue migration movements in less favorable winds and increased cloud clover with precipitation; however, storm conditions will result in 'fall outs' where birds are forced to wait out adverse weather at stop-over locations. Although birds will still migrate in sub-optimal weather conditions the magnitude of migration is generally lower during these periods than during optimal migration conditions.

4.2.2 Potential Collision Mortality of Nocturnally Migrating Passerines (Assessment Endpoint 3)

4.2.2.1 Literature Review (Measurement endpoint 3a)

Rates of avian collision mortality at existing wind facilities in the eastern and upper mid-west of the U.S. has been documented to range from 0 to approximately 10 bird fatalities per turbine per year (Appendix B, Table 4). Although avian collision mortality can occur during both the breeding and migration seasons, patterns in avian collision mortality at tall towers, buildings, wind turbines and other structures suggest that the majority of fatalities occur during the spring and fall migration period (NRC 2007). Limited data suggests that roughly half the fatalities at existing wind facilities represent migrant species, while the other half represents resident species (NRC 2007).

The majority of carcasses found at existing wind facilities in the US have been those of passerines (78%), while 5.3 percent of carcasses have been waterbirds, 4 percent have been fowl-like birds, 3.3 percent have been starling-pigeon-rock dove species, 2.7 percent have been diurnal raptors, 0.7 percent have been shorebirds, and 0.5 percent have been owls (NRC 2007). Most available data on patterns of avian mortality at wind facilities in the US is from the west and mid-west, although there is a growing database of mortality at existing wind farms in the east. Emerging results of wind farms in the east are consistent with other studies, indicating that passerines comprise the majority of avian fatalities at wind facilities. Seventy-six percent of fatalities at two forested facilities in the east (Buffalo Mountain, Tennessee and Mountaineer, West Virginia) were passerines (NRC 2007). A recent study at the Maple Ridge Wind Power Project in New York reported that 80 percent of avian fatalities were those of night migrants, and 95 percent of identifiable songbird species were night migrants. The data suggest that it may be the abundance of bird species that is associated with increased risk of collision; passerines are the most abundant terrestrial bird group and also represent the group with the highest observed fatality rate (NRC 2007).

Emerging evidence suggests that certain species of passerines are more susceptible to collision than others. Species most commonly found during carcass searches at Maple Ridge were golden-crowned kinglet (*Regulus satrapa*) (39% of fatalities) and red-eyed vireo (*Vireo olivaceus*) (9.6% of fatalities) (Jain *et al*. 2007). At Mountaineer, West Virginia red-eyed vireo represented 30% of all fatalities, magnolia warbler (*Dendroica magnolia*) represented 7 percent of fatalities, and blackpoll warbler (*Dendroica striata*) represented 4 percent of fatalities (Kerns and Kerlinger 2004). At the Buffalo Mountain Wind Farm in Tennessee, 25 percent of fatalities were red-eyed vireo, and rose-breasted grosbeak (*Pheucticus ludovicianus*) represented 17 percent of fatalities (Fiedler *et al*. 2007). A recent unpublished study conducted at another wind farm in the Northeast, the Mars Hill Wind Farm in Maine, indicated that all birds found during carcass searches were songbird species; blackburnian warbler (*Dendroica fusca*) and golden-crowned kinglets were among the most commonly found species (Stantec 2008). A few of the songbird fatalities at Mars Hill occurred during the breeding season; therefore, these collisions were not believed to occur during nocturnal migration (Stantec 2008).

Flight behavior is also believed to be associated with rates of avian collision mortality. Species that migrate at higher altitudes or avoid migrating during inclement weather would be at decreased risk of collision. Birds such as black-capped chickadee (*Poecile atricapillus*) that migrate diurnally are also at decreased risk of collision. Similarly, species such as Canada goose (*Branta canadensis*) migrate at heights of 300 to 1000 m (984.3 to 3280.8’). Although this species exhibits flocking behavior, which could suggest an increased risk of collision, collisions of these birds with man-made structures are rare and not considered a concern for the species (Mowbray *et al*. 2002). Conversely, birds taking off at dusk or landing at dawn, or birds traveling in low cloud or fog conditions are likely at the greatest risk of collision.

Although artificial lighting has been thought to influence rates of bird collision at guyed communication towers, buildings, and other tall structures, the blinking FAA lights typically installed on wind turbines do not appear to influence rates of collision (NRC 2007). Jain *et al*. found no significant correlation between mortality rates of nocturnally migrating birds at lit versus unlit turbines at Maple Ridge, NY (Jain *et al.* 2008), and this lack of correlation has been documented at other operational wind facilities (NRC 2007). Kerns and Kerlinger (2004) documented no differences in rates of collision between lit and unlit turbines at the Mountaineer facility in West Virginia. The largest single mortality event documented in their study (33 passerines in one night) was thought to be due to a combination of foggy conditions and bright sodium vapor lighting at a substation within the facility, and not related to the FAA-required lighting on the turbines themselves (NRC 2007).

A recent large collision event documented at a school on Backbone Mountain, near the Mountaineer wind facility in West Virginia further suggested the potential for bright lighting, combined with foggy conditions, to result in high collision mortality of nocturnal migrants. On the morning of September 29, 494 songbirds, many of them warblers, collided with windows of the school during a relatively short period of time before and after sunrise (Christy Johnson-Hughes, WVUSFWS, personal communication). This unprecedented mortality event was thought to be related to recent installation of bright lighting surrounding the school, which presumably attracted large numbers of birds, many of which collided with the building. The documentation of isolated, large scale mortality events such as this suggest that nocturnal migrants are susceptible to collision on an episodic basis rather than a continuous, predictable level, with factors such as lighting, weather conditions, and seasonal timing playing important roles in determining when collision events occur.

While available literature on avian collision at wind farms is limited, it has recently been increasing due to an increase in projects available for study. Because of this increase certain predictions can be made about patterns of collision mortality of nocturnally migrating passerines at the Groton Wind Farm. Appendix C, Table 1 discusses the species that are at increased risk of collision impact during the migration period, based on their behavior and abundance or due to relatively high mortality rates at existing facilities. Although the species included in the list are not the only species that may experience collision mortality at the Groton Wind Farm, available data suggest that these species are to be at increased risk of collision either because the species have experienced high mortality at existing facilities or because they are species of conservation concern that are known to occur in and also migrate through the region. The information in the table is based on the most recent data from existing wind farms in the east, population estimates and trends, and known migration collisions with man-made structures.

The majority of avian fatalities at existing wind farms appear to be of nocturnally migrating songbirds. The factors that influence increased risk of collision appear to be a combination of overall abundance, weather, and species specific flight behaviors. Mortality associated with collisions with modern wind turbine models in the U.S. have not been known to result in a significant population level impact to any one species, mainly because the species with relatively high collision mortality are regionally abundant. Collision mortality at the Project is expected to be within the range of mortality observed at existing facilities on forested ridges in the northeast. A population level impact for any single species is not anticipated to result from collision mortality during migration.

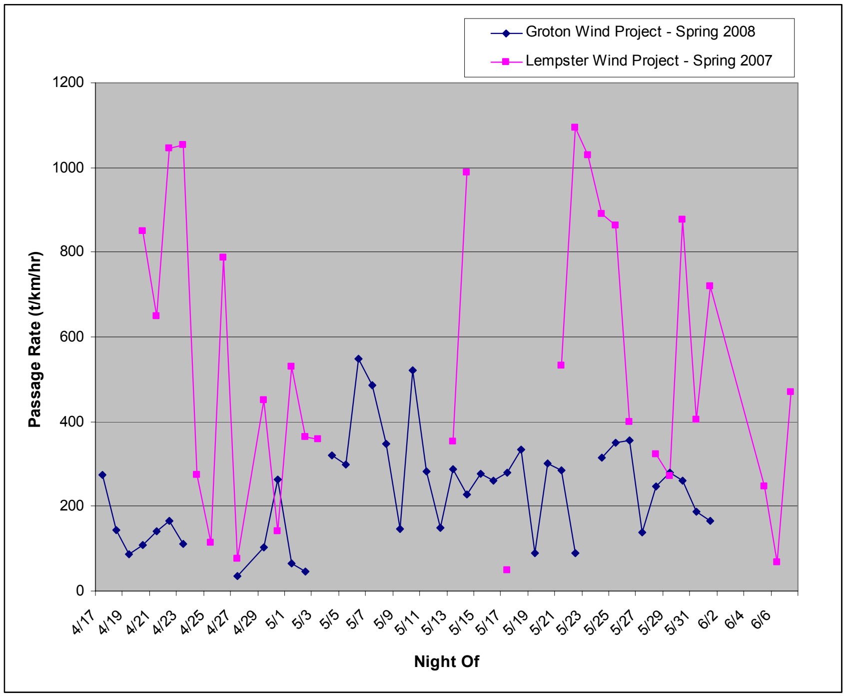
Curry and Kerlinger, in the Groton Phase I Avian Risk Assessment, indicate that the level of mortality for nocturnal migrants is not expected to be biologically significant because the populations of species that have been involved with collisions at existing wind farms in the east are stable, and avian fatalities expected to be similar in numbers and species composition as observed at existing facilities in the east.

4.2.2.2 Nocturnal Marine Radar Surveys (Assessment Endpoint 6b)

Nocturnal marine radar surveys were conducted for 40 nights in spring 2008 and 45 nights in fall 2008 (Table 2-1). Mean passage rate was 234 ± 20 targets per kilometer per hour (t/km/hr) in the spring and 470 ± 17 targets per kilometer per hour (t/km/hr) in the fall. Mean flight height was 321 m ± 16 m in spring 2008 and 342 m ± 16 m in fall 2008. The seasonal average of percentages of targets flying below the proposed rotor zone was 12 percent for the spring 2008 survey and 13 percent for the fall 2008 survey (Spring 2008 Radar Survey report; Fall 2008 Radar Survey Report). Passage rates documented at The Project were within the middle of the range of those documented in most publicly available radar surveys (Table 2-1, Stantec 2008a; Appendix A, Table 5, Stantec 2008b).

Although not conducted during the same nights and year, the results documented at the Project were similar to the results of the pre-construction radar surveys conducted at the currently operational Lempster Wind Project, located approximately 39 miles southwest of the Project. Stantec conducted nocturnal radar surveys at the Lempster Wind Project on 32 nights during the fall 2006 survey period and 30 nights during the spring 2007 survey period. Comparing the spring migration seasons, passage rates were consistently higher at the Lempster Wind Project than the Project, but the more significant result of the comparison is that the trends in flight heights between sites were nearly identical for a spring migration season (Figure 4-3). Comparing the fall migration seasons, passage rates were more similar between projects, and the trends in flight heights between sites were also nearly identical for a fall migration season (figure 4-4). This pattern suggest that factors influencing rates of nocturnal migration are occurring on a regional scale, such that trends in passage rates would be nearly identical between two sites located approximately 40 miles apart. In addition, the mean flight directions documented at both projects were northeasterly in spring and southwesterly in fall putting each project in roughly the same migration paths.

Although the final reports have not been released, preliminary information from post-construction survey results at Lempster suggest that mortality rates for nocturnally migrating passerines were low (only one bird carcass found during searches between April 20 and June 1; Tidhar 2009). Notably, pre-construction passage rates documented at Lempster, NH in spring 2006 (542 t/km/hr; Stantec 2008a) and fall, 2006 (620 t/km/hr) were among the highest documented in the region, although preliminary post-construction survey results suggests low levels of collision mortality for birds and bats. This demonstrates the challenge with correlating pre-construction radar survey results with post construction fatalities and may be the case at New England Projects where collision fatalities have been low.



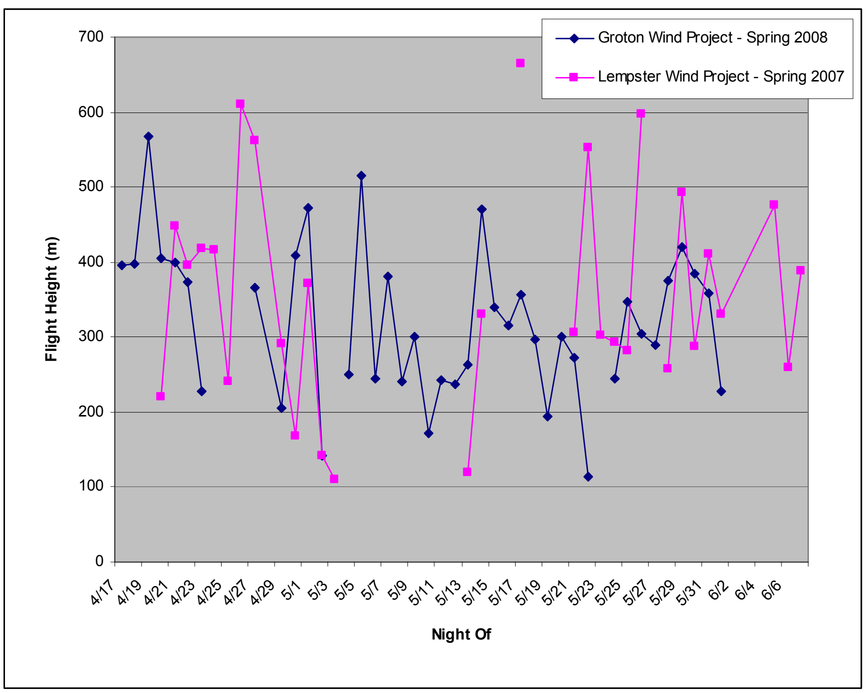
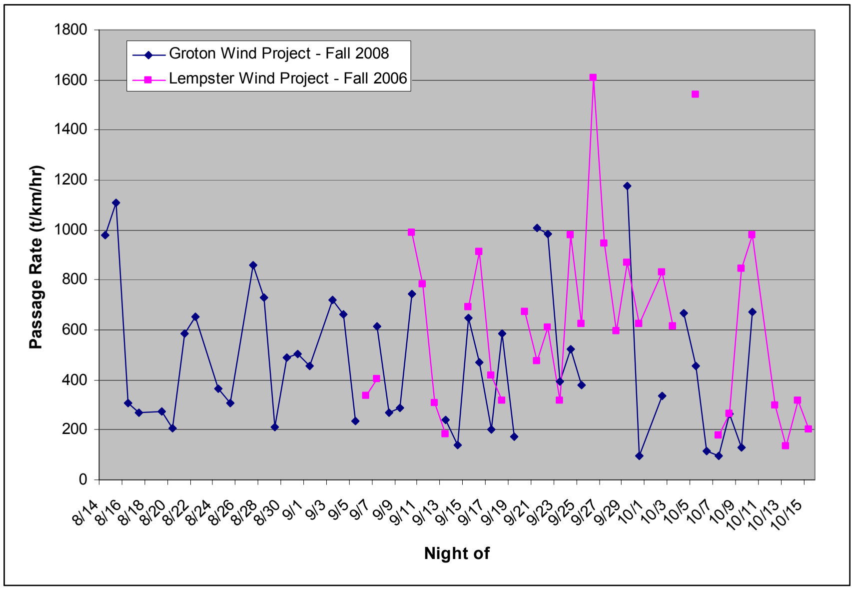


Figure 4-3. Mean nightly passage rates (above) and flight heights (below) documented at the Groton Wind Project and Lempster Wind Project during the spring migration season.



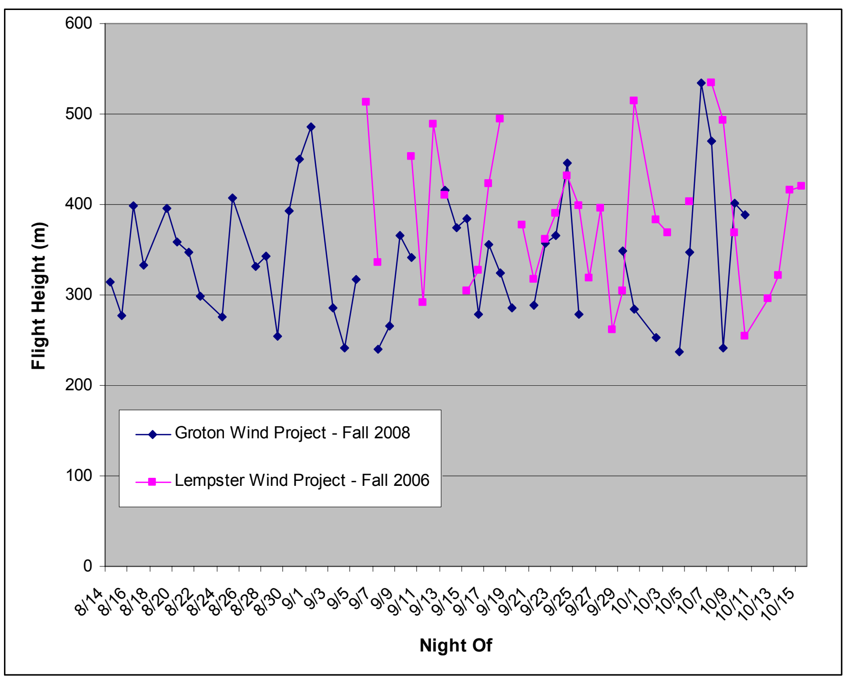


Figure 4-4. Mean nightly passage rates (above) and flight heights (below) documented at the Groton Wind Project and Lempster Wind Project during the fall migration season.

Because radar surveys were conducted from the same location at the Project during spring and fall 2008, differences in passage rates between fall and spring surveys represent variability in nocturnal migration between seasons rather than differences in site characteristics. Typically, the fall songbird migration would be expected to be heavier, due to the fact that the migratory flock includes young of the year as well as adults returning from their breeding range. This was also observed at the Project. The season mean fall (417 t/km/hr) passage rate was nearly twice that of the spring passage rate (234 t/km/hr). A more significant trend observed during both spring and fall surveys is a considerable night to night variation in passage rates, indicating that nocturnal migration is episodic, likely due to regional and local weather patterns, wind speed and direction, and other factors.

Unlike passage rates, flight heights were quite consistent between survey nights and between fall and spring surveys. A difference of only 21 meters was observed between the season mean flight height during spring than fall at the Project. The bulk of detections were recorded at heights of between 200 m and 500 m above ground level during both spring and fall 2008 radar surveys. This is quite typical of radar surveys, and is a consistent pattern observed across most radar surveys.

Overall, results of radar surveys suggest that migration patterns of nocturnal migrants are similar between fall and spring, and that flight height is consistent. While nocturnal migrants are passing through the air space above the Project area, the majority of targets are flying above the height of the proposed wind turbines. A relatively small percentage of targets fly below turbine height on most nights, and many of these targets were detected to one side of the ridge or another and not directly above the proposed turbines. Therefore, while nocturnal migrants are present within the rotor zone of proposed wind turbines, this measurement endpoint suggests that the magnitude of collision mortality of nocturnal migrants is expected to be low (Table 4-3).

Table 4-3. Evaluation of risk of impacts to nocturnally migrating passerines at the Groton Wind Project

Assessment Endpoint		Measurement Endpoints		WOE Score	Risk of Impact	Magnitude of Impact	Rationale
3	Potential collision mortality of nocturnally migrating passerines	3a	Literature Review	Low/ Medium	Yes	Low	While impacts to nocturnally migrating passerines have been documented at most wind energy facilities, rates of collision appear to be low
		3b	On-site Radar Surveys	Medium	Yes	Moderate	Radar surveys documented high passage rates, but most targets flying at heights above proposed turbine height

4.2.3 Conclusions

Although nocturnally migrating passerines are expected to pass above the Project area during spring and fall migration periods, most of these individuals are flying at consistently high altitudes above the height of the proposed turbines, as has been documented in the vast majority of recent radar surveys conducted at proposed wind facilities in the northeast. Literature review also suggested that, while impacts to nocturnally migrating passerines occur at most wind energy facilities, very small numbers of birds have collided with turbines relative to the large numbers of nocturnally migrating passerines. Both measurement endpoints predicted the potential for collision mortality to occur, with literature review predicting a low magnitude of impact and on-site radar surveys also predicting a low magnitude of potential impact (Table 4-4).

Table 4-4. Concurrence among measurement endpoints for nocturnally migrating passerines at Groton Wind Project

Increasing Evidence of Risk ↑	Evidence of Impact?/ Magnitude?	Weighting Factors				
		Low	**Low/ Medium**	**Medium**	**Medium/ High**	**High**
	Yes / High					
	Yes / Moderate			**3b**		
	Yes / Low		**3a**			
	No					
	Undetermined					
	Increasing Confidence or Weight →					
3a	Literature Review (Potential collision mortality of nocturnally migrating passerines)					
3b	On-site Radar Surveys (Potential collision mortality of nocturnally migrating passeries)					

4.3 BREEDING BIRDS

This section characterizes the non-raptor breeding bird population. Information regarding raptors that may breed within the Project area is described in Sections 3.1 and 4.1.

4.3.1 Characterization of the Breeding Bird Population

On-site breeding bird surveys (BBS), followed by USGS BBS, Audubon CBC, and eBird data provide the most site-specific and representative data available on species composition and relative abundance of breeding birds in the Project area or in the vicinity of the Project area. While one spring season of on-site surveys does not necessarily enable identification of all species of breeding birds present, these on-site data combined with USGS BBS and Audubon

CBC data collected in the vicinity of the Project over several years, provide an accurate representation of the local breeding bird community.

Breeding bird surveys at the Project documented a total of 36 species during point count surveys in the Project area, 34 of which were detected during point counts (the other two species were detected incidentally between point count surveys). A total of 38 species were detected within the control areas during point count surveys, 33 of which were documented during the counts and the five additional species were observed incidentally between the point count surveys. Excluding incidental observations, there were 27 species in common between the Project area and the control area. In general, species documented in the Project area were typical of the moderate elevation northern hardwood forests that dominate the Project area. Among the most common species were the ovenbird (*Seiurus aurocapillus*), black-throated blue warbler (*Dendroica caerulescens*), hermit thrush (*Catharus guttatus*), and dark-eyed junco (*Junco hyemalis*). All species observed, the number of individuals, relative abundance, and frequency of occurrence of species detected during the 2009 breeding bird surveys are available in the 2009 Spring, Summer, and Fall Bird and Bat Survey Report.

As part of the Groton Phase I Avian Risk Assessment for the Project, a list of 50 non-raptor species were identified during a site visit in 2007 (Curry and Kerlinger 2008). Thirty of these bird species were observed either on or just below the ridge, while the rest were documented at low elevations on the mountain and the valleys surrounding the project ridges. During the Stantec 2009 avian and bat surveys, a total of 55 non-raptor species were observed, including 43 species that were documented on the ridge in the Project area. Only two species were documented on the ridge during the 2007 surveys that were not observed in 2009: American goldfinch and evening grosbeak. A total of eleven species were documented on the ridge in 2009 that were not observed during the Groton Phase 1 assessment. In general, species composition was similar between surveys.

The uniformity of habitats within the Project area resulted in similar species composition between point counts. Overall, the assemblage of breeding bird species within the Project area is composed of forest interior breeders, as well as those associated with forest edge and disturbed forest habitats. Unusually large numbers of birds or unusually high species diversity were not documented during on-site surveys. Regional breeding bird surveys documented a greater diversity of species, as these surveys sampled additional lower elevation habitats. Regional surveys also provide multiple years of data, resulting in higher species richness.

There were no Federally Threatened or Endangered species observed during on-site BBS surveys. Of the 47 breeding-bird species considered rare by NH Fish and Game and NH Partners in flight, eleven were documented in the Project area during on-site field surveys (either during the point count surveys, raptor surveys, or incidentally between point counts) (Appendix B, Table 5). Of the 47 species considered rare by the NH Fish and Game and NH Partners in flight, 31 were detected during the regional surveys (CBC, Audubon BBS, and eBird data). Again, the higher species diversity documented in regional surveys is primarily a result of the fact that regional surveys sampled a greater diversity of habitats, were conducted at lower elevations with generally milder conditions, and occurred over many years. Additional years of breeding bird surveys at The Project would likely document year-to-year shifts in species composition and abundance, and would likely add a small number of additional species each year, but would not be expected to document a breeding bird community significantly different from that characterized by the on-site surveys conducted in 2009.

4.3.2 Collision Mortality to Breeding Birds (Assessment Endpoint 4)

4.3.2.1 Literature Review (Measurement Endpoint 4a)

Literature review on the risk of collision mortality to breeding birds suggests that, whereas the majority of documented avian collisions are thought to occur during spring and fall migration periods, avian collision mortality can occur during the breeding season as well. Most mortality studies have not been able to accurately distinguish between resident and breeding bird fatalities. Limited data suggest that roughly half the fatalities at existing wind facilities represent migrant species, while the other half represents resident species (NRC 2007).

Factors that could influence the susceptibility of breeding birds to collision mortality would include abundance, foraging behavior, and other behaviors such as courtship displays. In the West and Midwest, the species most commonly found at existing facilities are those that are locally abundant: horned lark (*Eremophila alpestris*), vesper sparrow, and bobolink (*Dolichonyx oryzivorus*). However, these species also engage in courtship displays which may result in flights within the rotor zone of turbines (NRC 2007). Many species of songbirds including wood warblers engage in territorial or courtship chasing flights during the breeding season, which may also increase their risk of collision. Although many passerines are foliage gleaners or ground foragers and therefore are at decreased risk of collision while foraging, some species engage in insect or bird 'hawking' behaviors that may put them at increased risk of collision at certain times.

While abundance and certain flight behaviors may increase risk of collision to certain breeding bird species, other species apparently avoid turbines. Crows and ravens (*Corvus spp*.) are often seen flying at heights that would be within the rotor zone of wind turbines and are often present in large numbers, yet they are rarely found during fatality searches (NRC 2007). Similar to raptors, breeding birds can 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 behaviors are presumably species specific and dependent on a range of environmental factors including visibility and auditory conditions. To some extent, resident birds are anticipated to habituate to the presence of turbines, as they have to other man-made structures such as bridges, buildings, and communication towers. Birds have been observed to become habituated to turbines and have been seen frequently flying between strings of non-operational turbines (Osborn *et al*. 1998).

Landscape features may also influence risk of collision mortality to breeding birds. Although there are currently no strong correlations demonstrated between habitat type and avian fatalities at wind farms, certain resources may influence bird abundance and susceptibility to collision including proximity to nesting habitat, prey abundance, water availability, or vegetation structure (NRC 2007). Habitat features that concentrate bird abundance or activity presumably increase risk of collision mortality. Certain facility design features may also influence the risk of collision. Modern turbine designs present less of an attraction to perching or nesting birds than the shorter, lattice-style towers used at older facilities.

While the majority of avian collisions at existing wind farms appear to be nocturnal migrant songbirds, collisions are also known to occur during the breeding season. The factors that influence increased risk of collision appear to be a combination of overall abundance, as well as species specific flight behaviors. Mortality associated with collisions with modern wind turbine models in the US will not likely result in a population level impact to any one species, mainly because the species with relatively high collision mortality are locally abundant species. Overall, literature review (measurement endpoint 4a) indicates that impacts to breeding birds could occur, although the expected magnitude of these impacts is low (Table 4-5).

The authors of the Groton Phase I Avian Risk Assessment indicate that the risk to nesting birds is expected to be minimal because during the breeding season, most birds typically fly below the forest canopy. Additionally, there are no significant wetland habitats in the direct vicinity of the Project that would attract breeding waterfowl and waterfowl are expected to rarely, or never, occur on-site. Therefore, Curry and Kerlinger expect little or no collision risk for breeding waterfowl.

Table 4-5. Evaluation of risk of impacts to breeding birds at the Groton Wind Project

Assessment Endpoint		Measurement Endpoints		Weighting Score	Risk of Impact	Magnitude of Impact	Rationale
4	Potential collision mortality of breeding birds	4a	Literature Review	Low/ Medium	Yes	Low	Collision mortality has been shown to occur for breeding birds, but at lower rates than during the migratory periods
		4b	On-site and Regional Bird Surveys	Medium/High	Yes	Low	Bird surveys documented typical abundances and species composition of breeding birds. Likelihood of collision is expected to vary by species depending on behavior and abundance.
5	Potential indirect impacts to breeding birds	5a	Literature Review	Low/ Medium	Yes	Low	Habitat removal and alteration will likely cause shifts in species abundance in the immediate vicinity of turbines and access roads. However, wind facilities generally result in a relatively small amount of clearing.
		5b	Habitat Characterization	Medium	Yes	Low	Habitats are currently relatively disturbed and fragmented. The small amount of clearing associated with the Project is expected to cause certain shifts in species distribution around turbines and access roads, but overall indirect impacts are expected to be minimal.

4.3.2.2 On-site and Regional Bird Surveys (Measurement Endpoint 4b)

According to the general understanding of interactions between breeding birds and wind turbines, species of breeding birds most susceptible to collision mortality at The Project would include those with high abundances in the Project area, those with behaviors that would cause them to fly in the rotor zone of the proposed turbines, and those species that have been most commonly found at mortality studies conducted at other operational facilities. Results of on-site BBS and regional data sets regarding avian species composition and abundance suggest that the breeding bird population at the Project is relatively limited in comparison to the surrounding region, as a low diversity of habitats occurs within the ridgeline Project area, where conditions are generally harsher and presumably less suitable as nesting habitat than in the surrounding valleys and plateaus. Species richness within the Project area was considerably lower than that documented regionally.

While overall risk of collision mortality to breeding birds is expected to be low, certain species are likely to be at slightly higher risk than others, based on their relative abundance, behaviors, or mortality data from other wind facilities. Appendix C, Table 2 lists species that could be at increased risk of collision mortality at the Project during the breeding period based on these factors. The species included in the list are not the only species that may experience collision mortality during the breeding season at the Project; however, based on available information, these species are believed to be at increased risk of impact. Among these (but not limited to) are the ovenbird, rose-breasted grosbeak, red-eyed vireo, purple finch, and chestnut-sided warbler. The table also includes species of conservation concern that were documented in the Project area. Whereas most of these species were not present in the Project area in large numbers, they could suffer greater cumulative impacts due to their vulnerable populations even though these species would likely not constitute a large number of fatalities at the Project.

Overall, collision mortality of breeding birds at The Project is expected to be within range of mortality observed at existing facilities in the east, although differentiation between mortality of breeding and non-breeding passerines is difficult (Appendix B, Table 4). Results of on-site and regional bird surveys (measurement endpoint 4b) suggest that, while impacts to breeding birds may occur, the magnitude of these impacts is expected to be low (Table 4-5). Moreover, the Project area does not appear to support large numbers of any RTE bird species during the breeding season and impacts to these species are expected to be minimal. A population level impact for any single species is not anticipated to result from collision mortality during the breeding season.

4.3.3 Indirect Impacts (Assessment Endpoint 5)

4.3.3.1 Literature Review (Measurement Endpoint 5a)

In addition to direct impacts associated with collision mortality, development of wind facilities can result in indirect impacts associated with habitat loss or displacement of species. These types of impacts are potentially complex, involving shifts in species abundance, turbine avoidance, habitat use, and behavioral disruption. While wind facilities generally result in relatively small amounts of habitat loss, they create a considerable amount of edge habitat associated with turbine pad clearings, new roads, and transmission lines.

The creation of edge habitat in previously forested areas may decrease the abundance of forest interior species while increasing the abundance of predatory species such as American crow or blue jay (*Cyanocitta cristata*), or brood parasitic species such as brown-headed cowbird (*Molothrus ater*). Additionally, increased human presence around nesting areas due to maintenance activities may decrease the reproductive success of more sensitive species. The level of habitat disturbance associated with the Project relates to the topography, the conditions of habitats present, the amount of existing roads or infrastructure, and the turbine layout (NRC 2007). Habitat disturbances would be species specific and would depend on the condition and availability of habitat prior to construction (NRC 2007). Species with specific habitat requirements or species of conservation concern would be at increased risk of impact due to habitat modifications. Forest dwelling species such as wood thrush (*Hylocichla mustelina*) or blue-headed vireo (*Vireo solitarius*) require extensive tracks of undisturbed forest for successful reproduction.

At wind farms, an estimate of the total area disturbed per turbine ranges from one to three acres (NRC 2007). However, impacts such as edge effect may extend as far as 100 to 340 m (330' to 1122') from the footprint of a turbine for some forest interior species (NRC 2007). Habitat loss due to the modification of habitat or displacement due to an edge effect or fragmentation may be long-term, whereas habitat loss due to displacement because of disturbances associated with construction may be temporary for some species (NRC 2007). The creation of forest edge habitat results in net loss of habitat for some forest dwelling species, while the same impact may increase the local population of species including brown thrasher, Northern cardinal (*Cardinalis cardinalis*), Northern mockingbird (*Mimus polyglottos*), ruffed grouse (*Bonasa umbellus*), and wild turkey (*Meleagris gallopavo*) (NRC 2007). The decrease of forest canopy can improve habitat for shrub-nesting species such as eastern towhee, indigo bunting, and song sparrow (*Melospiza melodia*). However, species such as ovenbird and blackburnian warbler may be impacted by the removal of stands of mature hardwood trees (NRC 2007). Historically, forest harvesting and other impacts have resulted in decreases in the populations of ovenbird, Kentucky warblers (*Oporornis formosus*), and worm-eating warblers (*Helmitheros vermivorus*). In grassland settings, development may increase habitat for some species that nest on recently disturbed ground such as many species of sparrow (Johnson *et al*. 2000).

Some species have a greater tolerance than others for human activity and habitat modification in the vicinity of nesting areas. Although the majority of grassland nesting birds decreased their use adjacent to the turbines at the Buffalo Ridge facility, waterfowl observed continued use of the area. For example, a mallard nested 31 m (100') away from one of the turbines, suggesting some waterfowl become habituated to the presence of turbines (Osborn *et al*. 1998). Another wind power facility located in grassland habitat, however, did not produce large-scale displacement of grassland nesting birds. Savannah Sparrow (*Passerculus sandwichensis*) and Bobolink (*Dolichonyx oryzivorus*) densities at the Maple Ridge Wind Power Facility were compared to undeveloped nearby reference plots, and it was found that nesting Savannah Sparrow populations suffered no displacement and nesting Bobolink populations were minimally affected only at distances under 100 m from the turbine (Kerlinger and Dowdell 2008). At the Lempster Wind Project a common night hawk (*Chordeiles minor*) nest was observed during pre-construction surveys and was documented again at the project in the vicinity of operating turbines in July, at the end of nesting season (Tidhar 2009).

There are limited data available addressing impacts to birds associated with habitat loss due to wind farm developments in the U.S., as the majority of studies have focused on the more direct impact of collision mortality. A study conducted at the Buffalo Ridge facility indicated that some species were more susceptible to displacement than others, including common yellowthroat and grassland nesting species. Species were generally displaced from areas less than 100 m from the towers (NRC 2007, Johnson *et al*. 2000). However, analysis indicated that the turbines did not affect use of the area within 100 m from the towers for 65 percent of bird groups (waterfowl, shorebirds, doves, flycatchers, corvids, blackbirds, chickadees/nuthatches, tanagers/orioles, and thrushes (Johnson *et al*. 2000).

Habitat impact information is more limited for existing wind facilities in the east. Breeding bird surveys were conducted prior to construction, during construction, and after construction at the Green Mountain Power Corporation's Wind Power Facility in Searsburg, Vermont. The same diversity of species was detected during the three survey periods; however, the abundance and frequency of species at study sample sites changed over the three periods. Four of the most abundant species prior to construction, Swainson's thrush (*Catharus ustulatus*), white-throated sparrow (*Zonotrichia albicollis*), ovenbird, and red-eyed vireo, experienced declines in abundance during post-construction surveys. The decline was believed to be a result of the creation of forest edge as these birds are primarily forest interior species. Some species including blackpoll warbler, magnolia warbler, and dark-eyed junco (*Junco hyemalis*) remained unchanged. Yellow-rumped warbler (*Dendroica coronata*) and other edge species such as American robin and blue jay increased in abundance (Kerlinger 2002).

Habitat modifications that occur during activities such as logging, residential development, and wind development have resulted in observable changes in the abundance of locally breeding birds. Impacts associated with habitat modification have resulted in the direct loss of habitat, as well as other indirect effects such as increased exposure to brood parasitism or nest predation. Habitat decline is a major factor associated with the declining populations of many avian species in the U.S. At wind facilities, turbines located in unique habitats that support sensitive species may present more of a risk of impact. Species with specific habitat requirements and species of conservation concern are more susceptible to impacts associated with habitat modification.

Overall, literature review on the likelihood of indirect impacts to breeding birds (measurement endpoint 5a) suggests that some indirect impacts will likely occur as the result of the Project, but that the magnitude of these impacts will be minimal, as the Project will result in a relatively small amount of clearing relative to the entire Project area and this area has experienced frequent changes in habitat conditions due to timber harvesting activities in which the breeding bird population has likely become accustomed to (Table 4-5). These impacts are expected to consist primarily of shifts in distribution of species within the Project area which could also occur as the result of other types of impacts such as timber harvesting.

4.3.3.2 On-site General Habitat Characterization (Measurement Endpoint 5b)

As described in several sections of this document, habitats at the Project consist of a mid-successional northern hardwood – mixed conifer forest. Within the Project area, ridgeline heights are relatively uniform and topographic variation is 200 m (656') at the greatest. The forest structure is influenced by a long tradition of timber harvesting in the area, although small pockets of late successional red spruce exist on the steeper and less accessible slopes. Throughout the Project area, forests have been recently cut, and are fragmented by existing haul roads and, on the south side of the Project area, a communications tower, transmission lines, and infrastructure associated with the Tenney Mountain Ski Resort.

Despite some anthropogenic impact, the forest is a largely intact mid-successional ecosystem. The bird species breeding within the Project area are both interior species, such as black-throated green warblers, and edge-associated species, such as chestnut-sided warbler. Impact on breeding bird species is likely to be complex and highly species-specific. While some species may be negatively affected by habitat changes or inter-species competition, others may benefit from these changes. Interior forest species, such as the ovenbird, that are more typically associated with contiguous forests, may shift their local distribution in response to construction of the Project, but are expected to remain within the Project area (Appendix C, Table 3). Because much of the Project area has been previously logged, the composition of the species present is not likely to change significantly after development.

Whereas indirect impacts of habitat loss and creation of edges will not necessarily diminish the overall abundance of breeding birds in the Project area, species composition of birds will likely shift in areas containing turbines, with forest interior species becoming less abundant and forest edge species becoming more common. Also, increased human activity may cause displacement of species such as blue-headed vireo and black-throated blue warblers, which are more sensitive to human activity in the vicinity of nests and may experience decreased breeding success.

Based on field surveys and the habitat characterization (measurement endpoint 5b), indirect impacts are expected to result in species shifts from forest interior to forest edge species in the immediate project footprint. However, the magnitude of these impacts is expected to be relatively minimal, considering the fact that much of the habitat in the Project area is currently fragmented by timber harvesting and existing development, many of the species observed during field surveys are forest edge species rather than forest interior species, the footprint of development areas is relatively small (Table 4-5).

4.3.4 Conclusions

While collision mortality has been demonstrated for resident breeding birds, it is generally thought that collision mortality affects migrating birds to a greater extent based on the timing of fatalities during post-construction monitoring at existing wind facilities. On-site bird and habitat surveys did not reveal unique species assemblages, an unusually high species diversity, or unusually large numbers of birds. Based on comparison to regional surveys conducted in adjacent valleys with more diverse habitats occurring at lower elevations, breeding bird diversity is relatively low within the Project area. Generally, direct and indirect impacts to breeding birds at the Project are expected to be limited to a small amount of collision mortality and slight shifts in the distribution of breeding bird species within the Project area. Because many of the common species in the Project area are edge-associated species, typically inhabiting areas with human activity, many breeding bird species are expected to become habituated to the presence of the turbines, minimizing displacement and other indirect impacts. The four measurement endpoints used to assess potential direct and indirect impacts to breeding birds all predicted that, while impacts could occur, the magnitude of these impacts is expected to be low, indicating concurrence among the measurement endpoints (Table 4-6).

Table 4-6. Concurrence among measurement endpoints for breeding birds at the Groton Wind Project

Increasing Evidence of Risk ↑	Evidence of Impact?/ Magnitude?	Weighting Factors				
		Low	Low/ Medium	Medium	Medium/ High	High
	Yes / High					
	Yes / Moderate					
	Yes / Low		**4a, 5a**	**5b**	**4b**	
	No					
	Undetermined					
	Increasing Confidence or Weight →					
4a	Literature Review (Potential collision mortality of breeding birds)					
4b	On-site and regional bird surveys (Potential collision mortality of breeding birds)					
5a	Literature Review (Indirect impacts to breeding birds)					
5b	Habitat Characterization (Indirect impacts to breeding birds)					

4.4 BATS

4.4.1 Characterization of the Bat Community

Eight species of bats occur in New Hampshire, 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*) (Whitaker and Hamilton, eds 1998). Of these, the small-footed bat is a state-listed endangered species. Based on available habitat within the Project area, existing cleared areas, timber harvest roads, and other linear features provide potential foraging habitat for all of the bat species mentioned. The little brown bat, northern long-eared bat, and big brown bat are likely among the most common species based on the largely forested habitat and generally widespread nature of these species (DeGraaf and Yamasaki 2001).

4.4.2 Potential Collision Mortality of Bats (Assessment Endpoint 6)

4.4.2.1 Literature Review (Measurement Endpoints 6a)

Mortality of eight bat species has been documented at wind energy facilities in the eastern United States (Kunz *et al*. 2007a), with most fatalities occurring during what is generally considered the fall migration period (August to November; Arnett *et al*. 2008, Cryan 2003, Cryan and Brown 2007, Johnson *et al*. 2005). Species documented under turbines in the east include little brown myotis, northern myotis, tri-colored bat, seminole, silver-haired, hoary, red, and big brown bats. With the exception of tri-colored bats, the species killed most frequently—hoary, red, and silver-haired bat—are long-distance migrants, traveling dramatically greater migration distances than other North American species (Cryan 2003, Cryan *et al.* 2004, Cryan and Brown 2007). Hoary, red, and silver-haired bats are closely related members of the *Lasiurus* and *Lasionycteris* genera, and it has been hypothesized that the migratory behavior of these species leads to their propensity to strike wind turbines (Cryan and Brown, 2007; Kunz *et al*. 2007a, 2007b). Of the eight eastern species documented in post-construction mortality surveys, only the seminole bat does not occur in New Hampshire (BCI 2001).

Various hypotheses attempting to explain bat fatalities at wind energy sites are summarized in Kunz *et al*. 2007a. Several of these hypotheses propose attraction of bat to wind turbines through creation of linear habitat and/or potential roosts, habits and/or conditions favorable for foraging and high insect abundance, and attraction through auditory cues. Other hypotheses propose turbines cause electromagnetic disorientation, or that bats are unable to accurately determine turbine speed through echolocation. A recent study of bat activity around wind turbines documented bats foraging near and landing on turbines and on turbine monopoles, suggesting that bats are at risk during routine nightly behaviors, and that bat-turbine interactions are non-random (Horn *et al*. 2008). Thus, Horn et al. (2008) found evidence for attraction of bats to turbines, that bats actively forage around turbines, and that bat activity was positively correlated to insect activity. Although no relationships were found between bat activity and weather conditions, other studies have found that bat collisions with wind turbines are greatest on relatively calm nights (wind speeds less than 4-6 m/s) (Arnett *et al*. 2008). This pattern is reinforced by pre-construction acoustic monitoring of bat activity, which has documented that bat activity was highest on nights with wind speeds of less than 5.4 m/s (Reynolds 2006) as well as more recent curtailment studies conducted in Alberta, which documented reductions in bat mortality when certain turbines were feathered at wind speeds below 5.5 m/s (Baerwald et al 2009).

In a recent survey of results of post-construction mortality of bats at wind facilities, Kunz *et al.* (2007a) published results of five studies in which acoustic surveys were conducted concurrently with mortality searches (Table 4-7). Although only five studies were available, results suggest a correlation between pre-construction bat activity and collision mortality rates. When comparing these survey results, it is important to consider that calls reported in these studies were not categorized by species, indicating that calls may have been from different species than those documented in mortality surveys. Also, certain surveys involved detectors deployed at various heights, potentially influencing detection rates (Kunz *et al.* 2007a).

Table 4-7. Evaluation of risk of impact to bats at the Groton Wind Project

Assessment Endpoint		Measurement Endpoints		WOE Score	Risk of Impact	Magnitude of Impact	Rationale
6	Potential collision mortality of bats	6a	Literature review	Low/ Medium	Yes	Moderate	Some bats are killed at most wind facilities in northeast, although there are variable rates of mortality at different sites and locations.
		6b	Acoustic Bat Surveys	Medium	Yes	Low	Presence of bat species indicates potential risk, which is expected to vary by species, although levels of acoustic activity recorded in met towers were relatively low.
		6c	Weather Data Analysis	Medium/High	Undetermined	N/A	Weather analysis indicates that "higher risk" conditions occur between 0-53% of the time, depending on the season, using values of 6 m/s for wind speed and 14°C for temperature.
7	Potential habitat loss or displacement of bats from the Project area	7a	Literature Review	Low/ Medium	Yes	Low	Removal of roost habitat is likely the greatest potential impact and is not generally outweighed by creation of additional foraging habitat associated with turbine pad clearings. However, wind facilities typically result in relatively small amount of forest clearing.
		7b	Habitat Characterization	Medium	Yes	Low	Forest clearing will affect a relatively small amount of habitat within the Project, although removal of roost trees may impact the quality of bat habitat.

Table 4-8. Results of surveys that correlated bat activity rates derived from acoustic surveys to mortality rates, as cited in Kunz *et al.* 2007a

Study Area	Inclusive Dates of Survey	Bat Mortality (no./turbine/yr)	Bat Activity (no./detector/night)	Total Detector Nights	Source
Mountaineer, WV	31 Aug–11 Sep 2004	38.0	38.2	33	E. B. Arnett, Bat International, unpublished
Buffalo Mountain, TN	1 Sep 2000–30 Sep 2003	20.8	23.7	149	Fiedler 2004
Top of Iowa, IA	15 Mar–15 Dec 2003, 2004	10.2	34.9	42	Jain 2005
Buffalo Ridge, MN	15 Mar–15 Nov 2001, 2002	2.2	2.1	216	Johnson et al. 2005
Foote Creek Rim, WY	1 Nov 1998–31 Dec 2000	1.3	2.2	39	Gruver 2002

To date, mortality rates have been highest at wind developments along forested ridges in eastern United States, particularly in the Mid Atlantic States, with some of the highest estimated mortality occurring at the Mountaineer, WV development (38.0 bats/turbine/year) and Buffalo Mountain, TN development (63.9 bats/turbine/year Appendix B, Table 6). Post-construction surveys nearer to this Project area, and potentially more relevant include three seasons of post-construction surveys at Maple Ridge, in Lewis County, New York, a preliminary survey at Lempster, NH, and two seasons of surveys at the Mars Hill facility in Maine. Currently, the results of the spring season only at Lempster, NH are available (the estimate of the bat mortality rate is currently not available). One little brown bat was found at Lempster on May 25, 2009 (Tidhar 2009) despite the detection of long distance migratory bat species during pre-construction surveys at this site. Estimates of bat mortality among the three years of surveys at Maple Ridge, New York ranged from 8.18 to 20.31 bats per turbine per year (based on the results of daily verses bi-weekly verses weekly searches) (Jain et al. 2007, 2008, 2009). In 2008, species involved in collisions at Maple Ridge included hoary bats, silver-haired bats, eastern red bats, little brown bats, and big brown bats (Jain et al. 2009). Estimates of bat mortality among the two years of surveys at Mars Hill ranged from 0.17 to 4.4 bats per turbine per year (based on the results of daily verses weekly verses seasonal dog searches). Species involved with collisions at Mars Hill included silver-haired bat, hoary bat, eastern red bat, and little brown bat (Stantec 2008 and 2009). The majority of bat fatalities at both the Maple Ridge and Mars Hill facilities were documented from July to September (Jain et al. 2009, Stantec 2008 and 2009), consistent with the findings of other mortality studies conducted in the U.S. (Arnett et al. 2008).

Measurement endpoint 7a therefore indicates that the likelihood of collision mortality of individual bats as a result of the Project is relatively high (largely related to long-distance migrants), and the magnitude of these impacts will be within the range of collision mortality observed at operational wind facilities located on forested ridgelines (Table 4-7). However, it is expected that collision mortality at the Project will be more similar to Projects on forested ridges in New England which have documented relatively low collision rates. Given the small number of post-construction mortality studies that include detailed information on bats, and the inability to relate literature to site-specific issues, this measurement endpoint has a large degree of uncertainty associated with it.

While the majority of documented bat fatalities at wind facilities appear to occur during migration, bats are also at risk of collision during the summer. Exposure pathways may be different in the breeding season versus migratory periods, and could be more related to foraging patterns than migrating, flocking, swarming, or mating behavior. However, cumulative impacts of collision mortality during both migration periods and the summer breeding season are a particular concern for bats, as North American species tend to be relatively long-lived, and reproduce very slowly (Barclay and Harder 2003). Very little is known about the population status and trends of most bat species, and assessing the population-wide impacts of collision mortality can only be speculative at this point. Because susceptibility of collision mortality at wind facilities appears to differ by species and guild within the bat community, information regarding collision mortality of various species and guilds within the bat community is presented below.

4.4.2.1.1 Long-distance Migratory Bat Species

Hoary, red, and silver-haired bats, considered long-distance migratory bat species, appear to be at the greatest risk of collision with wind turbines (Arnett et al 2008, Cryan 2003, Kunz et al. 2007a). This can be assumed given the number of recorded mortalities across the United States, and especially in the east (Kunz et al. 2007a). Current data from mortality surveys to date show fatalities of these species occur at greater levels during fall migration, although mortalities of summer residents have also been observed (Kunz et al. 2007a). Fall migration patterns of hoary bats differs from spring migration patterns, with male and female hoary bats geographically separated until fall migration when mating occurs (Cryan 2003). This pattern led Cryan and Brown (2007) to postulate that migratory species flock at wind turbines during the fall, using these areas to locate potential mates and thus exposing them to higher mortality risk. Many other hypotheses regarding the increased mortality of long-distance migrants, and there are currently not enough data to explain why hoary, red, and silver-haired bats are killed in larger numbers than Myotis species and big brown bats. Although this trend has not yet been explained, no data suggests that different patterns should be expected for this Project.

4.4.2.1.2 Tri-colored bats

Tri-colored bats have also been found in large numbers during mortality surveys at wind facilities, with more observed mortalities than silver-haired bats (Kunz *et al*. 2007a). Interestingly, tri-colored bats are not known to migrate long distances between their summer and winter range (Fujita and Kunz 1984), setting them apart from the other three species frequently killed by wind turbines. Lack of long-distance migrations does not necessarily mean that fatalities are not linked to small-scale migration behavior, but it is unknown why small-scale movements would result in high mortality rates in tri-colored bats but not in *Myotis* species. Little research has been conducted on this species' foraging behavior, but it does appear that they are more frequently found over fields, water, and other open areas (Carter *et al*. 1999, van Zyll De Jong 1985). If tri-colored bats do prefer to forage in open areas or above the forest canopy this could potentially explain high mortality rates for this species.

4.4.2.1.3 *Myotis* species

Although *Myotis* species also migrate (Fenton and Barclay 1980, Kurta and Murray 2002), they do so at smaller scales than has been observed among the *Lasiurus* and *Lasionycteris* genera (Cryan 2003). Unlike red bats and hoary bats, North American *Myotis* species hibernate in caves (Whitaker and Hamilton 1998), where copulation occurs prior to hibernation. Unlike the tree-roosting bats, *Myotis* species exhibit swarming behavior, in which they gather in large numbers outside hibernacula during the fall to find mates and copulate prior to entering hibernation. It is unknown whether the difference in migration and mating behavior between *Myotis* species and long-distance migrants is the cause for differing mortality rates, or if differences in mortality rates are the result of differences in other behaviors (i.e., foraging). Regardless, *Myotis* species are likely at lower levels of risk than hoary bats, red bats, and silver-haired bats based on post-construction surveys (Kunz *et al*. 2007a). Despite their abundance, *Myotis* species have comprised only 6.2 percent of documented bat fatalities across the US, and only two species have been documented during mortality surveys (little brown and northern) (Kunz *et al*. 2007a).

To date, no publicly available post-construction mortality surveys have documented fatalities of small-footed myotis at wind energy facilities (Kunz et al. 2007a). Although no mortalities have been observed, there is some uncertainly regarding the collision risk of this species. First, large mortality rates across the species' range cannot be expected since the eastern small-footed myotis is uncommon and is believed to migrate very small distances (Best and Jennings 1997, Johnson and Gates 2008). These two factors suggest that exposure to wind turbines is likely limited across the species' range. Additionally, and the species' small size potentially makes finding carcasses during mortality surveys more difficult than finding larger, more noticeable species.

Despite uncertainty, there are some ecological aspects of the eastern small-footed myotis' behavior which suggest the species might be at low risk from collision with wind turbines. Specifically, recent dietary studies of the eastern small-footed myotis suggest the species gleans prey off of vegetation (Johnson and Gates 2007, Moosman et al. 2007). If true, this gleaning behavior would result in individuals spending a substantial amount of time beneath the canopy, not exposing them to collision risk, but there are currently no published data of foraging behavior to support or refute this hypothesis.

4.4.2.1.4 Big Brown Bats

Although big brown bats are abundant throughout the northeast, they have made up only 2.4 percent of total mortalities at wind developments across the United States, indicating their risk is comparable to that of little brown and northern myotis and low relative to migratory tree bats and pipistrelles. Big brown bats are known for their ability to navigate using the Earth's magnetic field (Holland *et al*. 2006). However, they are not known to migrate distances comparable to hoary, red, and silver-haired bats, although movements of up to 228 km have been recorded (Mumford 1958). Big brown bats are relatively large and are strong fliers, suggesting that they may be more inclined to fly in open spaces or at higher altitudes than *Myotis* species.

4.4.2.2 On-site Surveys (Measurement Endpoint 6b)

Acoustic surveys conducted in 2006 and again in 2009 documented relatively low activity levels, particularly at detectors mounted near turbine height in met towers. Year 2006 surveys, which involved 3 detectors (69 calendar nights,162 detector-nights) yielded recordings of 62 call sequences (0.4 call sequences per detector-night), and year 2009 surveys, which involved 8 detectors (72 calendar nights, 466 detector-nights) yielded recordings of 2,104 call sequences for an overall activity level of 4.5 call sequences per detector-night (Stantec 2006; Stantec

2009b). Detailed descriptions of the methods and results of these surveys can be found in corresponding survey reports, included separately.

Year 2009 surveys, which were more robust, documented a steady decline in bat activity levels between August and October, with over 80% of call sequences recorded during August, which likely coincides with bat migration. Peaks in activity levels occurred in late August, and activity levels at all detectors, although variable throughout the survey, declined as the survey progressed. As is often observed in acoustic bat surveys, species composition differed between ground-level detectors and met-tower detectors during 2009 surveys, which *Myotis* species being detected far more frequently near the ground than above the forest canopy. Notably, hoary bats and silver-haired bats were detected relatively frequently during 2009 acoustic surveys, with silver-haired bats comprising the majority of identified calls at the highest detectors. For both species, peaks in activity levels occurred between August 15 and 20 (Stantec 2009b).

In comparison to similar studies conducted at other proposed wind projects in the northeast, bat activity levels recorded within the Project area were generally low (see Appendix C Table 12 in Stantec 2009b), although direct comparison of acoustic activity levels is not necessarily a valid means of assessing potential risk to bats. Variation in detection rates typical for results of acoustic surveys due to a variety of factors (Hayes 1997; Hayes 2000). More relevant to this Project are the results that activity levels were highest in August, and that species composition of recorded activity near turbine height was skewed towards long-distance migratory species, including silver-haired and hoary bats. Risk of collision mortality would therefore be expected to be greatest during August, and greatest for long-distance migratory species. Overall, this measurement endpoint indicates a moderate potential for collision mortality based on comparison to other sites (Table 4-10). Potential impacts are expected to vary by season, following patterns observed at other operational wind facilities, particularly those in New England with impacts being greatest during the fall migration period, particularly in mid to late August but overall relatively low. Potential impacts are also expected to vary by species, due to behavioral factors, relative abundance, and documented patterns in collision mortality, as discussed below.

4.4.2.2.1 Long-distance Migratory Bat Species

Hoary, red, and silver-haired bats were all documented during acoustic surveys between August and October, indicating the presence of each species within the Project area, although red bats were detected less frequently than the other two species. Long-distance migrants were recorded more often at met detectors than were *Myotis* species, suggesting that long-distance migratory species tend to fly higher than other species and would therefore be at greater risk of collision mortality. Regardless, the biology of these species (Cryan and Brown 2007, Kunz *et al*. 2007a) and peak acoustic activity during the fall suggests that they are more vulnerable to collision mortality at the Project than other bat species.

4.4.2.2.2 Tri-colored bats

Tri-colored bats were documented during acoustic surveys, indicating their presence in the Project area, although they were identified infrequently. Available post-construction data suggest that this species is among species more vulnerable to collision mortality (Kunz *et al.* 2007a), suggesting potential risk of collision mortality at this Project .

4.4.2.2.3 *Myotis* species
Myotis species were documented at the Project during 2009 acoustic surveys at each detector, particularly at the ground-level detectors. Although expected to be the most common group of bats within the Project area during much of the summer and fall, *Myotis* species tend to be active below the forest canopy (Arnett *et al.* 2006). Therefore, despite their likely prevalence, these species may be at a lower risk of collision mortality than other less common species.

4.4.2.2.4 Big Brown Bats
Big brown bats were documented during acoustic surveys in 2009, indicating their presence in the Project area. Big brown bats were detected at met tower detectors throughout the acoustic survey, evidencing some risk of collision with wind turbines. However, the results of post-construction surveys suggest risk to this species is low despite activity above the forest canopy (Kunz *et al*. 2007a).

4.4.2.3 Weather Data Analysis (Measurement Endpoint 6c)

The use of weather data analysis to predict potential impacts to bats associated with collision mortality assumes a relationship between rates of collision mortality and weather variables. Although this pattern has not been conclusively proven, it has been noted in several post-construction mortality surveys. Also, surveys comparing bat activity levels to weather patterns have indicated correlation between activity and weather variables (Reynolds 2006). Comparison of bat detection rates documented during on-site acoustic surveys with nightly mean temperature and wind speed, suggested a correlation between bat activity levels and weather variables, although the degree to which these variables are independent was not assessed and analysis did not address whether or not “critical” values appear to exist for these variables above or below which bats are rarely active. However, qualitative comparison of wind speed, temperature, and acoustic bat activity measured in the Project area and at other sites where similar surveys have been conducted suggest that bat activity levels were generally higher on nights with calmer wind speeds and higher temperatures.

Given the uncertainty surrounding potential relationships between wind speed, temperature, and bat activity levels, a variety of combinations of wind speed and temperature were analyzed for three different wind speeds and temperatures and summarized by month. The most restrictive of these combinations (wind speeds less than 4 m/s and temperatures greater than 16°C) occurred during 10 percent of nights (Table 3-9) and 8 percent of hours (Table 3-10) for the 2009 survey period. The least restrictive set of conditions (wind speeds less than 8 m/s and temperatures greater than 12°C) occurred on 30 percent of nights (Table 3-9) and 31 percent of hours (Table 3-10) for the 2009 survey period. Generally, wind speeds were calmest and temperatures were warmest during August, and grew steadily colder and windier through October. Use of weather data alone to predict risk would suggest that bats are most vulnerable to collision mortality during periods of calm, warm weather, which were most common in August.

This measurement endpoint suggests that certain weather conditions that have been associated with increased rates of collision, occur in the Project area between approximately 8 and 31 percent of the hours overall in between August and October, depending upon which combination of wind speeds and temperatures are analyzed (Table 3-10). Thus, by affecting the ways bats may interact with turbines, the endpoint influences the likelihood of collision on any given night, but does not determine whether or not potential impacts exist (Table 4-9). "High risk" weather conditions were most common in August, when temperatures were warmer and wind speeds lesser. However, factors other than weather variables clearly influence rates of collision, and this endpoint is limited in its ability to predict mortality without considering other factors such as time of year. Relationships between wind speed, temperature, and bat fatality rates have not been adequately explored, although bats could be expected to be more vulnerable to collision mortality during conditions in which they are more active, or when prey are abundant; i.e., relatively warm, calm conditions.

4.4.3 Indirect Impacts to Bats (Assessment Endpoint 7)

4.4.3.1 Literature Review (Measurement Endpoint 7a)

In addition to direct collision mortality, the construction of wind energy facilities has the potential to cause indirect impacts such as habitat loss, habitat conversion, and displacement of bats. Although no studies have measured the response of existing bat communities to the creation of a wind facility and its associated infrastructure, several effects could be expected.

If existing forest stands were removed during the creation of access roads and turbines pads, available roosting habitat could be reduced. The magnitude of impact on local bats communities would vary based on the quality and quantity of habitat removed and the availability of alternate habitat of comparable quality and character. For example, removal of large diameter dead and declining trees of many species would constitute removal of high quality roosting habitat. Additionally, if the habitat conversion lowered the overall habitat diversity of an area, it could negatively affect the bat community (Hayes and Loeb 2007). The duration of the impact would vary depending on whether the original habitat was allowed to revert to its pre-construction condition or whether the habitat would be permanently lost. Long-term loss of habitat would be incurred where the forest was cleared for turbine placement, thus preventing recruitment of potential snags for the near future.

In some cases, conversion from forested to non-forest habitat could result in short or long-term benefits to local bat communities, depending upon the configuration of the surrounding forested landscape. For example, forest gaps and clearings create additional foraging opportunities, as documented by higher levels of bat activity in fields, edges, and clearings (Hayes and Loeb 2007). This apparent enhancement of foraging habitat is possibly a function of reduction in clutter rather than enhancement of insect (prey) habitat. Depending on the size, plant species composition and diversity, and surrounding habitats, fields have been shown to produce lower insect diversity and abundances, but may still be close enough to forest habitat to still maintain insect levels suitable for bat foraging (Burford *et al*. 1999, Dodd 2006). Creation of forest gaps and clearing has been recommended as a management technique for some species (Krusic *et al*. 1996), but not all bat species in the eastern U.S. would benefit from such practices (Owen *et al*. 2003). However, foraging habitat is typically present in far greater abundance than roosting habitat, and therefore any potential increase in foraging habitat would not outweigh potential loss of roosting habitat if suitable trees/stands are removed during construction.

Overall, the literature review indicates the potential for indirect impacts to bats, from removal of roost trees (impacts to rock habitat discussed in 4.4.4.2), creation of edge habitat, and construction of wind turbines, which may affect the distribution and movement patterns of bats in an area. Results from other wind projects and general understanding of how bats utilize habitat suggest that the creation of edge habitat and clearing associated with the Project will likely cause a shift in bat activity patterns along the ridgeline, increasing the amount of foraging habitat, possibly creating flight corridors along the ridgeline (similar to the existing roads). While some of these impacts are not necessarily harmful to bats, the project may influence the distribution and possibly species composition of bats within the Project (Table 4-7).

4.4.3.2 Habitat Characterization (Measurement Endpoint 7b)

Project turbines and infrastructure are located primarily within hardwood and mixed hardwood-softwood forests. The Project area is primarily forested, yet includes numerous flight corridors, forest gaps, water-sources, and diverse roosting potential. Flight corridors are typically linear features which offer natural flight paths for navigation and low-clutter foraging habitat (Hayes and Loeb 2007, Lacki *et al*. 2007), and occur as forest roads, timber harvesting clearings, and 'hard' edges within the Project area. Forest gaps are also important, and have been shown to have higher levels of bat activity than surrounding habitat in several studies (Hayes and Loeb 2007, Lacki *et al*. 2007, Menzel *et al*. 2002, Tibbels and Kurta 2003). Forest gaps at the Project occur primarily as clearings for man-made structures (met towers, communication towers,) and currently as timber harvest clearings.

Day-roost habitat and standing water appear scarcer than foraging habitat within the Project area. Bat species in the Project area utilize live and dead trees, buildings, and rock-structures as summer day-roosts. While a few buildings associated with Tenney Mountain Ski Resort and the communications tower are present along the Project ridge, potential roosts in the form of live and dead (snags) trees are the primary roosting habitats throughout the Project area.

Creation of cleared areas for turbines and project infrastructure will result in the development of some additional edge habitat within forested stands and may result in an increase in the amount of available foraging habitat for bats. However, clearing of forest associated with turbines and infrastructure may potentially remove roosting habitat for some species as currently occurs as a result of timber harvests. Because foraging habitat is abundant within the Project area, roosting habitat is a more likely limiting factor for local bat species. Generally speaking, ridgetop habitat contains fewer open water wetlands, shorter tree canopy height, and generally harsher conditions than are present at lower elevations within the Project area making this habitat less suitable for roosting. Because tree clearing associated with the Project will primarily affect ridge-top habitats, and because the amount of tree removal will be minimal in comparison to the amount of available habitat, indirect impacts to bats as a result of habitat removal are expected to be minor. Bats are expected to roost where habitat is suitable and forage along the edges of turbine access roads and clearings, as they currently do along edges of existing timber harvesting roads, skidder trails and cleared areas as well as ski trails and maintenance roads at the Tenney Mountain Ski Resort.

4.4.4 Conclusions

When the three types of measurement endpoints used in this analysis (literature review, on-site surveys, and weather data analysis) are considered together, impacts to bats, particularly long-distance migratory species, will likely occur, particularly during the late summer and early fall migration period, given that rates of acoustic activity documented at the site for these species was higher during this period and based on patterns documented during post-construction surveys in the northeast. Patterns in timing and species composition of bat mortality at the Project are expected to be similar to those observed at other sites although probably more similar to the nearby Lempster Wind Project which is similar in elevation and habitat to the Groton Wind Project which documented low bat mortality. Results of post-construction surveys provide the most relevant information in predicting patterns in mortality at the Project. Therefore, impacts to bats from the Project are most likely to affect long distance migratory species (e.g., hoary, red, and silver-haired) and possibly tri-colored bats. Acoustic surveys revealed higher levels of activity for these species, particularly silver-haired and hoary bats, above canopy height, potentially indicating the presence of migratory individuals passing through the Project area. Moreover, most bats expected to collide with turbines are likely to be migrating individuals rather than resident bats. The relatively small number of relevant studies and the variability between results of surveys presently makes it impossible to predict levels of mortality at the Project with certainty. However, it is expected that the Project will have similar levels of mortality to other operational wind projects in New England, including the Lempster Wind Project which documented low levels of mortality. Indirect impacts to bats are expected to be minor at The Project, given the relatively small amount of anticipated clearing, the currently disturbed nature of many habitats within the Project area, and the apparent lack of avoidance of operational wind projects.

The various endpoints used to assess risk to bats at the Project each focused on a specific source of data and thus provided slightly different information. With respect to T&E bat species (assessment endpoint 6), literature review (measurement endpoint 6a) indicated a potential for impacts, but with low magnitude, and on-site surveys (measurement endpoint 6b) predicted no risk of impacts, with low magnitude of impacts. For the assessment endpoint 7 (collision mortality of non-listed bats), literature review (measurement endpoint 7a) predicted potential impacts with high magnitude (based on results of mortality surveys at mid-Atlantic sites), on-site field surveys (measurement endpoint 7b) predicted potential impacts with moderate magnitude, and weather data analysis (measurement endpoint 7c) suggested that “high risk” conditions within a night exist in the Project area between 8-31% of the time, although this endpoint was indeterminate as to whether impacts would occur. The three measurement endpoints for indirect impacts to bats (assessment endpoint 8) predicted risk of impacts, with low magnitude. Thus, six measurement endpoints predicted some level of risk to bats associated with the Project, one endpoint predicted no risk, and one was undetermined (Table 4-9).

Table 4-9. Concurrence among measurement endpoints for bats at the Groton Wind Project

Increasing Evidence of Risk ↑

Evidence of Impact?/ Magnitude?	Weighting Factors				
	Low	**Low/ Medium**	**Medium**	**Medium/ High**	**High**
Yes / High					
Yes / Moderate		**6a**			
Yes / Low		**7a**	**6b, 7b**		
No					
Undetermined				**6c**	

Increasing Confidence or Weight →

6a	Literature Review (Potential collision morality of bats)
6b	On-site Field Surveys (Potential collision morality of bats)
6c	Weather Analysis (Potential collision morality of bats)
7a	Literature Review (Indirect impacts)
7b	Habitat Characterization (Indirect impacts)

5.0 Summary and Conclusions

This document attempts to make the most appropriate use of a combination of types of data ranging from on-site field surveys to regional databases to assess potential impacts to birds and bats associated with construction of a wind energy facility on Tenney and Fletcher Mountains. The WOE approach provides a means to use all available data to the extent that it can be used to predict risk of direct and indirect impacts to birds and bats.

While the predictions made in this assessment contain uncertainty, additional pre-construction data would not necessarily facilitate more accurate predictions of risk to birds and bats. At present, no pre-construction survey techniques allow for quantitative prediction of risk to bird and bat resources, given the complexity of ecological, climatic, seasonal, and behavioral factors that likely play roles in influencing rates of direct and indirect impacts to bird and bat resources. The primary difficulties encountered in predicting risk of collision mortality and indirect impacts associated with wind facilities include the lack of understanding of factors causing birds and bats to collide with wind turbines, the influence site location may play on collision factors, and the inadequately established relationship between pre-construction and post-construction survey results.

Of the four groups of species considered in this assessment (raptors, nocturnally migrating passerines, breeding birds, and bats), potential impacts to bats are likely to be greatest, as bats tend to reproduce slowly and have longer life spans than birds, and as rates of collision mortality at existing wind farms tend to be higher for bats than for breeding birds, raptors, or nocturnally migrating passerines. Also, less is known about the behaviors and mechanisms of collision for bats than for the other groups. On-site surveys revealed relatively low rates of bat activity, although long-distance migratory species, comprised the majority of bat activity recorded near turbine height during mid to late August, coincident with the apparent peak in fall bat migration. However, potential risks posed to bats are not unique to this Project, and bat activity levels are likely similar to those on other forested ridgelines in the region, particularly the Lempster Wind Project.

Potential impacts to other species studied for this Project, specifically raptors, nocturnally migrating passerines and breeding birds will likely occur at a low magnitude, although data from existing facilities suggests that the bird group most susceptible to collision is nocturnally migrating passerines given the timing and species composition of observed mortalities at other operational wind facilities. However, the Lempster Wind Project documented low passerine mortality. Since passage rates documented during pre-construction radar surveys were higher at the Lempster Wind Project than found at the Groton Wind Project, collision mortality of nocturnally migrating passerines may be lower than found during post construction surveys at Lempster. Based on the similarities (i.e., elevation, habitat, and pre-construction survey results) between the Lempster Wind Project and Groton Wind Project it is expected that collision risk to birds will be low.

When viewed together, most assessment and measurement endpoint pairs indicate that potential impacts will occur, but that the magnitude of impacts will be low (Table 5-1). One endpoint (literature review) suggested moderate magnitudes of impact to migratory bats. However, the literature review may have been skewed by including post construction survey results from developed Wind Projects outside of New England where bat mortality has been significantly higher. As described in the preceding sections, risk of impacts for each group will vary by time of year, conditions, species, season, and presumably by particular aspects of the site. Because it is therefore difficult and perhaps misleading to summarize potential impacts too broadly, the purpose of Table 5-1 is to help understand the process followed within this document and the WOE approach to assessing potential impacts associated with the Project.

Table 5-1. Concurrence among measurement endpoints for raptors, nocturnally migrating passerines, breeding birds, and bats at the Groton Wind Project

Increasing Evidence of Risk ↑	Evidence of Impact?/ Magnitude?	Weighting Factors: Low	Low/ Medium	Medium	Medium/ High	High
	Yes / High					
	Yes / Moderate		**6a**			
	Yes / Low		**1a, 2a, 3a, 4a, 5a, 7a**	**2b, 3b, 5b, 6b, 7b**	**1b, 1c, 4b**	
	No					
	Undetermined				**6c**	
	Increasing Confidence or Weight →					

1a	Literature Review (Potential collision mortality of raptors)
1b	Raptor Migration Surveys (Potential collision mortality of raptors)
1c	Summer/Early-Fall Peregrine Falcon Surveys (Potential collision mortality of peregrines)
2a	Literature Review (Indirect impacts to raptors)
2b	Habitat Characterization (Indirect impacts to raptors)
3a	Literature Review (Potential collision mortality of nocturnally migrating passerines)
3b	On-site Radar Surveys (Potential collision mortality of nocturnally migrating passeries)
4a	Literature Review (Potential collision mortality of breeding birds)
4b	On-site Raptor Surveys (Potential collision morality of breeding birds)
5a	Literature Review (Indirect impacts to breeding birds)
5b	Habitat Characterization (Indirect impacts to breeding birds)
6a	Literature Review (Potential collision morality of bats)
6b	On-site Field Surveys (Potential collision morality of bats)
6c	Weather Analysis (Potential collision morality of bats)
7a	Literature Review (Indirect impacts)
7b	Habitat Characterization (Indirect impacts)

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Appendix A

Agency Correspondence

Attachment 1

2004-0792

New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Web site: www.wildlife.state.nh.us

TDD Access: Relay NH 1-800-735-2964
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Lee E. Perry
Executive Director

November 2, 2004

Brian KillKelley
Wind Works LLC
PO Box 245
Charlotte VT 05445

Re: NHFG ID 2004-0792

Dear Mr. KillKelley:

The NH Fish and Game Nongame and Endangered Wildlife program has reviewed your request for information regarding state-listed species at the proposed Groton wind project. There are potential for impacts to a variety of wildlife species under the proposed project, including potential impacts to rare or endangered species. We have no known locations of state listed species found within the boundary of the project. However, we have several nearby locations of species that may potentially be impacted. In addition, although we have not documented the presence of endangered species at the proposed impact location, this area likely has not been sampled for rare species.

Of major concern are the potential effects on migratory birds and bats. U.S. Fish and Wildlife Service has authority over impacts to migratory birds through the Migratory Bird Treaty Act of 1918 and the NHFG has authority under the Endangered Species Conservation Act (RSA 212A). The state endangered peregrine falcon nests on the south face of Rattlesnake Mt. in Rumney, less than 2.5 mile from the project location. The impacts of wind turbines on foraging or migrating falcons are not known at this time and needs further consideration. Also, several bats of conservation concern could be potentially found in areas surrounding the proposed impact including Eastern red bat, Hoary bat, Silver-haired bat, Eastern pipistrelle and the state endangered small-footed bat. If spruce-fir habitat occurs on this site, it is possible that state-threatened pine marten and three-toed woodpeckers occur.

In addition to direct impacts to migratory birds and bats, we have concerns over the habitat loss and fragmentation that would occur as a result of clearing and construction of access roads. Wide ranging mammals may be particularly vulnerable to these fragmentation features, including marten, bobcat, black bear, and moose. The Natural Heritage Bureau should be contacted for potential impacts to rare plants or exemplary natural communities (Sara Cairns 603-271-3623 x 302).

Please contact me at 603-271-3016 for further assistance.

Conserving New Hampshire's wildlife and their habitats since 1865.

New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Web site: www.WildNH.com

TDD Access: Relay NH 1-800-735-2964
FAX (603) 271-1438
E-mail: info@wildlife.nh.gov

Glenn Normandeau
Executive Director

July 9, 2008

Michael Curry
Curry & Kerlinger, L.L.C.
1734 Susquehannock Drive
McLean, VA 22101

Dear Mr. Curry:

This letter is in response to your request for wildlife information from our Department regarding your proposed wind farm on Tenney Mountain in the Town of Groton. Our Department (primarily Michael Marchand) had previous discussions regarding this project and provided some details on areas of concern (see attachments). We do not know if studies previously recommended by NHFG and others (e.g., USFWS) have been initiated and/or completed. In addition to potential wildlife impacts, NHFG is interested in fisheries habitat, especially wild brook trout streams (if any are present within the project site), proposed impacts to wetlands including vernal pools, and any other rare habitats or communities that may exist on-site (e.g., rocky slides for small-footed bats).

For reference to previous select correspondences, please see attached:

1) NHFG November 2, 2004 letter to Brian Kilkelly identifying our initial concerns for wildlife and wildlife habitat.
2) A copy of an email (May 18, 2007) sent from Michael Marchand to Brian Killkelly and Derek Hengstenberg regarding the initial peregrine falcon survey that was conducted on-site (Woodlot summary report dated November 15, 2006) and recommendations for further survey work.

We appreciate the opportunity to comment on your proposed wind project and look forward to working with you in the future to minimize impacts on NH's wildlife resources. Our primary contact for this project is Michael Marchand (603-271-3016; Michael.Marchand@wildlife.nh.gov). Future meetings and discussions can be sent directly to him.

Sincerely,

Steven J. Weber

Steve Weber
Wildlife Division Chief

cc: Mike Marchand

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087
http://www.fws.gov/northeast/newenglandfieldoffice

August 6, 2008

Reference:	Project	Location
	Wind turbines	Groton, NH

Michael Curry
Curry & Kerlinger, L.L.C.
P.O. Box 453
Cape May Point, NJ 08212

Dear Mr. Curry:

This responds to Sharon Sharp-Harrison's recent correspondence requesting information on the presence of federally-listed and/or proposed endangered or threatened species in relation to the proposed activity(ies) referenced above.

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area(s). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required.

This concludes our review of listed species and critical habitat in the project location(s) and environs referenced above. No further Endangered Species Act coordination of this type is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

In order to curtail the need to contact this office in the future for updated lists of federally-listed or proposed threatened or endangered species and critical habitats, please visit the Endangered Species Consultation page on the New England Field Office's website:

www.fws.gov/northeast/newenglandfieldoffice/EndangeredSpec-Consultation.htm

In addition, there is a link to procedures that may allow you to conclude if habitat for a listed species is present in the project area. If no habitat exists, then no federally-listed species are present in the project area and there is no need to contact us for further consultation. If the above conclusion cannot be reached, further consultation with this office is advised. Information describing the nature and location of the proposed activity that should be provided to us for further informal consultation can be found at the above-referenced site.

Thank you for your coordination. Please contact us at 603-223-2541 if we can be of further assistance.

Sincerely yours,

Anthony P. Tur
Endangered Species Specialist
New England Field Office

Appendix B

Bird and Bat Data Tables

Appendix B Table 1. Breeding Bird Survey Data from the Wilmot survey route, New Hampshire, 2000 through 2009											
Common name	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Alder Flycatcher	4	2	0	0	2	4	3	0	2	-	17
American Bittern	0	1	0	1	0	0	0	0	0	-	2
American Black Duck	0	0	0	0	0	0	0	0	0	-	0
American Crow	14	15	10	10	16	19	14	18	13	-	129
American Goldfinch	14	9	16	11	10	7	0	7	4	-	78
American Kestrel	0	0	0	0	0	0	0	0	0	-	0
American Redstart	5	3	1	5	1	6	9	5	5	-	40
American Robin	19	50	26	21	13	32	30	34	28	-	253
American Woodcock	0	0	0	0	0	0	0	0	0	-	0
Baltimore Oriole	1	3	0	2	0	2	1	3	2	-	14
Bank Swallow	0	0	0	0	0	0	0	0	0	-	0
Barn Swallow	1	1	0	0	0	0	0	0	0	-	2
Barred Owl	0	0	0	0	0	0	0	0	0	-	0
Belted Kingfisher	1	0	0	0	0	0	0	0	0	-	1
Black-and-white Warbler	5	0	3	1	1	2	3	2	5	-	22
Black-billed Cuckoo	0	0	0	0	1	0	0	0	0	-	1
Blackburnian Warbler	26	32	8	23	35	32	10	15	24	-	205
Black-capped Chickadee	8	6	4	11	6	14	18	12	10	-	89
Black-throated Blue Warbler	11	11	7	12	13	13	8	14	12	-	101
Black-throated Green Warbler	16	3	3	10	4	6	5	0	5	-	52
Blue Jay	16	20	15	6	8	15	5	8	7	-	100
Blue-headed Vireo	3	0	1	3	13	7	9	5	10	-	51
Bobolink	1	1	2	2	1	2	2	1	2	-	14
Broad-winged Hawk	2	1	0	0	1	0	2	0	1	-	7
Brown Creeper	3	0	2	3	1	2	3	1	1	-	16
Brown Thrasher	0	0	0	0	0	0	0	0	0	-	0
Brown-headed Cowbird	2	6	0	1	1	0	9	0	0	-	19
Canada Goose	3	0	0	0	0	0	0	0	0	-	3
Canada Warbler	0	0	0	0	0	0	0	0	0	-	0
Cedar Waxwing	9	19	35	18	18	16	19	16	20	-	170
Chestnut-sided Warbler	7	6	3	3	6	16	5	9	14	-	69
Chimney Swift	2	0	0	5	0	2	0	0	0	-	9
Chipping Sparrow	15	15	10	20	18	22	11	18	16	-	145
Cliff Swallow	0	0	0	0	0	0	0	0	0	-	0
Common Grackle	2	5	3	6	6	6	8	0	0	-	36
Common Nighthawk	0	0	0	1	0	0	0	0	0	-	1
Common Raven	17	1	2	4	11	21	1	12	11	-	80
Common Yellowthroat	7	10	4	18	13	14	11	11	10	-	98
Dark-eyed Junco (Slate-colored Junco)	0	0	2	2	0	1	0	2	5	-	12
Downy Woodpecker	4	2	2	0	2	3	0	1	2	-	16
Eastern Bluebird	0	0	0	1	0	2	0	0	0	-	3
Eastern Kingbird	5	1	2	1	3	2	0	2	2	-	18
Eastern Meadowlark	0	0	0	0	0	0	0	0	0	-	0
Eastern Phoebe	10	6	5	6	11	10	12	3	4	-	67
Eastern Towhee	0	2	0	0	0	1	0	0	0	-	3
Eastern Wood-Pewee	4	4	2	3	2	2	6	3	3	-	29
European Starling	2	1	2	28	4	3	1	2	0	-	43
Evening Grosbeak	0	0	2	0	8	2	0	0	0	-	12
Field Sparrow	0	0	0	0	0	0	0	0	1	-	1
Golden-crowned Kinglet	0	0	0	0	0	0	0	1	3	-	4
Gray Catbird	6	4	9	8	2	2	1	6	5	-	43
Great Blue Heron	1	0	0	0	0	0	0	0	1	-	2
Great Crested Flycatcher	1	1	1	0	2	0	2	0	0	-	7
Green Heron	0	0	0	0	0	0	0	0	0	-	0
Hairy Woodpecker	3	3	4	2	2	0	2	2	1	-	19
Hermit Thrush	7	14	10	10	10	9	14	8	15	-	97
Hooded Merganser	0	2	0	0	1	0	0	0	0	-	3
House Finch	1	0	0	0	0	0	0	0	0	-	1
House Sparrow	0	0	0	0	0	0	0	0	0	-	0
House Wren	0	0	0	0	0	0	1	1	0	-	2
Indigo Bunting	3	2	1	2	7	6	3	3	4	-	31
Killdeer	2	1	0	0	0	0	0	0	0	-	3
Least Flycatcher	3	3	1	2	2	3	2	1	4	-	21
Louisiana Waterthrush	0	0	0	0	0	0	0	0	0	-	0
Magnolia Warbler	1	1	2	4	2	3	5	6	6	-	30
Mallard	5	0	0	0	0	0	0	0	0	-	5
Marsh Wren	0	0	0	0	0	0	0	0	0	-	0
Mourning Dove	17	11	12	9	10	8	4	18	3	-	92
Nashville Warbler	1	2	1	2	2	1	0	0	0	-	9
Northern Cardinal	0	0	0	0	0	1	1	2	1	-	5
Northern Flicker (Yellow-shafted Flicker)	1	0	2	1	0	0	1	1	1	-	7
Northern Harrier	0	1	0	0	0	0	0	0	0	-	1
Northern Mockingbird	0	0	0	1	0	0	0	0	0	-	1
Northern Parula	0	0	0	0	0	0	1	0	1	-	2
Northern Rough-winged Swallow	0	0	0	0	0	0	0	0	0	-	0
Northern Waterthrush	0	1	1	1	3	3	4	1	1	-	15

Olive-sided Flycatcher	0	1	0	0	0	0	0	0	0	-	1
Ovenbird	22	19	18	32	24	36	30	32	31	-	244
Philadelphia Vireo	0	0	0	0	0	0	0	0	0	-	0
Pied-billed Grebe	0	0	1	0	0	0	0	0	0	-	1
Pileated Woodpecker	1	3	2	4	2	2	2	0	0	-	16
Pine Warbler	4	1	3	5	6	7	3	2	3	-	34
Prairie Warbler	0	2	1	2	0	1	1	0	0	-	7
Purple Finch	2	1	7	2	3	0	1	2	3	-	21
Red Crossbill	0	0	0	0	0	0	0	0	0	-	0
Red-breasted Nuthatch	3	5	6	2	7	4	1	3	2	-	33
Red-eyed Vireo	40	33	37	50	38	59	55	52	52	-	416
Red-shouldered Hawk	0	1	0	0	0	0	0	0	0	-	1
Red-winged Blackbird	7	16	9	7	10	11	26	11	7	-	104
Rock Pigeon	0	0	0	5	0	0	0	0	0	-	5
Rose-breasted Grosbeak	1	2	0	4	0	0	1	2	1	-	11
Ruby-crowned Kinglet	0	0	0	0	0	0	0	0	0	-	0
Ruby-throated Hummingbird	0	0	0	1	0	2	3	0	0	-	6
Ruffed Grouse	0	0	0	0	0	0	0	0	0	-	0
Rusty Blackbird	0	0	0	0	0	0	0	0	0	-	0
Savannah Sparrow	0	0	0	1	0	1	0	0	0	-	2
Scarlet Tanager	7	3	3	4	4	10	4	6	6	-	47
Sharp-shinned Hawk	0	0	0	0	0	0	0	0	0	-	0
Song Sparrow	7	9	11	10	11	11	16	13	10	-	98
Spotted Sandpiper	0	0	0	0	0	0	0	0	0	-	0
Swainson's Thrush	0	1	0	0	0	1	0	0	1	-	3
Swamp Sparrow	4	11	5	9	5	5	6	4	8	-	57
Tree Swallow	8	7	2	5	10	2	4	2	29	-	69
Tufted Titmouse	3	0	0	1	3	3	2	4	4	-	20
Turkey Vulture	0	0	0	0	0	0	0	0	0	-	0
Veery	9	7	4	10	9	12	11	14	13	-	89
Vesper Sparrow	0	0	0	0	0	0	0	0	0	-	0
Warbling Vireo	1	0	1	1	1	2	1	1	3	-	11
Whip-poor-will	0	0	0	0	0	0	0	0	0	-	0
White-breasted Nuthatch	1	1	2	5	10	7	7	4	4	-	41
White-throated Sparrow	3	5	3	3	5	9	6	8	4	-	46
Wild Turkey	1	0	3	2	0	0	0	1	0	-	7
Willow Flycatcher	0	0	0	0	0	0	0	0	1	-	1
Wilson's Snipe	0	1	0	0	1	0	0	1	0	-	3
Winter Wren	4	5	0	2	7	13	3	3	3	-	40
Wood Duck	0	0	0	1	0	0	0	0	1	-	2
Wood Thrush	9	8	1	7	8	5	5	8	3	-	54
Yellow Warbler	2	0	0	1	1	5	2	6	0	-	17
Yellow-bellied Flycatcher	0	0	0	0	0	0	0	0	0	-	0
Yellow-bellied Sapsucker	0	0	4	10	8	7	8	13	10	-	60
Yellow-billed Cuckoo	0	0	0	0	0	0	0	1	0	-	1
Yellow-rumped Warbler (Myrtle Warbler)	8	12	3	10	9	15	2	5	13	-	77
Yellow-throated Vireo	0	0	0	1	0	0	0	0	0	-	1
Total Species	68	64	58	70	62	64	62	60	63	-	571
Total Individuals	438	436	342	477	454	552	446	452	477	-	4074

Appendix B Table 2. Christmas Bird Count Data from the Baker Valley, New Hampshire count, 2000 through 2009

Common Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
American Black Duck				6		1	18	14			39
American Crow	78	75	40	72	39	61	45	75	22	44	551
American Goldfinch	53	129	41	221	31	366	49	224	24	113	1251
American Robin		3								68	71
American Tree Sparrow	6	21	4	18	59	7	26	4	8	18	171
American Woodcock								0			0
Bald Eagle						4				1	5
Barred Owl		0					4	0		0	4
Belted Kingfisher			1	1				1			3
Black-capped Chickadee	551	359	462	346	1147	415	640	382	479	419	5200
Blue Jay	84	134	205	313	98	180	275	76	102	358	1825
Bohemian Waxwing							22				22
Brown Creeper	2	0	0	4	1	1	1	1	0	2	12
Brown-headed Cowbird				1							1
Canada Goose							31				31
Cedar Waxwing				2	21					0	23
Chipping Sparrow		1									1
Common Merganser	112					0		1			113
Common Raven	11	6	9	7	10	8	14	13	8	11	97
Common Redpoll	115		120		370		53		24		682
Cooper's Hawk			1					2	1	1	5
Dark-eyed (Slate-colored) Junco	4	96	10	19	9	11	3	34	0	11	197
Downy Woodpecker	15	18	11	10	21	28	35	29	18	10	195
Eastern Bluebird								2		1	3
European Starling	45	25	47	102	29	307	56	235	50	60	956
Evening Grosbeak	45	25	52		24	64	25		14	20	269
Fox Sparrow			1								1
Golden-crowned Kinglet	5	5	5	18	24	6	2	13		2	80
Great Black-backed Gull					13						13
Hairy Woodpecker	16	15	16	14	26	17	26	12	14	12	168
Herring Gull	1										1
Hoary Redpoll					1						1
House Finch	7		8	12	2			3	0		32
House Sparrow	31	36	86	75	29	13	39	43	28	25	405
Mallard	1	3		90	29	39	18		24		204
Mourning Dove	75	45	143	66	104	50	166	63	54	72	838
Northern Cardinal	5	6	7	12	10	7	23	13	10	3	96
Northern Flicker								2			2
Northern Goshawk						1					1
Northern Shrike		2							0		2
Pileated Woodpecker		0				3	3	3	1	0	10
Pine Grosbeak		1	23				7		1	4	36
Pine Siskin	9	28			4	23				2	66
Purple Finch	6	59	2	21		41		6			135
Red Crossbill		12									12
Red-bellied Woodpecker						1					1
Red-breasted Nuthatch	28	21	16	13	59	29	10	13	4	15	208
Red-tailed Hawk					1	1		2		0	4
Ring-necked Duck	1										1
Ring-necked Pheasant										6	6
Rock Dove	44	14	81	69							208
Rock Pigeon					120	115	79	26	28	20	388
Rough-legged Hawk						1					1
Ruffed Grouse	2	5	1	1	3	10		8	1	2	33
Sharp-shinned Hawk	1	1	0		1	1			0		4
Snow Bunting		0							5		5
Song Sparrow							1				1
Tufted Titmouse	26	1	24	8	47	36	27	20	19	13	221
Tundra Swan											0
White-breasted Nuthatch	36	9	44	33	74	61	60	46	21	16	400
White-throated Sparrow			1		1						2
White-winged Crossbill		2	2							21	25
Wild Turkey	109	1	74	15	67	67	19		99	81	532

Appendix B Table 3. 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

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

Appendix B Table 4. Comparison of bird mortality at existing wind farms in the east and upper mid-west, U.S.

Site	Habitat type (# turbines)	Dates surveyed	Search interval	# BIRDS found during surveys (incidental)	Estimated total BIRD fatalities/turbine/year (total)	Reference
Buffalo Ridge, Minnesota	agricultural grassland (73)	April 1994 - Dec 1995	30-50 weekly	7	0.33-0.66 fatalities/t/yr (36 total)	Osborn *et al*. 2000
Buffalo Ridge, Minnesota (Phase 3)	agricultural grassland (138)	15 March - 15 November, 1999	30 every 14 days	20	4.45/t/yr (613)	Johnson *et al.* 2002
Buffalo Ridge, Minnesota	agricultural grassland (281)	15 June - 15 September, 2001 and 2002	83 of 103 bi-weekly	n/a	n/a	Johnson and Strickland 2004
Searsburg, Vermont	forested (11)	30 June - 18 October, 1997	11 total (4 per search) 2 to 6 days per month	0	n/a	Kerlinger 2002
Kewaunee County, Wisconsin	agricultural (31)	1999 - 2001	n/a	25	1.29/t/yr (40)	Sagrillo 2003, Sagrillo 2007
Somerset County, Pennsylvania	agricultural (8)	2000 (12 months)	n/a	0	n/a	Kerlinger 2006
Mountaineer, West Virginia	forested ridgeline (44)	4 April - 11 Nov, 2003	2x per week	69*	4.04/t/yr (178 + 33 due to substation lighting)	Kerns and Kerlinger, 2004
Mountaineer, West Virginia	forested ridgeline (44)	31 July- 11 September, 2004	22 daily, 22 weekly	15 (n/a)	n/a	Arnett 2005
Meyersdale, Pennsylvania	forested ridgeline (20)	2 August - 13 September, 2004	10 daily, 10 weekly	13 (4)	n/a	Arnett 2005
Top of Iowa, Iowa	agricultural (89)	24 March- 10 December, 2004	26 every 3-days	5 (n/a)	0.9/t/yr (80 total)	Koford et al. 2005
Buffalo Mtn, Tennessee	reclaimed mine on ridge (18)	April - December, 2005	18 of 18 every week, every 2 weeks, or every 2-5 days	9 (2)	1.8/t/yr (111.6 total)	Fiedler *et al.* 2007
Maple Ridge, New York	woodland, grassland, agricultural (120)	June 17 - November 15, 2006	10 every 3-days, 30 7-days, 10 daily	123 (15)	3.10-9.48/t/yr (372-1138 total)	Jain *et al*. 2007
Maple Ridge, New York	woodland, grassland, agricultural (195)	April 30 - November 14, 2007	64 weekly	64 (32)	5.67-6.31/t/yr (1106-1230)	Jain *et al.* 2008
Maple Ridge, New York	woodland, grassland, agricultural (195)	April 15 - November 9, 2008	64 weekly	74 (23)	3.42-3.76/t/yr (667-733)	Jain *et al.* 2009a
Mars Hill, Maine	forested ridgeline (28)	23 April- 3 June, 15 July-23 Sept 2007	2 of 28 daily, 28 of 28 weekly, seasonal dog searches	19 (3)	0.44-2.5/t/yr (26.8-69.2 total)	Stantec 2008
Mars Hill, Maine	forested ridgeline (28)	19 April- 6 June, 15 July-8 Oct 2008	28 of 28 weekly, seasonal dog searches	17(4)	2.4/t/yr-2.65/t/yr (57-74)	Stantec 2009
Munnsville, NY	agricultural and forested uplands	April 15-November 15, 2008	12 of 23 weekly, seasonal dog searches	7 (3)	1.71-2.22/t/yr (39.2-51.12)	Stantec 2009b
Mount Storm, WV	forested ridgeline (82)	July 18-October 17 2008	18 weekly, 9 daily	29 (8)	2.41-3.81/t/yr (198-312)	Young *et al.* 2009
Clinton, NY	agricultural, woodland (67)	April 26 to October 13, 2008	8 daily, 8 every 3-days, 7 every 7-days	14 (9)	1.43-2.48 small birds/t/yr (96 -166); 0.88 med-large birds/t/yr (59)	Jain et al. 2009b
Ellenburg, NY	agricultural, woodland (54)	April 28 to October 13, 2008	6 daily, 6 every 3-days, 6 every 7-days	12 (10)	0.92-1.10 small birds/t/yr (62-74); 0.77 med-large birds/t/yr (51)	Jain et al. 2009c
Bliss, NY	agricultural, woodland (67)	April 21 - Nov 14, 2008	8 daily, 8 every 3-days, 7 every 7-days	20 (7)	0.74-4.04 small birds/t/yr (50-271); 0.25-0.66 med-large birds/t/yr (17-44)	Jain et al. 2009d
Lempster, NH	forested ridgeline (12)	April 20 to June 1**	4 daily	1 (2)	not calculated for interim report	Tidhar 2009

*33 birds found on May 23, 2003 at turbines near a substation and at substation associated with sodium vapor lights

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

Appendix B Table 5. New Hampshire Fish and Game (NHF&G) listed species and New Hampshire Partners in Flight (PIF) Priority Species, indicating which species were detected in the Groton Wind Project area or region.

Common Name	Documented in region?	Documented on-site?	NHF&G Listing	Additional Notes[1]
Rare and/or Priority Species documented in the Project area:				
Common loon	BBA, eBird	RAP	Threatened	
Least Flycatcher	BBA, BBS, eBird	SBBS INC	PIF High Priority	
Veery	BBA, BBS, eBird	SBBS	PIF High Priority	
Wood Thrush	BBA, BBS, eBird	SBBS INC	PIF High Priority	
Chestnut-sided Warbler	BBA, BBS, eBird	SBBS	PIF High Priority	
Blackburnian Warbler	BBA, BBS, eBird	SBBS	PIF High Priority	
American Redstart	BBA, BBS, eBird	SBBS	PIF High Priority	
Scarlet Tanager	BBA, BBS, eBird	SBBS	PIF High Priority	
Chimney Swift	BBA, BBS, eBird	RAP INC	PIF High Priority	
Northern Flicker	BBA, BBS, CBC, eBird	RAP INC	PIF Species to Watch	
White-throated Sparrow	BBA, BBS, CBC, eBird	RAP, BBS	PIF Species to Watch	
Rare and/or Priority Species not documented in the Project area, but documented in the region:				
Common nighthawk	BBA, BBS, eBird		Endangered	
Olive-sided flycatcher	BBA, BBS, eBird		Special Concern	Consistent population declines and range retractions. NH population declining at -7.5% per year
Horned Lark	BBA, CBC		Special Concern	May only occur at 6-7 sites in state, all of which are airports. A small airport is located in the Baker Valley
Bank Swallow	BBA, BBS, eBird		Special Concern	
Cliff Swallow	BBA, BBS, eBird		Special Concern	Consistent population declines and range retraction throughout the region
Vesper sparrow	BBA, BBS, CBC		Special Concern	Significant declines. Now only known from fewer than 20 sites statewide
Eastern meadowlark	BBA, BBS		Special Concern	State and regional population declines (NH -5.8% per year). Appears to have disappeared from many formerly occupied areas, especially from the Lakes Region north.
Rusty blackbird	BBA, BBS, CBC, eBird		Special Concern	Species of high regional and continental concern due to population declines. Limited data suggest absence from many formerly occupied sites in NH.
Barn Swallow	BBA, BBS, eBird		PIF High Priority	
Marsh Wren	BBA, BBS		PIF High Priority	
Canada Warbler	BBA, BBS, eBird		PIF High Priority	
Eastern Towhee	BBA, BBS, CBC, eBird		PIF High Priority	
Field Sparrow	BBA, BBS, CBC, eBird		PIF High Priority	
Song Sparrow	BBA, BBS, CBC, eBird		PIF Species to Watch	
Gray Jay	BBA, BBS, CBC		PIF Species to Watch	
Additional species of concern known to breed in similar habitats to the Project area:				
American three-toed woodpecker	BBA		Threatened	
Spruce grouse	BBA		Special Concern	
Whip-poor-will	BBA		PIF High Priority	
[1] Information taken from the NHF&G Nongame and Endangered Species Program Special Concern List				
BBS=USGS Breeding Bird Survey, BBA=Breeding Bird Atlas, CBC=Audubon Christmas Bird Count, RAP=raptor surveys, SBBS=Stantec Breeding Bird Surveys, INC=Incidentally observed during Stantec surveys				
RTE Species=Globally rare, federally listed or proposed listed, have unique habitat requirements, or occur in the state at the extent of global range				

Appendix B Table 6. Comparison bat mortality at existing wind farms in the east and upper mid-west, U.S.

Site	Habitat type (# turbines)	Dates surveyed	Search interval	# BATS found during surveys (incidental)	Estimated total BAT fatalities/turbine/year (total)	Reference
Buffalo Ridge, Minnesota	agricultural grassland (73)	April 1994 - Dec 1995	30-50 weekly	n/a	n/a	Osborn *et al.* 2000
Buffalo Ridge, Minnesota (Phase 3)	agricultural grassland (138)	15 March - 15 November, 1999	30 every 14 days	n/a	n/a	Johnson *et al.* 2002
Buffalo Ridge, Minnesota	agricultural grassland (281)	15 June - 15 September, 2001 and 2002	83 of 103 bi-weekly	151	1.30-3.02/t/yr (364-849)	Johnson and Strickland 2004
Searsburg, Vermont	forested (11)	30 June - 18 October, 1997	11 total (4 per search) 2 to 6 days per month	0	n/a	Kerlinger 2002
Kewaunee County, Wisconsin	agricultural (31)	1999 - 2001	n/a	n/a	1.16-4.26/t/yr (36-132)	Sagrillo 2003, Sagrillo 2007
Somerset County, Pennsylvania	agricultural (8)	2000 (12 months)	n/a	0	n/a	Kerlinger 2006
Mountaineer, West Virginia	forested ridgeline (44)	4 April - 11 Nov, 2003	2x per week	475	47.53/t/yr (2092)	Kerns and Kerlinger, 2004
Mountaineer, West Virginia	forested ridgeline (44)	31 July- 11 September, 2004	22 daily, 22 weekly	398 (68)	38/t/yr (1364-1980)	Arnett 2005
Meyersdale, Pennsylvania	forested ridgeline (20)	2 August - 13 September, 2004	10 daily, 10 weekly	262 (37)	25/t/yr (400-660)	Arnett 2005
Top of Iowa, Iowa	agricultural (89)	24 March- 10 December, 2004	26 every 3-days	44 (n/a)	10.17/t/yr (905)	Koford et al. 2005
Buffalo Mtn, Tennessee	reclaimed mine on ridge (18)	April - December, 2005	18 of 18 every week, every 2 weeks, or every 2-5 days	243 (14)	63.9/t/yr (1,149)	Fiedler *et al.* 2007
Maple Ridge, New York	woodland, grassland, agricultural (120)	June 17 - November 15, 2006	10 every 3-days, 30 7-days, 10 daily	326 (58)	11.39-20.31/t/yr (1367-2437.2)	Jain *et al*. 2007
Maple Ridge, New York	woodland, grassland, agricultural (195)	April 30 - November 14, 2007	64 weekly	202 (81)	15.54-18.53/t/yr (3030-3614)	Jain *et al.* 2008
Maple Ridge, New York	woodland, grassland, agricultural (195)	April 15 - November 9, 2008	64 weekly	140 (76)	8.18 - 8.92/t/yr (1595-1739)	Jain *et al.* 2009a
Mars Hill, Maine	forested ridgeline (28)	23 April- 3 June, 15 July-23 Sept 2007	2 of 28 daily, 28 of 28 weekly, seasonal dog searches	22 (2)	0.43/t/yr-4.4/t/yr (12.1-122.5)	Stantec 2008
Mars Hill, Maine	forested ridgeline (28)	19 April- 6 June, 15 July-8 Oct 2008	28 of 28 weekly, seasonal dog searches	5	0.17/t/yr-0.68/t/yr (5-19)	Stantec 2009
Munnsville, NY	agricultural and forested uplands	April 15-November 15, 2008	12 of 23 weekly, seasonal dog searches	9 (1)	0.70-2.90/t/yr	Stantec 2009b
Mount Storm, WV	forested ridgeline (82)	July 18-October 17 2008	18 weekly, 9 daily	182 (27)	7.76-24.21/t/yr (636-1985)	Young *et al.* 2009
Clinton, NY	agricultural, woodland (67)	April 26 to October 13, 2008	8 daily, 8 every 3-days, 7 every 7-days	39 (14)	3.76-5.45/t/yr (252-365)	Jain et al. 2009b
Ellenburg, NY	agricultural, woodland (54)	April 28 to October 13, 2008	6 daily, 6 every 3-days, 6 every 7-days	34 (25)	3.37-6.59/t/yr (226-441)	Jain et al. 2009c
Bliss, NY	agricultural, woodland (67)	April 21 - Nov 14, 2008	8 daily, 8 every 3-days, 7 every 7-days	74 (15)	7.58-14.66/t/yr (508-983)	Jain et al. 2009d
Lempster, NH	forested ridgeline (12)	April 20 to June 1**	4 daily	1	not calculated for interim report	Tidhar 2009

*33 birds found on May 23, 2003 at turbines near a substation and at substation associated with sodium vapor lights

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

Appendix C

Potential Risk of Impact by Species

Appendix C Table 1. Nocturnally migrating passerines at increased potential risk of impact* due to collision during nocturnal migration at New Creek

Species	Risk Factor	Exposure Pathway	Applicable information
Red-eyed vireo	Abundance and high mortality at existing wind farms in the east	documented occurrence in project area	commonly killed during nocturnal migration by collision with tall structures, among most common species killed at communication towers in Florida, 280 killed at one tower in a single night
			represented 9.6% of fatalities at Maple Ridge, NY (Jain et al. 2007), represented 30% of fatalities at Mountaineer, WV (Kerns and Kerlinger 2004), represented 25% of fatalities at Buffalo Mountain, Tennessee (Fiedler et al. 2007)
			Abundant and widespread across its range, BBS data suggest increasing populations in East (Cimprich 2000)
Golden-crowned kinglet	relatively high mortality at existing facilities in the east	documented occurrence in project area	represented 39% of fatalities at Maple Ridge, NY (Jain et al. 2007) and 9% of fatalities at a wind farm in the Northeast (Stantec/Woodlot, unpublished data)
			relatively stable population in the east, though declines observed in the west (Ingold and Galati 1997)
Magnolia warbler	relatively high mortality at existing wind farms	documented occurrence in project area	relatively high mortality, represented 7% of total fatalities at Mountaineer (Kerns and Kerlinger 2004)
			fairly common fatalities at communication towers, over 1,000 found during 2 search days at a Wisconsin communication tower in 1963; and over 1,000 found at lighted buildings and wires in Texas (Hall 1994)
			BBS data indicate a relatively stable population (Hall 1994)
Rose-breasted grosbeak	relatively high mortality at existing facilities in the east	occurrence in region	relatively high mortality at a wind farm in the east, represented 17% of fatalities at a wind farm in Tennessee (Fiedler et al. 2007)
			69 reported fatalities at communication towers in Florida over 25 years (Wyatt and Francis 2002)
			BBS data suggest a relatively stable population (Wyatt and Francis 2002)
Cedar waxwing	relatively high mortality at existing facilities in the east	documented occurrence in project area	6.9% of total avian mortality at Mount Storm Wind Energy Facility (Young et al. 2009)
			evidence of mortality during nocturnal migration from communication-tower strike (Witmer et al. 1997)
Cape May warbler	relatively high mortality at existing facilities in the east	documented occurrence in project area, nocturnal migrant	6.9% of total avian mortality at Mount Storm Wind Energy Facility (Young et al. 2009)
			evidence of mortality during nocturnal migration from communication-tower strike (Baltz and Latta 1998)
European starling	Abundance and high mortality at existing wind farms in the east	occurence in region; mostly diurnal migrant	relatively high mortality observed during Maple Ridge, NY 2008 monitoring season (Jain et al. 2008)
Vesper sparrow	species of conservation concern, high mortality at existing facilities in the U.S.	documented occurrence in project area	relatively low mortality at communication towers, overall 191 kills documented (Jones and Cornely 2002)
			relatively high mortality observed at existing sites in the West and Midwest, but in areas where relatively common (NRC 2007)
			BBS data suggest significant declines in Eastern region, likely due to loss of grassland or mowing of grassland habitat (Jones and Cornely 2002)
Black-throated green warbler	abundance	documented occurrence in project area	collision reported at existing facility in the Northeast (Stantec/Woodlot, unpublished data)
			BBS data suggests a relatively stable population range wide (Morse 2005)
Ovenbird	abundance	documented occurrence in project area	susceptibility to collision unknown
			BBS data suggest significant population declines (Van Horn and Donovan 1994)
Chestnut-sided warbler	abundance	documented occurrence in project area	hundreds known to collide with smokestakes, buildings, and communicaiton towers (Richardson and Brauning 1995)
			population generally showing slight decreases (Richardson and Brauning 1995)
American redstart	abundance	documented occurrence in project area	nocturnal migrant, known to collide with communication towers (Sherry and Holmes 1997)
			populations currently in fluctuation with unknown causes (Sherry and Holmes 1997)
Yellow-bellied sapsucker	species of conservation concern	occurrence in region	nocturnal migrant, known to collide with communication towers (Walters et al. 2002)
			Appalachian region population declines (Walters et al. 2002)
Olive-sided flycatcher	species of conservation concern	occurrence in region	BBS data suggest broad-scale population declines in many physiographic regions (Altman and Sallabanks 2000)
			incomplete understanding of migration routes and population viability
White-throated sparrow	species of conservation concern	occurrence in region	known to collide with communication towers and lighted buildings (Falls and Kopachena 1994)
			generally declining through most of range (Falls and Kopachena 1994)
Nashville warbler	species of conservation concern	documented occurrence in project area	over 100 birds known to collide with a 7 different communication towers on a single night (Williams 1996)
			population appears generally stable (Williams 1996)
Blackburnian warbler	species of conservation concern	documented occurrence in project area	relatively stable populations (Morse 2004)
			blackburnian warbler represented 9% of bird mortality at a wind farm in the Northeast (Stantec/Woodlot, unpublished data)

Black-and-white warbler	abundance	documented occurrence in project area	known to collide with wind turbines (Stantec, unpublished data)
			common and widespread, generally stable population (Kricher 1995)
Blue-headed vireo	abundance	documented occurrence in project area	relatively small numbers of collisions at communication towers during migration (James 1998)
			populations generally increasing (James 1998)
Northern flicker	abundance	documented occurrence in project area	primarily nocturnal migrant
			population generally declining (Moore 1995)
Wood thrush	species of conservation concern	occurrence in project vicinity	reported collisions with communication towers and windows (Roth et al. 1996)
			population has been declining substantially across its range
Swainson's thrush	species of conservation concern	occurrence in project vicinity	collisions with buildings and communication towers during migration considered source of significant mortality (Mack and Yong 2000)
			population generally declining (Mack and Yong 2000)
*RTE species in the region, species with high mortality rates at existing wind farms, species that exhibit flight behaviors that put them at increased risk, and species that have high abundance in the project area			

Appendix C Table 2. Non-raptor breeding bird species at increased potential risk of impact* due to collision mortality at Groton Wind Project

Species	Risk Factor	Exposure Pathway	Applicable information
Ovenbird	abundance	documented occurrence in project area, abundance, courtship flights	primarily low flights in forest, quick manuverability around trees (Van Horn and Donovan 1994)
			forages in leaf litter on the forest floor or in low vegetation (Van Horn and Donovan 1994)
			evening courtship display flights (Van Horn and Donovan 1994)
Rose-breasted grosbeak	relatively high mortality at existing wind farms in the east	documented occurrence in region	forages in canopy and understory vegetation, occassionally on the ground (Wyatt and Francis 2002)
			BBS data suggest a relatively stable population (Wyatt and Francis 2002)
			relatively high mortality at a wind farm in the east, represented 17% of fatalities at a wind farm in Tennessee (Fiedler et al. 2007)
Red-eyed vireo	Abundance and high mortality at existing wind farms in the east	documented occurrence in project area, abundance	relatively high mortality among existing wind farms in the East (Jain et al. 2007, Kerns and Kerlinger 2004, Fiedler et al. 2007)
			Abundant and widespread across its range, BBS data suggest increasing populations in East (Cimprich 2000)
			hops along branches in forest canopy or makes short flights in shrubby understory while foraging (Cimrich 2000)
Common nighthawk	species of conservation concern	documented occurrence in project area, foraging exposure	small numbers of mortality documented at communication tower sites (Poulin et al. 1996)
			males feed at heights up to 175m with spiraling downward descents (Poulin et al. 1996)
Chestnut-sided warbler	abundance	documented occurrence in project area	foliage gleaner, forages on the ground as well as in canopy, particularly in shrubby areas - hops and perches (Richardson and Brauning 1995)
			exhibits territorial and courtship chasing (Richardson and Brauning 1995)
			population generally showing slight decreases (Richardson and Brauning 1995)
Black-throated blue warbler	abundance	documented occurrence in project area	primarily low flights in forest, generally under canopy or quick tree-to-tree movements (Holmes et al. 2005)
			populations generally stable with highest breeding densities in forests with dense shrub layer (Holmes et al. 2005)
Chimney swift	species of conservation concern	documented occurrence in project area, foraging exposure	ariel feeder at various heigts above canopy; recorded at altitudes of 2,134 m (Cink and Collins 2002)
			courtship- and "trio-flights" recorded to 150 m (Cink and Collins 2002)
Blackburnian warbler	species of conservation concern	documented occurrence in region	blackburnian warbler represented 9% of bird mortality at a wind farm in the Northeast (Stantec/Woodlot, unpublished data)
			males may perform courtship gliding (Morse 2004)
			forages in tall trees, rarely 'hawks' for insects (Morse 2004)
			relatively stable populations (Morse 2004)
Black-and-white warbler	abundance	documented occurrence in project area	foliage gleaner and bark creeper (Kricher 1995)
			territorial and courtship chasing (Kricher 1995)
			common and widespread, generally stable population (Kricher 1995)
Blue-headed vireo	abundance	documented occurrence in project area	populations generally increasing (James 1998)
			forages mainly at mid-tree height (James 1998)
			moves slowly and deliberately from perch to perch or tree to tree (James 1998)
			short distances territorial chasing (James 1998)
Northern flicker	abundance	documented occurrence in project area, abundance	population generally declining (Moore 1995)
			collisions with man-made objects not believed to be significant source of mortality (Moore 1995)
Magnolia warbler	relatively high mortality at existing wind farms	documented occurrence in project area	relatively high mortality, represented 7% of total fatalities at Mountaineer (Kerns and Kerlinger 2004)
			territorial displays occasionally involve chases and flights (Hall 1994)
			faily commonly collides with communication towers and buildings (Hall 1994)
			BBS data indicate a relatively stable population (Hall 1994)
			feeds mid-height in conifer trees and shrubs (Hall 1994)
black-capped chickadee	abundance	documented occurrence in project area, abundance	most flights are short and not significantly higher than canopy height
			BBS data suggest population is increasing in eastern range (Smith 1993)
Eastern wood-pewee	species of conservation concern	documented occurrence in region	forages for insects by making sallie flights from subcanopy or canopy (Mccarty 1996)
			population generally stable (Mccarty 1996)
			relatively insensitive to fragmentation when choosing nesting sites (Mccarty 1996)
			territorial fighting and chasing and sexual chasing reported (Mccarty 1996)
Ruffed grouse	relatively high mortality at existing wind farms	documented occurrence in project area, abundance	mortality has been observed at existing wind farms (Jain et al. 2007)
Wild Turkey	abundance	documented occurrence in project area, abundance	although not generally a high flier, turkeys don't have great manueverability in flight (Eaton 1992)
			3.4% of total avian mortality at Mount Storm Wind Energy Facility (Young et al. 2009)

*RTE species in the region, species with high mortality rates at existing wind farms, species that exhibit flight behaviors that put them at increased risk, and species that have high abundance in the project area

Appendix C Table 3. Non-raptor breeding bird species at higher potential risk of indirect effects due to loss of habitat or disturbance at Groton Wind Project

Species	Risk Factor	Predicted Effect	Applicable information
Forest edge and early successional habitat			
Chestnut-sided warbler	Abundance	Increase in suitable habitat	responds positively to a variety of habitat changes, flourishes in clearcuts allowed to regenerate (Richardson and Brauning 1995)
			population generally showing slight decreases (Richardson and Brauning 1995)
American robin	Abundance	Increase in suitable habitat	increased in abundance prior to construction of VT facility (Kerlinger 2002)
			stable and increasing population in the east (Sallabanks and James 1999)
			land uses such as forest harvesting, agriculture, and urbanization have increased habitat (Sallanbanks and James 1999)
American redstart	Abundance and quality local habitat	Undetermined effect	prefers "mid-aged" succesional forest habitat, often moist or riparian and deciduous or deciduous-mixed canopy; does not appear to avoid edge (Sherry and Holmes, 1997)
			displays "Area-sensitive" habitat choices in many parts of breeding range (Sherry and Holmes, 1997)
Hermit thrush	Abundance	Increase in suitable habitat	a forest interior bird which favors interior edges, particularly at drier sites such as anthropogenic-, wind- and fire-openings (Jones and Donovan, 1996)
			BBS data suggest positive population trends (Jones and Donovan, 1996)
Black-capped chickadee	Abundance	Increase in suitable habitat	occurs in forests, open woods, thickets, edges of wooded areas, disturbed areas (Smith 1993)
			primarily arboreal foliage and bark gleaner
			BBS data suggest population is increasing in eastern range (Smith 1993)
			forest clearing increases forest edge habitat which benefits chickadees (Smith 1993)
Dark-eyed junco	Abundance	Little influence	a habitat generalist found in open woodlands (especially conifer), regenerating stands and edges (Nolan et al 2002)
			forest-management and moderate anthropogenic disturbance generally has little influence in nesting or habitat use by juncos (Nolan et al 2002)
Common yellowthroat	observed displacement at existing facility	Increase in suitable habitat, but potential behavioral displacement	observed to have decreased use of area surrounding turbines (100 m radius) at Buffalo Ridge, Minnesota (NRC 2007, Johnson et al. 2000)
			among species at Buffalo Ridge, Minnesota with observed displacement (Johnson et al. 2000)
			temporarily benefits from areas where thick vegetation growth is promoted by disturbance such as the removal of canopy (timber harvesting) (Guzy and Ritchison 1999)
			BBS data suggest slight population decreases in eastern region (Guzy and Ritchison 1999)
Forest habitat			
Ovenbird	Abundance	Decrease in suitable habitat	observed impacts from forest harvesting practices (NRC 2007)
			threatened by reduction of extensive tracts of forest and fragmentation (Van Horn and Donovan 1994)
			sensitive to cowbird brood parasitism (Van Horn and Donovan 1994)
			one of most abundant species prior to construction of the Searsburg, Vermont windfarm but suffered a decline in abundance after construction (Kerlinger 2002)
			BBS data suggest significant population declines (Van Horn and Donovan 1994)
Black-throated Blue Warbler	Abundance	Fragmentation of suitable habitat	breeds in relatively intact, mature northern hardwood forest, often montaine with shrubby understory (Holmes and Sillett, 2005)
			area sensitive, occuring primarily in forest tracts > 100ha (Robbins et al 1989); although found to frequently cross roads and habitat gaps (Harris and Reed, 2002b)
			forest interior birds found to have higher reproductive productivity than those breeding near edges, although due to pairing success in edge habitats, both seem to have similar probabilities of producing fledglings (Harris and Reed, 2002a)

Red-eyed vireo	Abundance and high mortality at existing wind farms in the east	Decrease in suitable habitat, potential avoidance	populations apparently not impacted by small scale disturbances to habitat, were observed to tolerate small and narrow clearcuts of 2-10 hectares, larger scale clear-cuts have resulted in decreases in breeding populations (Cimprich et al. 2000)
			susceptible to cowbird brood parasitism (Cimprich et al. 2000)
			one of most abundant species prior to construction of the Searsburg, Vermont windfarm but suffered a decline in abundance after construction (Kerlinger 2002)
			disturbed by isolation of forest fragments, athough have been found breeding in fragments as small as 0.5 hectares (Cimprich et al. 2000)
			abundant and widespread across its range, BBS data suggest increasing populations in East (Cimprich 2000)
Blackburnian warbler	Abundance	Decrease in suitable habitat	occurs in coniferous to coniferous-deciduous mixed forest primarily, often in late successional stands (Morse 2004)
			an interior-forest species sensitive to fragmentation and the removal of large conifers (morse 2004)
Blue-headed vireo	Abundance	Decrease in suitable habitat	occurs in conifer and mixed forests, particularly old growth conifer forests and riparian hemlock forests (PGC 2005)
			occurs in stratified forests and is sensitive to edge effects (PGC 2005)
			populations generally increasing (James 1998)
			sensitive to clearing of forests and fragmentation (James 1998)
			very sensitive to human activity during breeding, female may abandon nest and mate (James 1998)
Northern flicker	Abundance	Decrease in suitable habitat	prefers forest edge and open woodlands (Moore 1995)
			population generally declining (Moore 1995)
			sensitive to loss of snags, trees with dead limbs, and live trees with core rot for nesting (Moore 1995)
Chipping sparrow	Abundance	Increased vulnerability to brood parasites	prefers open, grassy coniferous forests, glades, or edges (Middleton 1998)
			clearing of forests, agriculture, creation of open grassy spaces benefits habitat (Middleton 1998)
			common and abundant population (Middleton 1998)
			clearing forests increases vulnerability to cow bird brood parasitism (Middleton 1998)
Wood thrush	Species of conservation concern	Decrease in suitable habitat	occurs in both desciduous and mixed forests, it is an indicator species for high quality forests (PGC 2005)
			suceptible to fragmentation, significantly less abundant at edges bordered by paved road and powerlines than along narrow unpaved roads (Roth et al. 1996)
			will use fragments if intact canopy and dense understory occur, although susceptible to predation and brood parasitism (Roth et al. 1996)
			sensitive to nest abandonment if disturbances occur around the nest (Roth et al. 1996)
			population has been declining substantially across its range

*RTE species in the region, species with high mortality rates at existing wind farms, species that exhibit flight behaviors that put them at increased risk, and species that have high abundance in the project area