DRAFT
2011 Breeding Bird Survey Report for the Antrim Wind Power Project

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1.0 PROJECT DESCRIPTION

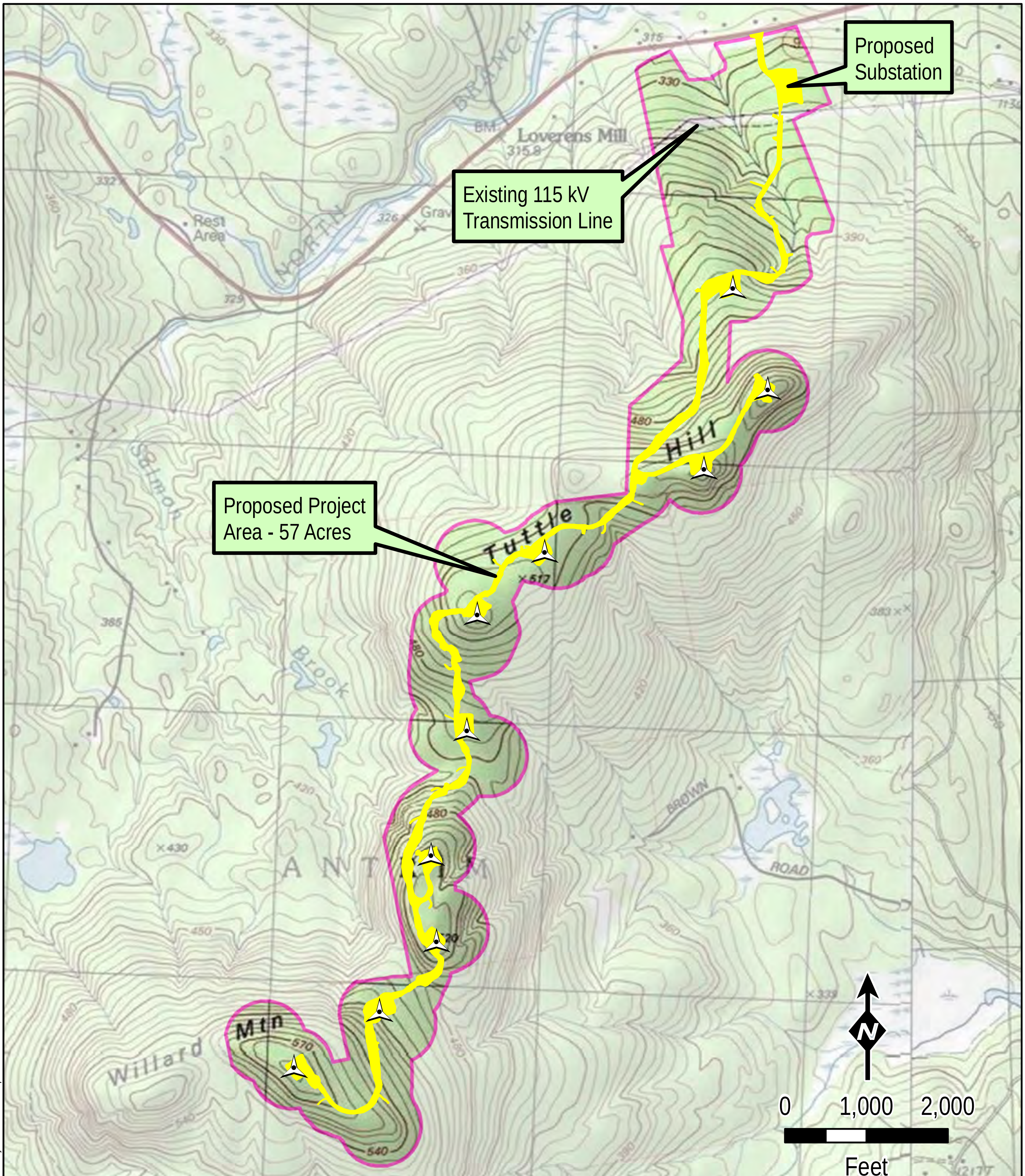
Antrim Wind Energy LLC (AWE) is proposing to construct the Antrim Wind Energy Project (Project) on Tuttle Hill and Willard Mountain in the Town of Antrim, Hillsborough Country, New Hampshire. The proposed Project is sited entirely on privately owned land that is leased by AWE. The proposed Antrim Wind Energy Project involves the construction of 10 wind turbines, an electrical collection system and interconnection substation, approximately 4 miles of new access road, and an operations and maintenance building. There will be no new electrical transmission lines, other than collector system lines, constructed as part of this Project. The total direct impact for the access roads, the turbine pads, and electrical collector system will be approximately 57 acres.

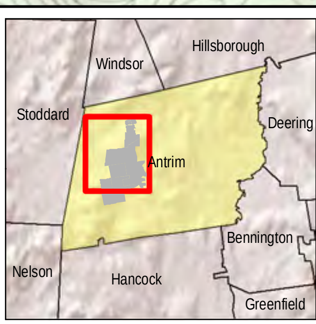
The proposed project is sited on the ridges of Tuttle Hill and Willard Mountain which are oriented east-northeast to west-southwest. The ridges are approximately parallel to NH Route 9, which is about ¾ of a mile to the north. Between the ridgeline and Route 9 is an existing transmission corridor containing both an 115kV transmission line and a 34.5kV distribution circuit; the proposed Project will interconnect with the existing 115kV line. See Attachment A, Figure 1, for a map of the Project area and Project elements.

1.1 Objectives

The primary objective of this study was to document use of the proposed project area by breeding bird species. The primary components of this study include:

- Compiling a species index and relative abundance for birds breeding in the project area;
- Calculating frequency of occurrence for each species by dividing the number of survey points where each species was detected by the total number of survey points; and
- Characterizing the cover type and habitat at each survey point.





Legend

Proposed WTG

Proposed Project Area - 57 Acres

Resource Survey Area

EOLIAN RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

354 KEENE ROAD, ANTRIM, NH

Figure 1

Project Location Map

Produced by: TRC | 1/23/2012

S:\Projects\TRCAugusta\182878-Antrim Windpark\Figure 1 Project Location Map.mxd

2.0 STUDY METHODOLOGY

2.1 Survey Protocol

Breeding bird surveys in the Antrim Wind Energy Project vicinity consisted of two major components: point count surveys for breeding birds and habitat evaluations at survey locations. A draft survey protocol was sent out to New Hampshire Fish and Game and United States Fish and Wildlife Service in March 2011, for review and comment. A consultation meeting with NH DES and United State Fish and Wildlife Service (USFWS) took place on April 6, 2011. These agencies reviewed the proposed protocol for the breeding bird survey and generally agreed with the proposed methodologies for this survey.

Point count survey procedures were based upon methods used in the Vermont Institute of Natural Science's *Mountain Birdwatch* program (VINS 2005) and Bird Studies Canada's *High Elevation Landbird Program* (*HELP*) (Whittam and Ball 2002, and 2003). These surveys were performed during the early morning hours starting at first light. Twelve points were selected on the ridge area, with half outside of the proposed project area and half within the project area. See Figure 2 for the location of survey points.

Habitat evaluation was performed using methods described by James and Shugart (1970). Quantitative estimates of vegetation were made using tenth-acre (0.04-hectare) circular plots, consisting of a 37-foot (11.28-m) radius around a center point. These plots were located at each survey point.

For more detail on the methods and protocols used for this study, see Appendix A.

2.2 Data Analysis

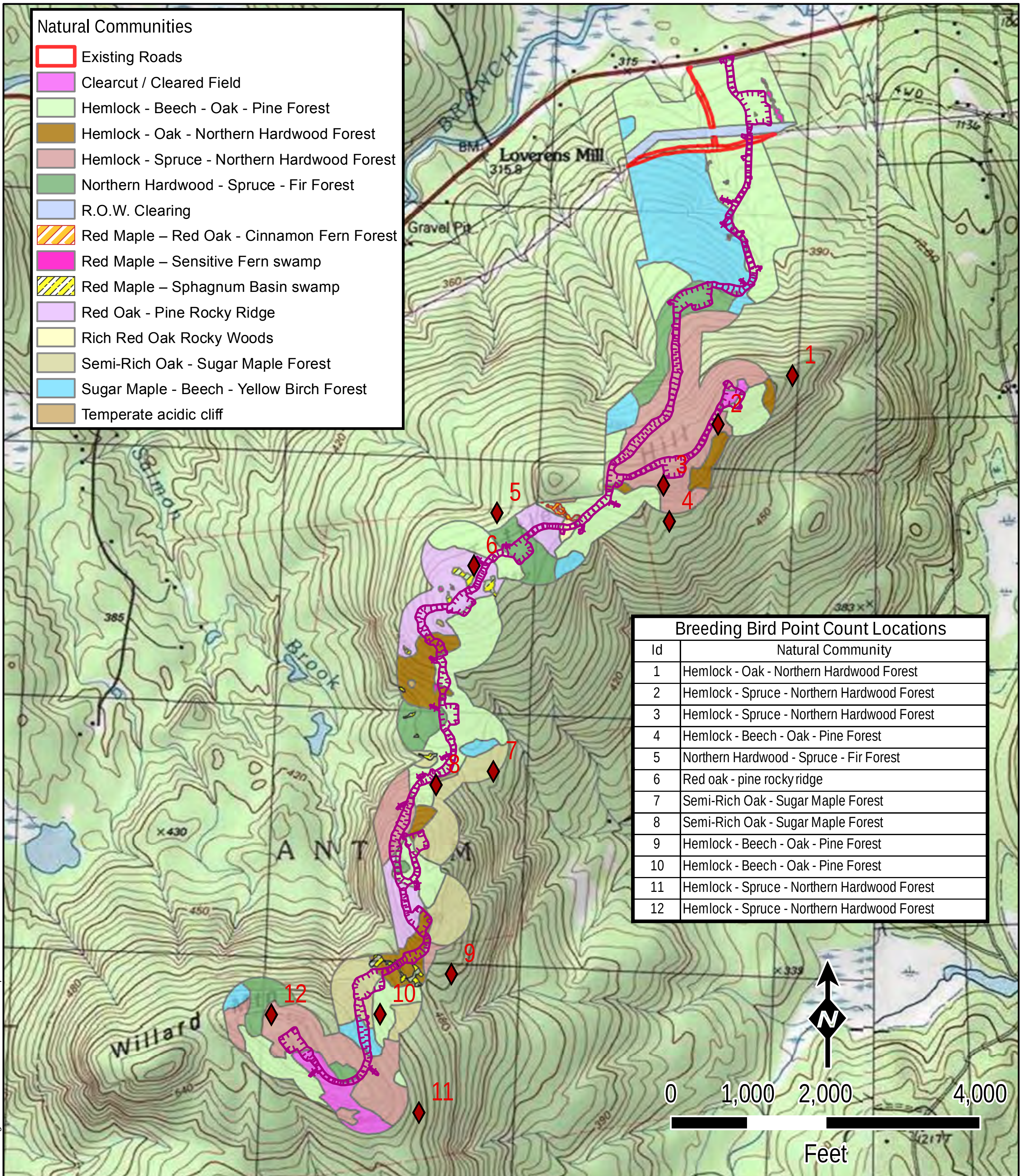
Data were entered and stored in a numerical database or spreadsheet format.

Both Federal and New Hampshire lists of endangered and threatened species were reviewed to confirm whether any listed species were found on the site. Additionally, the lists of Federal Birds of Conservation Concern in Bird Conservation Region 14 (Atlantic Northern Forest) and the Birds of Conservation Concern in USFWS Region 5 (USFWS 2008) were also reviewed.

The following summaries and statistics were generated, as applicable, to address the objectives and goals of this study:

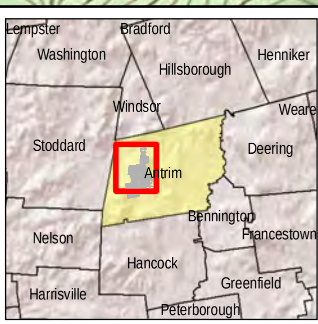
- Species lists and indices of relative abundance; and
- Frequency of occurrence for each species.

Relative abundance is summarized using the maximum and average number of individuals for each transect. The maximum number of individuals is the highest count of different individuals for each species at a point. The average number of individuals is the mean of all survey counts for each species. The total number of individuals is the sum of all counts from all surveys for all species and does not account for the same individual seen during separate surveys. Frequency of occurrence is the number of points where each species was detected divided by the total number of survey points.



Breeding Bird Point Count Locations

Id	Natural Community
1	Hemlock - Oak - Northern Hardwood Forest
2	Hemlock - Spruce - Northern Hardwood Forest
3	Hemlock - Spruce - Northern Hardwood Forest
4	Hemlock - Beech - Oak - Pine Forest
5	Northern Hardwood - Spruce - Fir Forest
6	Red oak - pine rocky ridge
7	Semi-Rich Oak - Sugar Maple Forest
8	Semi-Rich Oak - Sugar Maple Forest
9	Hemlock - Beech - Oak - Pine Forest
10	Hemlock - Beech - Oak - Pine Forest
11	Hemlock - Spruce - Northern Hardwood Forest
12	Hemlock - Spruce - Northern Hardwood Forest



Legend

Breeding Bird Survey Location

Proposed Disturbance Area

Hillsboro and Stoddard 7.5-Minute USGS Topographic Quadrangles

EOLIAN RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

ANTRIM, NH

Figure 2

Breeding Bird Point Count Locations and Natural Communites Map

Produced by: TRC | 1/23/2012

S:\Projects\TRCAugusta\182878-Antrim Windpark\Figure 2 Breeding Bird and Natural Communities Map 8x11.mxd

3.0 RESULTS AND DISCUSSION

3.1 Summary of Breeding Bird Surveys

In spring of 2011, 12 survey points for breeding bird surveys were selected based on available habitat found in the Project area by analysis of aerial photography and site visits. Points were spaced a minimum of 250 m apart. The points sited outside the project area were located at least 500 feet from potential turbine locations. See Figure 2 for point count locations.

A total of 2 breeding bird surveys were completed on June 7 and June 16, 2011.

3.1.1 Species Identified

A total of 131 birds were counted, all identified to species. These comprised 25 species in 19 genera. An additional 14 species in 13 genera were observed incidentally during June 2011 in the Antrim vicinity, but not at the breeding bird survey points. See Appendix B, Table 1 for the species list. Some of the incidental sightings were not within the project area, were at lower elevation and may have been in different cover types than those found on the point count survey.

Thirteen, or 52 percent, of the species identified during the 2011 surveys are considered neo-tropical migrants.

3.1.2 Relative Abundance and Frequency of Occurrence

The total number of individuals observed was used to assess the relative abundance for each species.

The maximum number of breeding individuals at all 12 point counts combined was 131 individuals. The most abundant birds observed were the ovenbird (*Seiurus aurocapillis*) and blackburnian warbler (*Dendroica fusca*), each making up 12.98 percent of the birds observed. The red-eyed vireo (*Vireo olivaceus*) was the next most abundant bird observed, and accounted for about 10.69 percent of the total number of breeding birds.

The frequency of occurrence, which gives an indication of the distribution of a given species across the site, is calculated by the number of points the species was observed divided by the total number of points. The ovenbird, blackburnian warbler, red-eyed vireo and the black-throated blue warbler (*Dendroica caerulescens*) were observed at the most survey points, with each found at 8 of the 12 survey points. A summary of the frequency of occurrence for all species can be found in Appendix B, Table 1.

3.2 Species of Concern Within the Project Area

3.2.1 Federal and State Listed Species

No Federal-listed or New Hampshire state-listed species were found at point count locations or within the project during breeding bird surveys. Incidental observations of the State-listed endangered common nighthawk (*Chordeiles minor*) were made during trips to the site to do breeding bird surveys. On June 6, a nighthawk was heard vocalizing between 7:30 PM and 9:00 PM from near point 12, from the area north of Willard Mountain. On June 7, a nighthawk was also heard vocalizing in the same area at approximately 4:15 AM. On the next breeding bird survey trip to the site, up to 4 common nighthawks were observed between approximately 7:00 PM and 8:30 PM on June 15 foraging over the valley north of Tuttle Hill. After dark (about 8:30) and up until 9:10 PM the nighthawks were heard vocalizing, still north of Tuttle Hill. The following morning a series of nighthawk calls were heard from between points 1 and 2, with the calls originating from north of the ridge, in the same area as heard the previous night. Breeding habitat for common nighthawks consists of open areas of bare bedrock or gravel. This site is forested and this habitat does not naturally occur on the site, so it is not likely that any of these birds nested on the site. There is a recent clear cut on the south east side of Willard Mountain, however much of this area is vegetated with ground cover.

3.2.2 Federal Birds of Conservation Concern

No bird listed on either the Federal Birds of Conservation Concern in Bird Conservation Region 14 (Atlantic Northern Forest) or the Birds of Conservation Concern in USFWS Region 5 (USFWS 2008) were observed at the site during breeding bird surveys or incidentally at the site during breeding season.

3.2.3 State of New Hampshire Special Concern Species

No State Species of Special Concern were observed at the site either during breeding bird surveys or incidentally.

3.3 Results of Vegetation Survey

Vegetation surveys on tenth-acre (0.04 hectare) plots were completed at all 12 point count locations during the last week of August following methods described by James and Shugart (1970). This methodology was developed specifically for making habitat measurements associated with estimating bird populations. The raw data is attached in Appendix B, Table 2.

The entire site is forested, and most of the site is currently populated by young to mature tree cover. Trees that are between 3 and 15 inch diameter breast height (DBH) make up 94% of the trees found within the vegetation plots. Large trees (greater than 15" DBH), while present throughout the site, made up a small proportion (6%) of the trees found in the survey plots. The density of trees on the site is relatively low, with an average of 29 tree stems greater than 3 inches observed per plot. Woody species less than 3 inches in diameter were also found in relatively low densities on the site with an average of 12 shrub size woody stems observed per plot. Hardwood species were dominant on the site, making up 65% of trees counted in the plots, while softwoods made up 35 percent of all species counted. Most habitat types found on the site had some component of softwood present, however. Red spruce was the most abundant softwood species observed in the plots. The most common hardwood species were red maple, red oak, American beech, and yellow birch. The largest diameter tree was a red maple located at point 10, with a DBH of 24 in.

Canopy cover on the site ranged from approximately 36% to 95%, and the average canopy cover overall was 77%. Each point count location was in forested areas, and canopy height ranged from 45 feet to 70 feet, with an average canopy height of 60 feet among the 12 point count location. Ground cover observed ranged from about 5% at sites with the heaviest canopy cover to about 85%, and on average ground cover was 33%.

The majority of the survey points (1, 2, 3, 5, 11, and 12) can be characterized as one of the various types of Northern Hardwood Forest, in accordance with the “Natural Communities of New Hampshire, Second Edition” (Sperduto and Nichols 2011). Types found on the site include Hemlock-Spruce, Spruce-Fir, and Hemlock-Oak Northern Forest.

Other common vegetation communities identified at the surveys points can be characterized as Hemlock-Beech-Oak-Pine Forest (points 4, 9, 10), Red Oak-Pine Rocky Ridge (point 6), and Semi-Rich Oak-Sugar Maple Forest (points 7 and 8).

All of these forest communities will have varying degrees of canopy dominance from primarily hardwoods, a mix of hardwood and softwood, or softwood dominated stands. The composition of hardwood and softwood depends on soils, slope and aspect, and this site has the full range of variation.

4.0 SUMMARY OF FINDINGS

Breeding birds observed at 12 point counts consisted of 25 breeding species in the project area. The ovenbird and blackburnian warbler were the most commonly observed species, and each accounted for 12.98 percent of the average number of birds during the surveys. The following most common bird based on their average counts was the red-eyed vireo (10.69 percent). These three species were present at 8 of the 12 survey points. An additional 14 species were observed incidentally in the Antrim vicinity in June 2011, in addition to those observed at point count locations.

No Federal-listed or New Hampshire state-listed species were found at point count locations or within the project during breeding bird surveys. Incidental observations of the State-listed endangered common nighthawk were made during trips to the site to do breeding bird surveys. None of these birds were observed within the project area, and suitable breeding habitat is not found within the project area so it is not likely any common nighthawks are breeding on the project site.

No bird listed on either the Federal Birds of Conservation Concern in Bird Conservation Region 14 (Atlantic Northern Forest) or the Birds of Conservation Concern in USFWS Region 5 were observed at the site during breeding bird surveys or incidentally at the site during breeding season. No State Species of Special Concern were observed at the site either during breeding bird surveys or incidentally.

5.0 REFERENCES

James, F. C. and H. H. Shugart, Jr. 1970. A Quantitative Method of Habitat Description. Audubon Field Notes 24: 727-736.

Sperduto, D.D. and William F. Nichols. 2011. Natural Communities of New Hampshire. 2nd Ed. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, NH.

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APPENDIX A

Breeding Bird
Survey Protocol
For the Antrim Wind Energy Project
& Data Forms and Instructions

Breeding Bird Survey Protocol for the Antrim Wind Energy Project

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March 2011
(Revised, May 2011)

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1.0 INTRODUCTION

1.1 Project Description

Antrim Wind Energy LLC (AWE) is proposing to construct the Antrim Wind Energy Project (Project) on Tuttle Hill and Willard Mountain in the Town of Antrim, Hillsborough Country, New Hampshire. The proposed Project is sited entirely on privately owned land that is leased by AWE. The Project will include: up to ten (10) wind turbines for a nameplate capacity of approximately 20mw; an access road; collections lines; and an interconnection substation.

The ridgeline on which the project is proposed to be developed is a mostly contiguous ridgeline which runs east-northeast to west-southwest. The ridge is nearly parallel to NH Route 9, which is approximately ¾ of a mile to the north. Between the ridgeline and Route 9 is an existing transmission corridor containing both a 115 kV transmission line and a 34.5 kV distribution circuit; the proposed Project will interconnect with this existing transmission.

AWE has contracted TRC Companies (TRC) to conduct the breeding bird survey for the Project to determine what effects, if any, the proposed project may have on breeding birds in the Project vicinity.

1.2 Goals and Objectives

The goal of breeding bird surveys within the proposed Antrim Wind Energy Project area is to document the pre-construction presence, diversity and relative abundance of breeding bird species in the proposed area of development.

The specific objectives of breeding bird surveys are to:

- produce a comprehensive list of breeding bird species in the project area and in adjacent areas outside of the “zone of influence” of the project area;
- compile a species index and relative abundance for birds breeding in the project area;
- calculate frequency of occurrence for each species;
- characterize habitat that is available for species which occur in the project area; and
- qualitatively assess the general patterns of breeding bird use in the vicinity of the proposed project.

2.0 STUDY PROTOCOL

Breeding bird surveys for the Antrim Wind Energy Project will be performed using point count methods. This protocol was developed based on methods used for the Vermont Institute of Natural Science's *Mountain Birdwatch* program (VINS 2005) and Bird Studies Canada's *High Elevation Landbird Program* (*HELP*) (Whittam & Ball 2002, and 2003). Other recent protocols which have been referenced include: VINS *Breeding Landbird Monitoring Program* Volunteer Training manual (VINS 2008); VINS *Mountain Birdwatch 2.0 Volunteer Training manual* (VINS 2010); and *Mountain Birdwatch Protocol and Standard Operating Procedures for Monitoring High-Elevation Landbirds in the Northern Appalachian and Laurentian Regions* (Hart and Lambert 2008). The USFWS and state lists of rare, threatened and endangered birds will be reviewed, and will include consideration of birds of concern and any applicable conservation plans.

2.1 Site Selection

Point counts will be conducted within the area proposed for project development and adjacent to the proposed project area. The surveys will be made up of twelve point count locations. Points along individual transects will be 250 m apart (Whittam & Ball 2002, VINS 2005). Each point will consist of a central location from where observations will be made. Each of the points will be located with Global Positioning System (GPS). Elevation will also be recorded for each point, based on aerial survey topographic data and GPS data.

The ultimate point locations will be selected based on aerial photography, topography and field reconnaissance. Half of the points (six) will be in a transect along the ridge within the project area. The remaining six points will be in areas outside of the "zone of influence" from the project area, and will be sited a minimum of 500 feet from the zone of influence. Some or all of the survey transect may be located in areas where there are no trails. Flagging will be used as necessary to locate transects and to mark each survey point; no permanent markers will be used. All flagging will be removed upon the final survey. Cutting of vegetation will be avoided to the extent practical. Access along the study transect will be limited to on-foot only.

2.2 Number and Timing of Surveys

All breeding bird point count surveys will be conducted between June 1 and June 21. These periods correspond with the height of breeding and vocal activity for migratory songbirds in the Atlantic Northern Forest (Hart and Lambert 2008). Surveys will start approximately 45 min before local sunrise, and will be completed by 8:00 AM.

All points shall be visited at least twice during the study period. Surveys will only be performed in weather conditions that do not hamper observations; therefore, inclement weather may preclude surveys. Acceptable weather conditions are defined by temperatures that are above 35ºF, and absence of rain and/or wind that could interfere with intensity or audibility of bird sounds. Steady drizzle, prolonged rain and/or windy periods that interfere with audibility are not acceptable for sampling. Wind speeds must be less than 4 on the Beaufort scale to allow proper audibility of bird sounds. Surveys may be delayed up to 30 minutes if weather conditions are poor upon arrival at a survey site, however, if poor conditions persist after that time, surveys will be rescheduled for another morning (VINS 2005).

2.3 Breeding Bird Survey Protocol

Breeding bird surveys will consist of performing point counts (or listening periods) at each of the determined points. These surveys will focus on identifying and quantifying bird species present. The procedure will adhere to that which is described in the VINS *Breeding Landbird Monitoring Program Volunteer Training Manual* (VINS 2008).

At least six points will be assessed consecutively during the same survey event. The survey at each point will consist of 10 minutes of silent listening. Stopwatches will be used to mark time. Observers will record all birds that are detected (seen or heard) during the listening period, and will record the approximate distance and behavior of the birds from the observation point as described in VINS 2008.

Personnel performing the surveys will be experienced bird watchers who are familiar with breeding bird species found in the northeast, and are able to identify them by sight and by sound. Training for this survey will help eliminate error or bias, and will include listening to breeding bird vocalizations and studying field guides.

2.4 Data Collection

Breeding bird observations will be recorded directly onto field cards and Data Coding Sheets based on those provided in the VINS *Breeding Landbird Monitoring Program – Volunteer Training Manual* (VINS 2008). Data sheets for breeding bird surveys at the Antrim Wind Energy Project are provided in Appendix A. Data over the course of each 10 minute listening period will be divided into 2, 3 and 5 minute segments. Information such as observer, route name, date, start time at each point, and weather information will also be entered on each data sheet. Weather information will include temperature, cloud conditions, precipitation, and wind direction and speed (Beaufort scale).

Species of birds seen or heard outside of point count areas during surveys will be noted separately as incidental observations in order to establish a comprehensive species occurrence list. An Incidental Observation Form is provided with the data sheets in Appendix A.

2.5 Habitat Evaluation Protocol

Habitat parameters associated with point count locations will be quantified using methods described by James and Shugart (1970). This methodology was developed specifically for making habitat measurements associated with estimating bird populations; it is still used by the national Breeding Bird Survey (USGS 2009b), as well as other current studies.

Quantitative estimates of vegetation will be made using tenth-acre (0.04-hectare) circular plots, consisting of a 37-foot (11.28-m) radius around a center point. For point count transects, tenth-acre habitat evaluation plots will coincide with listening station locations. Along trail-based transects, a 40-foot offset will be used to avoid cataloging the area of the trail. One plot will be evaluated alongside each survey point, with the offset side determined in each instance through a random coin toss. For spot-mapping parcels, tenth-acre plots will be centered on randomly selected grid points within the interior of the parcel (James and Shugart 1970, Ring et al. 2005). No less than six total tenth-acre plots will be measured within the spot mapping parcel.

Data collected at each tenth-acre plot will include:

- species and size class of all trees encountered within the plot;
- estimated number (and dominant species) of woody stems less than 3 inches diameter at breast height;
- estimated canopy cover and ground cover; and
- estimated canopy height.

All data will be recorded onto a data sheet (see Appendix B). Vegetation density will be quantified using these data, and calculations will be performed as described in James and Shugart (1970).

This effort will deviate from the James and Shugart (1970) protocol in the use of certain tools to gather data. Instead of using a “reach stick” to determine diameter, a forester’s diameter tape will be used. Instead of using a bright yardstick at the center of the 37’-foot-radius circle, the center will be marked with flagging tape, and a measuring tape or a laser range finder (LRF) will be used to determine distance (any flagging used will be removed at the end of the survey). Finally, instead of using a mirror and level to determine canopy height, the LRF will be used.

3.0 LITERATURE CITED

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Whittam, B. & M. Ball. 2003. High Elevation Landbird Program: 2002 Report. Bird Studies Canada, February 2003.

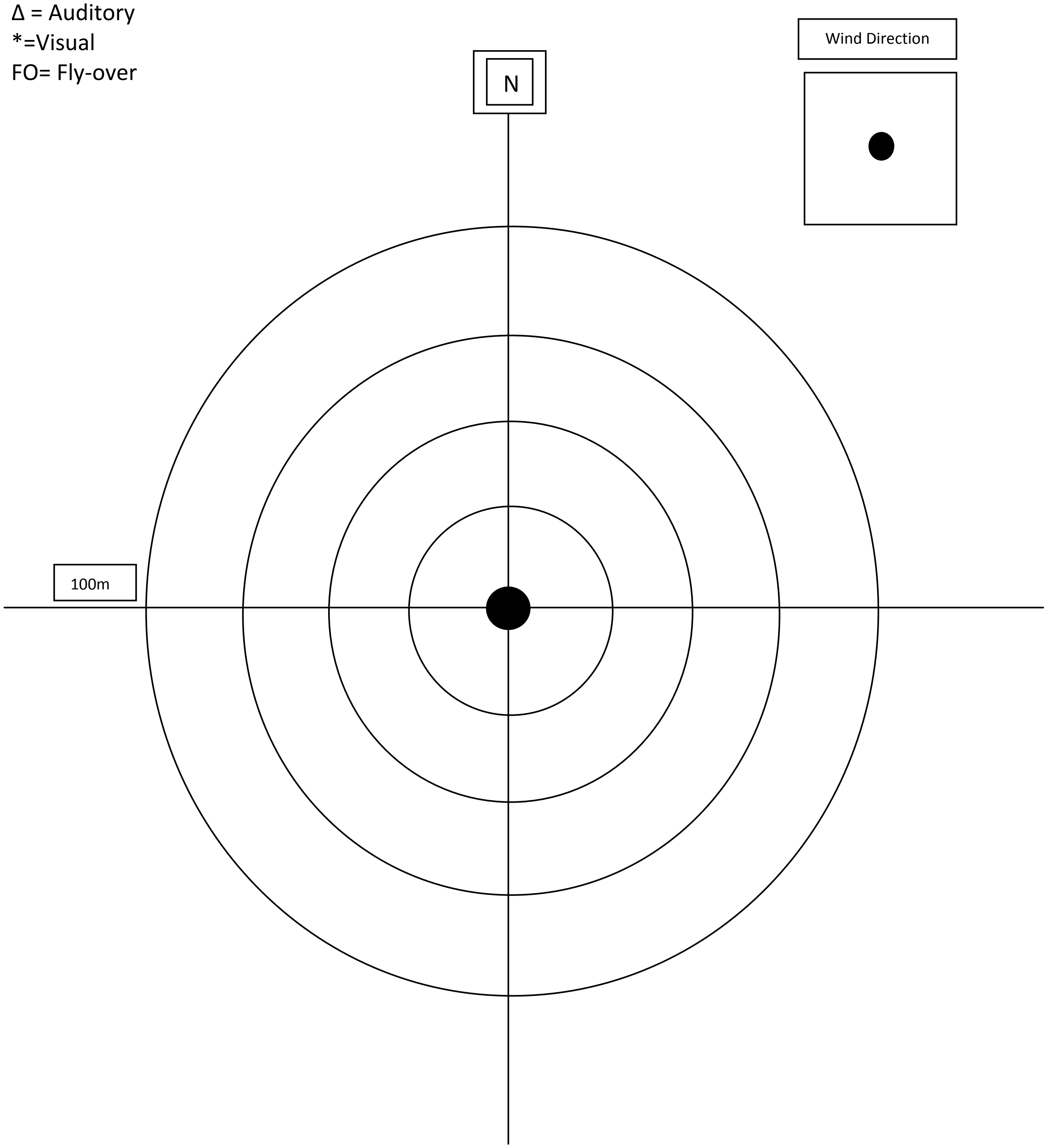
APPENDIX A:
Point Count Data Sheets

- *Point Count Transect Field Card*
- *Transect Data Coding Sheet*
- *Incidental Observation Form*

POINT COUNT FIELD CARD

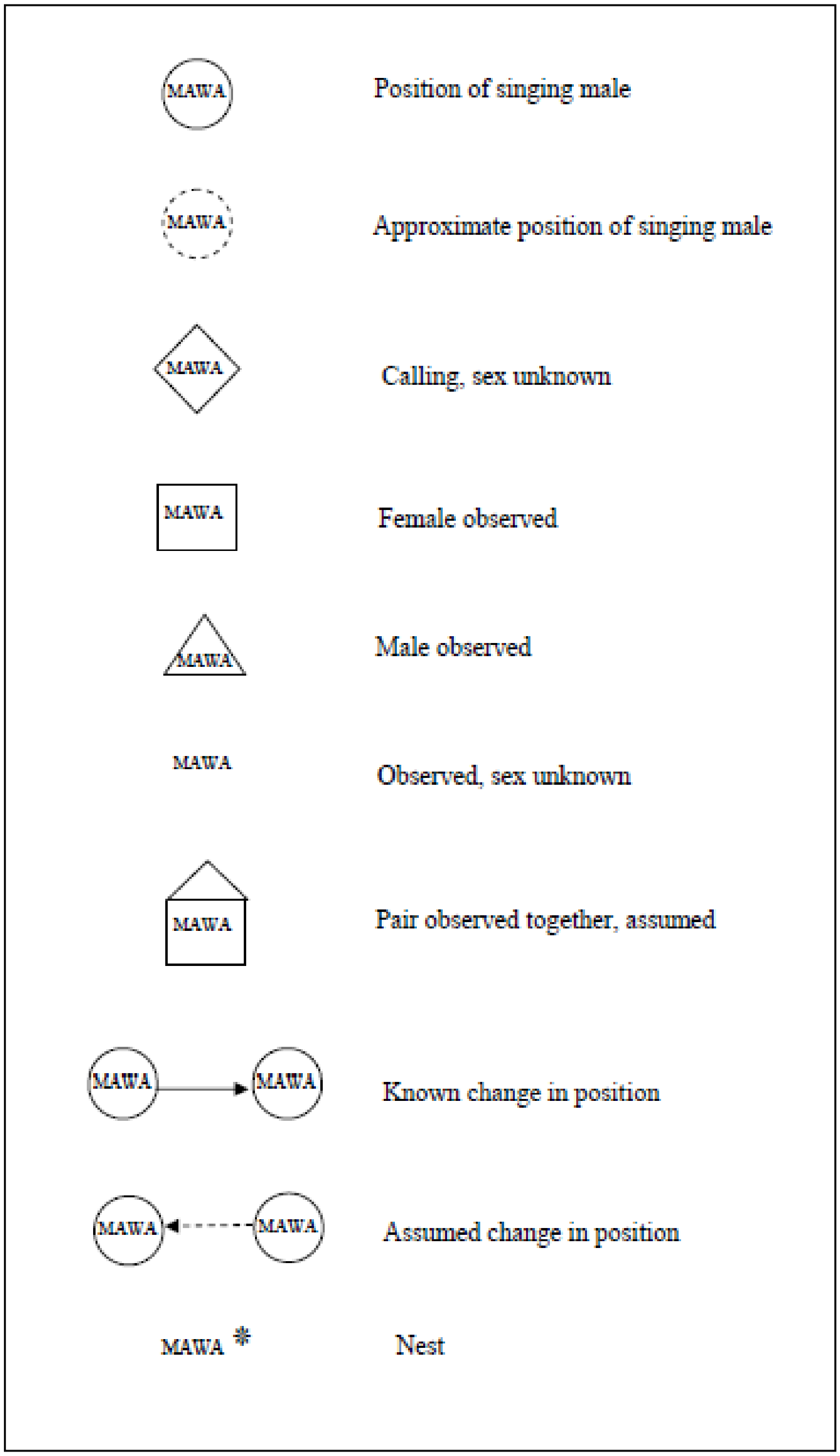
DATE:___________ OBSERVERS:____________________ LOCATION:________________POINT #:____
COMMENTS:

Start time:______ Temp:______%Clouds:____Rain:____Windsp:____End time:_____
π=0-3 minutes
ε=3-5 minutes
#=5-10 minutes
Δ = Auditory
*=Visual
FO= Fly-over



Standard symbols used for mapping bird locations.

Magnolia Warbler in this example



This key from VINS Breeding Landbird Monitoring Program – Volunteer Training Manual (VINS 2008)

BREEDING BIRD SURVEY FOR THE ANTRIM WIND ENERGY PROJECT

DATA CODING SHEET

Observer(s)	Route name	Date

Start time	End time	Temperature	Sky code (0-6)	Wind code (0-5)

Start Time	Point #	Species	Time Period	Less Than 50m	More Than 50m

Start Time	Point #	Species	Time Period	Less Than 50m	More Than 50m

Place the appropriate code from the following list in the appropriate distance column above:
*Singing male = **S*** *Calling = **C*** *Drumming = **D*** *Individual seen = **I*** *Family group = **F*** *Active nest = **N***

__Time Period__ **–** Place a **"A"** in the column if bird was detected during first **3 minutes**
Place a **"B"** in the column if bird was detected during **minutes 4 or 5** (a "+" on the field card)
Place a **"C"** in the column if bird was detected during the **last 5 minutes** (a "•" on the field card)

This Data Sheet Adapted From Vermont Institute of Natural Science Mountain Birdwatch – All Species Data Coding Sheet

<u>WIND CODES</u> <u>(Beaufort Wind Scale):</u>

0: *< 1 mph*; smoke rises vertically
1: *1-3 mph*; wind direction shown by smoke drift
2: *4-7 mph*; wind felt on face; leaves rustle at times
3: *8-12 mph*; leaves and small twigs in constant motion; light flag extended
4: *13-18 mph*; raises dust and loose paper; small branches in motion
5: *19-24 mph*; small trees sway; crested wavelets on inland waters

<u>SKY CODES</u> <u>(Sky Condition):</u>

0: clear, or very few clouds
1: partly cloudy (roughly halfclouded)
2: mostly cloudy (overcast; few sky openings)
3: fog or smoke (impairs visibility beyond 30 m)
4: light drizzle
5: constant snow
6: constant rain

Incidental Wildlife Observation Form

Antrim.Wind.Power Project

Species Observed:	# :
	Age (A/J/U) :
	Gender (M/F/U):
Date of Observation:	Time of Observation:
Observer:	Recorded by:
Location:	
GPS:	
Habitat Description:	
NOTES:	

APPENDIX B:
Data Sheet for Habitat Evaluations

Vegetation Data Sheet		
Location:	Study Plot:	Plot Size:
General Area Description:		Date:
Topography:		Observer:
Tenth-acre circles		
Trees	Diameter Size Classes (inches): A= <3 B = 3-6, C = 6-9, D = 9-15, E = 15-21, F = 21-27, G = 27-33, H = 33-40, I = >40	

	Species and Size Class	Circle #:_______	**Shrubs** Number of woody stems less than 3 inches DBH intercepted in 2 armlength transects: Note species
1			
2			
3			
4			
5			**Ground Cover** 20 random + or - sitings through ocular tube for presence or absence of green vegetation: Note species
6			
7			
8			
9			
10			
11			
12			**Canopy Cover** 20 + or - sitings through ocular tube for presence or absence of green vegetation on transect: Note species
13			
14			
15			**Canopy Height** Maximum canopy height in feet: Note species
16			
17			
18			
19			
20			**Photos**
21			
22			
23			
24			**Slope and Bearing**
25			
26			
27			
28			**Other Notes**
29			
30			
31			
32			

Species Abbreviations: black spruce-PIMA; red spruce-PIRU; white spruce-PIGL; hemlock-TSCA; balsam fir-ABBA; N. white cedar-THOC; quaking aspen-POTR; bigtooth aspen-POGR; balsam poplar-POBA; hop-hornbeam-OSVI; yellow birch-BEAL; gray birch-BEPO; paper birch-BEPA; alder-ALRU; Am. beech-FAGR; Am. mtn. ash-SOAM; showy mtn. ash-SODE; serviceberry-AMAR; pin cherry-PRPE; sugar maple-ACSA; red maple-ACRU; striped maple-ACPE; mtn. maple-ACSP; black ash-FRNI; white ash-FRAM; green ash-FRPE

APPENDIX B

TABLES

Table 1

Breeding Bird Species Observed within the Antrim Wind Energy Project Vicinity					
Common Name	**Latin Name**	**Residence***	**Number Observed**	**Relative Abundance**	**Frequency of Occurence**
Species Observed During Formal Breeding Bird Surveys					
American Goldfinch	*Carduelis tristis*	L/US	1	0.76%	0.08%
Black and White Warbler	*Mniotilta varia*	NT	5	3.82%	0.41%
Blackburnian Warbler	*Dendroica fusca*	NT	17	12.98%	0.67%
Black-capped Chickadee	*Poecile atricapillus*	L	2	1.53%	0.08%
Black-throated Blue Warbler	*Dendroica caerulescens*	US/NT	10	7.63%	0.67%
Blue Jay	*Cyanocitta cristata*	US/L	4	3.05%	0.33%
Cedar Waxwing	*Bombycilla cedrorum*	L/US	2	1.53%	0.08%
Chesnut-sided Warbler	*Dendroica pensylvanica*	NT	2	1.53%	0.08%
Common Yellowthroat	*Geothlypis trichas*	NT	2	1.53%	0.08%
Eastern Wood Pewee	*Empidonax*	NT	4	3.05%	0.33%
Golden-crowned Kinglet	*Regulus calendula*	L/US	2	1.53%	0.17%
Hairy Woodpecker	*Picoides villosus*	L	6	4.58%	0.50%
Hermit Thrush	*Catharus guttatus*	US	9	6.87%	0.58%
Magnolia Warbler	*Dendroica magnolia*	NT	3	2.29%	0.17%
Morning Dove	*Zenaida macroura*	US/L	1	0.76%	0.08%
Myrtle Warbler	*Dendroica coronata*	US/NT	12	9.16%	0.58%
Ovenbird	*Seiurus aurocapillus*	US/NT	17	12.98%	0.67%
Purple Finch	*Carpodacus purpureus*	L/US	1	0.76%	0.08%
Red-breasted Nuthatch	*Sitta canadensis*	L/US	2	1.53%	0.17%
Red-eyed Vireo	*Vireo olivaceus*	NT	14	10.69%	0.67%
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	NT	3	2.29%	0.25%
Scarlet Tanager	*Piranga olivacea*	NT	3	2.29%	0.25%
Slate-colored Junco	*Junco hyemalis*	L/US	5	3.82%	0.33%
Winter Wren	*Troglodytes troglodytes*	US	2	1.53%	0.17%
Veery	*Catharus fuscescens*	NT	2	1.53%	0.08%
Total Species Observed During Formal Surveys		***25***			
Total Individuals Observed During Formal Surveys			***131***		
Species Recorded as Incidental Observations during Summer 2011					
American Redstart	*Detophaga ruticilla*	NT			
Barred Owl	*Strix varia*	US/L			
Blue-headed Vireo	*Vireo solitarius*	US/NT			
Broad-winged Hawk	*Buteo platypterus*	NT			
Brown Creeper	*Certhia americana*	na			
Common Nighthawk	*Chordeiles minor*	NT			
Cooper's Hawk	*Accipiter cooperii*	US/L			
Least Flycatcher	*Empidonax minimus*	NT			
Pileated Woodpecker	*Picadae*	L			
Red-tailed Hawk	*Buteo jamaicensis*	US/L			
Ruffed Grouse	*Bonasa umbellus*	L			
TurkeyVulture	Cathartes aura	US			
Wild Turkey	*Meleagris gallopavo*	L			
Yellow-bellied Sapsucker	*Sphyrapicus varius*	US			
Total Species Observed Incidentally		***14***			
Total Breeding Bird Species Recorded in 2011		***39***			
* L – Local year round resident; US – Migrates within US; NT – Neotropical migrant					

Table 2

Trees						Shrubs (< 3 inch dbh)		% Ground Cover	% Canopy Cover	Canopy Height (ft)	Photo #	% Slope	Compass Bearing	Notes
Date	Point	Habitat Plot	Species	Size Class	#	Species	#							
8/31/2011	1	1	PIRU	B	2	PIRU	3	73	35.5	45	23-26	20%	336	East facing slope, open woodlands, patches of exposed bedrock
			PIRU	C	5	QURU	3							
			PIRU	D	7	PRPE	8							
			PIRU	E	1									
			QURU	B	6									
			QURU	C	3									
			QURU	D	2									
			BELE	B	1									
					27		14							
8/31/2011	2	1	PIRU	B	15	none		6.5	76.5	50	27-30	14%	346	moose bark browsing
			PIRU	C	6									
			PIRU	D	4									
			QURU	B	5									
			QURU	C	1									
			QURU	D	3									
			PIST	B	2									
			PIST	C	2									
			PIST	E	1									
			ACRU	B	1									
			ABBA	C	1									
					41									
8/31/2011	3	1	PIRU	C	1	FAGR	1	84.25	80	50	31-34	37%	23	East facing slope, open woodlands
			PIRU	D	3	QURU	1							
			QURU	B	7	PIRU	1							
			QURU	C	5									
			QURU	D	1									
			ACRU	B	8									
			ACRU	C	2		**3**							
					27									
8/31/2011	4	1	PIRU	B	5	FAGR	3	24	87.5	65	35-38	5%	35-38	
			PIRU	D	3	PIRU	3							
			PIRU	E	1									
			QURU	B	1	QURU	1							
			QURU	D	2									
			QURU	E	1									
			ACRU	B	1									
			ACRU	C	1									

Trees						Shrubs (< 3 inch dbh)		% Ground Cover	% Canopy Cover	Canopy Height (ft)	Photo #	% Slope	Compass Bearing	Notes
Date	Point	Habitat Plot	Species	Size Class	#	Species	#							
			ACRU	E	1									
			FRAM	B	2									
			FRAM	C	1									
			PIST	C	1									
			PIST	F	1									
			TSCA	D	1									
			BEAL	D	1									
			BEAL	E	1		**7**							
					24									
8/31/2011	5	1	PIRU	B	5	PIRU	8	11	91.75	70	39-42	8%	184	A few boulders, old moose bark browsing
			PIRU	D	1	ACPE	1							
			QURU	B	2	FAGR	1							
			QURU	D	2									
			PIST	E	1									
			PIST	F	1									
			BEPA	D	1									
			ACRU	B	5									
			ACRU	C	5									
			ACRU	D	3									
			ACRU	E	1									
			ACPE	B	2									
			BEAL	B	3									
			TSCA	D	1									
			FAGR	B	2		**10**							
					35									
8/31/2011	6	1	PIRU	B	1	FAGR	5	4.75	94.25	65	43-46	4%	224	Rock outcrops, several very large diameter/hollow trees, a few snags, good wildlife habitat
			TSCA	B	1									
			TSCA	C	5		**5**							
			TSCA	D	8									
			TSCA	E	2									
			FAGR	E	2									
			BEAL	D	1									
			ACRU	E	1									
					21									
9/1/2011	7	1	PIRU	B	2	FAGR	5	9	80	60	73-76	12%	246	irregular terrain, numerous large boulders
			BEPA	B	1	ACRU	1							

Trees						Shrubs (< 3 inch dbh)		% Ground Cover	% Canopy Cover	Canopy Height (ft)	Photo #	% Slope	Compass Bearing	Notes
Date	Point	Habitat Plot	Species	Size Class	#	Species	#							
			BEPA	C	1	ACPE	4							
			BEPA	D	3	VILA	2							
			BEAL	B	2									
			FAGR	B	8									
			FAGR	C	3									
			FAGR	D	6									
			ACRU	B	3									
			ACRU	C	2									
			ACRU	D	3									
			ACPE	B	1									
			QURU	D	1		12							
					36									
9/1/2011	8	1	ACPE	B	3	FAGR	5	33	78.75	70	69-72	42%	142	Irregular, many large boulders, steep slope, moose bark browse
			ACRU	C	1	BEAL	3							
			ACRU	D	1	ASCP	1							
			FAGR	B	13	ACPE	1							
			FAGR	C	5	ACRU	2							
			FAGR	D	4									
			BEPA	B	2									
			FRAM	F	1									
			ACSA	D	2									
			PRPE	B	1									
			BEAL	B	1									
			BEAL	C	2		**12**							
					36									
9/1/2011	9	1	PIRU	B	1	ACRU	13	48.75	63.75	65	65-68	35%	324	Lots of large boulders, irregular terrain
			BEAL	B	3	FAGR	3							
			BEAL	C	3	ACPE	13							
			BEAL	D	2	PIST	11							
			ACRU	B	1	PIRU	5							
			ACRU	D	2	QURU	1							
			FAGR	C	2	HAVI	2							
			QURU	B	1									
			QURU	D	2									
			QURU	E	1									
			ACPE	B	1		**48**							
					19									

Trees						Shrubs (< 3 inch dbh)		% Ground Cover	% Canopy Cover	Canopy Height (ft)	Photo #	% Slope	Compass Bearing	Notes
Date	Point	Habitat Plot	Species	Size Class	#	Species	#							
9/1/2011	10	1	PIRU	B	2	COCO	1	19.5	84	65	59-62	24%	244	Many large boulders, moose bark browse
			BEAL	B	6	BEAL	2							
			BEAL	C	3	FRAM	10							
			BEAL	D	2	ASCP	1							
			ACRU	B	3	ACPE	6							
			ACRU	C	1	COAL	1							
			ACRU	D	1									
			ACRU	E	1									
			ACRU	F	1									
			ACPE	B	7		21							
			OSVI	B	1									
			OSVI	C	1									
			FRAM	B	2									
			FRAM	D	1									
					32									
9/1/2011	11	1	PIRU	B	4	ACRU	2	33	80.25	60	47-50	28%	284	moose bark browsing
			PIRU	C	3	LYLI	1							
			PIRU	D	2									
			PIRU	E	1									
			BEPA	D	2									
			QURU	B	1									
			QURU	E	1									
			PRSE	C	1									
			OSVI	B	1									
			OSVI	C	1									
			FAGR	B	1		**3**							
			ACRU	B	3									
			ACRU	C	4									
			ACRU	D	3									
					28									
9/1/2011	12	1	PIRU	B	3	PIRU	6	49	71	65	55-58	24%	202	steep slope, large boulders
			PIRU	C	2	VILA	1							
			PIRU	D	16	ILMU	1							
			PIRU	E	1	BEAL	2							
			BEPA	C	1		**10**							

Daytime Raptor Migration Survey Report for the Antrim Wind Energy Project

Spring and Fall 2011

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January 2012

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Project Description

Antrim Wind Energy LLC (AWE) is proposing to construct the Antrim Wind Energy Project (Project) on Tuttle Hill and Willard Mountain in the Town of Antrim, Hillsborough Country, New Hampshire. The proposed Project is sited entirely on privately owned land that is leased by AWE. The Project is expected to include 10 wind turbines, associated access roads, collector lines, an operations/maintenance building and an interconnection substation.

The ridgeline on which the Project is proposed to be developed is a mostly contiguous ridgeline which runs east-northeast to west-southwest. The ridge is nearly parallel to NH Route 9, which is approximately ¾ of a mile to the north. Between the ridgeline and Route 9 is an existing transmission corridor containing both a 115 kV transmission line and a 34.5 kV distribution circuit; the proposed Project will interconnect with this existing transmission.

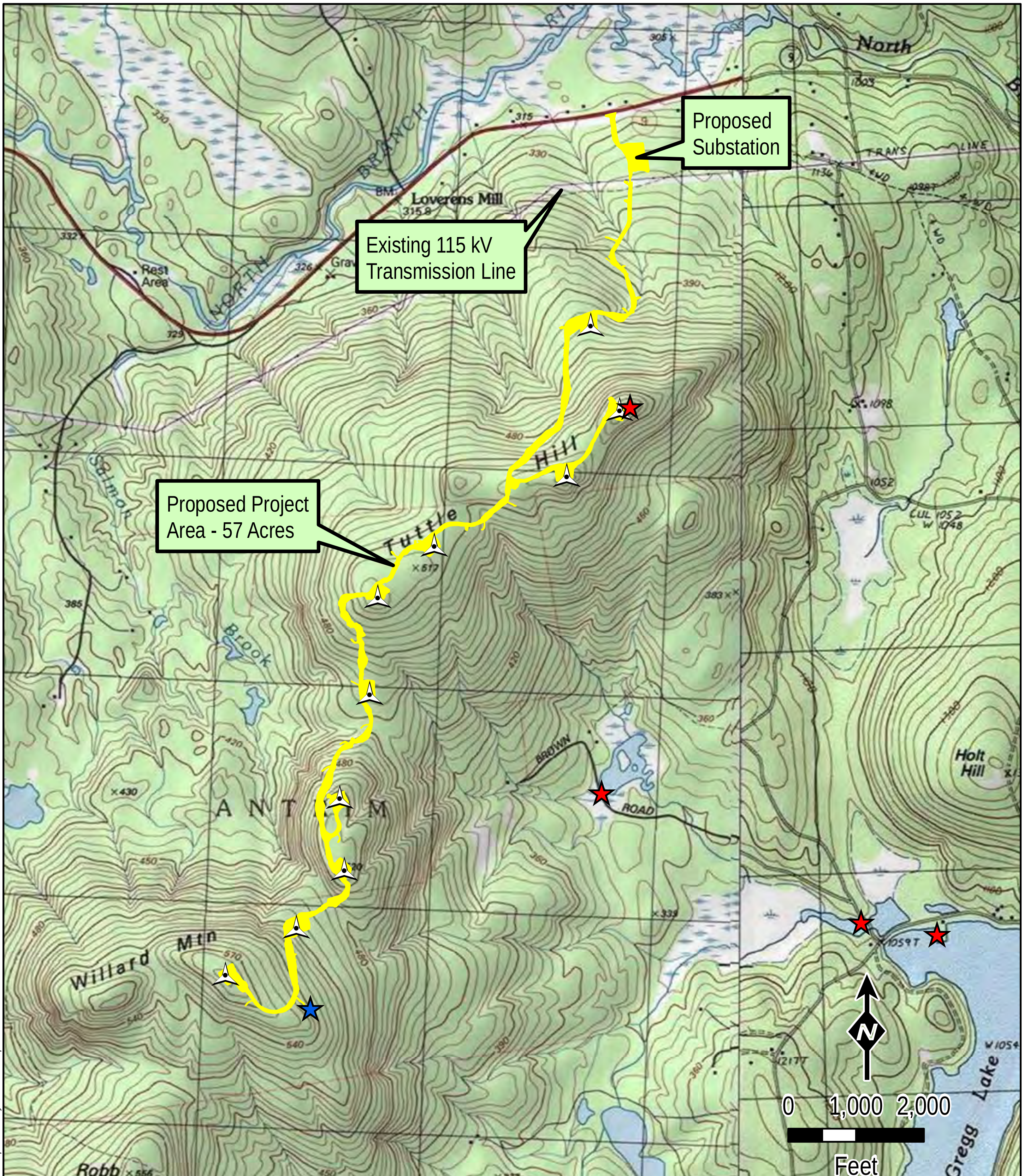
AWE has contracted TRC Companies (TRC) to conduct a diurnal raptor migration survey for the Project to determine what effects, if any, the proposed Project may have on raptor species migrating in the Project vicinity.

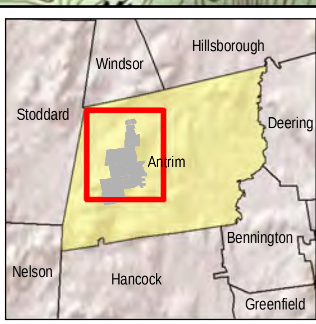
1.2 Goals and Objectives

The specific purpose of diurnal raptor migration surveys is to observe the numbers, species, and flight patterns of migrating raptors in the Project vicinity. The goal of these surveys is to ultimately assess the degree of potential impact the proposed Project may have on migrating raptors.

The main objectives of daytime avian migration surveys were to:

- Obtain a quantitative assessment of species composition, relative abundance, distribution, and spatial patterns of use by raptors migrating during daytime hours in and around the area of proposed development;
- Identify routes used by daytime migrating raptors passing through/near the area of proposed development;
- Document flight heights and use of topographical features in and near the area of proposed development;
- Evaluate potential impacts of Project development and operation on migrating raptors; and
- Evaluate potential for collisions at proposed turbine sites.





Legend

- Spring Raptor Survey Location
- Fall Raptor Survey Location
- Proposed WTG
- Proposed Project Area - 57 Acres

EOLIAN RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

354 KEENE ROAD, ANTRIM, NH

Figure 1

Raptor Survey Location Map

Produced by: TRC | 1/23/2012

S:\Projects\TRC\Augusta\182878-Antrim Windpark\Figure 1 Raptor Survey Location Map.mxd

2.0 METHODS

The protocol for diurnal raptor migration surveys at the proposed Antrim Wind Energy Project followed standards set forth by the Hawk Migration Association of North America (HMANA 2011), and by HawkWatch International (HawkWatch International 2011, Hoffman and Smith 2003).

Observation sites were selected based on vantage, and range of visibility. Sites were selected which provided optimal detection, observation and follow-through of avian flight paths approaching, traversing and exiting the area of proposed development.

2.1.1 Number and Timing of Surveys

Spring surveys for migrating raptors were scheduled to be performed between March 21 and May 31. Fall surveys were scheduled to be performed between September 1 and November 15. Early survey dates (in March), and late survey dates (in November) were intended to capture the passage of temporally extended migrant species such as golden eagles (*Aquila chrysaetos*).

Surveys were performed on multiple survey dates during each season. Sampling was performed based upon favorable weather for migration. In spring, fair weather days with southerly or southwesterly winds were favored. In fall, surveys favored fair weather with strong north to northwest winds. In general, fall surveys were timed to start the morning after the passage of a cold front and continue for three consecutive days following such a weather event. Surveys were not conducted during precipitation, in fog, on days that are overcast with low cloud cover, or during any other circumstances that hamper visibility.

On each survey date, data was generally collected for eight consecutive hours between 9 am to 5 pm. This timeframe represents the peak hours of thermal development and associated raptor movement.

Publicly available satellite tracking data for raptors (particularly bald and golden eagles) was also monitored during the course of surveys. This information was considered with respect to timing of movements when scheduling survey efforts.

2.1.2 Data Collection

Weather conditions (including wind speed and direction, temperature, cloud cover, visibility, etc.) were noted on data sheets at the beginning of each survey and hourly thereafter.

When collecting data on migrating raptors, surveyors performed continuous scanning with binoculars. Spotting scopes were used as necessary to aid in identification. Detailed raptor observation data were collected continuously during each survey onto specialized data sheets. In addition to tabular data, the flight path of each raptor observed was recorded on a topographical map of the survey area.

The following data were recorded for each bird observed:

- Species, sex, and age class, to the extent possible;
- Altitude at first observation, with noted variations over duration of presence within the survey area (using codes denoting below, within, or above rotor swept area);
- Position and flight path relative to the area of proposed development;
- Position and flight path relative to the topography of the area;

- Distance from observation point at first observation, and variations over duration of presence within the survey radius;
- Specific flight behavior (such as soaring, flapping, circling, gliding, perching, hunting, or other);
- General compass bearing of flight direction (S, SSW, NE, etc.); and
- Notes describing the general activity of each bird.

In the event a bird could not be identified to the species level, it was described to the greatest extent possible. For example, unknown raptors may have been further described as "buteo" versus "accipiter", or "large" versus "small".

Topographical flight positions were categorized for each bird observed. These "horizontal flight position" categories described the individual's flight habit relative to the landscape below. These categories include: A1) parallel to ridge, A2) perpendicular to ridge, A3) over saddle, B) flight path over upper slope of ridge, C) flight path over lower slope of ridge, and D) flight path over a valley (see Figure 3-2 below). Where appropriate, multiple flight positions were recorded for individual raptors as they traversed the Project area (for example, a bird that travelled along the upper slope, then crossed the ridge in a saddle would be recorded as B, A3).

Flight height (above ground level) was estimated for raptors that used the ridge area and upper slopes of Tuttle and Willard Mountains, as these are the areas where potential development has been considered or proposed over the course of project development. The remaining raptors were recorded as "outside" of the proposed Project area. Flight height estimates were grouped into 3 categories: 0-50 feet above the ground, 50-500 feet above the ground, and 500+ feet above the ground. Estimation of raptor elevation can be influenced by such factors as perspective, distance, topography, and individual observer perception. For this reason, the flight height categories were designed conservatively to produce the most conservative potential risk estimate, with field observers also erring on the side of caution around the 50-500-foot category.

All raptors observed were recorded, including likely residents. Care was taken to record resident raptors only once per date, to the extent possible.

2.2 Data Entry and Analysis

Data as recorded onto data sheets in the field were entered into and stored in a numerical spreadsheet format. The following summaries and statistics were then generated to address the objectives and goals of this study.

- Species lists by season;
- Indices of bird relative abundance;
- Avian migration patterns by species, season, and habitat type;
- Flight paths and heights, by species and season;
- Number and proportion of observations, by species and season, within the rotor-swept area of the proposed turbines; and
- Standard statistical parameters (e.g., means, standard deviations) were computed, where appropriate.

Data resulting from this study were compared to available concurrent data from numerous regional hawk watch sites, as provided on the HMANA website (HMANA 2011).

3.0 RESULTS AND DISCUSSION

3.1 Summary of Effort

Spring
The spring 2011 diurnal raptor migration survey for the proposed Antrim Wind Energy Project consisted of 65 total hours of observation across 9 dates between March 25 and May 13. Surveys averaged 7.2 hours in length, with most dates consisting of 8 continuous hours of observation.

The primary survey location was in an open swamp area in the Meadow Marsh Preserve. On two survey dates, observations were conducted from the area of the meteorological tower on the eastern prominence of Tuttle ridge. On one date, observations were made from the Gregg Lake public beach area, and an open bog area on the northwest side of Gregg Lake. Each of these locations is mapped on Figure 1 (Project Location Map).

Fall
The fall survey consisted of 147.5 total hours of observation across 21 dates between September 14 and November 18. Surveys averaged approximately 7 hours in length, with most dates consisting of 8 continuous hours of observation.

The primary survey location was in a small clearing on the southeast flank of Willard Mountain. This location is mapped on Figure 1 (Project Location Map).

3.2 Species Identified and Relative Abundance

A collective species list and summary of relative abundance is provided in Table 1.

Spring
In the spring of 2011, a total of 441 individual raptors[1], representing eleven species were identified within the immediate vicinity of the proposed Antrim Wind Energy Project. As shown in Table 1, the vast majority of individuals observed were turkey vultures, which comprised 54% (n=237) of all observations. The next most abundant species observed were broad winged hawks and red-tailed hawks at 18% (n-77) and 14% (n=60) relative abundance, respectively. Unidentified *Buteo* species and unidentified raptor species were the next most frequently recorded categories at approximately 7% (n=30) and 3% (n=13), respectively. All other species were recorded at a relative frequency of less than 1%.

The overwhelming abundance of turkey vultures may be attributable to multiple observations of resident individuals (or groups) over the course of the survey.

Threatened or Endangered raptor species that were observed during spring migration surveys for the proposed Antrim Wind Energy Project include: bald eagle (State Threatened); peregrine falcon (State Threatened); and northern harrier (State Endangered). A total of 3 bald eagles were recorded in the spring. A single peregrine falcon was also observed in the spring of 2011. Northern Harriers were documented on 5 occasions in the spring of 2011. In addition to these threatened and endangered species, three state listed species of special concern were also observed; these are American kestrel, northern goshawk, and osprey. One American kestrel,

[1] For the purpose of this study, the term "raptors" refers to all members of Order Falconiformes; this order currently includes the family Cathartidae (New World vultures, including turkey vultures), despite debate regarding their taxonomic relationship to true raptors.

one northern goshawk, and five osprey were observed in the spring of 2011. The details of Project area use by these individuals are presented in Section 3.4: Listed Species Flight Details.

Fall

In fall, a total of 978 individual raptors, representing 10 species were identified. The vast majority of these were broad-winged hawks, which comprised approximately 70% (n=689) of all observations. A total of 471 of these individuals were recorded on one date: September 18. The majority of these broad-wings passed in a few large aggregations ("kettles"). For comparison: on the same date (September 18), Carter Hill Observatory (in Concord, NH) recorded a total of 7,212 broad-winged hawks and Pack Monadnock Observatory (in Peterborough, NH) recorded 5,208. Large, temporally concentrated fall movement of broad-winged hawks is typical in New England. Red-tailed hawks and turkey vultures were the next most frequently observed species at approximately 8% and 6% relative abundance, respectively.

Threatened or Endangered raptor species that were observed during fall migration surveys for the proposed Antrim Wind Energy Project include bald eagle (State Threatened) and golden eagle (State Endangered). A total of 11 bald eagles and 3 golden eagles were recorded in the fall. In addition to these threatened and endangered species, 5 osprey, a listed species of special concern were also observed. The details of Project area use by these individuals are presented in Section 3.4: Listed Species Flight Details.

Table 1: Species List and Relative Abundance

Common Name	Binomial Nomenclature	Bird Banding Laboratory (BBL) Code	Total Individuals Observed		Percent Relative Abundance	
			Spring	Fall	Spring	Fall
Accipiter spp. (small)	(n/a)	(n/a)	2	23	0.45%	2.35%
American Kestrel	*Falco sparverius*	AMKE	1	0	0.23%	0.00%
Bald eagle	*Haliaeetus leucocephelus*	BAEA	3	11	0.68%	1.12%
Broad-winged hawk	*Buteo platypterus*	BWHA	77	689	17.46%	70.45%
Buteo spp.	(n/a)	(n/a)	30	22	6.80%	2.25%
Cooper's hawk	*Accipiter cooperii*	COHA	3	15	0.68%	1.53%
Falcon spp.	(n/a)	(n/a)	1	1	0.23%	0.10%
Golden eagle	*Aquila chrysaetos*	GOEA	0	3	0.00%	0.31%
Merlin	*Falco columbarius*	MERL	0	3	0.00%	0.31%
Northern Goshawk	*Accipiter gentilis*	NOGO	1	0	0.23%	0.00%
Northern Harrier	*Circus cyaneus*	NOHA	5	0	1.13%	0.00%
Osprey	*Pandion haliaetus*	OSPY	5	5	1.13%	0.51%
Peregrine Falcon	*Falco peregrinus*	PEFA	1	0	0.23%	0.00%
Raptor spp.	(n/a)	(n/a)	13	48	2.95%	4.91%
Red-shouldered hawk	*Buteo lineatus*	RSHA	0	1	0.00%	0.10%
Red-tailed hawk	*Buteo jamaicensis*	RTHA	60	75	13.61%	7.67%
Sharp-shinned hawk	*Accipiter striatus*	SSHA	2	19	0.45%	1.94%
Turkey vulture	*Cathartes aura*	TUVU	237	63	53.74%	6.44%
		TOTAL	441	978		

3.3 Passage Rate

An assessment of diurnal movement trends was performed by comparing passage rates during specific one-hour time brackets across the survey dates. Typically, migration activity is expected to peak between 10:00 AM and 2:00 PM. Spring and fall daily passage rates, in terms of raptors observed per hour of effort, are illustrated on Chart 1. Diurnal passage trends, in terms of raptors recorded per specific hour bracket, are illustrated in Chart 2. Section 3.3.1 provides a discussion of how passage rates at the study site compare to other contemporary regional data.

Spring

The spring raptor migration survey for the proposed Antrim Wind Energy Project involved 65 total hours of observation. A total of 441 raptors (including turkey vultures) were recorded during this effort. This constitutes an overall passage rate was 6.78 raptors per hour of effort (441/65 = 6.78).

As expected, passage rates followed a temporal curve, with peak rates recorded in mid- to late April. Passage rates ranged from approximately 2 raptors per hour of effort (in late March) to 14.25 raptors per hour of effort in mid-April. See Chart 1.

In the spring, no diurnal trend of peak passage was demonstrated. This may be attributable, in part, to the influence of a high abundance of turkey vultures, which was consistent over the course of survey, and during daily survey periods. See Chart 2.

Fall

The fall raptor migration survey for the proposed Antrim Wind Energy Project involved 147.5 total hours of observation. A total of 978 raptors (including turkey vultures) were recorded during this effort. This constitutes an overall passage rate was 6.63 raptors per hour of effort (978/147.5 = 6.63).

As expected, passage rates followed a temporal curve, with peak rates recorded in mid-September. This peak is consistent with the period of concentrated migration of broad winged hawks. Following the passage of broad winged hawks, passage rates dropped sharply, then dwindled steadily to a plateau of less than 1.73 raptors per hour of effort (with a range of 0 to 1.73) in late October through mid-November. See Chart 1.

In general, a diurnal peak of passage was demonstrated between 10:00 AM and 12:00 PM. An exception occurred on September 18, when 405 broad-winged hawks passed in kettles between 3:00 and 4:00 PM; this pulse is evident in the 15:00 (3:00 PM) hour bracket, illustrated on Chart 2.

Chart 1: Daily Passage Rate of Migrating Raptors (Raptors/Hour of Effort)

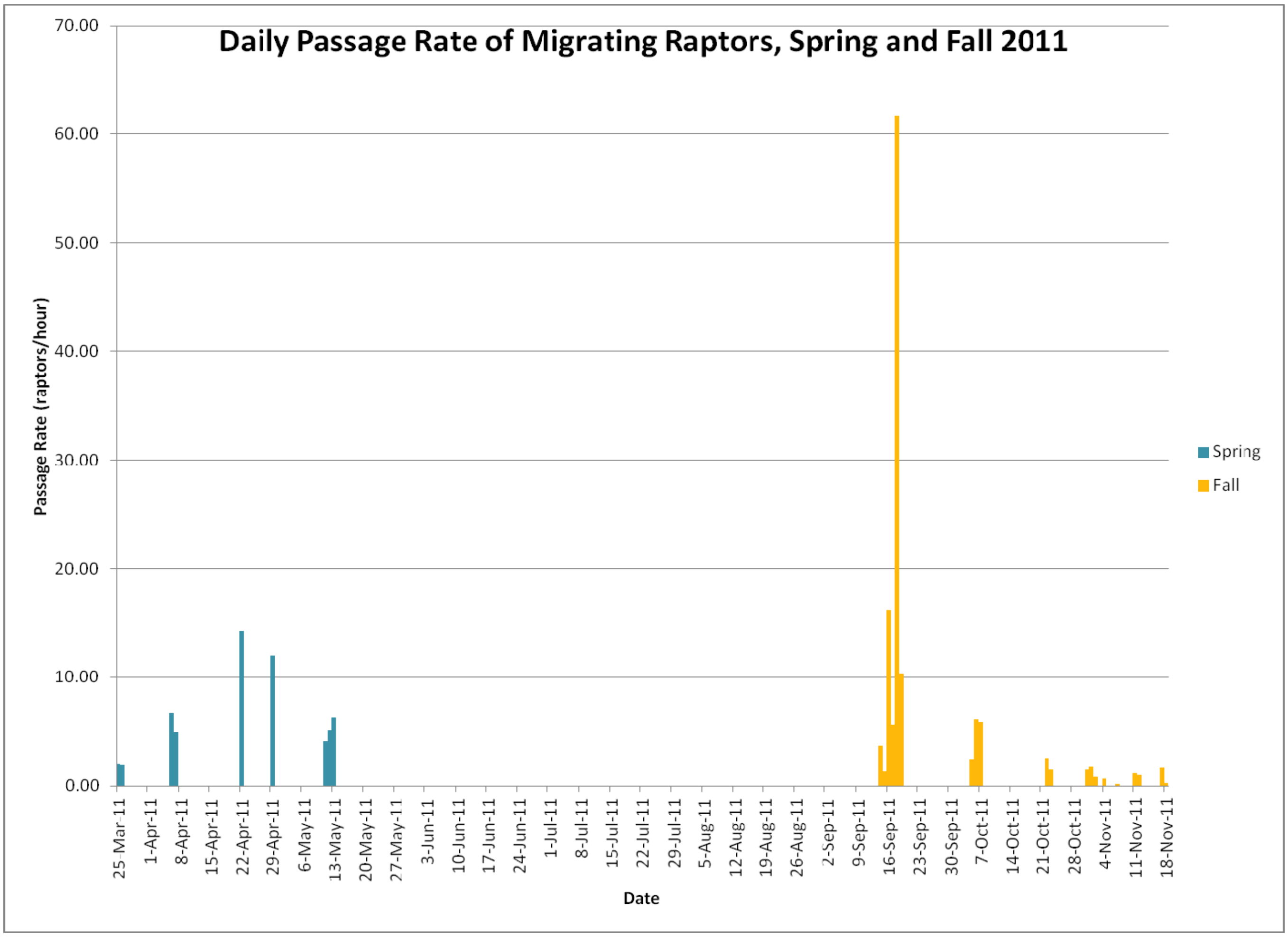
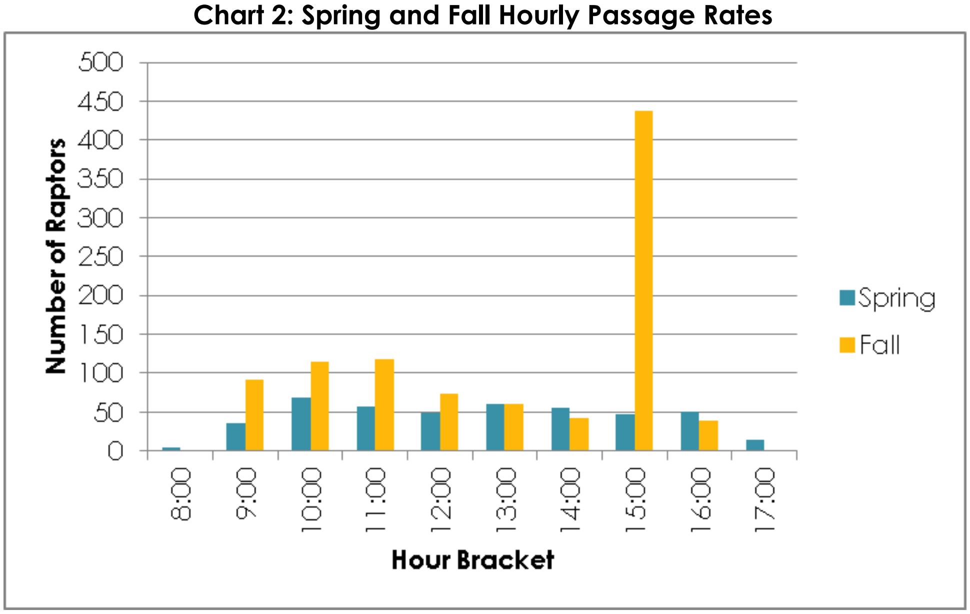


Chart 2: Spring and Fall Hourly Passage Rates



3.3.1 *Comparison of Passage Rates with Regional Hawk Watches*

Passage rates recorded for the Project area were compared to data from the five most comparable (in terms of proximity and geographic similarity) hawk watch sites for which data was available across the same sampling period. Many New England hawkwatch sites collect data only in fall; for this reason, the most proximal sites for comparison differ in spring and fall, with fall sites generally being more geographically similar and proximal the Project site.

Variations in count efficiency may occur between sites due to differences in location, topography, weather, climate, range of view, observer efficiency and etc. Also, some hawk counts do not enumerate individuals that are believed to be residents; at Antrim in 2011, *all* raptors observed (including probable residents) were recorded, providing a higher estimate of passage. Also, many hawkwatches record at least some hours of observation on poor weather days, with little or no migratory movement. This brings the overall average seasonal passage rate for a given site down. At Antrim, efforts were made to collect data only during weather conditions that are conducive to migration, thus providing an average passage rate which is more reflective of peak passage days, than of the entire season. Such variables should be considered when interpreting these data.

Daily raptor migration survey data for comparison sites were obtained from the HMNA website at hawkcount.org, and are summarized in Table 3.

Spring

Spring daily passage rates in the vicinity of the proposed Antrim Wind Energy Project were compared to concurrent spring 2011 data from five northeastern hawk count sites, including: Bradbury Mountain, in Maine; Barre Falls and Plum Island, in Massachusetts; and Allegheny Front and Hawk Mountain, in Pennsylvania. These were the five closest and/or most comparable hawkwatch sites in the region which had available data for the spring of 2011.

The spring average passage rate at Antrim (6.78 raptors per hour of effort) is similar to the spring average of 5.78 raptors per hour of effort among five regional hawk watch sites. The spring maximum of 14.25 raptors per hour of effort at Antrim is well below the regional maximum of 49.08. Spring comparative data are illustrated on Chart 3.

Fall

Fall daily passage rates in the vicinity of the proposed Antrim Wind Energy Project were compared to concurrent fall 2011 data from five northeastern hawk count sites, including: Pack Monadnock and Carter Hill, in New Hampshire; Barre Falls and Blueberry Hill, in Massachusetts; and Putney Mountain, in Vermont. These were the five closest and/or most comparable hawkwatch sites in the region which had available data for the fall of 2011.

The fall average of 6.63 raptors per hour of effort at Antrim is well below the regional average of 21.83; likewise, the fall maximum of 61.75 raptors per hour of effort is significantly lower than the regional max of 730 raptors per hour of effort. Fall comparative data are illustrated on Chart 4.

Table 3: Daily Passage Rates for Regional Hawk Watch Sites, 2011

SPRING 2011

DATE	Antrim, NH	Barre Falls, Barre, MASS	Hawk Mountain, Kempton, PENN	Plum Island, Newberry-port, MASS	Bradbury Mountain, Pownal, ME	Allegheny Front, Central City, PENN
3/1/2011						2.00
3/2/2011						0.77
3/3/2011						2.78
3/4/2011						6.35
3/5/2011						4.20
3/6/2011						
3/7/2011						0.17
3/8/2011			21.00			5.43
3/9/2011						2.00
3/10/2011						
3/11/2011						
3/12/2011		5.20				1.86
3/13/2011						0.62
3/14/2011						10.27
3/15/2011					6.00	7.73
3/16/2011					0.44	0.17
3/17/2011		2.00			2.75	1.71
3/18/2011					3.13	1.76
3/19/2011		2.80			1.50	2.93
3/20/2011					4.13	9.22
3/21/2011					2.50	0.62
3/22/2011					0.13	2.13
3/23/2011					3.50	
3/24/2011					0.67	0.67
3/25/2011	2.00	4.22			2.13	
3/26/2011	1.88	1.50			1.38	1.60
3/27/2011					2.00	1.00
3/28/2011			1.20		1.50	0.67
3/29/2011		0.29			1.88	0.40
3/30/2011		3.40			5.00	0.00
3/31/2011					3.75	
4/1/2011						
4/2/2011		9.40	2.07		1.00	
4/3/2011		3.75	0.80		1.38	0.86
4/4/2011			1.75		1.33	4.67
4/5/2011			11.71			
4/6/2011	6.75	7.78	6.74	46.82	3.25	0.73
4/7/2011	5.00		2.88		11.00	4.89
4/8/2011		2.00	0.00	0.31	5.88	
4/9/2011		2.67	4.13	0.75	11.52	
4/10/2011		1.33	1.43		9.00	28.10
4/11/2011			7.11	0.00	5.50	3.86
4/12/2011				6.55	4.88	0.00
4/13/2011					1.90	
4/14/2011		6.50	14.34	2.35	0.75	5.56
4/15/2011		36.83	5.33		3.13	25.38
4/16/2011		8.40	0.00		6.00	
4/17/2011			27.71	19.57	7.54	1.54
4/18/2011		38.55	2.50	42.40	25.13	7.20
4/19/2011			0.00		4.63	
4/20/2011					0.21	0.53
4/21/2011		28.67	6.08	49.08	2.25	3.33
4/22/2011	14.25	26.17	3.00		14.91	
4/23/2011					7.69	0.40
4/24/2011		11.78	7.57	22.40	24.63	1.71
4/25/2011			7.83		5.88	1.86
4/26/2011			9.50		0.00	2.36
4/27/2011			0.42	8.20	38.14	0.43
4/28/2011				0.89	23.87	1.25
4/29/2011	12.00	2.20	1.12	0.41	12.25	
4/30/2011		2.57	0.43	2.67	2.50	4.59
5/1/2011		2.00	0.29		2.00	1.07
5/2/2011			0.00		5.45	6.73
5/3/2011			1.50		4.63	6.00
5/4/2011					0.25	0.00
5/5/2011			0.44		6.51	0.00
5/6/2011			1.12	18.00	3.59	0.31
5/7/2011			0.73		1.00	0.00
5/8/2011			0.14		0.00	
5/9/2011			0.00		0.00	
5/10/2011			0.16		0.27	
5/11/2011	4.13		1.33		0.13	
5/12/2011	5.13		0.38		7.50	
5/13/2011	6.29		0.00		2.53	
5/14/2011			0.00			
5/15/2011						
Min	**1.88**	**0.29**	**0.00**	**0.00**	**0.00**	**0.00**
Max	**14.25**	**38.55**	**27.71**	**49.08**	**38.14**	**28.10**
Average	**6.38**	**9.13**	**3.92**	**14.69**	**5.39**	**3.47**
					Overall Min	***0.00***
					Overall Max	***49.08***
					Overall Average	***5.78***

Fall 2011

Date	Antrim, NH	Pack Monadnock, Peterborough, NH	Carter Hill, Concord, NH	Barre Falls, Barre, MASS	Putney Mt, Putney, VT	Blueberry Hill, Granville, MASS
1-Sep		3.88	5.00		1.20	0.76
2-Sep		2.38	3.43		0.46	3.00
3-Sep		1.11	2.33		1.69	0.67
4-Sep		0.15	1.57		0.00	0.67
5-Sep		0.43	0.50		0.50	0.80
6-Sep		1.05	2.83		2.32	
7-Sep			3.25			
8-Sep		0.67	8.50		0.00	0.63
9-Sep		16.48	6.88	5.20	12.19	13.00
10-Sep		76.59	15.89	50.88	22.60	11.25
11-Sep		65.58	33.22	21.60	49.94	6.75
12-Sep		12.29	10.67	4.22	31.43	7.88
13-Sep		3.25	2.14		36.89	4.40
14-Sep	3.63	2.50	3.13	1.78	22.26	6.63
15-Sep	1.38	4.76	11.60		2.25	32.84
16-Sep	16.13	64.46	14.86	96.12	86.42	82.94
17-Sep	5.63	383.47	59.00	594.13	55.31	133.37
18-Sep	61.75	542.56	730.00	12.00	98.11	113.67
19-Sep	10.38	108.25	197.44	4.80	36.57	5.10
20-Sep			0.44			
21-Sep		16.46	69.43	2.67	2.79	2.71
22-Sep		0.57	2.00			
23-Sep		1.17	4.00		2.91	
24-Sep		2.71			4.67	5.20
25-Sep		23.06	13.00	9.73	43.24	18.77
26-Sep		63.88	18.83	24.67	4.38	18.62
27-Sep		21.82	3.57	39.41	9.14	21.09
28-Sep		21.30	21.78	12.80	15.63	14.00
29-Sep						
30-Sep		6.88		3.67	1.43	6.71
1-Oct						
2-Oct		0.00				
3-Oct		7.43			2.40	1.38
4-Oct						
5-Oct	2.44	8.13	4.75	23.33	22.56	9.49
6-Oct	6.13	6.18	3.38	24.50	12.94	13.00
7-Oct	5.86	12.13	5.13	24.00	3.08	5.65
8-Oct		4.50	5.00	17.60	5.60	3.88
9-Oct		2.97	2.57	4.50	7.76	4.47
10-Oct		6.00	3.13		7.23	6.06
11-Oct		14.45	9.00	8.44	10.57	8.40
12-Oct		13.63	4.33	10.55	9.47	5.17
13-Oct						
14-Oct						
15-Oct		1.50	0.50	2.22	5.63	3.25
16-Oct		1.50	3.60	3.27	16.94	8.33
17-Oct		2.38	3.17	13.00	19.10	7.63
18-Oct		3.07	3.50		8.39	6.84
19-Oct		3.14	2.50		4.55	
20-Oct			2.00		0.67	5.87
21-Oct		4.38	3.00	22.80	14.13	11.87
22-Oct	2.53	9.88		17.80	10.82	16.20
23-Oct	1.50	7.75		16.55	11.29	5.33
24-Oct		5.86		17.56	2.34	2.78
25-Oct		6.06		24.92	18.12	9.38
26-Oct						
27-Oct						
28-Oct		6.13		30.52	39.18	19.07
29-Oct		3.50			2.00	
30-Oct						
31-Oct	1.50	12.50		18.75		
1-Nov	1.73			8.20	1.00	
2-Nov	0.86			4.25		2.40
3-Nov					0.00	0.67
4-Nov	0.71			5.40	7.64	2.33
5-Nov				4.50	1.25	0.57
6-Nov					0.75	
7-Nov	0.17					2.96
8-Nov	0.00					0.00
9-Nov						0.70
10-Nov					0.00	
11-Nov	1.20			0.29	2.92	2.00
12-Nov	1.00			1.11		
13-Nov						0.67
14-Nov						0.00
15-Nov						
16-Nov						
17-Nov	1.69					
18-Nov	0.25					
19-Nov						
20-Nov						
Min	**0.00**	**0.00**	**0.44**	**0.29**	**0.00**	**0.00**
Max	**61.75**	**542.56**	**730.00**	**594.13**	**98.11**	**133.37**
Average	**6.02**	**31.81**	**30.97**	**31.26**	**14.41**	**12.55**
					Overall Min	***0.00***
					Overall Max	***730.00***
					Overall Average	***21.83***

Chart 3: Spring Comparative Passage Rates

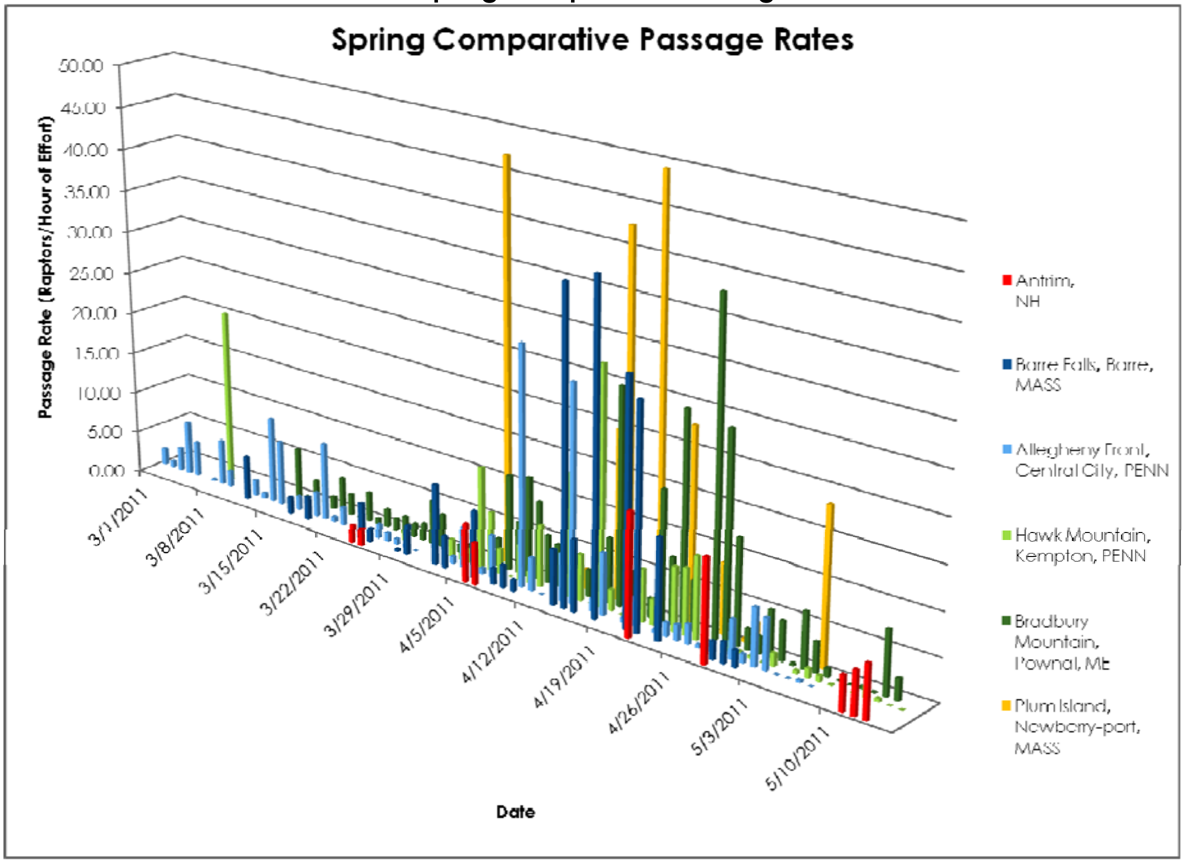
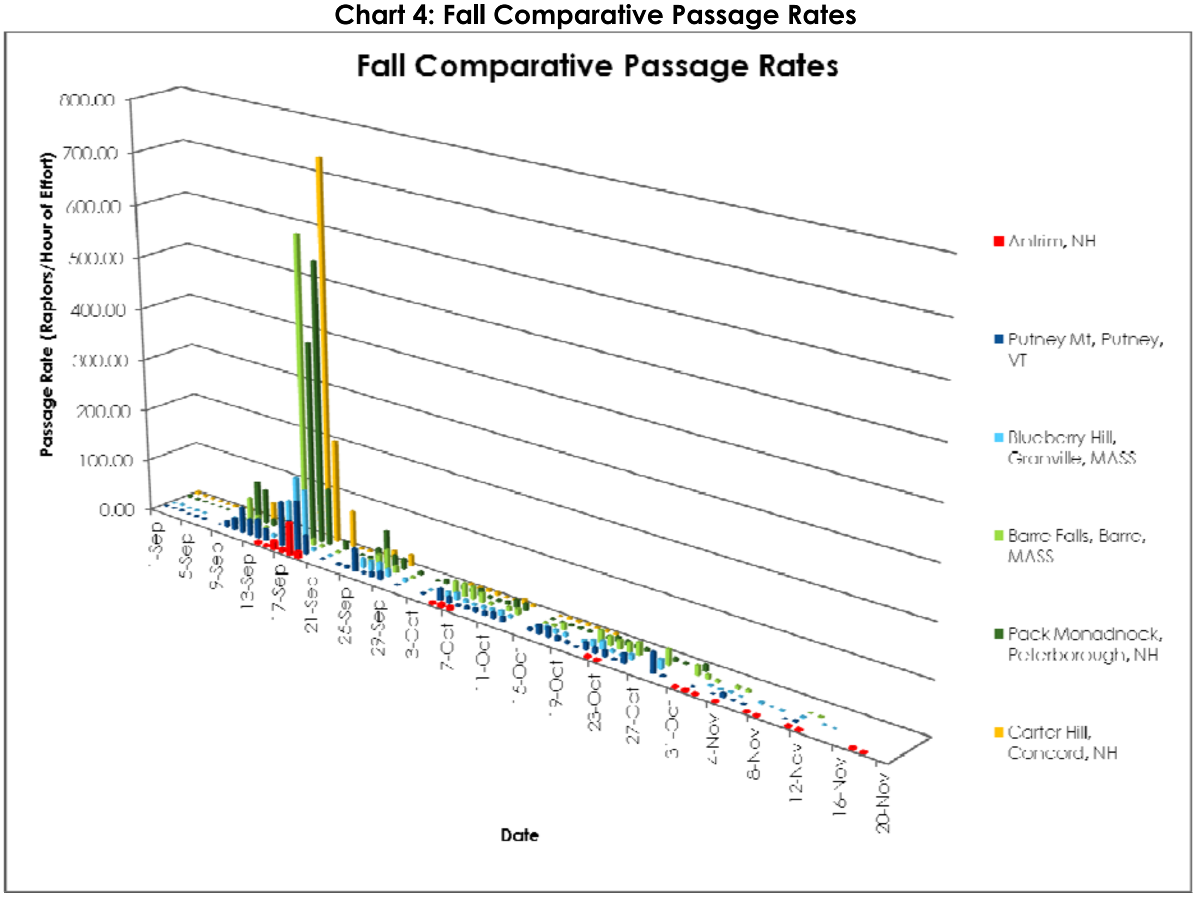


Chart 4: Fall Comparative Passage Rates



3.4 Flight Characteristics

3.4.1 Flight Position

Spring

The most frequently recorded flight position category in spring was “upper slope”, with 248 raptors (56% of all raptors recorded) using this area during their recorded flight path. The next most frequently recorded categories were “over ridge” and “valley”, with 105 raptors recorded (24% of all raptors recorded) per category. A total of 57% (250 out of 441) of all raptors recorded used the ridge (either generally, parallel, perpendicularly or in a saddle) at some point during their recorded flight path. See Table 4.

Fall

The most frequently recorded flight position category in fall was “valley”, with 523 (53%) of all raptors recorded (n=978) using the valley during their recorded flight. The next most frequently assigned categories were “parallel to ridge”, and “upper slope” with 230 (24%) and 228 (23%) raptors, respectively, using these areas. A total of 458 (47% of 978 total raptors recorded) used the ridge (either generally, parallel, perpendicularly or in a saddle) at some point during their recorded flight path. See Table 4. A frequently observed flight pattern observed in fall was: raptors approaching from the north or northeast tended to follow the north face or the ridgeline of the Tuttle Hill ridge landform from the point at which they encountered it, southwestward along the landform’s orientation.

Table 4: Flight Positions by species

HORIZONTAL POSITION

Species	Horizontal Position													
	Over Ridge		Paralell to Ridge		Perpen- dicular to Ridge		Through Saddle		Upper Slope		Lower Slope		Valley	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Accipiter spp. (small)	0	3	1	3	0	1	1	7	0	12	0	6	0	2
American Kestrel	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Bald Eagle	0	1	0	3	3	3	0	2	0	3	0	2	1	3
Broad-winged hawk	13	26	21	180	12	45	1	8	32	75	8	114	20	469
Buteo spp.	7	3	4	4	6	0	0	0	15	10	2	5	1	11
Cooper's hawk	0	1	0	0	0	4	0	1	1	12	1	3	2	0
Falcon spp.	0	0	0	1	0	0	0	0	1	0	1	0	0	0
Golden eagle	0	0	0	0	0	1	0	1	0	2	0	1	0	1
Merlin	0	0	0	0	0	2	0	1	0	2	0	0	0	0
Northern Goshawk	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Northern Harrier	2	0	0	0	0	0	0	0	1	0	1	0	2	0
Osprey	0	0	0	0	0	1	1	1	4	3	1	2	2	3
Peregrine falcon	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Raptor spp.	6	3	0	12	3	5	1	4	8	21	2	9	1	17
Red-shouldered hawk	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Red-tailed hawk	9	17	7	14	13	17	2	18	25	43	8	7	17	2
Sharp-shinned hawk	0	6	0	0	1	3	0	5	0	15	0	3	1	0
Turkey vulture	68	10	22	13	31	4	15	24	160	29	57	14	56	15
TOTAL SPRING	**105**		**55**		**69**		**21**		**248**		**83**		**105**	
% of birds (n=441)	**24%**		**12%**		**16%**		**5%**		**56%**		**19%**		**24%**	
total ridge flights	**250**													
% of birds using ridge	**57%**													
TOTAL FALL		**70**		**230**		**86**		**72**		**228**		**166**		**523**
% of birds (n=978)		**7%**		**24%**		**9%**		**7%**		**23%**		**17%**		**53%**
total ridge flights	**458**													
% of birds using ridge	**47%**													

3.4.2 Flight Height

Flight height was estimated for all raptors which were judged to have flown within (or very near) the area of potential development. This area was conservatively estimated based on available development plans to date, but generally included the airspace over ridgeline and upper slope areas. Of all raptors recorded in 2011, 52% of them (n=741) never flew within the area of potential development. See Table 5.

Spring

Of 441 total raptors observed in spring 2011, 216 (49%) passed within the area of potential development (as conservatively estimated based on development plans to date). Of the raptors that did fly within the area of potential development (n=216), 162 of them (or 37% of all raptors observed) were judged to have flown within the 50-500-foot above ground range. Of the 162 raptors that flew within this range, 108 of them were turkey vultures. See Table 5.

Fall

Of 978 total raptors observed in fall 2011, 460 of them (47%) were observed to pass within the area of potential development. Of the raptors that did fly within the area of potential development (n=460), 296 of them (30% of all raptors recorded) were judged to have flown within the 50-500-foot above ground range. Of the 296 raptors that flew within this range, 168 of them were broad-winged hawks; 104 of these passed in kettles on the single date of September 18. See Table 5.

Table 5: Flight Height Categories

Species	Outside of Wind Resource Area		0-50 feet		50-500 feet		500+ feet	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Accipiter (small) sp.	0	4	0	14	2	4	0	1
American Kestrel	1	0	0	0	0	0	0	0
Bald eagle	1	6	0	1	2	4	0	0
Broad-winged hawk	29	461	5	20	25	168	19	40
Buteo sp.	21	14	1	3	8	5	0	0
Cooper's hawk	3	0	0	11	0	4	0	0
Falcon sp.	1	0	0	0	0	1	0	0
Golden eagle	0	1	0	0	0	2	0	0
Lg. Raptor Sp.	0	0	0	0	0	0	2	0
Merlin	0	0	0	2	0	1	0	0
Northern Goshawk	1	0	0	0	0	0	0	0
Northern Harrier	3	0	0	0	2	0	0	0
Osprey	5	1	0	1	0	3	0	0
Peregrine Falcon	1	0	0	0	0	0	0	0
Raptor sp.	7	18	1	15	1	12	2	3
Red-shouldered hawk	0	0	0	0	0	1	0	0
Red-tailed hawk	31	4	6	17	17	52	6	2
Sharp-shinned hawk	1	2	0	11	0	6	1	0
Turkey vulture	118	7	10	20	108	34	1	2
Seasonal Zone Totals	***223***	***518***	***23***	***115***	***165***	***297***	***31***	***48***
Overall Zone Totals	***741***		***138***		***462***		***79***	
% of Seasonal Total	***50%***	***53%***	***5%***	***12%***	***37%***	***30%***	***7%***	***5%***
% of 2011 Total	***52%***		***10%***		***33%***		***6%***	

3.4.3 Flight Direction

Spring

Spring flight directions were generally variable. Of 441 total raptors recorded, flight direction was recorded as "variable" for 181 of them. Flight direction for the remaining 253 raptors recorded in Spring 2011 are illustrated on Chart 5. As illustrated, most raptors with a specific recorded flight direction trended north or northeast, however, several raptors were recorded flying in other directions, particularly south and west.

Fall

In fall, 99 raptors were recorded as having "variable" flight patterns. The remaining 879 raptors showed a strong trend of southwestward flight. This trend is illustrated on Chart 6.

Chart 5: Spring Flight Directions

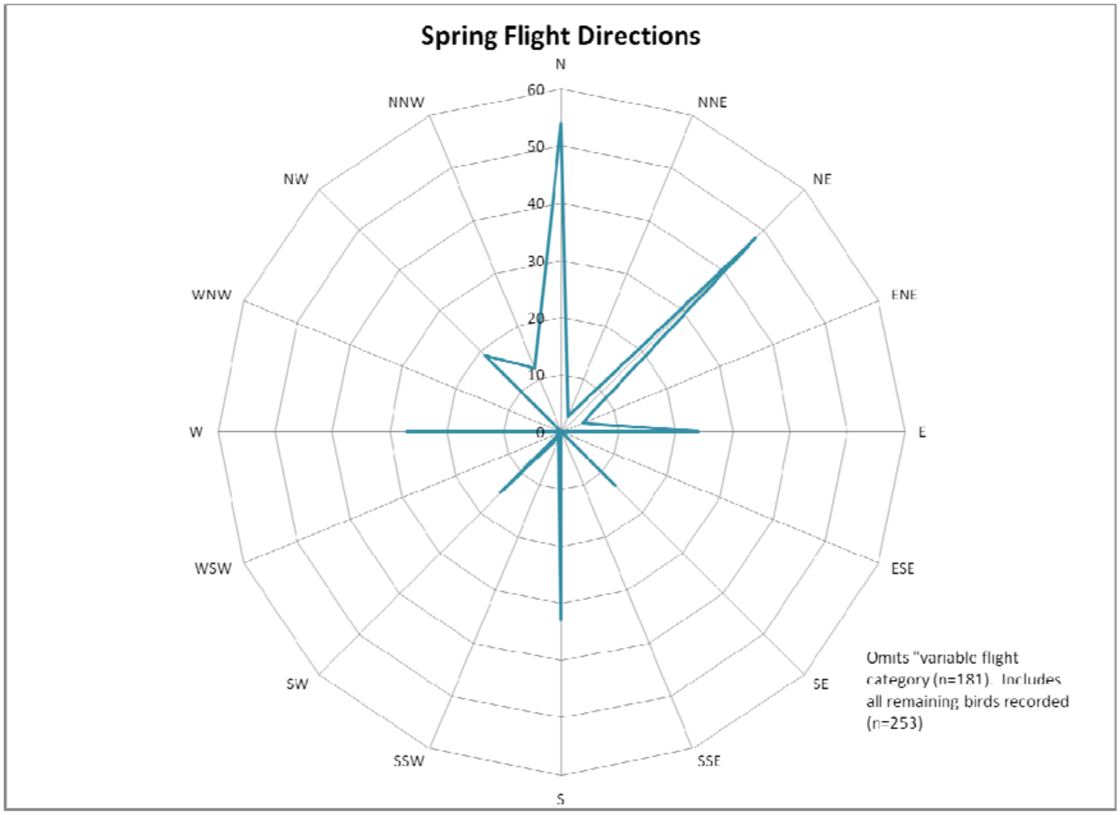
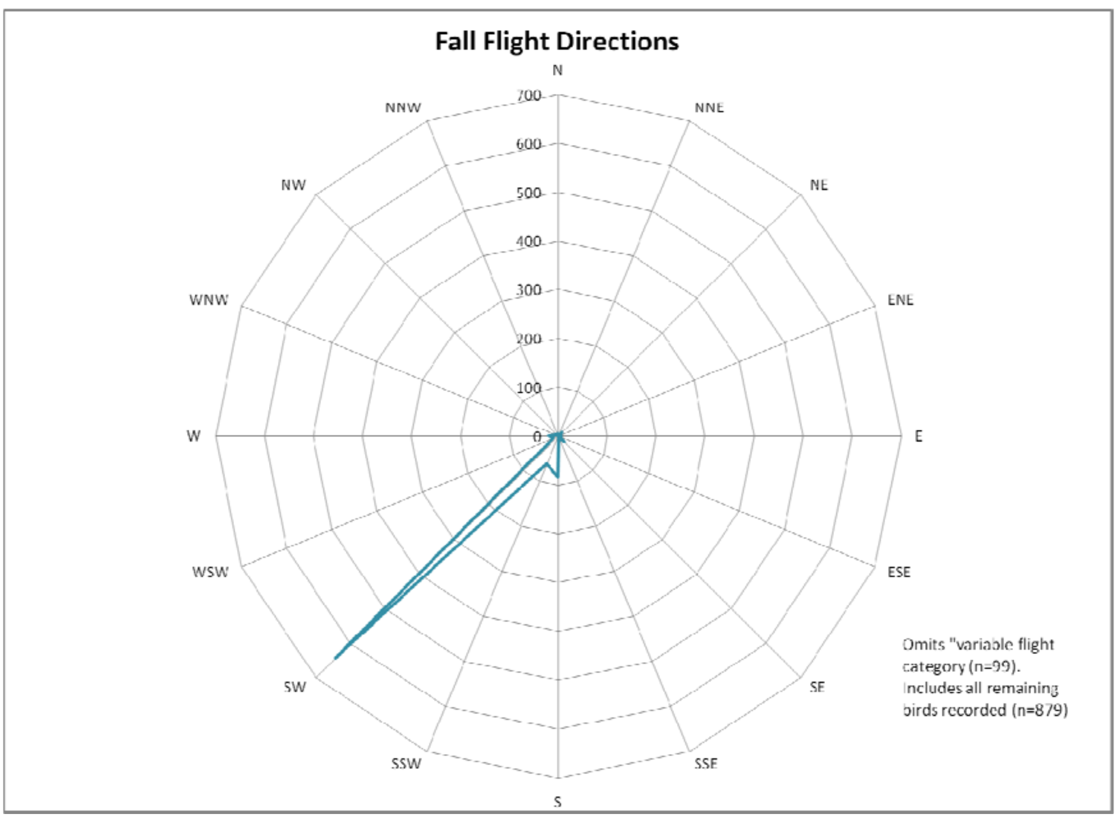


Chart 6: Fall Flight Directions



3.5 Listed Species Flight Details

Threatened or Endangered raptor species that were observed during spring and fall migration surveys for the proposed Antrim Wind Energy Project include:

- bald eagle (State Threatened);
- golden eagle (State Endangered);
- peregrine falcon (State Threatened); and
- northern harrier (State Endangered).

A total of 14 bald eagles were recorded (3 in spring and 11 in fall); 7 of these never flew within the proposed Project area. Of those bald eagles that did fly within the proposed Project area (n=7), 6 were judged to have passed within the 50-500 foot above-ground range.

A total of 3 golden eagles were observed in the fall of 2011; one of these never flew within the proposed Project area. The remaining 2 golden eagles were judged to have passed within the 50-500 foot above-ground range within the proposed Project area.

The single peregrine falcon that was observed in the spring of 2011 did not pass within the proposed Project area. Northern Harriers were documented on 5 occasions in the spring of 2011; three of these never flew within the proposed Project area, while 2 (a male and female together) were judged to have passed within the 50-500 foot above-ground range.

In addition to the threatened and endangered species listed above, three state listed species of special concern were also observed; these are American kestrel, northern goshawk, and osprey. One American kestrel was observed in the spring: it did not fly within the proposed Project area. One northern goshawk was also observed in the spring: it did not fly within the proposed Project area. Ten total osprey were observed (5 in the spring and 5 in the fall). None of the 5 osprey recorded in the spring flew within the proposed Project area. In the fall, one osprey did not fly within the proposed Project area, one flew in the 0-50-foot above ground range, and 3 were judged to have passed within the 50-500 foot above-ground range.

3.6 Discussion

The species assemblage, relative abundance, and passage parameters documented by this study were as expected for southern New Hampshire. Comparison with concurrent regional hawkwatch data found that spring passage rates at Antrim are similar to other regional locations. Fall maximum (61.75 raptors per hour of effort) and average (6.02 raptors per hour of effort) passage rates for the Project were significantly lower than those observed among comparative sites (which had an overall maximum of 730 raptors per hour of effort and an overall average of 21.83 raptors per hour of effort). These results suggest that passage rates at the proposed Project site are similar to the surrounding region, and that the site does not occur in a significant or unique flight corridor.

Bird mortality documented at operational wind facilities in New England is low. Avian mortality documented during post-construction studies (conducted between 2006 and 2010) at ten wind facilities in New England and New York is considered low, with a total of 528 avian fatalities (not corrected for searcher or removal biases) documented among all ten facilities. The majority of these fatalities were passerines (n=389). In general, the majority of avian collision at existing wind projects tends to occur during spring and fall migration, and appears to involve nocturnally migrating songbirds. Only 20 total raptor mortalities were documented during the above mentioned studies; 10 of these were red-tailed hawks, which are among the bird species most frequently found during fatality search studies in New England and New York. (Costa 2011). It should be noted, that one of the facilities included in the above study is the Lempster Wind Project, which is located approximately 13 miles to the northwest of the proposed Antrim Wind Energy Project.

Recent studies have shown that there is little correlation between pre-construction risk assessments and actual documented mortality of avian species at wind farms (Ferrer et al. 2011, de Lucas et al. 2008, Sharp et al. 2011). As such, it is difficult to predict expected mortality rates at a proposed facility. With this in mind, based on data collected at the Project site, coupled with observations at operational wind projects in the region, bird collisions (in general, and particularly for raptor species) at the Antrim Wind Energy Project are expected to occur at a low frequency. Overall, impacts to diurnally migrating raptors are expected to be very low, and are not expected to occur at a degree which would adversely affect populations.

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APPENDIX A

DATA FORM AND INSTRUCTIONS

Daytime Migrant Survey Data Sheet			
Observers:	Date:	Time Start:	Time End:

Weather (see reverse for instructions)		**Location:**
wind speed:	bar. press:	
wind direction:	cloud cover:	
temp (C):	visibility:	
humidity:	precipitation:	

ID	Species	#	Age	Gender	Time of Observation		Flight	Flight Height Code	Behavior Code	Horizontal Position Code	Notes
			(J,A,U)	(M,F,U)	Start	End	Direction				
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
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16											
17											
18											
19											
20											

GENERAL INSTRUCTIONS:

For weather, enter for the first hour of observation, for following hours only if data changes, if there are no changes, draw a line from the recorded data through the hours in which no change occurred; do not use ditto marks or dashes.
For hawks, enter only the number seen (no zeros). Write notes, comments, etc. below.
Observers : Number of observers **CONTRIBUTING** to the count for the hour noted.
Duration of Observation : Specify time in minutes.

Weather Codes

Wind Speed Codes :

- 0-less than 1 km/h, (calm, smoke rises vertically)
- 1 - 1-5 km/h, (smoke drift shows wind direction)
- 2 - 6-11 km/h, (leaves rustle, wind felt on face)
- 3 - 12-19 km/h, (leaves, small twigs in constant motion; light flag extended)
- 4 - 20-28 km/h (raises dust, leaves, loose paper; small branches in motion)
- 5 - 29-38 km/h (small trees in leaf sway)
- 6 - 39-49 km/h (larger branches in motion; whistling heard in wires)
- 7 - 50-61 km/h (whole trees in motion; resistance felt walking against the wind)
- 8 - 62-74 km/h (twigs small branches broken off trees; walking generally impeded)
- 9 - Greater than 75 km/h

Wind Direction : Enter compass direction from which the wind is coming, i.e., N, NNE, SE, etc. If variable, enter VAR.
Temperature : Record temperature in degrees Celsius.
Humidity : Record the percent relative humidity.
Barometric Pressure : Record barometric pressure in inches.
Cloud Cover : Record percent of sky with background cloud cover.
Visibility : Judge from your longest view and enter distance in kilometers. To convert miles to kilometers multiply by 1.61.
Precipitation : Enter code: 0 for none, 1 for Haze or Fog, 2 for Drizzle, 3 for Rain, 4 for Thunderstorm, 5 for Snow, 6 for wind driven dust, sand or snow.

Observation Codes

Flight Direction : Enter compass direction migrants are heading, i.e., S, SSW, etc.
Flight Height Codes

- 0 - outside of turbine array area
- 1 - below rotor swept area
- 2 - within rotor swept area
- 3 - above rotor swept area
- 4 - No predominant height

Behavior Codes: So: soaring, Fl: flapping, Ci: circling, Gl: gliding, Pe: perching, Hu: Hunting
Horizontal Position Codes:

A) over ridge (A1-parallel to ridge, A2-perpendicular to ridge, A3-over saddle),
B) flight path over upper slope of ridge,
C) flight path over lower slope of ridge, and D) flight path over a valley

COMMENTS

Spring 2011 Radar and Acoustic Bat Survey Report

for the Antrim Wind Energy Project
In Antrim, New Hampshire

Prepared for

Antrim Wind Energy, LLC
155 Fleet Street
Portsmouth, NH 03801

Prepared by

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

October 2011

Executive Summary

Antrim Wind Energy, LLC is considering development of the Antrim Wind Energy Project (Project) located in Antrim, New Hampshire. The proposed Project would include wind turbines located on a series of ridgelines associated with Tuttle Hill (Figure 1). Stantec Consulting Services Inc. performed nocturnal radar surveys and acoustic bat surveys at the Project to characterize seasonal nocturnal migration and bat activity patterns at the Project. This report discusses the methods and results of the spring 2011 radar and acoustic bat surveys.

Nocturnal Radar Survey

To characterize spring nocturnal migration activity over the Project area, radar surveys were conducted on 30 nights between April 18 and May 26, 2011. Surveys were conducted from sunset to sunrise using X-band radar. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar was placed within a clearing for the meteorological (met) tower, Met Tower 1, located at the northeastern end of Tuttle Hill. This site provided adequate visibility of the surrounding airspace.

The overall mean passage rate for the entire spring survey period was 223 ± 23 targets per kilometer per hour (t/km/hr), and nightly passage rates varied from 6 ± 3 t/km/hr on May 17 to 1215 ± 299 t/km/hr on May 20. The seasonal mean flight height of targets was 305 ± 1 meters (m; 1000 ft [']) above the radar site, and nightly flight heights ranged from 135 ± 31 m to 486 ± 85 m. Mean flight direction through the Project area for the season was northeasterly at 44° ± 49°. Flight heights, when analyzed for the anticipated 150 m (492') height of the proposed turbines; indicate that the percentage of targets flying below turbine height ranged from 7 to 63 percent with a seasonal average of 30 percent.

In summary, results at the Project are within the range of results recorded at other radar studies conducted in the East, and provide a sample of baseline migration activity over the Project area during spring 2011.

Acoustic Bat Survey

Stantec conducted spring acoustic bat surveys between April 7 and June 1, 2011 to sample bat activity patterns and species composition within the Project area. Six Anabat® detectors were deployed during this period, collecting data for a total of 304 detector-nights over a period of 323 available calendar nights. Two detectors were deployed in the guy wires of an existing 60 m meteorological tower and the remaining four detectors were suspended from trees along forested corridors and adjacent to wetlands where bats would likely travel or forage.

The six detectors recorded a total of 1,483 bat call sequences yielding an overall detection rate of 4.9 bat call sequences per detector-night. Among sampling locations, detection rates ranged

from 0.1 to 14.1 bat call sequences per detector-night. Typical of this type of survey, activity levels varied considerably among nights within the survey period and among detectors.

Although bats within the *Myotis* genus comprised the greatest overall percentage of detected call sequences (32 %), most of these sequences were recorded at a single detector over only a few nights. Other species, such as hoary bats (*Lasiurus cinereus*) were detected at all six detectors, though in smaller numbers. Spring 2011 acoustic bat surveys documented variable activity levels within the Project area, although results suggest that activity increased in May relative to April.

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Figures

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Appendices

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

1.0 Introduction

1.1 PROJECT BACKGROUND

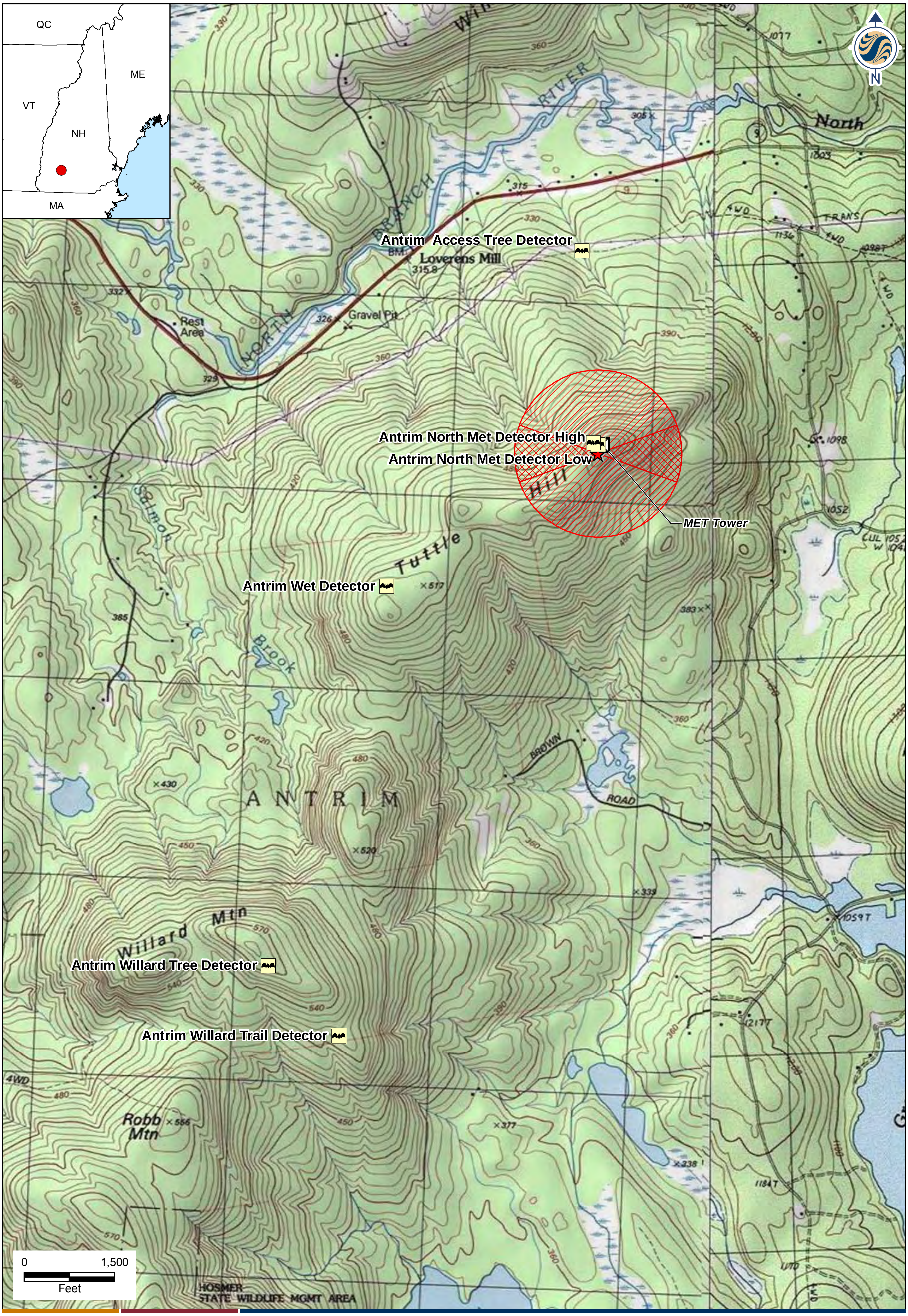
Eolian Renewable Energy (Eolian) is considering development of the Antrim Wind Energy Project (Project) located in Antrim, New Hampshire (Project; Figure 1-1). The Project is in the preliminary stages of design and the layout of Project infrastructure, including turbines and access roads, has not been determined at this time. The proposed turbines are expected to have a maximum height of 150 meters (m) (492 feet [’]).

As part of Project planning, Eolian contracted Stantec Consulting Services Inc. (Stantec) to conduct spring 2011 nocturnal radar surveys, and acoustic bat surveys. Stantec developed a work plan for the Project that described survey scopes and methodologies and presented it to the New Hampshire Department of Fish and Game and the U.S. Fish and Wildlife Service at an introductory project meeting on June 21, 2011. The scope and methodology of these surveys are consistent with several other studies conducted recently at proposed wind projects in New Hampshire and the Northeast U.S. Mist nest surveys for bats also were conducted for the Project, and the results of these surveys are presented in a separate report.

1.2 PROJECT AREA DESCRIPTION

The Project is located along the edge of the Sunapee Uplands and Worcester/Monadnock Plateau ecogregions of New England (Griffith *et al*. 2009). The Sunapee Uplands is a transition zone from the Worcester/Monadnock Plateau and the typically cooler ecoregions to the north. The mountains within the Sunapee Uplands are generally of lower elevations than those mountains to the north, but higher in elevation than those found in the Worcester/Monadnock Plateau (Griffith *et al*. 2009). The mountains and hills of the Sunapee Uplands are mostly between 305 to 610 m (1000 to 2000') in elevation, but range from 152 m (500') to more than 914 m (3000'). This ecoregion includes many streams and small lakes. Northern hardwood forests dominated by sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*) and yellow birch (*Betula alleghaniensis*) are common. Also present, but less common are eastern hemlock dominated (*Tsuga canadensis*) forests, oak (*Quercus* spp.) dominated forests, and forests dominated by spruce (*Picea* sp.) and balsam fir (*Abies balsamea*) (Griffith *et al*. 2009). The Worcester/Monadnock Plateau includes the north-central portion of Massachusetts and the south-central portion of New Hampshire. In many basic characteristics including elevation and climate this ecoregion is similar to colder and more mountainous ecoregions to the north. Elevations within this ecoregion range from 152 to 427 m (500 to 1400') with some peaks exceeding 610 m (2000'). Forested uplands include transition hardwoods such as maple-beech-birch-oak-hickory forests and northern hardwoods such as the maple-beech-birch forests (Griffith *et al*. 2009). Forested wetlands are common within the Worcester/Monadnock Plateau.

The Project area is associated with Tuttle Hill, which has an elevation of approximately 423 m (1,390’). The Project area is dominated by mixed forests with coniferous species more common along the ridge tops and deciduous species dominant along the slopes. Common tree species present include paper birch (*Betula papyrifera*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), northern red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), maple (*Acer* spp.), and eastern white pine (*Pinus strobus*). Forest management activities have occurred throughout the area in the recent past and are still ongoing. Evidence of these activities includes numerous skidder trails and stumps throughout the Project area.



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00689_1-1_SurveyLocation.mxd

Legend

- Met Tower
- Radar Survey Location
- Bat Detector Location
- Alignment Vertical Radar Sweep
- Horizontal Radar Detection Range

Client/Project
TRC Companies, Inc.
Antrim Wind Energy Project
Antrim, New Hampshire

Figure No.
1-1

Title
Survey Location Map
7/19/2011

2.0 Nocturnal Radar Survey

2.1 INTRODUCTION

Nocturnal radar surveys were conducted in the Project area to sample and characterize nocturnal migration patterns in spring 2011. The majority of North American passerines (songbirds) migrate at night. This migratory strategy may have evolved to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995); additionally, cooler nighttime temperatures may help regulate body temperature during more active, flapping flight and reduce predation risk while in flight (Alerstam 1990, Kerlinger 1995). Documenting the patterns of nocturnal migrants requires the use of radar or other non-visual technologies. The goal of the surveys was to sample and characterize nocturnal migration at the Project area including passage rate, flight direction, and flight altitude.

2.2 DATA COLLECTION METHODS

Spring radar surveys were conducted from sunset to sunrise on 30 nights between April 18 and May 26, 2011. The radar was placed within clearing for the meteorological (met) tower, Met Tower 1, located at the northeastern end of Tuttle Hill (Figures 1-1, 2-1). This site has an elevation of approximately 423 m (1,390').

Efforts were made to maximize the airspace sampled by elevating the radar antenna approximately 6 m (20') above ground level. Elevating the antenna helps to reduce the amount of the radar beam reflected back by surrounding vegetation and topography, which can cause ground clutter interference on the radar screen. The elevated radar limited ground clutter obstructions and resulted in an adequate view of the surrounding airspace.

Figure 2-1. Photo of the radar on the ridgeline of Tuttle Hill.

2.2.1 Radar Data

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

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

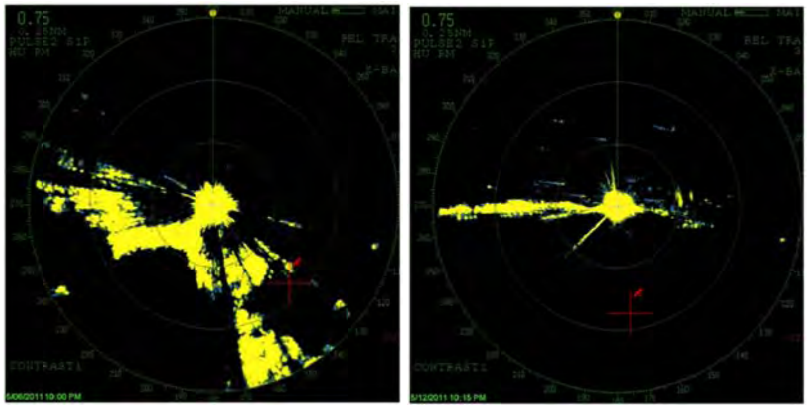

Figure 2-2. Screenshots from actual radar files showing ground clutter in horizontal mode (left) and vertical mode (right). Although the radar records three-dimensional space, it is translated by the radar screen as a two dimensional representation, which can cause targets to be obscured from view.

However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by "hiding" clutter-causing objects from the radar (Figure 2-3). These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen. Targets traveling into and out of the ground clutter areas can be tracked. The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

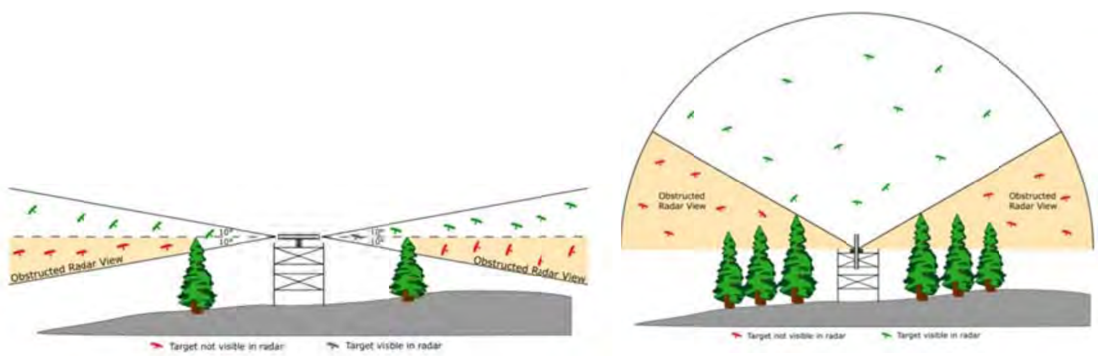

Figure 2-3. An example of a tree of a specific height that causes ground clutter, but "masks" a section of the radar beam, allowing adequate detection of targets beyond it (left). The effect of ground clutter on target detection in vertical mode is also shown (right).

The anti-rain function of the radar must be turned down to detect small songbirds and bats. Since radar surveys cannot be conducted during active rainfall, survey nights targeted nights without steady rain. To characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers, mist, or fog were sampled.

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

In vertical mode, the radar unit is tilted 90° to survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20° radar beam (Figure 2-4). .

Figure 2-4. Detection range of the radar in vertical mode.

The radar was operated at a range of 1.4 km (0.75 nautical miles) to ensure detection of small targets. When radar is operated at ranges greater than 1.4 km, the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, which limits the detection and observable movement pattern of individual targets. Consequently, 1.4 km is the appropriate detection range for this type of study.

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

2.2.2 Weather Data

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

2.3 DATA ANALYSIS METHODS

2.3.1 Radar Data

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

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

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 150 m (492'), the approximate maximum height of the proposed wind turbines with blades, was also calculated nightly and for the entire survey period.

2.3.2 Weather Data

The mean, maximum, and minimum temperature, hourly wind speed, and hourly wind direction were calculated from the onsite met tower for each night of survey.

2.4 RESULTS

Radar surveys were conducted during 30 nights between April 18 and May 26, 2011 (Appendix A Table 1) resulting in 284 total hours surveyed.

2.4.1 Passage Rates

Nightly passage rates varied from 6 ± 3 targets per kilometer per hour (t/km/hr) on May 17 to 1215 ± 299 t/km/h on May 20, and the overall passage rate for the entire survey period was 223 ± 23 t/km/hr (Figure 2-5; also Appendix A Table 1). Individual hourly passage rates varied between nights and throughout the season, and ranged from 0 t/km/hr during various hours of various nights to 2279 t/km/hr during the 7th hour of May 20 (Appendix A Table 2). For the entire season, mean passage rates increased rapidly between hours one and two after sunset, then gradually increased to the 6th hour after sunset before steadily declining until sunrise (Figure 2-6).

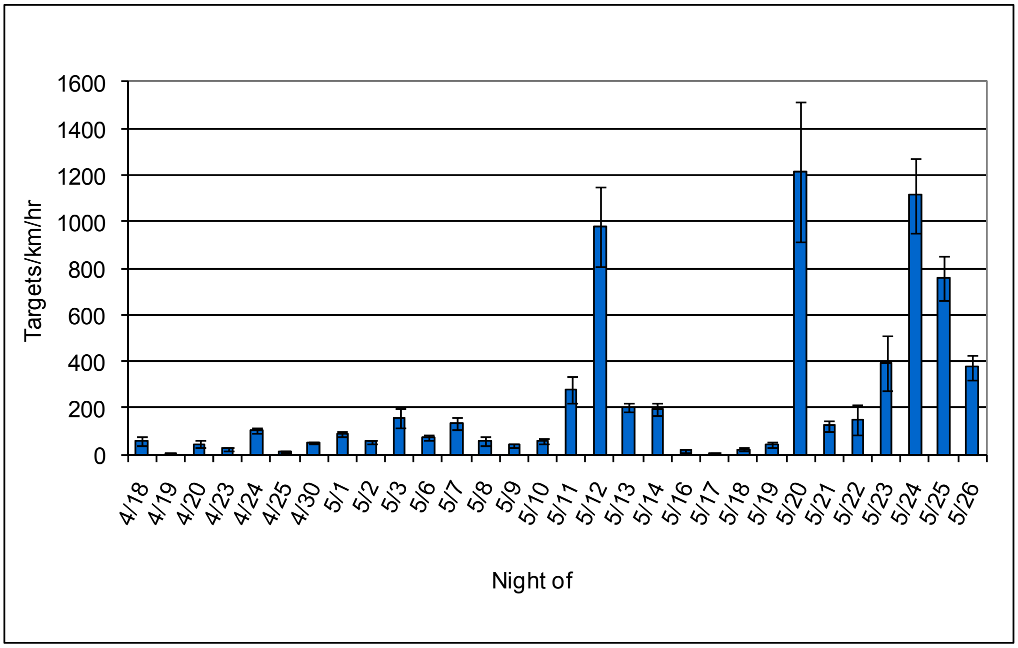

Figure 2-5. Nightly passage rates observed during spring 2011 at the Antrim Wind Project (error bars ± 1 SE).

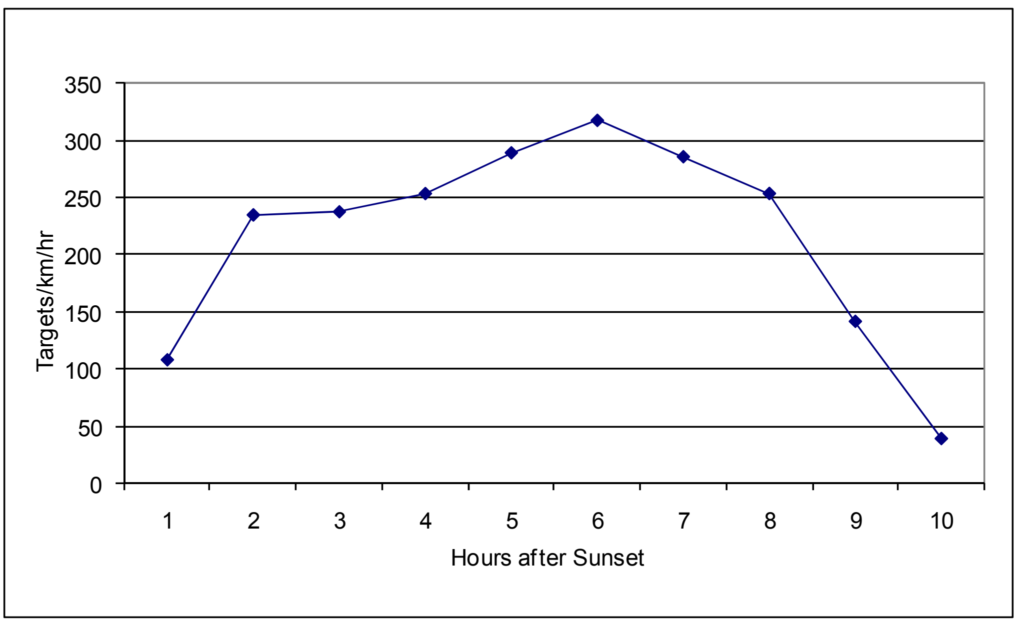

Figure 2-6. Hourly passage rates for entire season during spring 2011 at the Antrim Wind Project.

2.4.2 Flight Direction

Mean flight direction through the Project area was 44° ± 49° (Figure 2-7). Overall, the mean flight direction was northeast, but varied between nights (Appendix A Table 3).

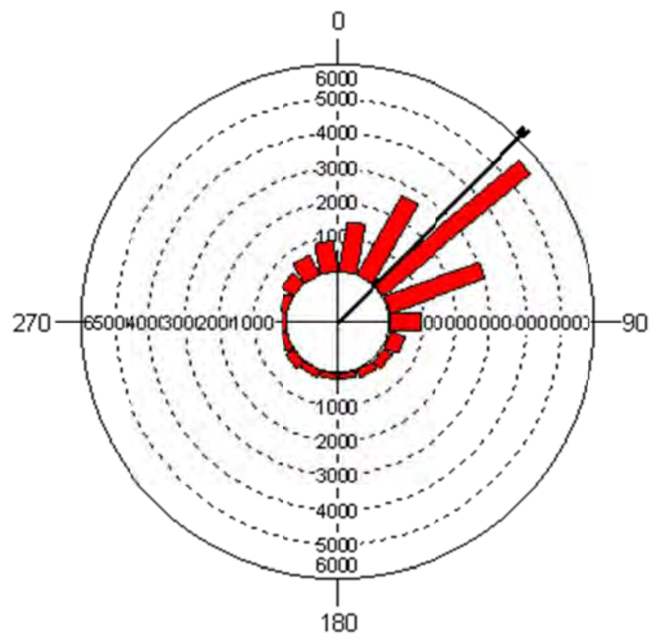

Figure 2-7. Mean flight direction for the entire season during spring 2011 at the Antrim Wind Project (the bracket along the margin of the histogram is the 95% confidence interval).

2.4.3 Flight Altitude

The seasonal mean flight height of targets was 305 ± 1 m (1000‘) above the radar site. The average nightly flight height ranged from 135 ± 31 m on May 9 to 486 ± 85 m on May 19 (Figure 2-8; Appendix A Table 4). The percent of targets observed flying below 150 m was 30 percent for the season and varied nightly from 7 percent (51 targets) on May 22 to 64 percent (253 targets) on May 7 (Figure 2-9). Figure 2-10 below shows the distribution of individual nightly flight heights of all targets recorded relative to the proposed turbine height. The yellow boxes seen in Figure 2-10 depict the middle 50 percent of targets. The error bars depict the statistical outliers, or 25 percent of targets above and below the middle 50 percent of targets. The horizontal line within each box represents the median flight height value for that night. For the entire season, the mean hourly flight heights did not vary greatly between the hours after sunset but were lowest during first and last hour after sunset (Figure 2-11).

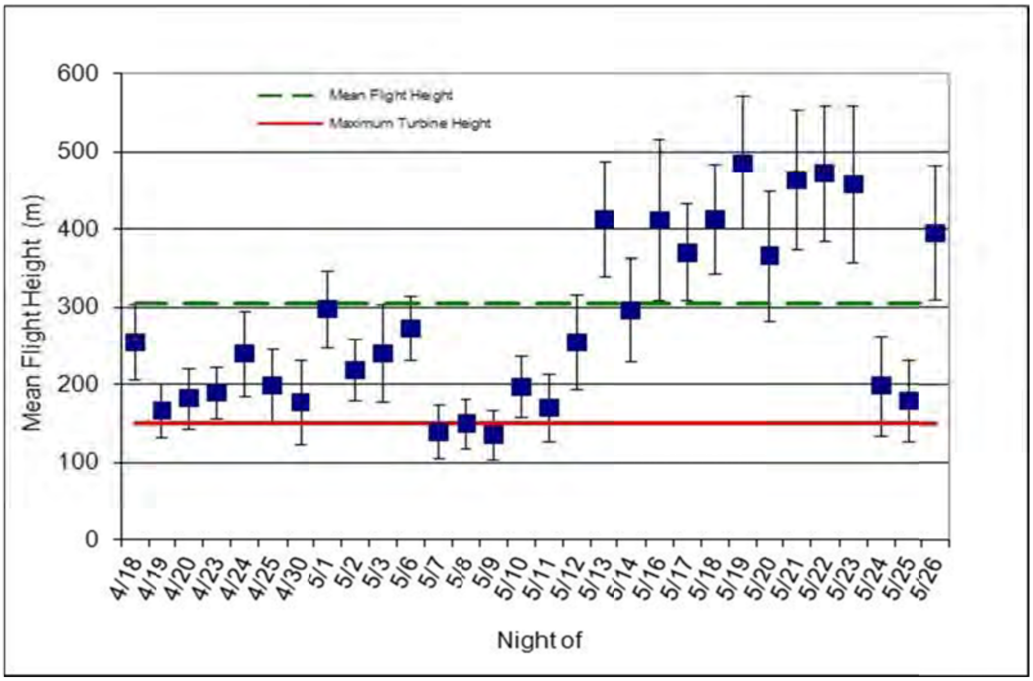

Figure 2-8. Mean nightly flight height of targets during spring 2011 at the Antrim Wind Project (error bars ± 1 SE).

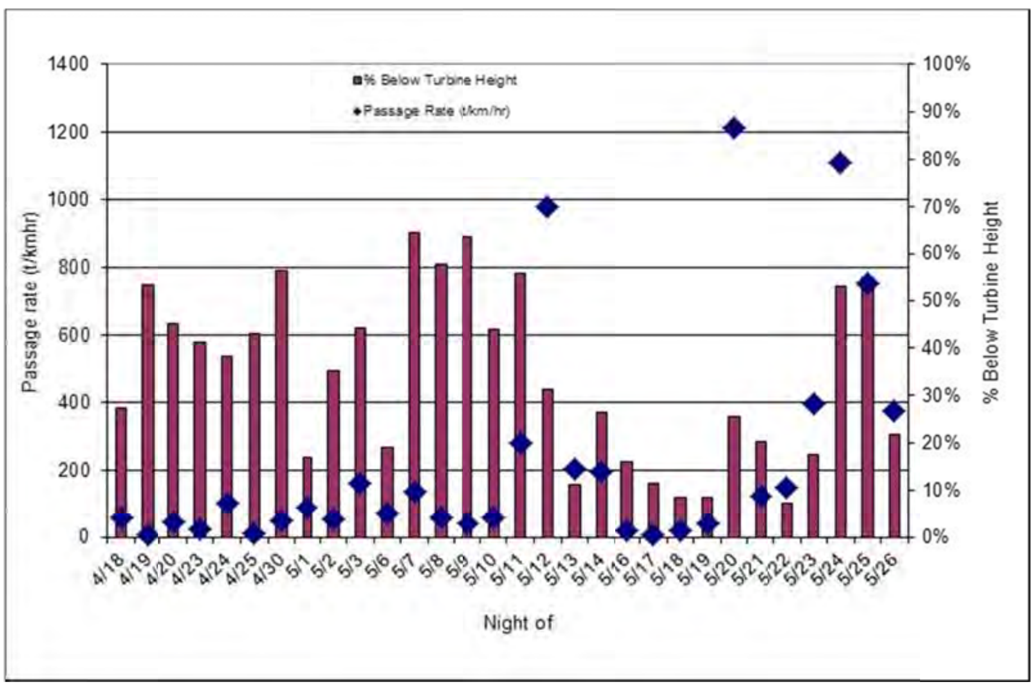

Figure 2-9. Percent of targets observed flying below a height of 150 m (492') during spring 2011 at the Antrim Wind Project.

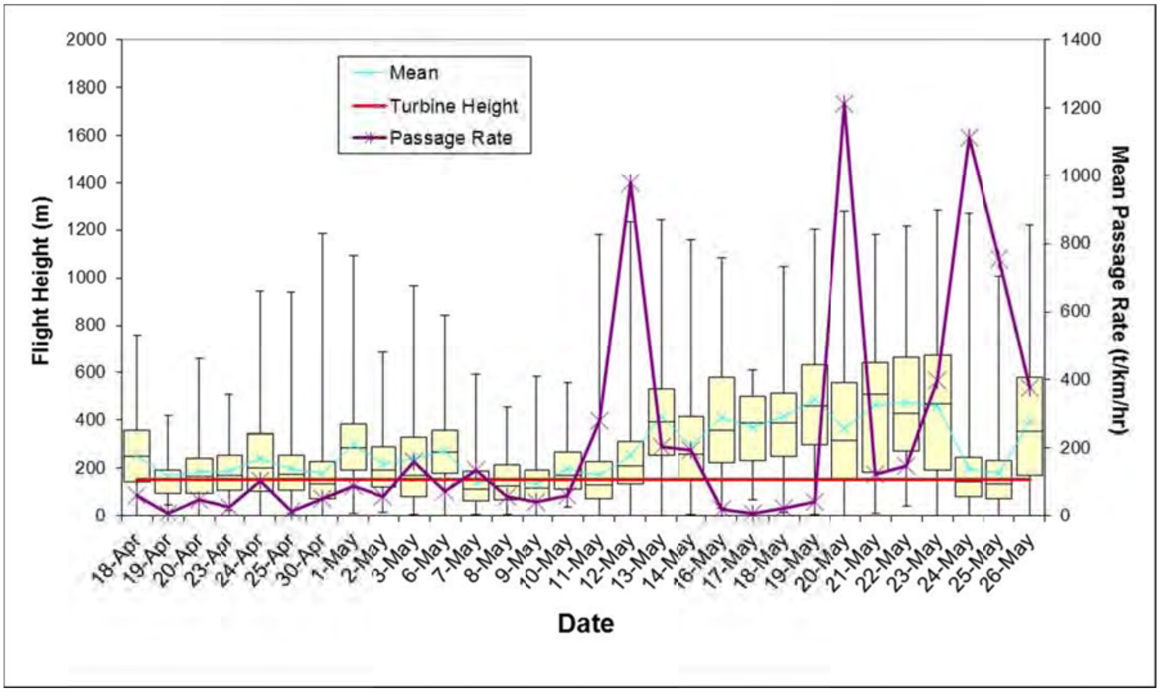

Figure 2-10. Flight height whisker plot depicting the vertical distribution of targets for each survey night during spring 2011 at the Antrim Wind Project.

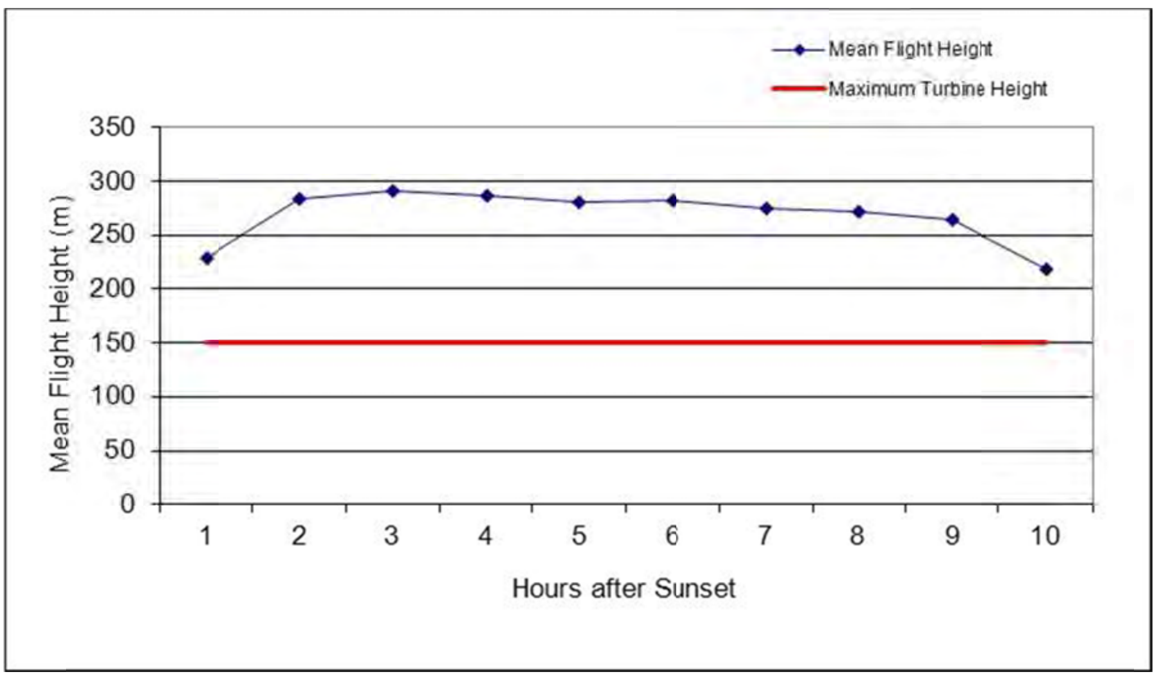

Figure 2-11. Hourly target flight height distribution during spring 2011 at the Antrim Wind Project.

2.4.4 Weather Data

Regional surface weather maps indicated that spring 2011 included many low pressure systems. During the nights surveyed from April 18 to May 26, average nightly wind speed varied between 1 and 10 meters per second (m/s), with an overall mean of 6 m/s (Figure 2-11). Mean nightly temperatures gradually increased throughout the survey period, and varied between 2 °C and 18 °C, with an overall mean of 9 °C (Figure 2-12).

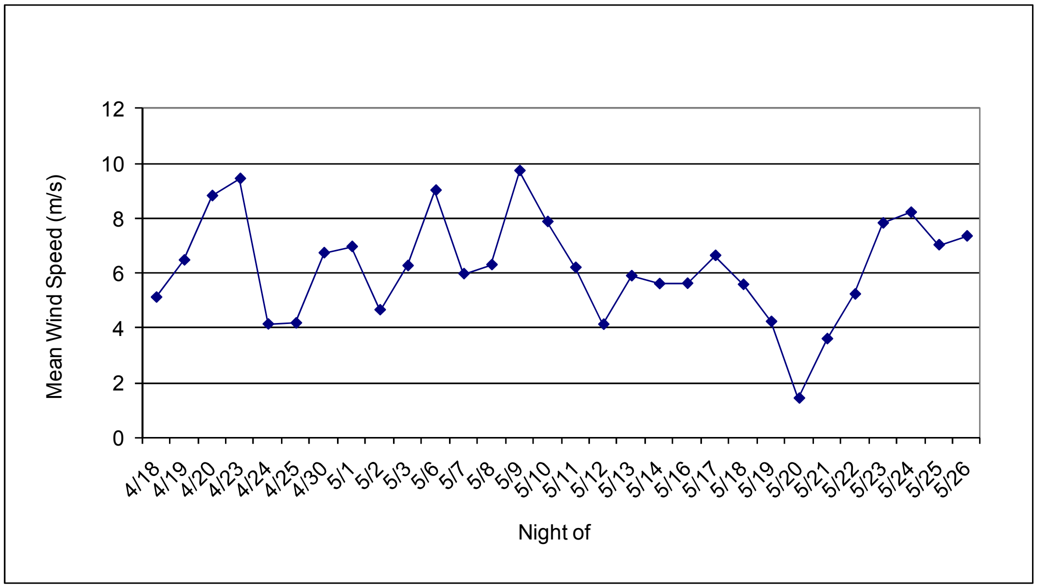

Figure 2-12. Nightly mean wind speed (m/s) during spring 2011 at the Antrim Wind Project. (nightly maximum and minimum temperatures not available)

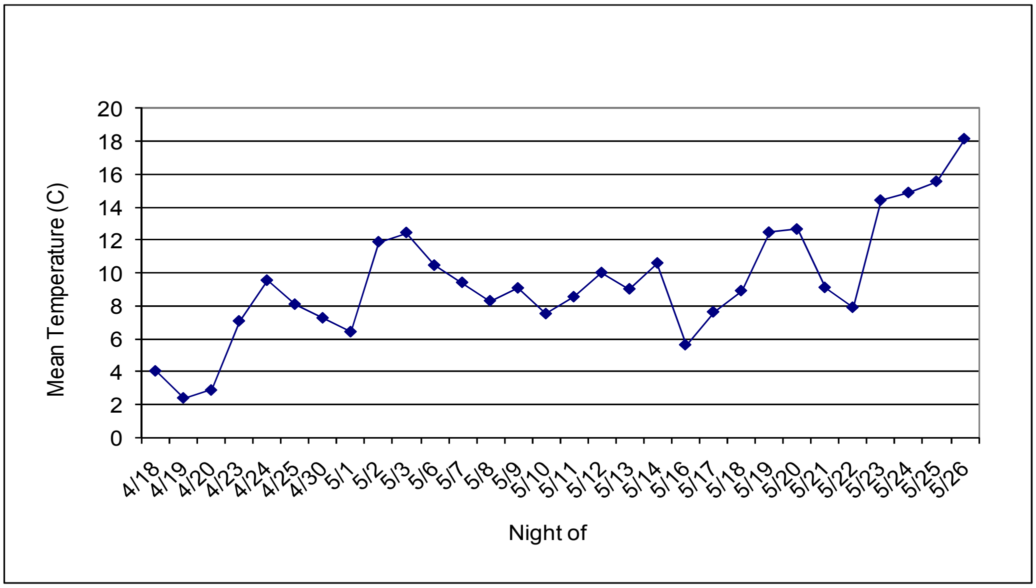

Figure 2-13. Nightly mean temperature (Celsius) during spring 2011 at the Antrim Wind Project.

2.5 DISCUSSION

Radar surveys are designed and implemented to sample migration activity over a specific location in the Project area to provide baseline pre-construction site data. The results of this nocturnal radar survey provide a snapshot of avian migration in space and time; in this case, over the Project area during dates typical for spring migration in New Hampshire. Spring radar surveys in the Project area documented patterns in nocturnal migration similar to those documented at recent radar surveys conducted at other locations in New Hampshire and the Eastern US (Appendix A Table 5). These include highly variable passage rates between nights, a generally northward flight direction, and flight heights typically averaging over 200 m.

The radar site was located within an existing met tower clearing at one of the highest points on Tuttle Hill. The radar had somewhat limited visibility of the airspace west and south of the radar site, but was still capable of detecting targets within the majority of its range. Nightly mean passage rates were highly variable, ranging from 6 ± 3 to 1215 ± 299 t/km/hr. This indicates that nocturnal migration was pulsed, presumably related to seasonal timing and regional weather conditions. Results also showed a general increase in mean nightly passage rates as well as mean nightly flight height during the course of the survey period. The average passage rate at the Project (223 ± 23 t/km/hr) is at the low end of the range of results of other radar studies conducted in the East (147 t/km/hr to 1020 t/km/hr; Appendix A Table 5). Comparison of passage rates between radar surveys at the Project and similar surveys conducted at other sites must be done with caution, as differences in passage rates are due in large part to differences in radar view between sites and varying weather patterns between years, and not necessarily the amount of migration above a radar site.

The average flight height (305 ± 1 m) is near the mid-range of average flight heights recorded at other radar studies conducted in the East (210 m to 552 m) and is well above the proposed turbine height (150 m). The nightly average flight heights were below the proposed turbine height on two nights (May 7 and 9) and at the proposed turbine height on one night (May 8). Passage rates on these three nights were relatively low, ranging from 40 to 134 t/km/hr. The emerging body of studies characterizing nocturnal migrant movements shows a relatively consistent pattern in flight altitude, with most targets appearing to fly at altitudes of several hundred meters or more above the ground (Figure 2-8; Appendix A Table 5). Comparison of flight height between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled.

Nightly variation in the magnitude and flight characteristics of nocturnal migrants is not uncommon and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). Overall, the spring 2011 migration season consisted of many low pressure systems resulting in many nights with rain. Between April 18 and May 26 the weather station located at Hillsborough, New Hampshire, approximately 9 miles northeast of the Project area, recorded 24 days with precipitation (Weather Underground 2011). The nights with the lowest passage rates (April 19 and May 17) were characterized by low pressure systems and rain. On the nights with the highest passage rates (1215 ± 299 t/km/hr on May 20 and 1139 ± 176 t/km/hr on May 24), a low pressure system was present on May 20 and no pressure system was evident on May 24. It is likely that migrants were forced to move on nights with less than optimal conditions because of the numerous low pressure systems that occurred during the traditional migration window. Wind speeds were low to moderate and from the southwest on those nights with the highest passage rates apparently providing more suitable conditions for migration than other nights. It is worth noting that a radar site located in western mountains of Maine and one located in Downeast Maine also recorded peak or near peak passage for the spring 2011 migration period on May 24 suggesting similar migration conditions for the region.

In summary, results at the Project are within the range of results recorded at other radar studies conducted in New Hampshire and the East, and provide a sample of baseline migration activity over the Project area during spring 2011 that is typical of data from other proposed projects on Northeastern forested ridges.

3.0 Acoustic Bat Survey

3.1 INTRODUCTION

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

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*) (BCI 2001). Of these eight species, the eastern small-footed bat is state-listed as endangered with a rank of S1 ("Critically Imperiled"[2]), and five species (tri-colored bat, eastern red bat, silver-haired bat, hoary bat, and northern long-eared bat) are state-listed as Species of Special Concern. All six state-listed species are also listed as Species of Greatest

[2] A state ranking of S1 is assigned to species characterized as critically imperiled because of extreme rarity (generally one to five occurrences) or because some factor of its biology makes it particularly vulnerable to extinction.

Conservation Need under New Hampshire's Wildlife Action Plan (New Hampshire Fish and Game Department 2005).

3.2 DATA COLLECTION METHODS

3.2.1 Acoustic Detector Site Selection

Anabat SDI and SD2 detectors (Titley Electronics Pty Ltd.) were used for the duration of the spring 2011 acoustic bat survey. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in the Project area. Anabat detectors were programmed to turn on and off on a daily basis to sample at least the period between sunset and sunrise, and stored recorded bat call sequences on removable 1 gigabyte (GB) compact flash cards. Anabat detectors are frequency division detectors, dividing the frequency of echolocation sounds made by bats by a factor of 16, then recording these sounds for subsequent analysis. The audio sensitivity setting of each Anabat system was set between six and seven (on a logarithmic scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33').

Each Anabat detector was powered by a 12-volt gel battery charged by a solar panel. Each solar-powered Anabat system was deployed in waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing suspends the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, the microphone was positioned within a 90 degree PVC elbow on the bottom of the waterproof enclosure, allowing the microphone to record the airspace horizontally surrounding the detector while minimizing acoustic signal loss.

The six Anabat detectors were deployed in the Project area between April 7 and April 16, and collected data through the end of May. Two detectors were deployed in the guy wires of the existing 60 m (197') met tower at heights of approximately 15 and 30 m (49 and 98') above ground level, and the remaining four detectors were deployed in trees throughout the Project area at heights of approximately 5 to 10 m (16 and 33') above ground level (agl) (Figures 3-1 to 3-3). Table 3-1 provides information on location and placement of detectors as well as surrounding habitat. Maintenance visits were conducted approximately every two weeks to check the condition of the detectors and to download data to a computer for archiving and subsequent analysis.

Table 3-1. Habitat descriptions of locations sampled during spring 2011 acoustic bat surveys at the Antrim Wind Project.

Detector Name	Elevation (m)	Height (m agl)	Habitat Notes
Willard Tree	563	5	Detector located 10 m from the edge of a 50 m diameter opening in an even-aged spruce/red maple forest with open understory, 15 m surrounding canopy height. Herbaceous vegetation and scattered trees in opening.
Willard Trail	522	5	Detector located 15 m from the edge of a 50 m clearing in an even-aged oak/maple forest with open understory.
Acces Tree	355	10	Detector suspended above intersection of forested trails 30 m from a transmission line corridor. Surrounding canopy (beech, birch, maple) 20 m tall with dense shrub understory.
Wetland	525	5	Detector located within a small wetland opening surrounded by uneven aged red maple/conifer forest.
N Met High	536	30	Detector deployed as high as possible in the guy wires of the met tower. Tower clearing surrounded by conifer-dominated forest.
N Met Low	536	15	Detector deployed in the guy wires of the met tower. Tower clearing surrounded by conifer-dominated forest.

Figure 3-1. Photos of the Willard Tree (left) and Willard Trail (right) bat detectors.

Figure 3-2. Photos of the Access Tree (left) and Wetland (right) bat detectors.

Figure 3-3. Photos of the North Met High (left) and Low (right) bat detectors.

3.3 DATA ANALYSIS METHODS

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

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

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

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

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Relatively accurate identification of bat species can be attained by visually comparing recorded call sequences of sufficient length to bat call reference libraries (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, as well as other bat researchers. However, due to the similar call signatures of several species, classified calls were categorized into five guilds[3] that reflect the bat community in the region of the Project area:

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

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

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

- **Big brown/silver-haired bat (BBSH)** – Big brown and silver-haired bats. The call signatures of these species commonly overlap and are included as one guild in this report.

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

This method of guild identification represents a conservative approach to bat call identification. Since some species sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds.

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[3] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI. To report the activity of the migratory hoary bat, it was placed into a separate guild.
[4] The scientific and common name of the eastern pipistrelle (*Pipistrellus subflavus*) has been changed to the tri-colored bat (*Perimyotis subflavus*).

Tables and figures in the body of this report will reflect those guilds. In addition, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

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

3.3.1 Weather Data

Temperature, wind speed and direction were recorded by the on-site met tower. Data at the met tower was recorded at 10-minute intervals for the survey period between April 10 and June 1, 2011. Weather data were summarized on a nightly basis during the survey period and compared to nightly bat activity levels using a scatterplot and linear correlation analysis. In addition to the met tower data, 24-hour precipitation, relative humidity, and barometric pressure data were obtained from a weather station located in Hillsborough, New Hampshire approximately nine miles northeast of the Project (Weather Underground 2011).

3.4 RESULTS

3.4.1 Timing of Activity

During the 56-night survey period (April 7 and June 1), individual detectors recorded between 38 and 56 nights of data with a total 304 detector-nights surveyed out 323 available calendar-nights (94 percent; Table 3-2). The only detector to malfunction for greater than one night was the North Met High detector, which malfunctioned on May 15 through the end of the spring survey period due to an improperly formatted memory card. This problem was corrected during a June 1 site visit.

Combined, detectors recorded a total of 1,483 bat call sequences during the spring survey period (Table 3-2). Individual detectors recorded between 5 sequences (North Met High) and 760 sequences (Access Tree) with corresponding detection rates ranging from 0.1 sequences per detector-night to 14.1 sequences per detector-night. The overall detection rate was 4.9 sequences per detector-night during the spring 2011 survey period (Table 3-2).

Table 3-2. Summary of bat detector field survey effort and results at the Antrim Wind Project, spring 2011.						
Location	**Dates Deployed**	**Calendar Nights**	**Detector-Nights***	**Recorded Sequences**	**Detection Rate ****	**Maximum Sequences recorded *****
Access Tree	4/7 - 5/31	55	54	760	14.1	331
N Met High	4/7 - 5/31	55	38	5	0.1	2
N Met Low	4/7 - 5/31	55	55	95	1.7	61
Wetland Tree	4/16 - 5/31	46	45	49	1.1	24
Willard Trail	4/7 - 6/1	56	56	211	3.8	60
Willard Tree	4/7 - 6/1	56	56	363	6.5	130
Overall Results		***323***	***304***	***1,483***	***4.9***	--
* One detector-night is equal to a one detector successfully operating throughout the night.						
** Number of bat echolocation sequences recorded per detector-night.						
*** Maximum number of bat passes recorded from any single detector for a detector-night.						

Acoustic bat activity was sporadic throughout the survey period, but the number of nights with recorded bat activity increased at each detector between April and May, indicating more consistent bat activity in late versus early spring (Table 3-3). By detector, acoustic activity was detected on the greatest percentage of nights at the Access Tree detector (54 percent of nights surveyed). In addition to more consistent bat activity, the total number of calls detected also increased from April through May (Table 3-4). The two met tower detectors recorded acoustic bat activity on the lowest percentage of nights sampled during April and May. The Access Tree detector recorded both the highest activity rate and detected bats on the highest percentage of nights surveyed. Nightly timing of acoustic activity varied among nights and detectors, although overall timing peaked during the hour of sunset and the first hour past sunset and declined steadily thereafter (Figure 3-4).

Table 3-3. Percent of nights with acoustic activity by month and overall during spring 2011 acoustic surveys*			
Detector	**April**	**May**	**Overall**
Access Tree	30% (7/23)	71% (22/31)	54% (29/54)
N Met High	0% (0/24)	29% (4/14)	11% (4/38)
N Met Low	0% (0/24)	45% (14/31)	25% (14/55)
Wetland Tree	27% (4/15)	43% (13/30)	38% (17/45)
Willard Trail	21% (5/24)	61% (19/31)	45% (25/56)
Willard Tree	4% (1/24)	52% (16/31)	32% (18/56)
*% Nights with activity (# nights with activity/# nights surveyed)			

Table 3-4. Monthly summary of spring 2011 acoustic survey results at the Antrim Wind Project .

Detector / Month	Dates	Calendar Nights	Detector-Nights*	Recorded Sequences	Detection Rate **	Maximum Sequences recorded ***
Access Tree						
April	01 April–30 April	30	23	541	23.5	331
May	01 May–31 May	31	31	219	7.1	39
N Met High						
April	01 April–30 April	30	24	0	0.0	0
May	01 May–31 May	31	14	5	0.4	2
N Met Low						
April	01 April–30 April	30	24	0	0.0	0
May	01 May–31 May	31	31	95	3.1	61
Wetland Tree						
April	01 April–30 April	30	15	7	0.5	4
May	01 May–31 May	31	30	42	1.4	24
Willard Trail						
April	01 April–30 April	30	24	6	0.3	2
May	01 May–31 May	31	31	162	5.2	60
June	01 June–30 June	30	1	43	43.0	43
Willard Tree						
April	01 April–30 April	30	24	1	0.0	1
May	01 May–31 May	31	31	319	10.3	130
June	01 June–30 June	30	1	43	43.0	43
Overall Results		**426**	**304**	**1483**	**4.9**	--

* One detector-night is equal to a one detector successfully operating throughout the night.
** Number of bat echolocation sequences recorded per detector-night.
*** Maximum number of bat passes recorded from any single detector for a detector-night.

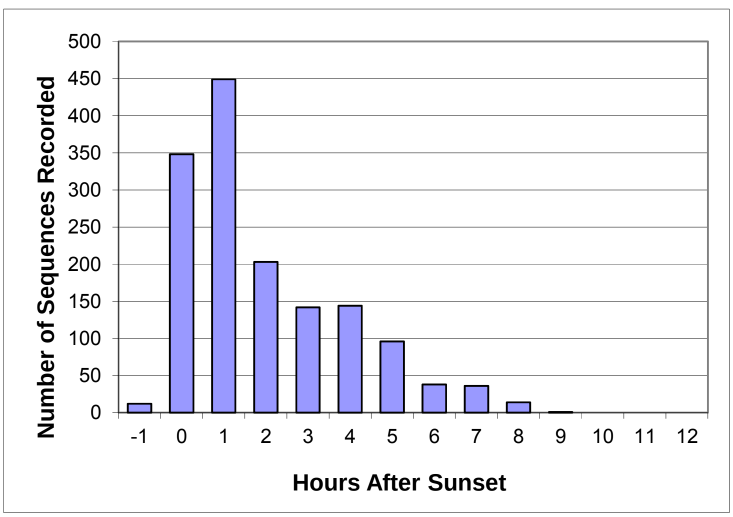

Figure 3-4. Hourly bat call sequence detections during spring 2011 surveys at the Antrim Wind Project.

3.4.2 Species Composition

Bats were identified within each of the defined guilds during analysis. Calls of species in the *Myotis* guild were the most common, comprising 32 percent of the total (Table 3-5). The BBSH guild was the next most commonly identified guild, comprising 31 percent of the total. Most call sequences within the BBSH guild were identified as big brown bats or big brown/silver-haired bats, and only a small fraction were classified as silver-haired bats. Twenty-four percent of call sequences were classified as "unknown" due to their relatively short length or quality. Hoary bats comprised 12 percent of bat call sequences recorded and were detected at all detectors. The RBTB guild was the least commonly detected guild and comprising only 1 percent of the recorded call sequences (Table 3-5).

Species composition differed among detectors. *Myotis* species were most common at the Access Tree detector where they comprised the majority of bats detected. Although the *Myotis* species were the most commonly recorded guild and represented a majority of calls at the Access Tree detector, they were recorded at relatively low numbers at three of the detectors and they were not recorded at the North Met High or Wetland Tree detectors. Unknown bats comprised between 16 and 67 percent of recorded call sequences by detector. The highest percentage of unknown call sequences was recorded at the Wetland Tree detector, where several sequences lacked a sufficient number of pulses to be classified. Hoary bats were detected most frequently at the Willard Tree detector, and three of the five bats recorded at the North Met High detector were hoary bats (Figure 3-5).

Table3-5. Distribution of detections by guild for detectors at Antrim Wind Project, spring 2011.

Detector	Guild					Total
	BBSH	HB	MYSP	RBTB	UNKN	
Access Tree	128	5	438	13	176	760
N Met High	0	3	0	1	1	5
N Met Low	41	5	24	0	25	95
Wetland Tree	8	8	0	0	33	49
Willard Trail	108	24	7	2	70	211
Willard Tree	167	132	5	1	58	363
Total	**452**	**177**	**474**	**17**	**363**	**1,483**
Guild Compositior	**30.5%**	**11.9%**	**32.0%**	**1.1%**	**24.5%**	

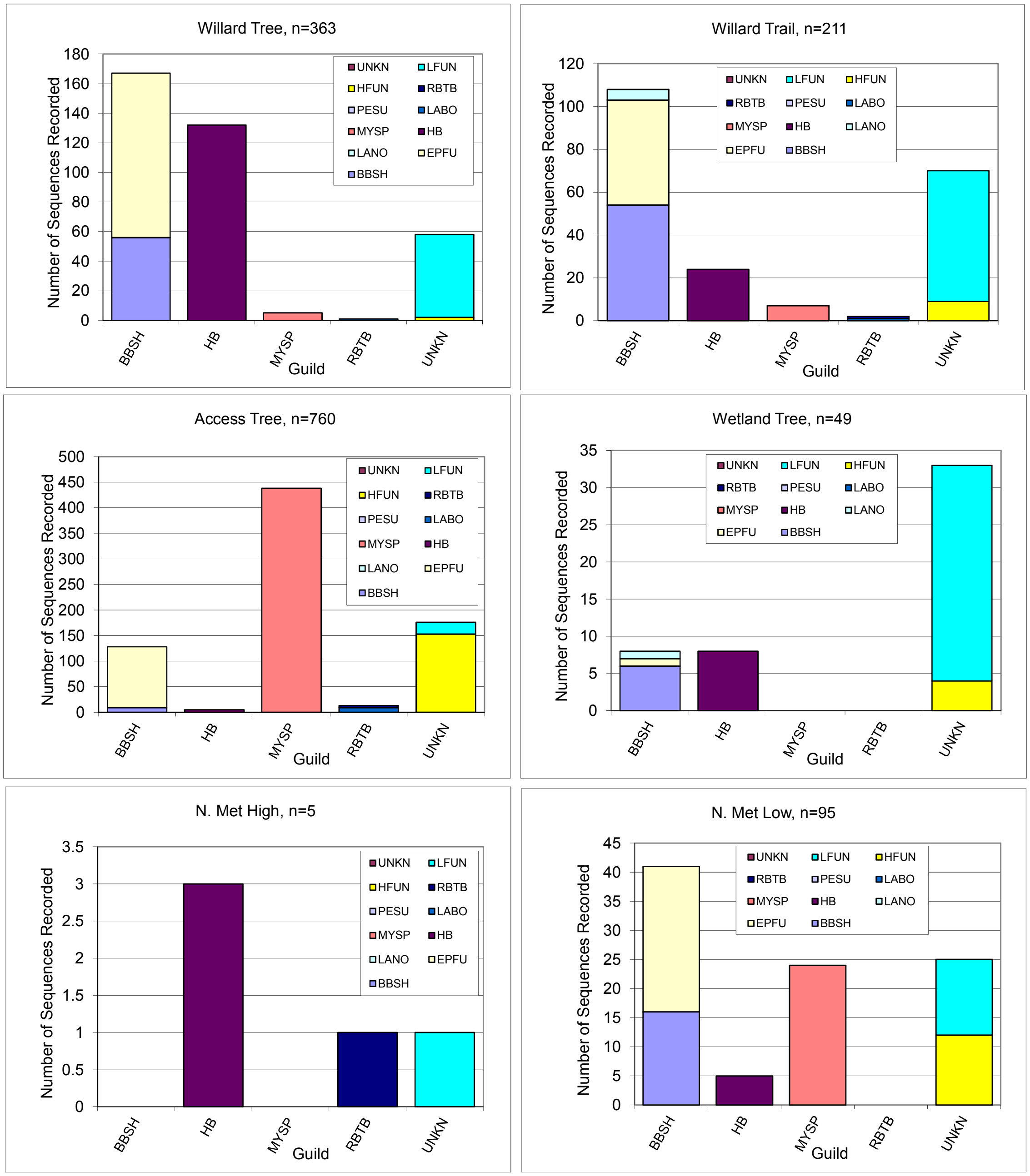

Figure 3-5. Histograms showing species composition of recorded bat call sequences. Note the differing scales on the y-axes. BBSH = big brown/silver-haired, HB = hoary bat, MYSP = Myotis species, RBTB = red bat/tri-colored bat, UNKN = unknown, LFUN = low frequency unknown, HFUN = high frequency unknown, PESU = tri-colored bat, LABO = red bat, LANO = silver-haired bat, EPFU = big brown bat.

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

3.4.3 Activity and Weather

Mean nightly wind speeds in the Project area from April 7 through June 1 varied between 1.4 and 12.5 m/s, with an overall mean of 7.3 m/s (Figure 3-6). Mean nightly temperatures varied between -1.8 °C and 20.2 °C, with an overall mean of 9.1 °C (Figure 3-7). Figure 3-9 displays scatterplots of overall acoustic activity versus nightly temperature and wind speed. Combined bat activity levels showed a weak negative correlation with increasing nightly wind speed and a weak positive correlation with increasing nightly temperature (Figure 3-8).

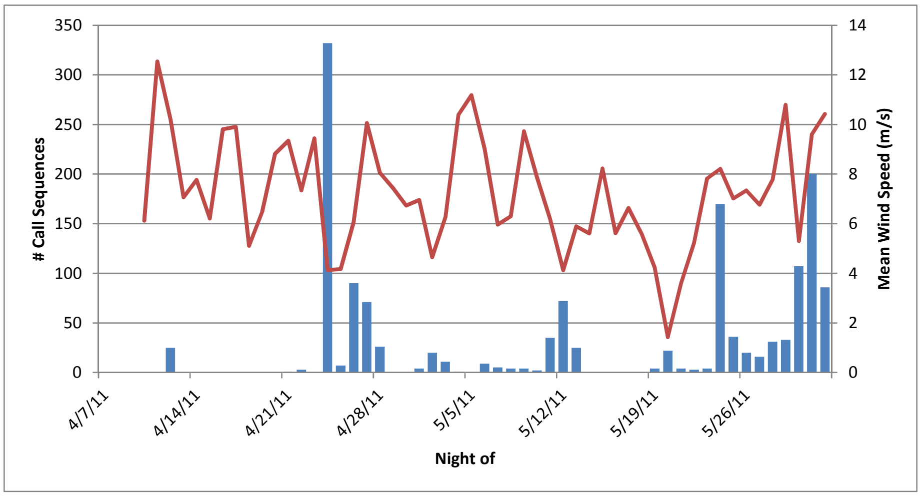

Figure 3-6. Nightly mean wind speed (m/s) (red line) and combined bat call detections during spring 2011 surveys at the Antrim Wind Project.

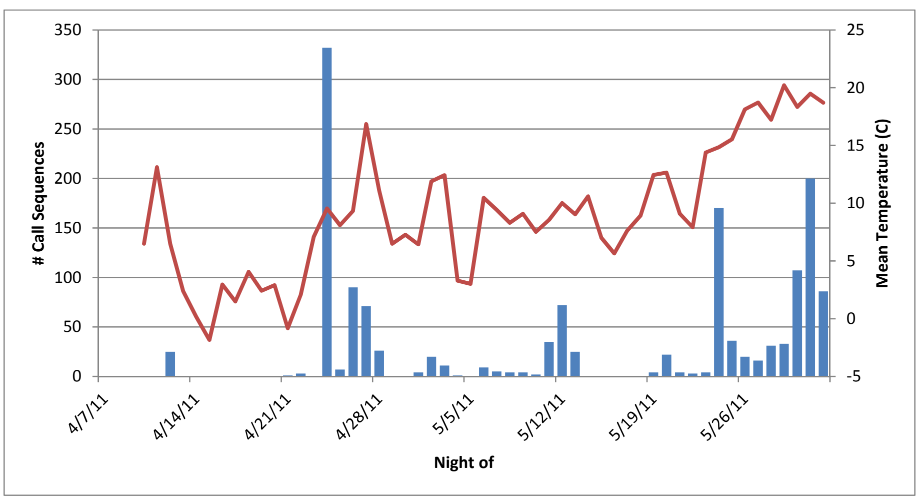

Figure 3-7. Nightly mean temperature (Celsius) (red line) and combined bat detections during spring 2011 bat surveys at the Antrim Wind Project.

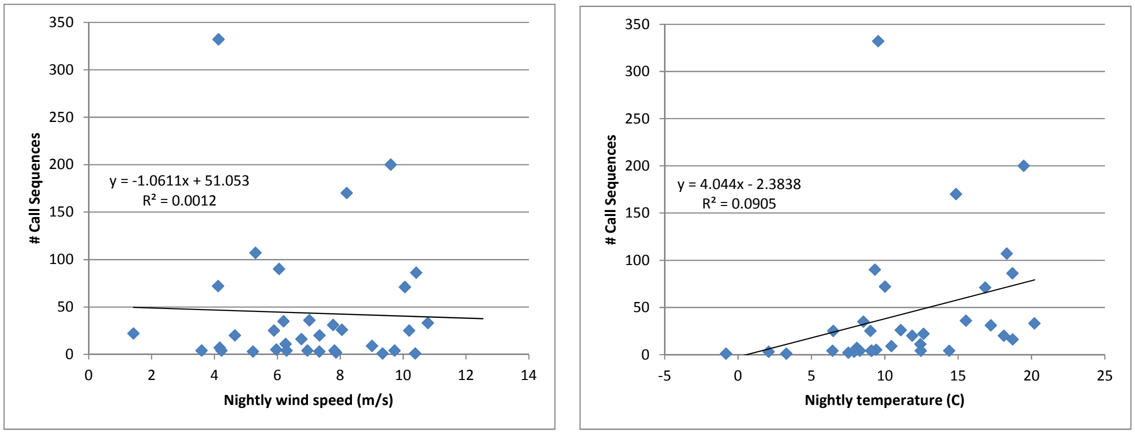

Figure 3-8. Nightly mean wind speed (left), and mean temperature (right) versus combined bat detections during spring 2011 bat surveys at the Antrim Wind Project

3.5 DISCUSSION

Spring 2011 acoustic surveys at the Antrim Wind Project documented variable levels of bat activity among the six detectors deployed in the Project area. Activity levels were also highly variable among nights during the April 7 to June 1 study period. However, some general trends were also observed, including more consistent acoustic activity in May than April (as indicated by the percentage of nights with detected activity), and overall increases in the number of call files in the second half of May as temperatures increased. In a subsequent report, the spring acoustic data will be considered together with data recorded for the remainder of summer and fall to discuss overall seasonal trends in activity.

Inter-night and inter-detector variability is common in acoustic bat surveys, where microhabitat surrounding detectors can influence the number of calls recorded as well as the quality of call files. Although Stantec made an effort to deploy acoustic detectors in similar configurations (along habitat edges and corridors that may concentrate bat activity), slight differences in deployment lead to inevitable differences in detection rates that do not necessarily correspond to the number of bats in the vicinity of the detectors.

The Access Tree detector recorded substantially more bat calls than the other detectors deployed in the Project area, and recorded the majority of the total *Myotis* species call sequences. The Access Tree detector also detected activity on the greatest percentage of nights surveyed. Although deployed in a similar configuration to other detectors, this detector was located approximately 170 m lower in elevation than the other five detectors. The lower elevation may have resulted in milder conditions, potentially increasing the amount of acoustic activity at this location. Nearly half of the bat call sequences and the majority of Myotis sequences recorded at this detector occurred on the night of April 24, highlighting the variability of acoustic detection rates among nights.

Comparison of acoustic bat activity documented at the North Met High and North Met Low detectors with the other Project detectors may help clarify activity patterns of bats in the air space above tree canopy and within the rotor zone of proposed wind turbines. The North Met

High detector recorded substantially less acoustic activity than any other detector, and recorded activity on the smallest percentage of nights sampled. However, it is also important to note that this detector malfunctioned for the final two weeks of the spring monitoring period, which corresponds to the period when higher activity levels were documented at the other detectors. The North Met Low detector recorded an activity rate slightly higher than the Wetland Tree detector, but recorded activity on a smaller percentage of sampled nights than all detectors except the North Met High detector. Despite the malfunctioning high detector, the met tower detectors recorded lower acoustic activity rates and less frequent activity than detectors suspended from trees along forested corridors, suggesting that bats were less active in open air spaces and above the forest canopy, which aligns with their foraging behavior.

Bat call sequences were identified to guild, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red and hoary bat, have easily identifiable calls, whereas other species, such as the big brown bat and silver-haired bat, are difficult to distinguish acoustically. Similarly, species within the *Myotis* genus have very similar calls and Stantec did not make an attempt to differentiate call sequences within this genus. *Myotis* species have been particularly affected by the white-nose syndrome (WNS) that has become widespread in the Northeast. While the large number of *Myotis* sequences recorded at the Access Tree detector is notable, the majority of these calls were recorded on one night, and do not necessarily reflect a large number of these bats in the Project area. The high variability activity levels of *Myotis* species at the Project may actually suggest that a small number of *Myotis* are present within the Project area. Prior to WNS, *Myotis* call sequences often tended to dominate acoustic data collected from detectors deployed in trees (Peterson *et al.* unpublished data). Exclusive of the Access Tree detector, the Project area detectors recorded fewer than 40 *Myotis* call sequences during spring 2011 surveys suggesting relatively few *Myotis* species within the surveyed area.

Recent studies have found that bat activity patterns are influenced by weather conditions (Arnett *et al*. 2006, Arnett *et al*. 2008, Reynolds 2006). Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared to be related to bat collision mortality rates documented at two wind energy facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett 2005). These patterns suggest that bats are more likely to migrate on nights with low wind speeds (less than 4 to 6 m/s) and generally warm temperatures. Thus, several weather variables can individually affect bat activity, as does the interaction among variables (*i.e*., warm nights with low wind speeds). Spring 2011 acoustic sampling at the Project documented weak correlations between acoustic activity and wind speed and temperature. Raw acoustic data of the type analyzed in this study are prone to substantial variability and it is not surprising that acoustic activity was still documented on nights with higher wind speeds and colder temperatures.

When considering the level of activity documented at the Project during the spring 2011 acoustic survey, it is important to acknowledge that numbers of recorded bat call sequences cannot be correlated with the number of bats in an area because acoustic detectors do not allow for differentiation between individuals. While these data may be useful in predicting trends in post-construction mortality rates, the current lack of data on this topic precludes quantitative prediction of risk.

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Appendix A

Radar survey results

Appendix A Table 1. Survey dates, results, level of effort, and weather - Spring 2011										
Date	Sunset	Sunrise	# of Hours Analyzed	Passage rate	Flight Direction	Flight Height (m)	% below 150 m	Temperature (C)	Wind Speed (m/s)	Wind Direction (degrees)
4/18	19:32	6:02	10	59	46	254	27%	4	5	297
4/19	19:34	6:01	10	7	209	166	54%	2	6	127
4/20	19:35	5:59	10	45	46	181	45%	3	9	255
4/23	19:38	5:54	10	25	48	189	41%	7	9	234
4/24	19:39	5:53	10	102	61	239	38%	10	4	232
4/25	19:41	5:51	10	13	309	198	43%	8	4	121
4/30	19:46	5:44	10	50	151	177	56%	7	7	160
5/1	19:47	5:43	10	88	25	297	17%	6	7	189
5/2	19:49	5:41	10	56	36	218	35%	12	5	230
5/3	19:50	5:40	10	160	29	240	44%	12	6	154
5/6	19:53	5:36	10	73	26	272	19%	10	9	229
5/7	19:54	5:35	10	134	66	139	64%	9	6	178
5/8	19:55	5:33	10	58	78	150	58%	8	6	154
5/9	19:56	5:32	10	40	89	135	63%	9	10	220
5/10	19:58	5:31	10	60	226	197	44%	8	8	36
5/11	19:59	5:30	10	279	46	169	56%	9	6	50
5/12	20:00	5:29	10	979	40	254	31%	10	4	191
5/13	20:01	5:27	10	203	4	412	11%	9	6	159
5/14	20:02	5:26	9	194	28	296	26%	11	6	202
5/16	20:04	5:24	9	19	271	412	16%	6	6	82
5/17	20:05	5:23	8	6	242	370	11%	8	7	71
5/18	20:06	5:22	9	22	253	413	8%	9	6	72
5/19	20:07	5:21	9	42	264	486	8%	12	4	74
5/20	20:08	5:20	9	1215	49	366	26%	13	1	187
5/21	20:09	5:19	9	123	335	464	20%	9	4	112
5/22	20:10	5:19	7	147	28	472	7%	8	5	163
5/23	20:11	5:18	8	395	32	458	18%	14	8	198
5/24	20:12	5:17	9	1113	55	198	53%	15	8	297
5/25	20:13	5:16	9	755	57	178	55%	16	7	191
5/26	20:14	5:15	9	375	30	395	22%	18	7	217
Entire Season			**284**	**223**	**44**	**305**	**30%**	**9**	**6**	**169**

Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.														
Night of	**Passage Rate (targets/km/hr) by hour after sunset**										**Entire Night**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**	**Median**	**Stdev**	**SE**
4/18	0	4	11	46	32	29	111	129	154	71	59	39	55	17
4/19	21	14	7	7	0	7	0	0	0	11	7	7	7	2
4/20	0	0	0	14	118	125	100	64	21	11	45	18	51	16
4/23	0	4	4	0	29	4	64	57	25	64	25	14	27	9
4/24	43	46	114	143	168	114	121	100	75	96	102	107	39	12
4/25	18	14	4	18	11	4	4	0	0	57	13	7	17	5
4/30	68	32	71	71	50	57	54	43	39	18	50	52	18	6
5/1	75	121	136	75	61	71	89	96	104	54	88	82	26	8
5/2	18	61	64	54	86	50	57	64	79	30	56	59	20	6
5/3	61	57	64	93	136	464	318	175	96	136	160	116	132	42
5/6	36	64	79	64	104	93	111	96	75	7	73	77	32	10
5/7	14	193	157	214	261	225	157	61	57	4	134	157	93	29
5/8	46	175	104	82	25	43	46	21	25	7	58	45	50	16
5/9	21	39	75	68	57	54	46	11	32	0	40	43	24	8
5/10	46	118	114	39	36	21	75	71	79	4	60	59	38	12
5/11	182	336	250	164	229	339	268	293	693	32	279	259	172	54
5/12	254	1282	1375	1718	1375	1179	1039	996	514	57	979	1109	536	170
5/13	218	286	236	254	161	236	246	154	200	39	203	227	70	22
5/14	104	239	229	261	304	236	146	137	93	N/A	194	229	75	25
5/16	61	57	11	21	7	11	0	0	0	N/A	19	11	24	8
5/17	7	11	0	25	Rain	0	4	0	0	N/A	6	2	9	3
5/18	89	11	25	14	18	7	21	0	11	N/A	22	14	26	9
5/19	104	25	25	25	68	75	32	21	0	N/A	42	25	33	11
5/20	171	254	429	768	2246	2125	2279	1857	807	N/A	1215	807	897	299
5/21	289	182	100	50	132	136	111	68	36	N/A	123	111	78	26
5/22	189	468	261	Rain	14	Rain	21	36	43	N/A	147	43	170	64
5/23	214	329	118	107	100	832	911	550	N/A	N/A	395	271	331	117
5/24	425	1282	1568	1489	1432	1514	1029	975	304	N/A	1113	1282	474	158
5/25	225	961	1004	1000	846	889	686	836	346	N/A	755	846	285	95
5/26	232	371	486	457	275	261	418	686	193	N/A	375	371	156	52
Entire Season	**108**	**235**	**237**	**253**	**289**	**317**	**285**	**253**	**141**	**39**	**223**	**73**	**393**	**23**
0 indicates no targets counted for that hour								N/A indicates no or only partial data for that hour						

Appendix A Table 3. Mean Nightly Flight Direction		
Night of	**Mean Flight Direction**	**Circular Stdev**
4/18	46	51
4/19	209	92
4/20	46	59
4/23	48	27
4/24	61	63
4/25	309	70
4/30	151	99
5/1	25	45
5/2	36	51
5/3	29	76
5/6	26	37
5/7	66	47
5/8	78	70
5/9	89	69
5/10	226	47
5/11	46	85
5/12	40	31
5/13	4	54
5/14	28	51
5/16	271	40
5/17	242	29
5/18	253	29
5/19	264	41
5/20	49	36
5/21	335	63
5/22	28	43
5/23	32	50
5/24	55	32
5/25	57	30
5/26	30	46
Entire Season	**44**	**49**

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

Night of	Mean Flight Height (m) by hour after sunset										Entire Night				Number of targets below 150 meters	% of targets below 150 meters
	1	2	3	4	5	6	7	8	9	10	Mean	Median	STDV	SE		
4/18	--	166	205	254	289	275	285	231	218	258	254	248	148	49	238	27%
4/19	279	158	215	190	111	135	93	--	--	124	166	147	97	34	15	54%
4/20	--	254	222	232	196	158	191	155	151	188	181	164	118	39	209	45%
4/23	--	290	180	210	247	238	194	183	158	157	189	171	98	33	136	41%
4/24	179	226	191	203	227	201	287	295	266	239	239	200	173	55	223	38%
4/25	129	181	137	215	221	206	--	313	201	286	198	175	143	48	47	43%
4/30	125	202	168	245	158	134	119	162	209	319	177	135	170	54	118	56%
5/1	208	289	322	314	299	282	293	279	293	304	297	285	155	49	217	17%
5/2	179	242	220	222	273	216	196	211	173	175	218	193	126	40	136	35%
5/3	152	264	366	325	300	136	162	112	162	194	240	171	201	64	275	44%
5/6	242	305	290	274	269	281	262	256	234	226	272	266	133	42	346	19%
5/7	207	186	126	142	96	136	111	127	158	272	139	113	108	34	253	64%
5/8	130	127	118	181	180	202	183	152	145	170	150	127	100	32	135	58%
5/9	102	138	90	125	171	132	167	199	152	--	135	114	94	31	99	63%
5/10	169	226	197	Rain	Rain	250	155	164	218	164	197	168	114	40	72	44%
5/11	175	209	226	157	148	93	88	116	104	101	169	131	139	44	320	56%
5/12	282	273	224	228	273	254	265	233	251	315	254	208	194	61	1388	31%
5/13	231	496	503	417	387	380	313	311	315	N/A	412	390	222	74	277	11%
5/14	258	297	296	273	304	317	326	302	277	N/A	296	257	201	67	269	26%
5/16	238	368	523	332	654	845	406	--	--	N/A	412	355	274	104	10	16%
5/17	353	--	444	Rain	Rain	511	439	536	174	N/A	370	386	152	62	4	11%
5/18	349	507	398	440	400	405	341	410	601	N/A	413	386	208	69	14	8%
5/19	292	417	362	425	526	519	438	482	677	N/A	486	460	256	85	23	8%
5/20	428	528	586	506	271	272	198	182	208	N/A	366	317	251	84	1328	26%
5/21	188	254	541	566	454	519	520	493	496	N/A	464	506	271	90	176	20%
5/22	342	376	498	465	528	Rain	680	601	561	N/A	472	429	247	87	51	7%
5/23	223	364	273	294	294	444	575	500	N/A	N/A	458	466	287	102	286	18%
5/24	222	266	212	195	157	125	125	121	212	N/A	198	142	191	64	1454	53%
5/25	232	225	182	167	142	117	104	96	197	N/A	178	134	157	52	1003	55%
5/26	281	406	437	438	307	415	476	385	319	N/A	395	353	261	87	471	22%
Entire Season	**229**	**284**	**292**	**287**	**281**	**283**	**276**	**272**	**264**	**218**	**305**	**244**	**230**	**1**	**9593**	**30%**

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

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

Year	Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	(Turbine Ht) % Targets Below Turbine Height	Reference
Spring 2005										
2005	Sheffield, Caledonia Cty, VT	20	180	Forested ridge	166	12-440	40	552	(125 m) 6%	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
2005	Stamford, Delaware Cty, NY	35	301	Forested ridge	210	10-785	46	431	(110 m) 8%	Woodlot Alternatives, Inc. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
2005	Deerfield, Bennington Cty, VT	20	183	Forested ridge	404	74-973	69	523	(100 m) 4%	Woodlot Alternatives, Inc. 2005. Spring 2005 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
2005	Franklin, Pendleton Cty, NY	21	204	Forested ridge	457	34-1240	53	492	(125 m) 11%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar and Acoustic Survey of Bird and Bat Migration at the Proposed Liberty Gap Wind Project in Franklin, West Virginia. Prepared for US Wind Force, LLC.
2005	Dans Mountain, Allegany Cty, MD	23	189	Forested ridge	493	63-1388	38	541	(125 m) 15%	Woodlot Alternatives, Inc. 2005. A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Dan's Mountain Wind Project in Frostburg, Maryland. Prepared for US Wind Force.
Spring 2006										
2006	Kibby, Franklin Cty, ME (Range 1)	10	80	Forested ridge	197	6-471	50	412	(120 m) 22%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
2006	Deerfield, Bennington Cty, VT	26	236	Forested ridge	263	5-934	58	435	(100 m) 11%	Woodlot Alternatives, Inc. 2006. Spring 2006 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
2006	Mars Hill, Aroostook Cty, ME	15	85	Forested ridge	338	76-674	58	384	(120 m) 14%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Radar, Visual, and Acoustic Survey of Bird Migration at the Mars Hill Wind Farm in Mars Hill, Maine. Prepared for Evergreen Windpower, LLC.
2006	Kibby, Franklin Cty, ME (Valley)	2	14	Forested ridge	443	45-1242	61	334	(120 m) n/a	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
2006	Kibby, Franklin Cty, ME (Mountain)	6	33	Forested ridge	456	88-1500	67	368	(120 m) 14%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
2006	Kibby, Franklin Cty, ME (Range 2)	7	57	Forested ridge	512	18-757	86	378	(120 m) 25%	Woodlot Alternatives, Inc. 2006. A Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Spring 2007										
2007	Stetson, Washington Cty, ME	21	138	Forested ridge	147	3-434	55	210	(120 m) 22%	Woodlot Alternatives, Inc. 2007. A Spring 2007 Survey of Bird and Bat Migration at the Stetson Wind Project, Washington County, Maine. Prepared for Evergreen Wind V, LLC.
2007	Laurel Mountain, Barbour Cty, WV	20	197	Forested ridge	277	13-646	27	533	(130 m) 3%	Stantec Consulting Services Inc. 2007. A Spring 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Laurel Mountain Wind Energy Project near Elkins, West Virginia. Prepared for AES Laurel Mountain, LLC.
2007	Errol, Coos County, NH	30	212	Forested ridge	342	2 to 870	76	332	(125 m) 14%	Stantec Consulting Inc. 2007. Spring 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windpark in Coos County, New Hampshire by Granite Reliable Power, LLC. Prepared for Granite Reliable Power, LLC.
2007	Roxbury, Oxford Cty, ME	20	n/a	Forested ridge	539	137-1256	52	312	(130 m) 18%	Woodlot Alternatives, Inc. 2007. A Spring 2007 Survey of Bird and Bat Migration at the Record Hill Wind Project, Roxbury, Maine. Prepared for Roxbury Hill Wind LLC.
2007	Lempster, Sullivan Cty, NH	30	277	Forested ridge	542	49-1094	49	358	(125 m) 18%	Woodlot Alternatives, Inc. 2007.A Spring 2007 Survey of Nocturnal Bird Migration, Breeding Birds, and Bicknell's Thrush at the Proposed Lempster Mountain Wind Power Project Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
Spring 2008										
2008	Allegany, Cattaraugus Cty, NY	30	275	Forested ridge	268	53-755	18	316	(150 m) 19%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
2008	Oakfield, Penobscot Cty, ME	20	194	Forested ridge	498	132-899	33	276	(120 m) 21%	Stantec Consulting Services Inc. 2008.A Spring 2008 Survey of Bird and Bat Migration at the Oakfield Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
2008	New Creek, Grant Cty, WV	20	n/a	Forested ridge	1020	289-2610	30	354	(130 m) 13%	Stantec Consulting Services Inc. 2008. A Spring 2008 Survey of Bird Migration at the New Creek Wind Project, West Virginia. Prepared for AES New Creek, LLC.
2008	Tenney, Grafton Cty, NH	40	373	Forested ridge	234	35-549	77	321	(125 m) 12%	Stantec Consulting Services Inc. 2008. Spring 2008 Radar Survey Report for the Groton Wind Project. Prepared for Groton Wind, LLC.
2008	Rollins, Penobscot Cty, ME	20	189	Forested ridge	247	40 - 766	75	316	(120 m) 13%	Stantec Consulting. 2008. Spring 2008 Bird and Bat Migration Survey Report: Visual, Radar and Acoustic Bat Surveys for the Rollins Wind Project. Prepared for First Wind, LLC.
Spring 2009										
2009	Sisk (Kibby Expansion), Franklin Cty, ME	21	193	Forested ridge	207	50-452	28	293	(125 m) 18%	Stantec Consulting Services Inc. 2009. Spring 2009 Nocturnal Migration Survey Report for the Kibby Expansion Wind Project. Prepared for TRC Engineers LLC.
2009	Vermont Community Wind Farm, Orleans Cty, VT	15	90	Forested ridge	435	49-771	48	320	(130 m) 22%	Stantec Consulting Services Inc. 2009. Spring and Summer 2009 Bird and Bat Survey Report. Prepared for Vermont Community Wind Farm, LLC.
2009	Moresville, Delaware Cty, NY	30	275	Forested ridge	230	30-575	53	314	(125 m)12%	Stantec Consulting Services Inc. 2009. 2009 Spring Nocturnal Radar Survey Report for the Moresville Energy Center. Prepared for Moresville Energy LLC.
2009	Highland, Somerset Cty, ME (location 1)	21	192	Forested ridge	496	10-1262	47	287	(130.5m) 26%	Stantec Consulting Services Inc. 2009. Spring 2009 Ecological Surveys for the Highland Wind Project. Prepared for Highland Wind LLC
2009	Highland, Somerset Cty, ME (location 2)	19	161	Forested ridge	511	8-1735	53	314	(130.5m) 23%	Stantec Consulting Services Inc. 2009. Spring 2009 Ecological Surveys for the Highland Wind Project. Prepared for Highland Wind LLC
Spring 2010										
2010	Bowers, Carroll Plantation, ME	20	188	Forested ridge	289	20-589	56	243	(131 m) 26%	Stantec Consulting Services Inc. 2010. Draft 2010 Spring Avian and Spring/Summer Bat Surveys for the Bowers Wind Project. Prepared for Champlain Wind Energy LLC.
2010	Bull Hill, T16 MD, ME	20	184	Forested ridge	387	43-879	48	217	(145 m) 38%	Stantec Consulting Services Inc. 2010. Spring 2010 Avian and Bat Survey Report for the Bull Hill Wind Project. Prepared for Blue Sky East Wind LLC.
Spring 2011										
2011	Antrim, Antrim, NH	30	284	Forested ridge	223	6-1215	44	305	(150 m) 30%	Stantec Consulting Services Inc. 2011. Spring 2011 Radar and Acoustic Survey Report for the Antrim Wind Energy Project. Prepared for Eolian Renewable Energy.

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

Appendix B

Bat survey results

Appendix B Table 1. Summary of acoustic bat data and weather during each survey night at the Access Tree detector – 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
04/07/11	0												**0**			1022	50
04/08/11	1												**0**			1025	38
04/09/11	1												**0**			1022	44
04/10/11	1												**0**	6	6	1021	57
04/11/11	1												**0**	13	13	1013	82
04/12/11	1		1			10				13			**24**	10	6	1021	50
04/13/11	1												**0**	7	2	1022	86
04/14/11	1												**0**	8	0	1024	74
04/15/11	1												**0**	6	-2	1033	46
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1												**0**	9	-1	1026	63
04/22/11	1									1			**1**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1					232				99			**331**	4	10	1016	72
04/25/11	1					7							**7**	4	8	1020	83
04/26/11	1		1		3	81				1	3		**89**	6	9	1018	96
04/27/11	1		1			54				9	3		**67**	10	17	1016	88
04/28/11	1		2			14				4	2		**22**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1												**0**	7	6	1027	45
05/02/11	1										1		**1**	5	12	1026	60
05/03/11	1				1	1				1	1		**4**	6	12	1021	69
05/04/11	1												**0**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1	1								2			**3**	9	10	1012	53
05/07/11	1	1								2			**3**	6	9	1011	65
05/08/11	1												**0**	6	8	1014	63
05/09/11	1										1		**1**	10	9	1016	46
05/10/11	1	1							1				**2**	8	8	1019	60
05/11/11	1		18			2				10	1		**31**	6	9	1021	74
05/12/11	1		35				1			1	2		**39**	4	10	1020	65
05/13/11	1		22										**22**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	1												**0**	8	7	1009	96
05/16/11	1												**0**	6	6	1016	96
05/17/11	1												**0**	7	8	1022	96
05/18/11	1												**0**	6	9	1023	97
05/19/11	1					3							**3**	4	12	1021	98
05/20/11	1		12			1					1		**14**	1	13	1017	98
05/21/11	1		2										**2**	4	9	1019	92
05/22/11	1					1	1			1			**3**	5	8	1022	94
05/23/11	1	1	2										**3**	8	14	1021	97
05/24/11	1		6			7	4		3	2	3		**25**	8	15	1009	88
05/25/11	1	1	1			15				3			**20**	7	16	1013	67
05/26/11	1		2			2				1	2		**7**	7	18	1014	76
05/27/11	1		3			2				1			**6**	7	19	1015	65
05/28/11	1		2			2	1				1		**6**	8	17	1019	92
05/29/11	1	2	3		1								**6**	11	20	1019	81
05/30/11	1	1	4			2	1			1	1		**10**	5	18	1020	67
05/31/11	1	1	2			2	1			1	1		**8**	10	19	1023	56
06/01/11													**0**	10	19	1020	76
By Species		**9**	**119**	**0**	**5**	**438**	**9**	**0**	**4**	**153**	**23**	**0**	**760**				
By Guild		**128**			**5**	**438**	**13**			**176**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 2. Summary of acoustic bat data and weather during each survey night at the N. Met High detector – 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	**Operational?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**	**Barometric Pressure (mb)**	**Relative Humidity (%)**
04/07/11	1												**0**			1022	50
04/08/11	1												**0**			1025	38
04/09/11	1												**0**			1022	44
04/10/11	1												**0**	6	6	1021	57
04/11/11	1												**0**	13	13	1013	82
04/12/11	1												**0**	10	6	1021	50
04/13/11	1												**0**	7	2	1022	86
04/14/11	1												**0**	8	0	1024	74
04/15/11	1												**0**	6	-2	1033	46
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1												**0**	9	-1	1026	63
04/22/11	1												**0**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1												**0**	4	10	1016	72
04/25/11	1												**0**	4	8	1020	83
04/26/11	1												**0**	6	9	1018	96
04/27/11	1												**0**	10	17	1016	88
04/28/11	1												**0**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1												**0**	7	6	1027	45
05/02/11	1												**0**	5	12	1026	60
05/03/11	1				1								**1**	6	12	1021	69
05/04/11	1				1								**1**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1												**0**	9	10	1012	53
05/07/11	1												**0**	6	9	1011	65
05/08/11	1												**0**	6	8	1014	63
05/09/11	1												**0**	10	9	1016	46
05/10/11	1												**0**	8	8	1019	60
05/11/11	1										1		**1**	6	9	1021	74
05/12/11	1												**0**	4	10	1020	65
05/13/11	1				1				1				**2**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	0												**0**	8	7	1009	96
05/16/11	0												**0**	6	6	1016	96
05/17/11	0												**0**	7	8	1022	96
05/18/11	0												**0**	6	9	1023	97
05/19/11	0												**0**	4	12	1021	98
05/20/11	0												**0**	1	13	1017	98
05/21/11	0												**0**	4	9	1019	92
05/22/11	0												**0**	5	8	1022	94
05/23/11	0												**0**	8	14	1021	97
05/24/11	0												**0**	8	15	1009	88
05/25/11	0												**0**	7	16	1013	67
05/26/11	0												**0**	7	18	1014	76
05/27/11	0												**0**	7	19	1015	65
05/28/11	0												**0**	8	17	1019	92
05/29/11	0												**0**	11	20	1019	81
05/30/11	0												**0**	5	18	1020	67
05/31/11	0												**0**	10	19	1023	56
By Species		**0**	**0**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**5**				
By Guild		**0**			**3**	**0**	**1**			**1**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 3. Summary of acoustic bat data and weather during each survey night at the N. Met Low detector – 2011.

		BBSH			HB	MYSP	RBTB			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN					
04/07/11	1												**0**			1022	50
04/08/11	1												**0**			1025	38
04/09/11	1												**0**			1022	44
04/10/11	1												**0**	6	6	1021	57
04/11/11	1												**0**	13	13	1013	82
04/12/11	1												**0**	10	6	1021	50
04/13/11	1												**0**	7	2	1022	86
04/14/11	1												**0**	8	0	1024	74
04/15/11	1												**0**	6	-2	1033	46
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1												**0**	9	-1	1026	63
04/22/11	1												**0**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1												**0**	4	10	1016	72
04/25/11	1												**0**	4	8	1020	83
04/26/11	1												**0**	6	9	1018	96
04/27/11	1												**0**	10	17	1016	88
04/28/11	1												**0**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1												**0**	7	6	1027	45
05/02/11	1				1								**1**	5	12	1026	60
05/03/11	1				1						2		**3**	6	12	1021	69
05/04/11	1												**0**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1												**0**	9	10	1012	53
05/07/11	1												**0**	6	9	1011	65
05/08/11	1				1						1		**2**	6	8	1014	63
05/09/11	1				1								**1**	10	9	1016	46
05/10/11	1												**0**	8	8	1019	60
05/11/11	1												**0**	6	9	1021	74
05/12/11	1					7				1			**8**	4	10	1020	65
05/13/11	1												**0**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	1												**0**	8	7	1009	96
05/16/11	1												**0**	6	6	1016	96
05/17/11	1												**0**	7	8	1022	96
05/18/11	1												**0**	6	9	1023	97
05/19/11	1												**0**	4	12	1021	98
05/20/11	1	1											**1**	1	13	1017	98
05/21/11	1												**0**	4	9	1019	92
05/22/11	1												**0**	5	8	1022	94
05/23/11	1		1										**1**	8	14	1021	97
05/24/11	1		6								2		**8**	8	15	1009	88
05/25/11	1												**0**	7	16	1013	67
05/26/11	1		1										**1**	7	18	1014	76
05/27/11	1	1	1							1			**3**	7	19	1015	65
05/28/11	1										1		**1**	8	17	1019	92
05/29/11	1	1			1								**2**	11	20	1019	81
05/30/11	1	13	16			17				10	5		**61**	5	18	1020	67
05/31/11	1										2		**2**	10	19	1023	56
By Species		**16**	**25**	**0**	**5**	**24**	**0**	**0**	**0**	**12**	**13**	**0**	**95**				
By Guild		**41**			**5**	**24**	**0**			**25**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 4. Summary of acoustic bat data and weather during each survey night at the Wetland Tree detector – 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	**Operational?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**	**Barometric Pressure**	**Relative Humidity (%)**
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1												**0**	9	-1	1026	63
04/22/11	1									1			**1**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1										1		**1**	4	10	1016	72
04/25/11	1												**0**	4	8	1020	83
04/26/11	1												**0**	6	9	1018	96
04/27/11	1	1	1								2		**4**	10	17	1016	88
04/28/11	1			1									**1**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1												**0**	7	6	1027	45
05/02/11	1									1			**1**	5	12	1026	60
05/03/11	1	1									1		**2**	6	12	1021	69
05/04/11	1												**0**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1									1	1		**2**	9	10	1012	53
05/07/11	1										1		**1**	6	9	1011	65
05/08/11	1												**0**	6	8	1014	63
05/09/11	1												**0**	10	9	1016	46
05/10/11	1												**0**	8	8	1019	60
05/11/11	1												**0**	6	9	1021	74
05/12/11	1				7						17		**24**	4	10	1020	65
05/13/11	1												**0**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	1												**0**	8	7	1009	96
05/16/11	1												**0**	6	6	1016	96
05/17/11	1												**0**	7	8	1022	96
05/18/11	1												**0**	6	9	1023	97
05/19/11	1												**0**	4	12	1021	98
05/20/11	1										1		**1**	1	13	1017	98
05/21/11	1												**0**	4	9	1019	92
05/22/11	1												**0**	5	8	1022	94
05/23/11	1												**0**	8	14	1021	97
05/24/11	1	1											**1**	8	15	1009	88
05/25/11	1	1											**1**	7	16	1013	67
05/26/11	1	1									2		**3**	7	18	1014	76
05/27/11	1				1						1		**2**	7	19	1015	65
05/28/11	1										2		**2**	8	17	1019	92
05/29/11	1									1			**1**	11	20	1019	81
05/30/11	1	1											**1**	5	18	1020	67
05/31/11	0												**0**	10	19	1023	56
By Species		**6**	**1**	**1**	**8**	**0**	**0**	**0**	**0**	**4**	**29**	**0**	**49**				
By Guild		**8**			**8**	**0**	**0**			**33**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 5. Summary of acoustic bat data and weather during each survey night at the Willard Trail detector – 2011.

		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**							
Night of	**Operational?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**	**Barometric Pressure**	**Relative Humidity (%)**
04/07/11	1												**0**			1022	50
04/08/11	1												**0**			1025	38
04/09/11	1												**0**			1022	44
04/10/11	1												**0**	6	6	1021	57
04/11/11	1												**0**	13	13	1013	82
04/12/11	1					1							**1**	10	6	1021	50
04/13/11	1												**0**	7	2	1022	86
04/14/11	1												**0**	8	0	1024	74
04/15/11	1												**0**	6	-2	1033	46
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1									1			**1**	9	-1	1026	63
04/22/11	1				1								**1**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1												**0**	4	10	1016	72
04/25/11	1												**0**	4	8	1020	83
04/26/11	1					1							**1**	6	9	1018	96
04/27/11	1												**0**	10	17	1016	88
04/28/11	1			1							1		**2**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1			1							3		**4**	7	6	1027	45
05/02/11	1				1								**1**	5	12	1026	60
05/03/11	1										1		**1**	6	12	1021	69
05/04/11	1												**0**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1								1	1	1		**3**	9	10	1012	53
05/07/11	1												**0**	6	9	1011	65
05/08/11	1									1			**1**	6	8	1014	63
05/09/11	1					1							**1**	10	9	1016	46
05/10/11	1												**0**	8	8	1019	60
05/11/11	1										1		**1**	6	9	1021	74
05/12/11	1				1								**1**	4	10	1020	65
05/13/11	1									1			**1**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	1												**0**	8	7	1009	96
05/16/11	1												**0**	6	6	1016	96
05/17/11	1												**0**	7	8	1022	96
05/18/11	1												**0**	6	9	1023	97
05/19/11	1												**0**	4	12	1021	98
05/20/11	1			3	1	1				1			**6**	1	13	1017	98
05/21/11	1	1											**1**	4	9	1019	92
05/22/11	1												**0**	5	8	1022	94
05/23/11	1												**0**	8	14	1021	97
05/24/11	1	1	6							1	2		**10**	8	15	1009	88
05/25/11	1	8	2								4		**14**	7	16	1013	67
05/26/11	1	1			2						4		**7**	7	18	1014	76
05/27/11	1						1				3		**4**	7	19	1015	65
05/28/11	1	2	2		3						6		**13**	8	17	1019	92
05/29/11	1	4	5							1	2		**12**	11	20	1019	81
05/30/11	1	9	4		1	2					5		**21**	5	18	1020	67
05/31/11	1	22	23		1	1				2	11		**60**	10	19	1023	56
06/01/11	1	6	7		13						17		**43**	10	19	1020	76
By Species		**54**	**49**	**5**	**24**	**7**	**1**	**0**	**1**	**9**	**61**	**0**	**211**				
By Guild		**108**			**24**	**7**	**2**			**70**							
		BBSH			HB	MYSP	RBTB			UNKN			**Total**				

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

Appendix B Table 6. Summary of acoustic bat data and weather during each survey night at the Willard Tree detector – 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	**Operational?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**	**Barometric Pressure**	**Relative Humidity (%)**
04/07/11	1												**0**			1022	50
04/08/11	1												**0**			1025	38
04/09/11	1												**0**			1022	44
04/10/11	1												**0**	6	6	1021	57
04/11/11	1												**0**	13	13	1013	82
04/12/11	1												**0**	10	6	1021	50
04/13/11	1												**0**	7	2	1022	86
04/14/11	1												**0**	8	0	1024	74
04/15/11	1												**0**	6	-2	1033	46
04/16/11	1												**0**	10	3	1033	75
04/17/11	1												**0**	10	1	1012	74
04/18/11	1												**0**	5	4	1017	61
04/19/11	1												**0**	6	2	1022	80
04/20/11	1												**0**	9	3	1021	92
04/21/11	1												**0**	9	-1	1026	63
04/22/11	1												**0**	7	2	1032	46
04/23/11	1												**0**	9	7	1029	83
04/24/11	1												**0**	4	10	1016	72
04/25/11	1												**0**	4	8	1020	83
04/26/11	1												**0**	6	9	1018	96
04/27/11	1												**0**	10	17	1016	88
04/28/11	1										1		**1**	8	11	1010	90
04/29/11	1												**0**	7	6	1010	63
04/30/11	1												**0**	7	7	1024	61
05/01/11	1												**0**	7	6	1027	45
05/02/11	1				9						7		**16**	5	12	1026	60
05/03/11	1												**0**	6	12	1021	69
05/04/11	1												**0**	10	3	1015	93
05/05/11	1												**0**	11	3	1012	77
05/06/11	1		1										**1**	9	10	1012	53
05/07/11	1					1							**1**	6	9	1011	65
05/08/11	1										1		**1**	6	8	1014	63
05/09/11	1									1			**1**	10	9	1016	46
05/10/11	1												**0**	8	8	1019	60
05/11/11	1					2							**2**	6	9	1021	74
05/12/11	1												**0**	4	10	1020	65
05/13/11	1												**0**	6	9	1016	70
05/14/11	1												**0**	6	11	1012	85
05/15/11	1												**0**	8	7	1009	96
05/16/11	1												**0**	6	6	1016	96
05/17/11	1												**0**	7	8	1022	96
05/18/11	1												**0**	6	9	1023	97
05/19/11	1				1								**1**	4	12	1021	98
05/20/11	1												**0**	1	13	1017	98
05/21/11	1				1								**1**	4	9	1019	92
05/22/11	1												**0**	5	8	1022	94
05/23/11	1												**0**	8	14	1021	97
05/24/11	1		1		95						30		**126**	8	15	1009	88
05/25/11	1				1								**1**	7	16	1013	67
05/26/11	1		1				1						**2**	7	18	1014	76
05/27/11	1					1							**1**	7	19	1015	65
05/28/11	1				7						2		**9**	8	17	1019	92
05/29/11	1	3	5		2						2		**12**	11	20	1019	81
05/30/11	1	1	3			1				1	8		**14**	5	18	1020	67
05/31/11	1	31	80		15						4		**130**	10	19	1023	56
06/01/11	1	21	20		1						1		**43**	10	19	1020	76
By Species		**56**	**111**	**0**	**132**	**5**	**1**	**0**	**0**	**2**	**56**	**0**	**363**				
By Guild		**167**			**132**	**5**	**1**			**58**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Summer and Fall 2011 Radar and Acoustic Bat Survey Report

for the Antrim Wind Energy Project
In Antrim, New Hampshire

Prepared for

Antrim Wind Energy, LLC
155 Fleet Street
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Prepared by

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Topsham, ME 04086

Stantec

December 2011

Executive Summary

Antrim Wind Energy, LLC is considering development of the Antrim Wind Energy Project (Project) located in Antrim, New Hampshire. The proposed Project would include wind turbines located on a series of ridgelines associated with Tuttle Hill (Figure 1). Stantec Consulting Services Inc. performed nocturnal radar surveys and acoustic bat surveys at the Project to characterize seasonal nocturnal migration and bat activity patterns at the Project. This report discusses the methods and results of the fall 2011 radar and acoustic bat surveys. Results of the spring 2011 radar and acoustic bat surveys are included in a separate report.

Nocturnal Radar Survey

To characterize fall nocturnal migration activity over the Project area, radar surveys were conducted on 30 nights between August 17 and October 8, 2011. Surveys were conducted from sunset to sunrise using X-band radar. Each hour of sampling included the recording of radar video files during horizontal and vertical operation. The radar was placed within a clearing for the meteorological (met) tower, Met Tower 1, located at the northeastern end of Tuttle Hill. This site provided adequate visibility of the surrounding airspace.

The overall mean passage rate for the entire fall survey period was 138 ± 9 targets per kilometer per hour (t/km/hr), and nightly passage rates varied from 4 ± 2 t/km/hr on October 1 to 538 ± 71 t/km/hr on August 26. The seasonal mean flight height of targets was 203 ± 1 meters (m; 666 ft [']) above the radar site, and nightly flight heights ranged from 147 ± 23 m to 266 ± 45 m. Mean flight direction through the Project area for the season was southwesterly at 217° ± 56°. Flight heights, when analyzed for the anticipated 150 m (492') height of the proposed turbines, indicate that the percentage of targets flying below turbine height ranged from 25 to 56 percent with a seasonal average of 40 percent.

In summary, results at the Project provide a sample of baseline migration activity over the Project area during fall 2011.

Acoustic Bat Survey

Stantec conducted summer/fall acoustic bat surveys between June 1 and October 23, 2011 to sample bat activity patterns and species composition within the Project area. Six Anabat® detectors were deployed during this period, collecting data for a total of 677 detector-nights over a period of 849 available calendar nights. Two detectors were deployed in the guy wires of an existing 60 m meteorological tower and the remaining four detectors were suspended from trees along forested corridors and adjacent to wetlands where bats would likely travel or forage.

The six detectors recorded a total of 35,450 bat call sequences yielding an overall detection rate of 52.4 bat call sequences per detector-night. Among sampling locations, detection rates ranged from 2.6 to 126.2 bat call sequences per detector-night. Typical of this type of survey, activity levels varied considerably among nights within the survey period and among detectors.

Bats within the big brown bat/silver-haired bat (BBSH) guild comprised the greatest overall percentage of detected call sequences (48%, n=17,006). The North Met Low detector recorded the majority of BBSH calls (47%). Other species such as hoary bats (*Lasiurus cinereus*) were detected at five of the six detectors, and species belonging to the *Myotis* guild and the eastern red bat/tri-colored bat guild were recorded by all six detectors. Summer/fall 2011 acoustic bat surveys documented variable activity levels within the Project area, although results suggest that activity was highest in July and August.

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

1.0 Introduction

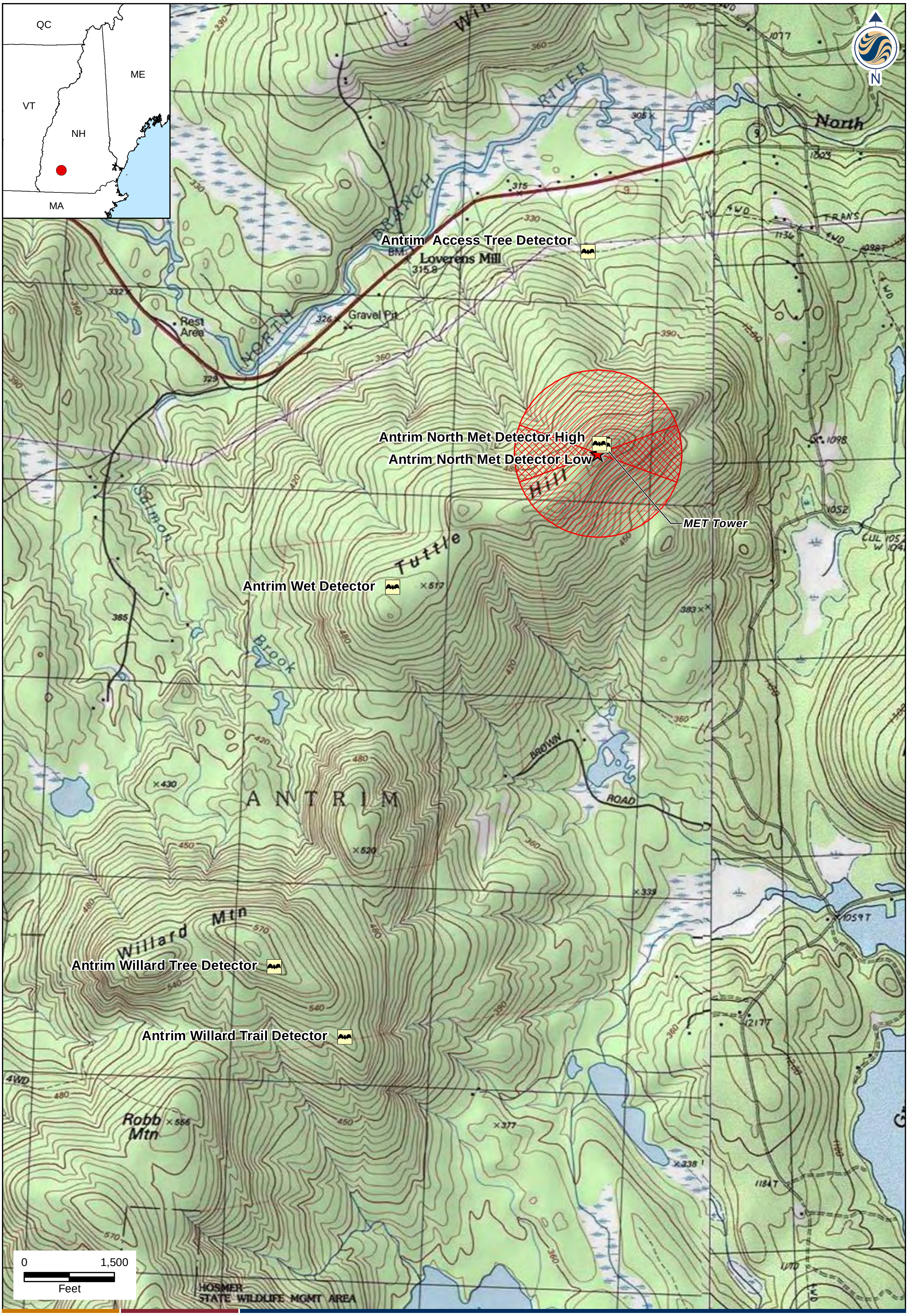
1.1 PROJECT BACKGROUND

Antrim Wind Energy, LLC (AWE) is considering development of the Antrim Wind Energy Project (Project) located in Antrim, New Hampshire (Project; Figure 1-1). The Project is in the preliminary stages of design and the layout of Project infrastructure, including turbines and access roads, has not been determined at this time. The proposed turbines are expected to have a maximum height of 150 meters (m) (492 feet [']).

As part of Project planning, AWE contracted Stantec Consulting Services Inc. (Stantec) to conduct fall 2011 nocturnal radar surveys, and acoustic bat surveys. Stantec developed a work plan for the Project that described survey scopes and methodologies and presented it to the New Hampshire Department of Fish and Game and the U.S. Fish and Wildlife Service at an introductory project meeting on June 21, 2011. The scope and methodology of these surveys are consistent with several other studies conducted recently at proposed wind projects in New Hampshire and the Northeast U.S. Results of the spring 2011 radar and acoustic bat surveys are included in a separate report. Mist nest surveys for bats also were conducted for the Project, and the results of these surveys are presented in a separate report.

1.2 PROJECT AREA DESCRIPTION

The Project is located along the edge of the Sunapee Uplands and Worcester/Monadnock Plateau ecogregions of New England (Griffith *et al*. 2009). The Sunapee Uplands is a transition zone from the Worcester/Monadnock Plateau and the typically cooler ecoregions to the north. The mountains within the Sunapee Uplands are generally of lower elevations than those mountains to the north, but higher in elevation than those found in the Worcester/Monadnock Plateau (Griffith *et al*. 2009). The mountains and hills of the Sunapee Uplands are mostly between 305 to 610 m (1000 to 2000') in elevation, but range from 152 m (500') to more than 914 m (3000'). This ecoregion includes many streams and small lakes. Northern hardwood forests dominated by sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*) and yellow birch (*Betula alleghaniensis*) are common. Also present, but less common are eastern hemlock dominated (*Tsuga canadensis*) forests, oak (*Quercus* spp.) dominated forests, and forests dominated by spruce (*Picea* sp.) and balsam fir (*Abies balsamea*) (Griffith *et al*. 2009). The Worcester/Monadnock Plateau includes the north-central portion of Massachusetts and the south-central portion of New Hampshire. In many basic characteristics including elevation and climate this ecoregion is similar to colder and more mountainous ecoregions to the north. Elevations within this ecoregion range from 152 to 427 m (500 to 1400') with some peaks exceeding 610 m (2000'). Forested uplands include transition hardwoods such as maple-beech-birch-oak-hickory forests and northern hardwoods such as the maple-beech-birch forests (Griffith *et al*. 2009). Forested wetlands are common within the Worcester/Monadnock Plateau.



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Legend

- Met Tower
- Radar Survey Location
- Bat Detector Location
- Alignment Vertical Radar Sweep
- Horizontal Radar Detection Range

Client/Project
TRC Companies, Inc.
Antrim Wind Energy Project
Antrim, New Hampshire

Figure No.
1-1

Title
2011 Survey Location Map
11/22/2011

00689_1-1_SurveyLocation.mxd

The Project area is associated with Tuttle Hill, which has an elevation of approximately 423 m (1,390'). The Project area is dominated by mixed forests with coniferous species more common along the ridge tops and deciduous species dominant along the slopes. Common tree species present include paper birch (*Betula papyrifera*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), northern red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), maple (*Acer* spp.), and eastern white pine (*Pinus strobus*). Forest management activities have occurred throughout the area in the recent past and are still ongoing. Evidence of these activities includes numerous skidder trails and stumps throughout the Project area.

2.0 Nocturnal Radar Survey

2.1 INTRODUCTION

Nocturnal radar surveys were conducted in the Project area to sample and characterize nocturnal migration patterns in fall 2011. The majority of North American passerines (songbirds) migrate at night. This migratory strategy may have evolved to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995); additionally, cooler nighttime temperatures may help regulate body temperature during more active, flapping flight and reduce predation risk while in flight (Alerstam 1990, Kerlinger 1995). Documenting the patterns of nocturnal migrants requires the use of radar or other non-visual technologies. The goal of the surveys was to sample and characterize nocturnal migration at the Project area including passage rate, flight direction, and flight altitude.

2.2 DATA COLLECTION METHODS

Fall radar surveys were conducted from sunset to sunrise on 30 nights between August 17 and October 8, 2011. The radar location in fall 2011 was the same as in spring 2011; the radar was placed within the clearing for the meteorological (met) tower, Met Tower 1, located at the northeastern end of Tuttle Hill (Figures 1-1, 2-1). This site has an elevation of approximately 423 m (1,390').

Efforts were made to maximize the airspace sampled by elevating the radar antenna approximately 6 m (20') above ground level. Elevating the antenna helps to reduce the amount of the radar beam reflected back by surrounding vegetation and topography, which can cause ground clutter interference on the radar screen. The elevated radar limited ground clutter obstructions and resulted in an adequate view of the surrounding airspace.

Figure 2-1. Photo of the radar on the ridgeline of Tuttle Hill.

2.2.1 Radar Data

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

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

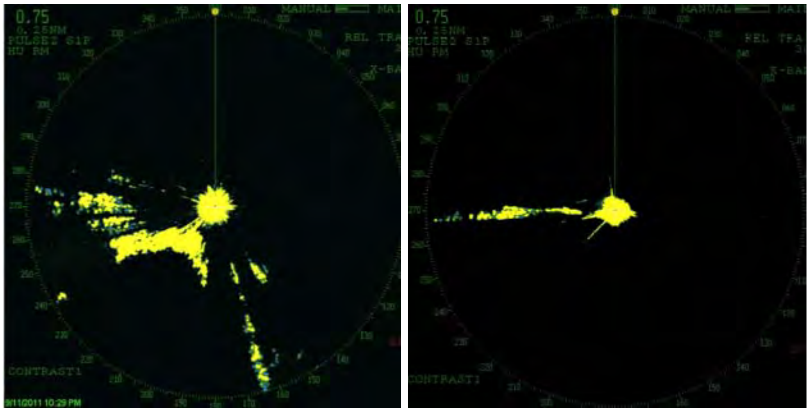

Figure 2-2. Screenshots from actual radar files showing ground clutter in horizontal mode (left) and vertical mode (right). Although the radar records three-dimensional space, it is translated by the radar screen as a two dimensional representation, which can cause targets to be obscured from view.

However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by "hiding" clutter-causing objects from the radar (Figure 2-3). These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen. Targets traveling into and out of the ground clutter areas can be tracked. The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

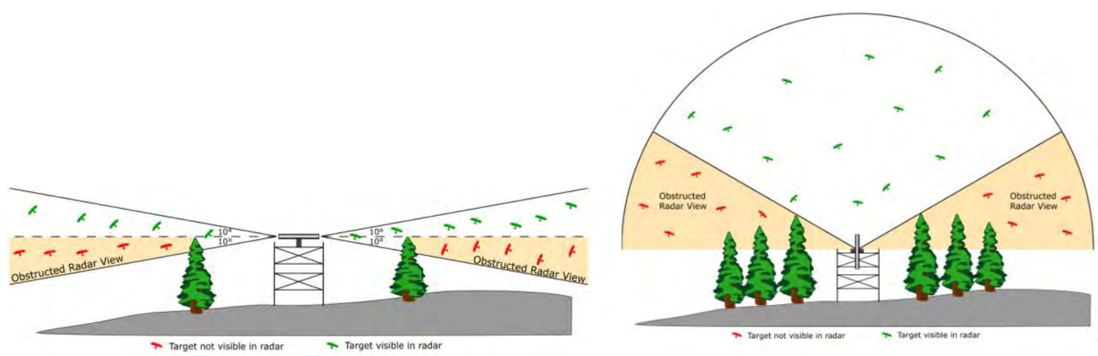

Figure 2-3. An example of a tree of a specific height that causes ground clutter, but "masks" a section of the radar beam, allowing adequate detection of targets beyond it (left). The effect of ground clutter on target detection in vertical mode is also shown (right).

The anti-rain function of the radar must be turned down to detect small songbirds and bats. Since radar surveys cannot be conducted during active rainfall, survey nights targeted nights without steady rain. To characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers, mist, or fog were sampled.

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

In vertical mode, the radar unit is tilted 90° to survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20° radar beam (Figure 2-4). .

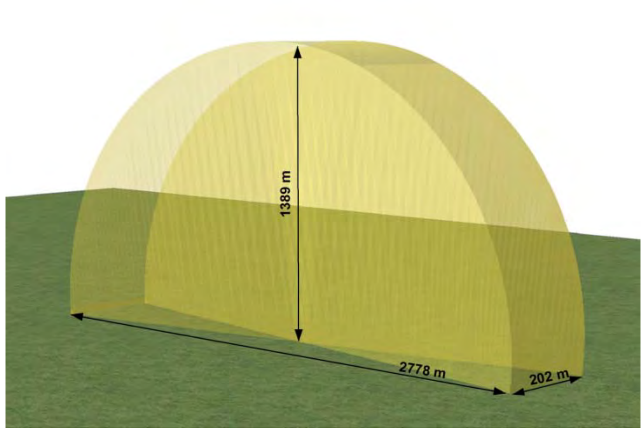

Figure 2-4. Detection range of the radar in vertical mode.

The radar was operated at a range of 1.4 km (0.75 nautical miles) to ensure detection of small targets. When radar is operated at ranges greater than 1.4 km, the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, which limits the detection and observable movement pattern of individual targets. Consequently, 1.4 km is the appropriate detection range for this type of study.

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

2.2.2 Weather Data

Temperature, wind speed and direction were recorded by the on-site met tower[2]. Additionally, to consider the atmospheric influences on migration, regional surface weather map images were interpreted to determine the dates that pressure systems (high, low, or none) moved through the region. Surface weather maps, prepared by the National Centers for Environmental Prediction,

[2] Weather data for October 7 and October 8 were compiled from wunderground.com (Weather Underground 2011).

the Hydro-meteorological Prediction Center, and the National Weather Service, were downloaded daily during the survey window.

2.3 DATA ANALYSIS METHODS

2.3.1 Radar Data

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

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

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percent of targets flying below 150 m (492'), the approximate maximum height of the proposed wind turbines with blades, was also calculated nightly and for the entire survey period.

2.3.2 Weather Data

The mean nightly temperature, wind speed, and wind direction were calculated from the onsite met tower for each night of survey.

2.4 RESULTS

Radar surveys were conducted during 30 nights between August 17 and October 8, 2011 (Appendix A Table 1) resulting in 327 total hours surveyed.

2.4.1 Passage Rates

Nightly passage rates varied from 4 ± 2 targets per kilometer per hour (t/km/hr) on October 1 to 538 ± 71 t/km/h on August 26, and the overall passage rate for the entire survey period was 138 ± 9 t/km/hr (Figure 2-5; also Appendix A Table 1). Individual hourly passage rates varied between nights and throughout the season, and ranged from 0 t/km/hr during various hours of various nights to 839 t/km/hr during the 2nd hour of August 26 (Appendix A Table 2). For the entire season, mean passage rates increased rapidly between the 1st and 3rd hours after sunset, then gradually declined until sunrise (Figure 2-6).

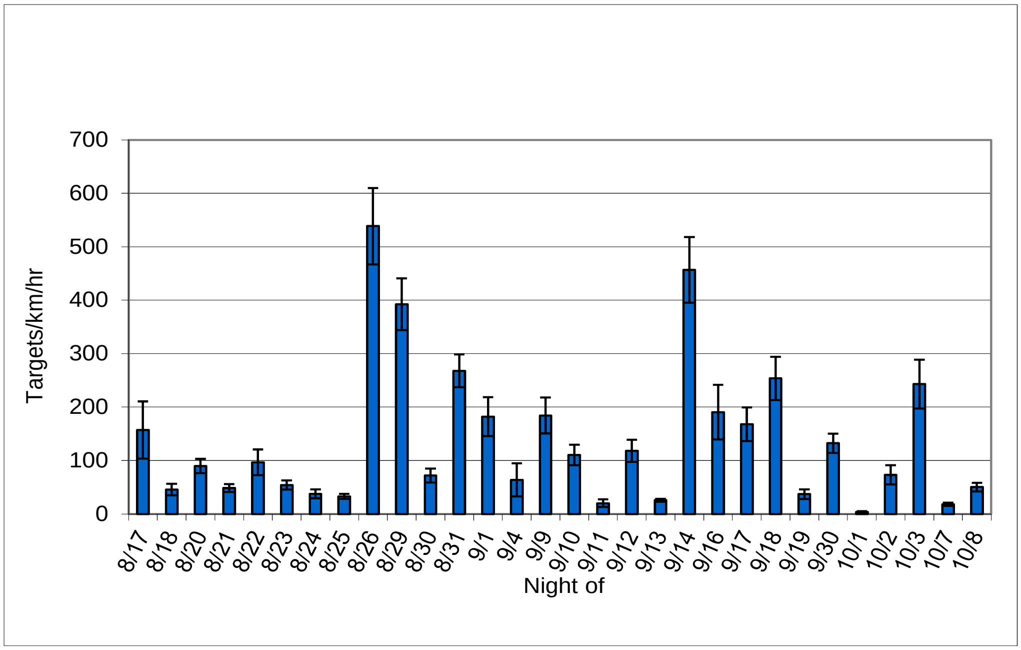

Figure 2-5. Nightly passage rates observed during fall 2011 at the Antrim Wind Project (error bars ± 1 SE).

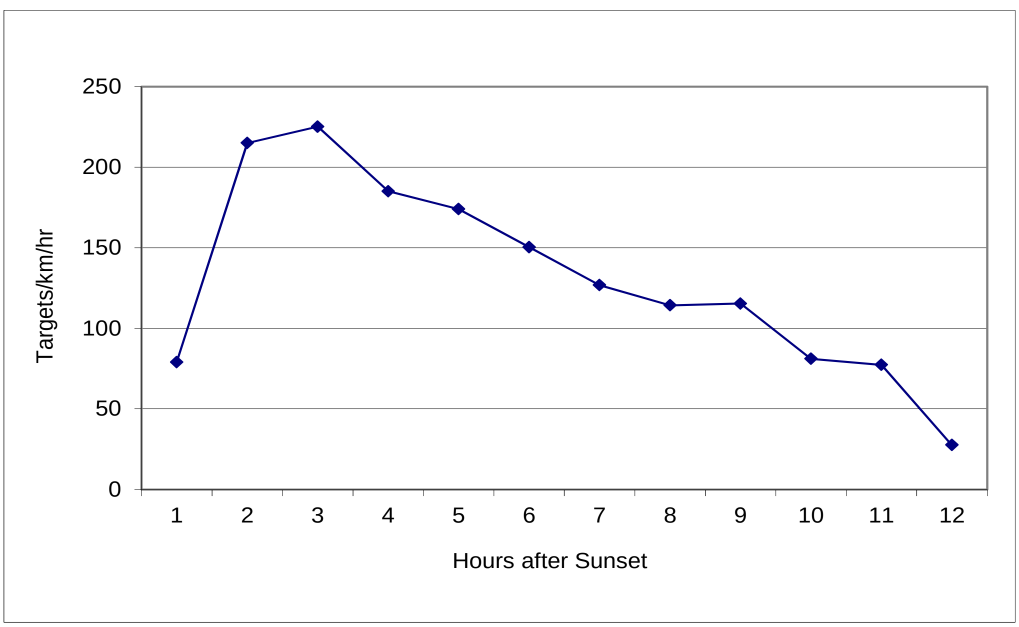

Figure 2-6. Hourly passage rates for entire season during fall 2011 at the Antrim Wind Project.

2.4.2 Flight Direction

Mean flight direction through the Project area was 217° ± 56° (Figure 2-7). Overall, the mean flight direction was southwest, but varied between nights (Appendix A Table 3).

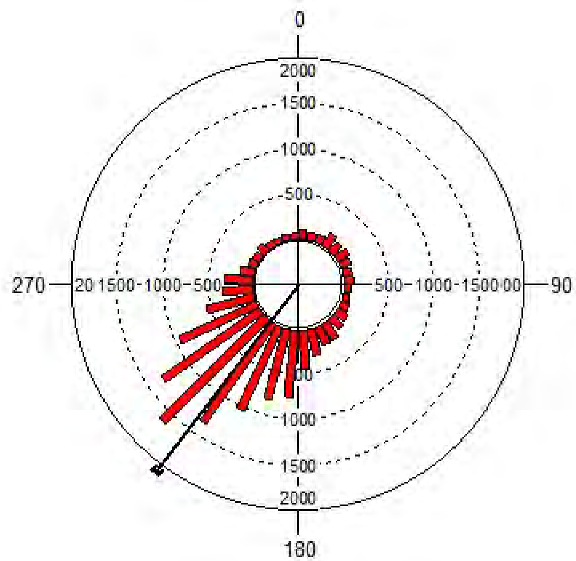

Figure 2-7. Mean flight direction for the entire season during fall 2011 at the Antrim Wind Project (the bracket along the margin of the histogram is the 95% confidence interval).

2.4.3 Flight Altitude

The seasonal mean flight height of targets was 203 ± 1 m (666') above the radar site. The average nightly flight height ranged from 147 ± 23 m on August 24 to 266 ± 45 m on September 9 (Figure 2-8; Appendix A Table 4). The percent of targets observed flying below 150 m was 40 percent for the season and varied nightly from 25 percent (169 targets) on September 9 to 56 percent (74 targets) on August 18 (Figure 2-9). Figure 2-10 below shows the distribution of individual nightly flight heights of all targets recorded relative to the proposed turbine height. The yellow boxes seen in Figure 2-10 depict the middle 50 percent of targets. The error bars depict the statistical outliers, or 25 percent of targets above and below the middle 50 percent of targets. The horizontal line within each box represents the median flight height value for that night. For the entire season, the mean hourly flight heights were lowest during 1st and 10th hour after sunset (Figure 2-11).

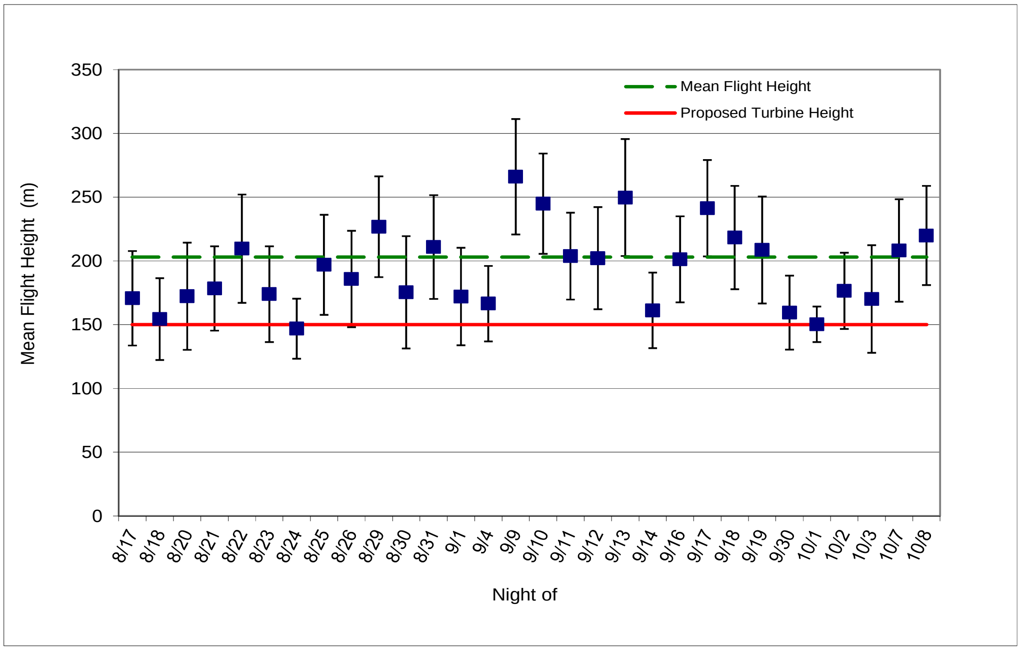

Figure 2-8. Mean nightly flight height of targets during fall 2011 at the Antrim Wind Project (error bars ± 1 SE).

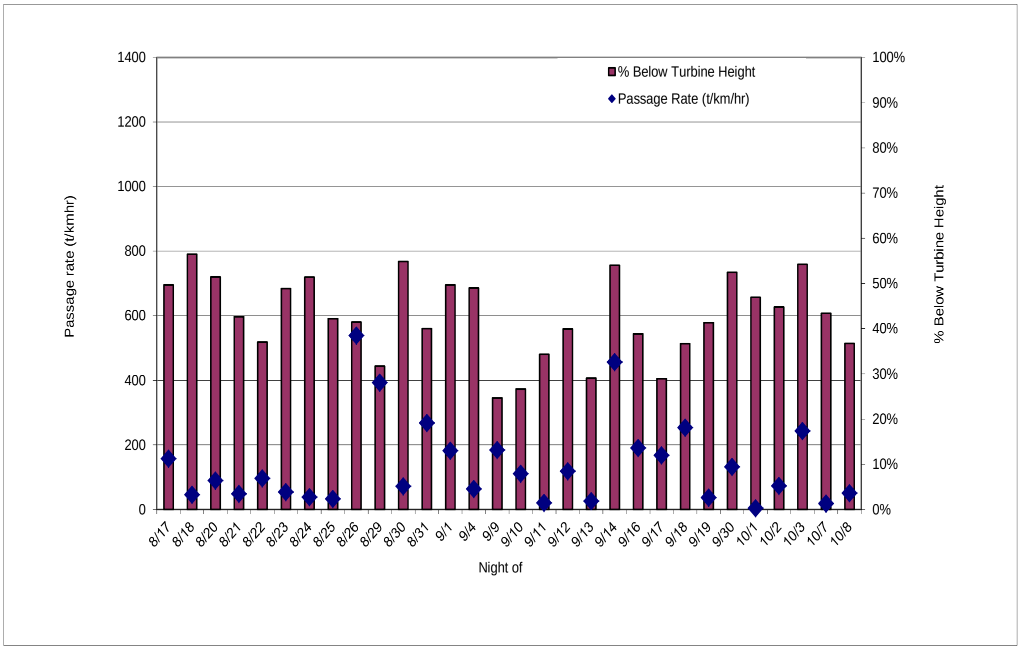

Figure 2-9. Percent of targets observed flying below a height of 150 m (492') during fall 2011 at the Antrim Wind Project.

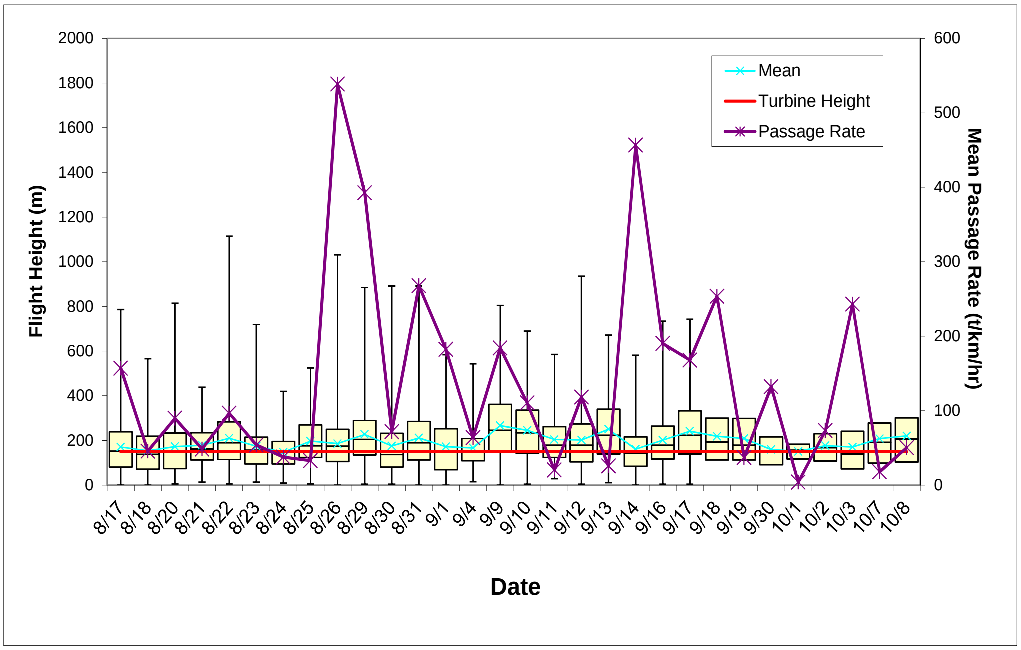

Figure 2-10. Flight height whisker plot depicting the vertical distribution of targets for each survey night during fall 2011 at the Antrim Wind Project.

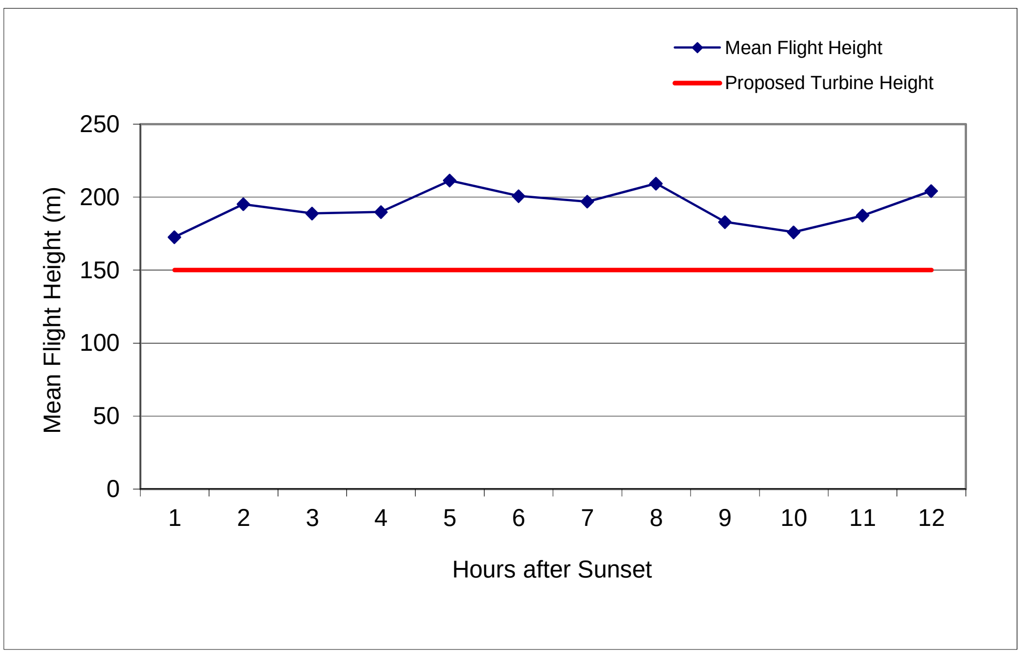

Figure 2-11. Hourly target flight height distribution during fall 2011 at the Antrim Wind Project.

2.4.4 Weather Data

During the nights surveyed from August 17 to October 8, average nightly wind speed varied between 2 and 11 meters per second (m/s), with an overall mean of 7 m/s (Figure 2-12). Mean nightly temperatures gradually decreased throughout the survey period, and varied between 5 °C and 20 °C, with an overall mean of 14 °C (Figure 2-13).

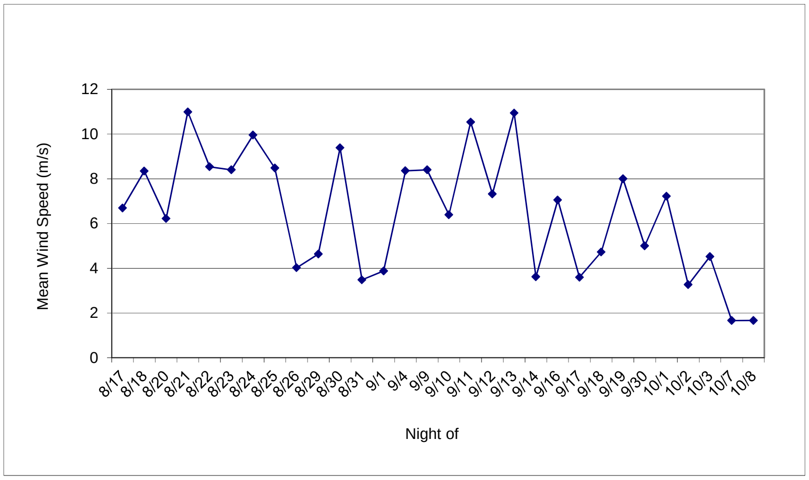

Figure 2-12. Nightly mean wind speed (m/s) during fall 2011 at the Antrim Wind Project. (nightly maximum and minimum temperatures not available)

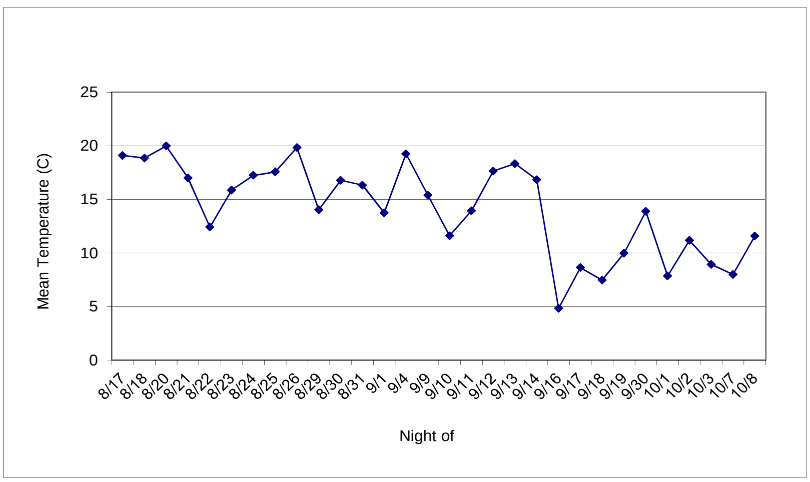

Figure 2-13. Nightly mean temperature (Celsius) during fall 2011 at the Antrim Wind Project.

2.5 DISCUSSION

Radar surveys are designed and implemented to sample migration activity over a specific location in the Project area to provide baseline pre-construction site data. The results of this nocturnal radar survey provide a snapshot of avian migration in space and time; in this case, over the Project area during dates typical for fall migration in New Hampshire. Fall radar surveys in the Project area documented patterns in nocturnal migration similar to those documented at recent radar surveys conducted at other locations in New Hampshire and the Eastern US (Appendix A Table 5). These include highly variable passage rates between nights, a generally southward flight direction, and flight heights typically averaging over 200 m.

The radar had somewhat limited visibility of the airspace west and south of the radar site, but was still capable of detecting targets within the majority of its range. Nightly mean passage rates were highly variable, ranging from 4 ± 2 to 538 ± 71 t/km/hr. As in spring 2011, average nightly passage rates were below 200 t/km/hr on most nights of the survey period (Figure 2-5). This indicates that nocturnal migration was pulsed, presumably related to seasonal timing and regional weather conditions. The average passage rate at the Project (138 ± 9 t/km/hr) is at the low end of the range of results of other radar studies conducted in the East (91 t/km/hr to 811 t/km/hr; Appendix A Table 5). Comparing the Project's passage rates to similar surveys conducted at other sites must be done with caution, as differences in passage rates are due in large part to differences in radar view among sites and varying weather patterns between years. Even at the same location in the same year, the radar's view may change between seasons depending on changes in the landscape (i.e. leaf off versus leaf out conditions).

The emerging body of studies characterizing nocturnal migrant movements shows a relatively consistent pattern in flight altitude, with most targets appearing to fly at altitudes of several hundred meters or more above the ground (Figure 2-8; Appendix A Table 5). The average flight height (203 ± 1 m) is the lowest average flight height recorded at other radar studies conducted in the East (287 m to 583 m), however is above the proposed turbine height (150 m). Comparison of flight height between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. The nightly average flight height was below the proposed turbine height on one night (August 24) and at the proposed turbine height on one night (October 1). Passage rates on these nights were relatively low: 38 t/km/hr on August 24 and 4 t/km/hr on October 1.

Nightly variation in the magnitude and flight characteristics of nocturnal migrants is not uncommon and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). A low pressure system bringing some rain occurred on the night with the lowest average passage rate (4 t/km/hr on October 1); this night also had a relatively low average temperature of 8°C. On the night with the highest passage rate (538 t/km/hr on August), a high pressure systems was present, average temperature was relatively high (20°C respectively), and average wind speed was relatively low (4 m/s).

In summary, average passage rates at the Project are within the range of results recorded at other radar studies conducted in New Hampshire and the East, and average flight height was at the low end of the range of flight heights. These radar results provide a sample of baseline migration activity over the Project area during fall 2011.

3.0 Acoustic Bat Survey

3.1 INTRODUCTION

Acoustic sampling of bat activity has become a standard pre-construction survey for proposed wind-energy development (Kunz *et al.* 2007). Although acoustic surveys are associated with several major assumptions (Hayes 2000) and results cannot be used to determine the number of bats inhabiting an area or determine the number of bats which will be killed post-construction, acoustic surveys can provide insight into seasonal patterns in activity levels and examine how weather conditions influence bat activity. While these data may be useful in predicting trends in post-construction mortality rates, the current lack of data on this topic precludes quantitative prediction of risk. The object of summer/fall acoustic surveys at the Project were (1) to document bat activity patterns from June 1 through October 20 in airspace near the rotor zone of the proposed turbines, at an intermediate height, and near the ground; and (2) to document bat activity patterns in relation to weather factors including wind speed, temperature, and relative humidity.

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*) (BCI 2001). Of these eight species, the eastern small-footed bat is state-listed as endangered with a rank of S1 ("Critically Imperiled"[3]), and five species (tri-colored bat, eastern red bat, silver-haired bat, hoary bat, and northern long-eared bat) are state-listed as Species of Special Concern. All six state-listed species are also listed as Species of Greatest Conservation Need under New Hampshire's Wildlife Action Plan (New Hampshire Fish and Game Department 2005).

3.2 DATA COLLECTION METHODS

3.2.1 Acoustic Detector Site Selection

Anabat SDI and SD2 detectors (Titley Electronics Pty Ltd.) were used for the duration of the summer/fall 2011 acoustic bat survey. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in the Project area. Anabat detectors were programmed to turn on and off on a

[3] A state ranking of S1 is assigned to species characterized as critically imperiled because of extreme rarity (generally one to five occurrences) or because some factor of its biology makes it particularly vulnerable to extinction.

daily basis to sample at least the period between sunset and sunrise, and stored recorded bat call sequences on removable 1 gigabyte (GB) compact flash cards. Anabat detectors are frequency division detectors, dividing the frequency of echolocation sounds made by bats by a factor of 16, then recording these sounds for subsequent analysis. The audio sensitivity setting of each Anabat system was set between six and seven (on a logarithmic scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33').

Each Anabat detector was powered by a 12-volt gel battery charged by a solar panel. Each solar-powered Anabat system was deployed in waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing suspends the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, the microphone was positioned within a 90 degree PVC elbow on the bottom of the waterproof enclosure, allowing the microphone to record the airspace horizontally surrounding the detector while minimizing acoustic signal loss.

The six Anabat detectors were deployed in the Project area between April 7 and April 16, and collected data through October 20 (the Access Tree detector recorded data until October 23 due to the demobilization schedule). Results from the spring migration season were presented in the Spring 2011 Radar and Acoustic Bat Survey Report dated October 2011. Two detectors were deployed in the guy wires of the existing 60 m (197') met tower at heights of approximately 15 and 30 m (49 and 98') above ground level, and the remaining four detectors were deployed in trees throughout the Project area at heights of approximately 5 to 10 m (16 and 33') above ground level (agl) (Figures 3-1 to 3-3). Table 3-1 provides information on location and placement of detectors as well as surrounding habitat. Maintenance visits were conducted approximately every two weeks to check the condition of the detectors and to download data to a computer for archiving and subsequent analysis.

Table 3-1. Habitat descriptions of locations sampled during fall 2011 acoustic bat surveys at the Antrim Wind Project.

Detector Name	Elevation (m)	Height (m agl)	Habitat Notes
Willard Tree	563	5	Detector located 10 m from the edge of a 50 m diameter opening in an even-aged spruce/red maple forest with open understory, 15 m surrounding canopy height. Herbaceous vegetation and scattered trees in opening.
Willard Trail	522	5	Detector located 15 m from the edge of a 50 m clearing in an even-aged oak/maple forest with open understory.
Acces Tree	355	10	Detector suspended above intersection of forested trails 30 m from a transmission line corridor. Surrounding canopy (beech, birch, maple) 20 m tall with dense shrub understory.
Wetland	525	5	Detector located within a small wetland opening surrounded by uneven aged red maple/conifer forest.
N Met High	536	30	Detector deployed as high as possible in the guy wires of the met tower. Tower clearing surrounded by conifer-dominated forest.
N Met Low	536	15	Detector deployed in the guy wires of the met tower. Tower clearing surrounded by conifer-dominated forest.

Figure 3-1. Photos of the Willard Tree (left) and Willard Trail (right) bat detectors.

Figure 3-2. Photos of the Access Tree (left) and Wetland (right) bat detectors.

Figure 3-3. Photos of the North Met High (left) and Low (right) bat detectors.

3.3 DATA ANALYSIS METHODS

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

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

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

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

Bat call sequences were individually marked and categorized by species group, or “guild” based on visual comparison to reference calls. Relatively accurate identification of bat species can be attained by visually comparing recorded call sequences of sufficient length to bat call reference libraries (O’Farrell *et al*. 1999, O’Farrell and Gannon 1999). Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, as well as other bat researchers. However, due to the similar call signatures of several species, classified calls were categorized into five guilds[4] that reflect the bat community in the region of the Project area:

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

- **Myotis (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for the three species in this genus that occur in New Hampshire, these characteristics are not sufficiently consistent to be relied upon for species identification at all times when using Anabat recordings.

[4] Gannon *et al.* 2003 categorized bats into guilds based upon similar minimum frequency and call shape. These guilds were: Unidentified, Myotis, LABO-PISU and EPFU-LANO-LACI. To report the activity of the migratory hoary bat, it was placed into a separate guild.

- **Eastern red bat/tri-colored bat[5] (RBTB)** – Eastern red bats and tri-colored bats. These two species can produce distinctive calls; however, significant overlap in the call pulse shape, frequency range, and slope can also occur.

- **Big brown/silver-haired bat (BBSH)** – Big brown and silver-haired bats. The call signatures of these species commonly overlap and are included as one guild in this report.

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

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

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

3.3.1 Weather Data

Temperature, and wind speed data were recorded by the on-site met tower at 10-minute intervals. For this report, met tower data was available for the survey period between June 1 and October 5, 2011. Daily wind speed and temperature data from October 6 through October 20 were compiled from the weather station in Hillsborough, New Hampshire approximately nine miles northeast of the Project (The Weather UnderGround, Inc. [c2008], accessed December 1, 2011). Weather data from the met tower was summarized on a nightly basis and weather data from the Hillsborough weather station was summarized on a daily basis. Weather data was compared to nightly bat activity levels using a scatterplot and linear correlation analysis.

3.4 RESULTS

3.4.1 Timing of Activity

During the 67-night survey period (June 1 through October 23), detectors surveyed a total of 677 detector-nights out of 849 available calendar-nights (80%; Table 3-2). All detectors suffered relatively short periods of equipment malfunction. The Wetland detector suffered the highest amount of data loss and operated for 85 of the 141 calendar nights (60%). The breaks in recording occurred from June 1 to July 12, and October 6 to October 20. The loss of data was a result of multiple equipment failures in conjunction with an improperly formatted memory

[5] The scientific and common name of the eastern pipistrelle (*Pipistrellus subflavus*) has been changed to the tri-colored bat (*Perimyotis subflavus*).

card. The initial problem was corrected during a July 13 maintenance check, and the second failure was discovered during detector retrieval at the end of the fall survey.

Combined, detectors recorded a total of 35,450 bat call sequences during the summer/fall survey period (Table 3-2). Individual detectors recorded between 224 sequences (Wet Tree) and 11,989 sequences (North Met Low [N Met Low]) during the summer/fall survey period; detection rates ranged from 2.6 sequences per detector-night at the Wet Tree detector to 126.2 sequences per detector-night at the N Met Low detector. The overall detection rate of all detectors combined was 52.4 sequences per detector-night during the summer/fall 2011 survey period (Table 3-2).

Table 3-2. Summary of bat detector field survey effort and results, Antrim Wind Project, Summer/Fall 2011.

Location	Dates Deployed	Calendar Nights	Detector-Nights*	Recorded Sequences	Detection Rate **	Maximum Sequences recorded ***
Access Tree	June 1 - Oct 23	144	134	7039	52.5	304
N Met High	June 1 - Oct 20	141	127	585	4.6	132
N Met Low	June 1 - Oct 20	141	95	11989	126.2	749
Wet Tree	June 1 - Oct 20	141	85	224	2.6	25
Willard Trail	June 1 - Oct 20	141	113	7143	63.2	449
Willard Tree	June 1 - Oct 20	141	123	8470	68.9	415
Overall Results		***849***	***677***	***35450***	***52.4***	--

* One detector-night is equal to a one detector successfully operating throughout the night.
** Number of bat echolocation sequences recorded per detector-night.
*** Maximum number of bat passes recorded from any single detector for a detector-night.

Acoustic bat activity was sporadic throughout the survey period, but the number of nights with recorded bat activity peaked between July and August (Table 3-3). By detector, acoustic activity was detected on the greatest percentage of detector nights (percent of nights surveyed) at the Willard Tree detector (92%), followed by the Willard Trail detector (90%). The Access Tree detector recorded acoustic bat activity on the lowest percentage of nights (50%) sampled during the survey period. Nightly timing of acoustic activity varied among nights and detectors, although overall timing peaked during the first hour past sunset and declined steadily until sunrise (Figure 3-4).

Table 3-3. Percent of nights with acoustic activity by month and overall, Antrim Wind Project, Summer/Fall 2011*

Detector	June	July	August	September	October	Detector Overall
Access Tree	97% (29/30)	100% (20/20)	100% (31/31)	87% (26/30)	35% (8/23)	**50% (58/116)**
N Met High	33% (9/27)	74% (14/19)	74% (23/31)	70% (21/30)	25% (5/20)	**57% (72/127)**
N Met Low	77% (23/30)	100% (31/31)	95% (20/21)	0% (0/0)	38% (5/13)	**83% (79/95)**
Wetland Tree	0% (0/0)	95% (18/19)	90% (28/31)	7% (2/30)	20% (1/5)	**58% (49/85)**
Willard Trail	67% (20/30)	100% (21/21)	100% (31/31)	100% (30/30)	0% (0/1)	**90% (102/113)**
Willard Tree	73% (22/30)	100% (31/31)	100% (31/31)	93% (28/30)	100% (1/1)	**92% (113/123)**
Monthly Overall	**70% (103/147)**	**96% (135/141)**	**93% (164/176)**	**71% (107/150)**	**32% (20/63)**	

*% Nights with activity (# nights with activity/# nights surveyed)

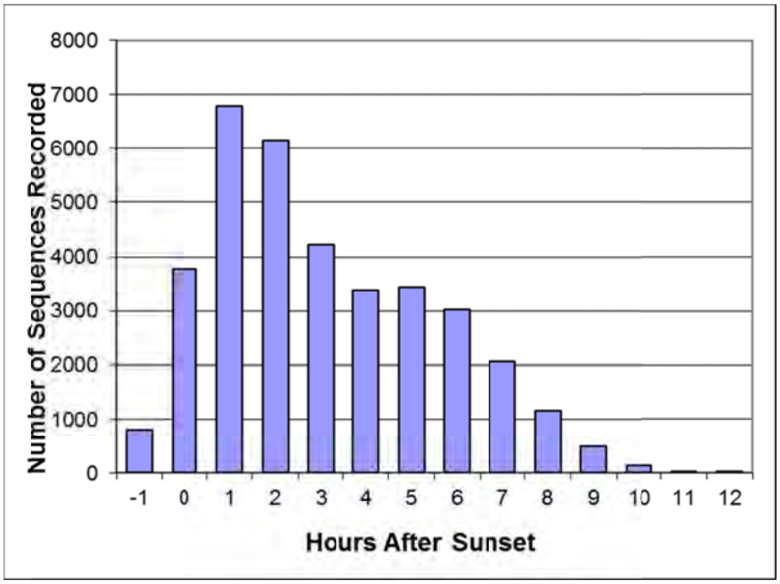

Figure 3-4. Hourly bat call sequence detections during summer/fall 2011 surveys at the Antrim Wind Project.

The two graphs in Figure 3-4 compare the percentage of nights each month with species occurrence, and species detection rates by month. Monthly detection rates varied between species, and peaks in activity may indicate periods of migration through the Project area (Figure 3-4, right). Big brown bats (EPFU), *Myotis* species (MYSP) and red bats (LABO) were detected most consistently throughout the survey period, and the timing of peak detection rates for these species varied by month. Hoary bats (LACI), silver-haired bats (LANO), and tri-colored bats (PESU) did not show the same consistent presence (Figure 3-4, left). Although not discernible at the inclusive scale used in Figure 3-4 (left), the highest monthly detection rate for both silver haired bats and tri-colored bats occurred in September. The highest monthly detection rate for hoary bats occurred in June. To highlight species-specific trends, calls identified to guild were not included in these figures.

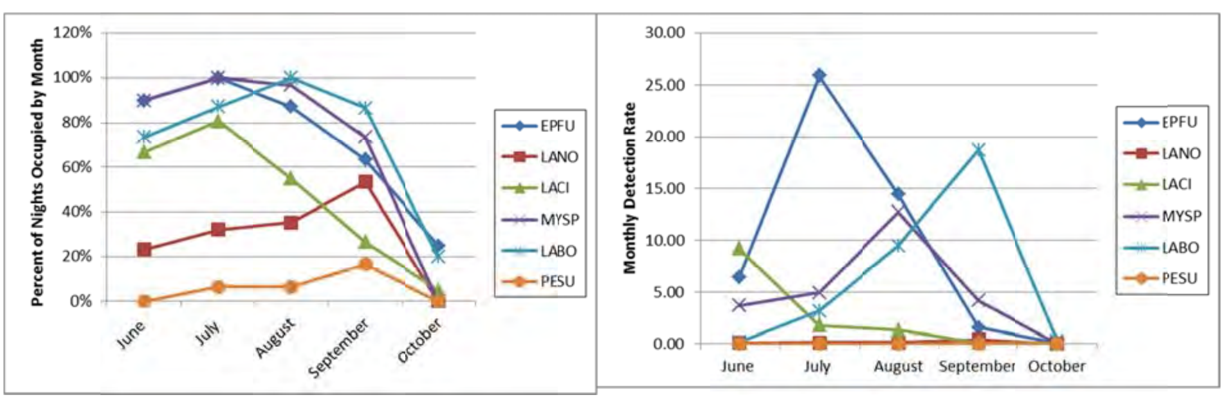

Figure 3-4. Species specific percent of nights occupied by month (left) and monthly detection rate of individual bat species (right) during summer/fall 2011 surveys at the Antrim Wind Project.

3.4.2 Species Composition

Bats within each of the defined guilds were identified during analysis. Calls of species in the big brown bat/silver-haired bat (BBSH) guild were the most common, comprising 48 percent of the total calls recorded (Table 3-4). Most call sequences within the BBSH guild were identified as big brown bats (43%) or big brown/silver-haired bats (56%), and only a small fraction were classified as silver-haired bats (1%). Twenty percent of call sequences were classified as "unknown" due to their relatively short length or quality. Within the Unknown guild, the majority of calls were classified as low-frequency calls (60%), with high-frequency unknown calls not as frequently identified (40%). The eastern red bat/tri-colored bat (RBTB) guild was the next most commonly identified guild, comprising 15.4 percent of the total calls recorded. Within the RBTB guild, eastern red bats were the most common call identified to species (91%), and a small fraction of the calls in this guild were identified as tri-colored bat calls (0.1%). Hoary bats comprised five percent of the total bat call sequences recorded and were detected at all detectors except the Wetlands Tree detector (Table 3-4).

Table 3-4. Distribution of detections by guild for detectors, Antrim Wind Project, Summer/Fall 2011.

Detector	Guild					Total
	BBSH	HB	MYSP	RBTB	UNKN	
Access Tree	2,499	5	3,302	245	988	7,039
N Met High	302	13	13	14	243	585
N Met Low	7,997	44	429	533	2,986	11,989
Wet Tree	79	0	35	11	99	224
Willard Trail	3,394	118	87	1,825	1,719	7,143
Willard Tree	2,735	1,671	238	2,834	992	8,470
Total	**17,006**	**1,851**	**4,104**	**5,462**	**7,027**	**35,450**
Guild Composition %	**48.0%**	**5.2%**	**11.6%**	**15.4%**	**19.8%**	

Species composition differed among detectors. *Myotis* species were most common at the Access Tree detector where they comprised the 47 percent of bats detected. Although the *Myotis* species were the most commonly recorded guild and represented a majority of calls at the Access Tree detector, they represented 16 percent of all calls recorded at the Wet Tree detector and less than five percent of calls at the remaining detectors. Unknown bats comprised between 12 and 44 percent of recorded call sequences by detector. The highest percentage of unknown call sequences was recorded at the Wetland Tree detector (44%), where many sequences lacked a sufficient number of pulses to be classified. Hoary bats were detected most frequently at the Willard Tree detector, where they represented 20 percent of calls recorded by that detector (Figure 3-5).

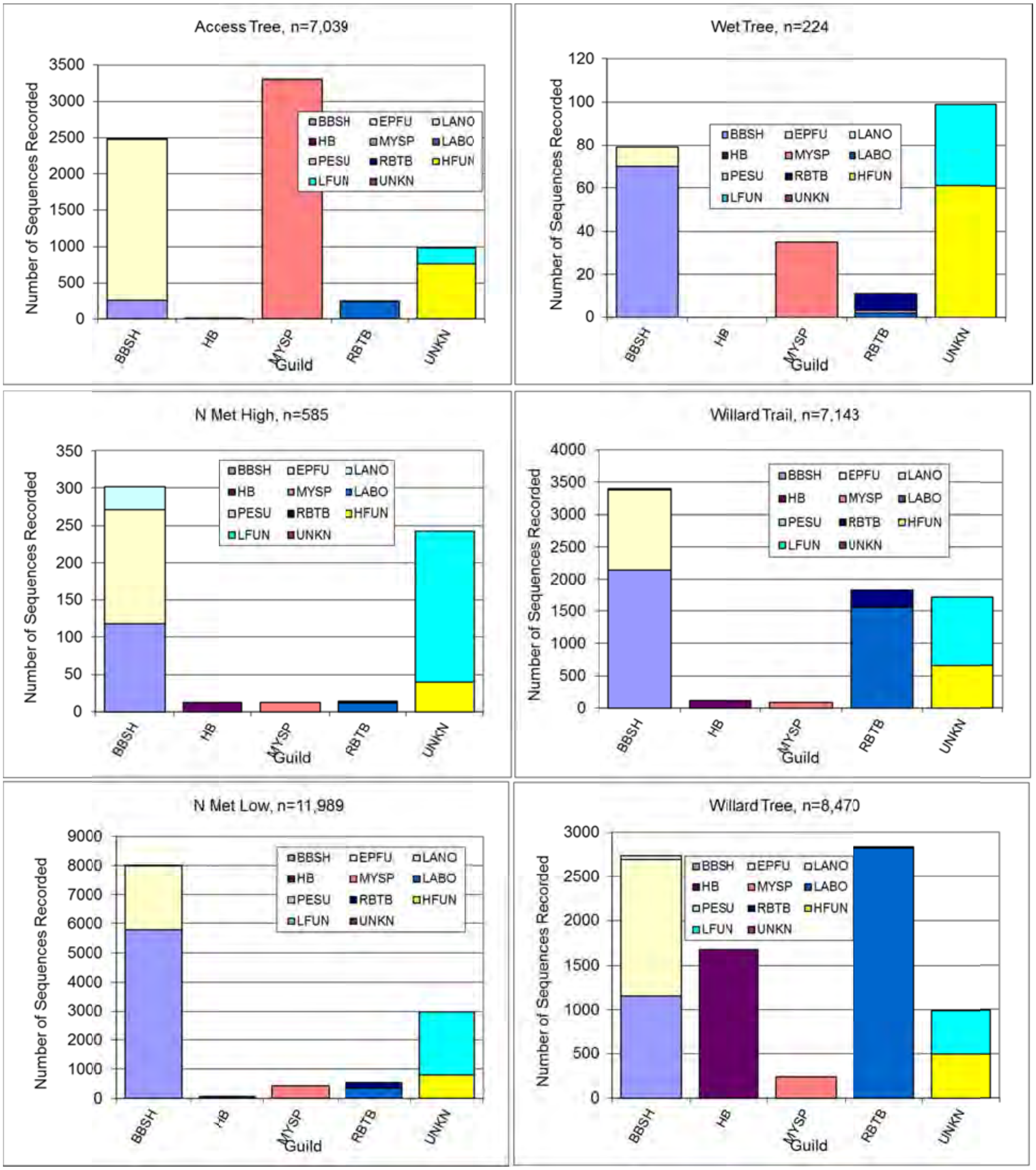

Figure 3-5. Histograms showing species composition of recorded bat call sequences during summer/fall 2011 surveys at the Antrim Wind Project. Note the differing scales on the y-axes. BBSH = big brown/silver-haired, HB = hoary bat, MYSP = Myotis species, RBTB = red bat/tri-colored bat, UNKN = unknown, LFUN = low frequency unknown, HFUN = high frequency unknown, PESU = tri-colored bat, LABO = red bat, LANO = silver-haired bat, EPFU = big brown bat.

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

3.4.3 Activity and Weather

Mean nightly wind speeds in the Project area from June 1 through October 23 varied between 0 and 15 m/s, with an overall mean of 6.4 m/s (Figure 3-6). Mean nightly temperatures varied between 3.4°C and 25.7°C, with an overall mean of 15.2°C (Figure 3-7). Figure 3-8 displays scatterplots of overall acoustic activity versus nightly temperature and wind speed. Combined bat activity levels showed a weak positive correlation with both increasing nightly wind speed, and increasing nightly temperature.

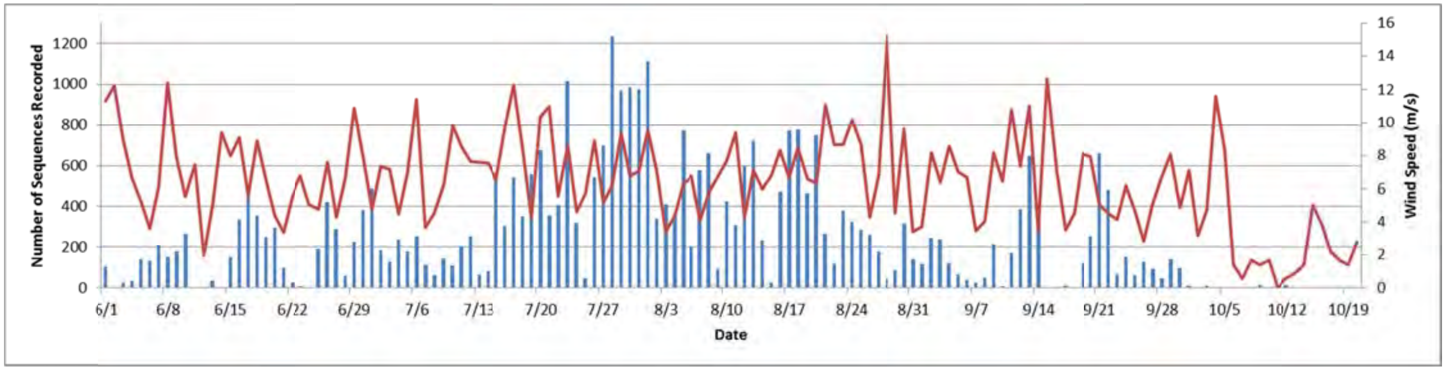

Figure 3-6. Nightly mean wind speed (m/s) (red line) and combined bat call detections during summer/fall 2011 surveys at the Antrim Wind Project.

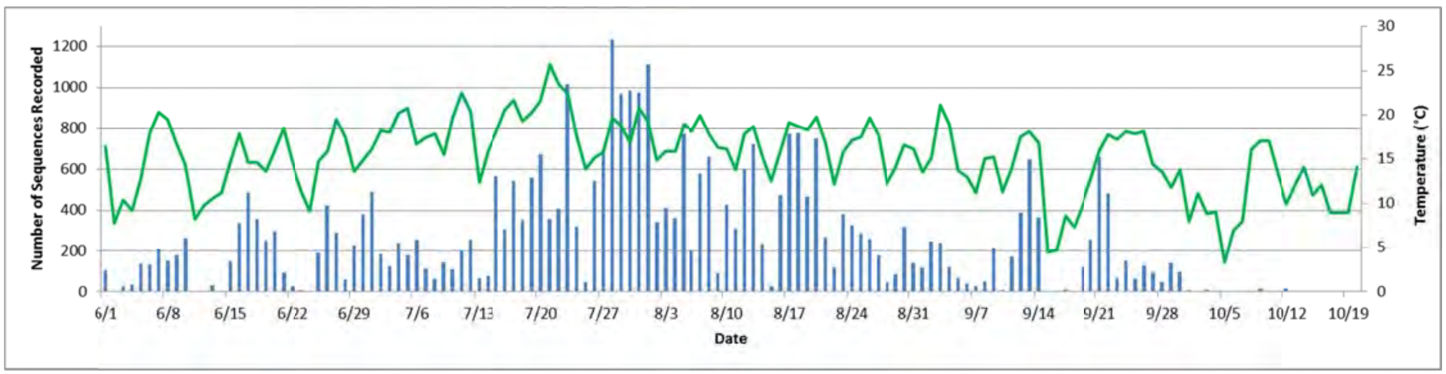

Figure 3-7. Nightly mean temperature (Celsius) (green line) and combined bat detections during summer/fall 2011 surveys at the Antrim Wind Project.

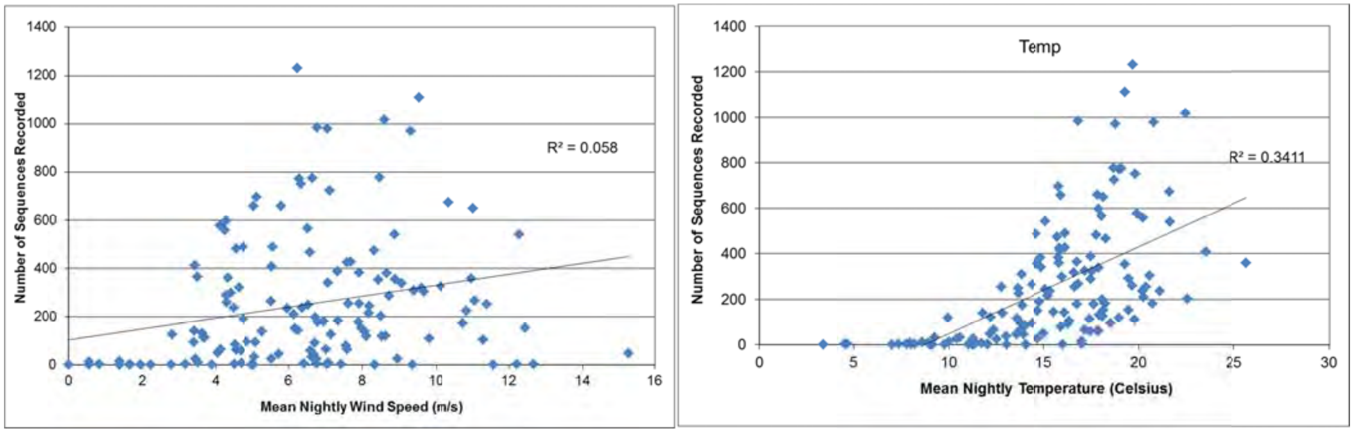

Figure 3-8. Nightly mean wind speed (left), and mean temperature (right) versus combined bat detections during summer/fall 2011 surveys at the Antrim Wind Project

3.5 DISCUSSION

Summer/fall 2011 acoustic surveys at the Antrim Wind Project documented variable levels of bat activity between the six detectors deployed in the Project area. Activity levels were also highly variable between nights during the June 1 to October 23 study period. However, some general trends also were observed, including more consistent acoustic activity in July and August (as indicated by the percentage of nights with detected activity), and overall increases in the number of call files in late July through early August as temperatures increased.

Inter-night and inter-detector variability is common in acoustic bat surveys, where microhabitat surrounding detectors can influence the number of calls recorded as well as the quality of call files. Although detectors were deployed in similar configurations (along habitat edges and corridors that may concentrate bat activity), slight differences in deployment and the surrounding vegetation likely lead to differences in detection rates.

Bat call sequences were identified to guild, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red and hoary bat, have easily identifiable calls, whereas other species, such as the big brown bat and silver-haired bat, are difficult to distinguish acoustically. Similarly, species within the *Myotis* genus have very similar calls and Stantec did not make an attempt to differentiate call sequences within this genus. *Myotis* call sequences represented 11 percent of calls recorded by Project area detectors during the summer/fall 2011 surveys. Eighty percent of *Myotis* calls were recorded by the Access Tree detector, which was located approximately 30 m from a transmission line corridor that likely provided high quality foraging conditions. At the other detectors, the percent composition of *Myotis* species ranged from 1.2 percent at the Willard Trail detector, to 16 percent of all bats recorded by the Wetland Tree detector. *Myotis* species have been particularly affected by the white-nose syndrome (WNS) that has become widespread in the Northeast (Brooks 2011, Watrous *et al*. in prep). *Myotis* are more commonly detected beneath canopy level (Arnett *et al*. 2006), and prior to WNS, *Myotis* call sequences often tended to dominate acoustic data collected from detectors deployed in trees (Brooks 2011, Watrous *et al*. in prep). No pre-WNS acoustic data exists for the Project, making it difficult to determine whether these results represent a significant decline in *Myotis* activity levels from pre-WNS conditions. A similar acoustic survey was conducted near Rutland, Vermont, approximately 100 km to the northwest, and documented significant reduction in Myotis species detection rates between pre and post-WNS outbreak (Watrous *et al*. in prep).

Comparison of acoustic bat activity documented at the North Met High and North Met Low detectors with the remaining tree detectors may help clarify activity patterns of bats in the air space above tree canopy and near the rotor zone of proposed wind turbines. The North Met High detector was located approximately 30 m above the ground, and recorded substantially less acoustic activity than any other detector. This detector had one of the lowest percentage of *Myotis* calls (2%) of all detectors. Since bats from the genus *Myotis* are more commonly detected beneath canopy level (Arnett *et al*. 2006), the low level of *Myotis* species activity at this detector is not unusual and corresponds to results from similar surveys in the Northeast. Other research conducted using Anabat detectors has shown that larger species such as big brown and hoary bats are more frequently detected at greater heights (Arnett *et al*. 2006), which is not reflected in the results of this survey. The North Met Low detector was deployed at only 15 m above the ground, and recorded the highest proportion of BBSH calls of any detector. The higher portion of BBSH calls at this lower height suggests that some other influence such as prey availability or surrounding habitat characteristic may be influencing foraging of bats at this location. Since habitats closer to the ground are generally more structurally complex, larger bats such as those in the BBSH guild are thought to be less able to maneuver in this habitat and therefore tend to forage at greater heights (Arnett *et al*. 2006). In the instance of the met tower clearing where essentially all woody vegetation is removed, these larger bats may easily forage at these lower heights, which may explain the high number of call sequences recorded at the North Met Low detector.

Recent studies have found that bat activity patterns are influenced by weather conditions (Arnett *et al*. 2006, Arnett *et al*. 2008, Reynolds 2006). Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). These patterns suggest that bats are more likely to migrate on nights with low wind speeds (less than 4 to 6 m/s) and generally warm temperatures. Thus, several weather variables can individually affect bat activity, as does the interaction among variables (*i.e*., warm nights with low wind speeds). Summer/fall 2011 acoustic sampling at the Project documented weak correlations between acoustic activity and wind speed and temperature.

When considering the level of activity documented at the Project during the summer/fall 2011 acoustic survey, it is important to acknowledge that numbers of recorded bat call sequences cannot be correlated with the number of bats in an area because acoustic detectors do not allow for differentiation between individuals. The survey sampled activity over the time period when bats are known to be active and identified general species groups that occur in the Project area.

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Appendix A

Radar survey results

Appendix A Table 1. Survey dates, results, level of effort, and weather - Fall 2011										
Date	Sunset	Sunrise	# of Hours Analyzed	Passage rate	Flight Direction	Flight Height (m)	% below 150 m	Temperature (C)	Wind Speed (m/s)	Wind Direction (degrees)
8/17	19:49	5:56	10	157	201	171	50%	19	7	256
8/18	19:48	5:57	10	46	47	154	56%	19	8	246
8/20	19:44	5:59	10	90	182	172	51%	20	6	249
8/21	19:43	6:00	9	48	29	178	43%	17	11	236
8/22	19:41	6:02	10	96	186	210	37%	12	9	297
8/23	19:40	6:03	10	54	42	174	49%	16	8	245
8/24	19:38	6:04	11	38	325	147	51%	17	10	197
8/25	19:36	6:05	11	33	133	197	42%	18	8	262
8/26	19:35	6:06	9	538	225	186	41%	20	4	231
8/29	19:30	6:09	11	393	215	227	32%	14	5	314
8/30	19:28	6:10	11	72	144	175	55%	17	9	280
8/31	19:26	6:11	11	268	230	211	40%	16	3	90
9/1	19:25	6:12	11	182	230	172	50%	14	4	123
9/4	19:20	6:16	10	64	158	166	49%	19	8	232
9/9	19:11	6:21	11	184	200	266	25%	15	8	308
9/10	19:09	6:22	11	110	259	245	27%	12	6	158
9/11	19:07	6:23	11	20	69	204	34%	14	11	241
9/12	19:05	6:24	11	118	173	202	40%	18	7	254
9/13	19:04	6:26	11	26	28	250	29%	18	11	239
9/14	19:02	6:27	12	457	222	161	54%	17	4	204
9/16	18:58	6:29	12	190	218	201	39%	5	7	330
9/17	18:56	6:30	12	168	227	241	29%	9	4	80
9/18	18:55	6:31	12	254	228	218	37%	7	5	68
9/19	18:53	6:32	12	37	264	209	41%	10	8	203
9/30	18:33	6:44	9	132	208	159	52%	14	5	349
10/1	18:31	6:45	12	4	150	150	47%	8	7	19
10/2	18:29	6:47	12	73	209	176	45%	11	3	88
10/3	18:28	6:48	11	243	215	170	54%	9	5	65
10/7[1]	18:21	6:52	12	18	93	208	43%	8	2	170
10/8	18:19	6:53	12	50	123	220	37%	12	2	158
Entire Season			**327**	**138**	**217**	**203**	**40%**	**14**	**7**	**206**

[1]Weather data for 10/7 and 10/8 were retrieved from wunderground.com

Appendix A Table 2. Summary of passage rates by hour, night, and for entire season.																
Night of	**Passage Rate (targets/km/hr) by hour after sunset**												**Entire Night**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Mean**	**Median**	**Stdev**	**SE**
8/17	321	525	304	111	99	50	60	50	25	25	N/A	N/A	157	79	169	53
8/18	111	77	79	64	29	26	14	18	14	25	N/A	N/A	46	27	34	11
8/20	64	96	93	161	121	118	75	111	25	32	N/A	N/A	90	95	42	13
8/21	82	rain	75	64	43	39	43	36	43	11	N/A	N/A	48	43	22	7
8/22	57	221	229	150	82	68	54	43	39	21	N/A	N/A	96	63	76	24
8/23	39	82	64	50	82	86	36	71	11	18	N/A	N/A	54	57	27	9
8/24	36	39	93	54	54	61	43	14	14	7	0	N/A	38	39	27	8
8/25	46	36	11	25	32	29	39	46	57	36	4	N/A	33	36	16	5
8/26	239	839	779	743	586	486	493	304	379	N/A[1]	N/A[1]	N/A	538	493	214	71
8/29	204	407	650	575	536	475	407	346	325	264	129	N/A	393	407	160	48
8/30	50	71	68	129	121	146	64	61	39	32	7	N/A	72	64	43	13
8/31	207	325	229	254	229	275	381	436	339	211	60	N/A	268	254	101	31
9/1	32	186	382	314	357	196	150	136	114	93	43	N/A	182	150	121	36
9/4	54	rain	321	118	64	18	4	11	0	7	39	N/A	64	29	98	31
9/9	82	189	354	296	364	236	107	89	121	121	64	N/A	184	121	111	34
9/10	43	193	204	146	132	111	93	161	79	32	21	N/A	110	111	63	19
9/11	39	75	39	18	21	7	0	14	4	4	0	N/A	20	14	23	7
9/12	29	89	139	139	246	200	175	54	86	79	64	N/A	118	89	68	20
9/13	7	36	32	18	21	18	25	32	29	29	36	N/A	26	29	9	3
9/14	57	646	618	532	646	550	482	421	450	518	557	0	457	525	212	61
9/16	125	439	400	439	339	282	118	82	25	25	7	0	190	121	177	51
9/17	14	279	282	139	68	75	161	111	246	346	243	50	168	150	108	31
9/18	68	404	471	361	368	336	250	271	189	171	132	21	254	261	140	40
9/19	54	96	68	86	32	36	25	7	18	7	14	0	37	29	32	9
9/30	rain	182	211	rain	rain	75	111	121	121	182	143	43	132	121	54	18
10/1	11	14	0	0	7	11	4	0	0	0	0	0	4	0	5	2
10/2	68	125	143	21	29	32	11	0	179	25	132	114	73	50	62	18
10/3	64	200	311	325	271	389	318	354	425	0	14	rain	243	311	152	46
10/7	18	32	32	11	11	21	7	7	7	14	32	21	18	16	10	3
10/8	68	114	75	25	54	61	54	21	57	14	36	25	50	54	28	8
Entire Season	**79**	**215**	**225**	**185**	**174**	**150**	**127**	**114**	**115**	**81**	**77**	**28**	**138**	**68**	**162**	**9**
0 indicates no targets counted for that hour								N/A indicates no or only partial data for that hour								
N/A[1] indicates equiment failure during that hour																

Appendix A Table 3. Mean Nightly Flight Direction		
Night of	**Mean Flight Direction**	**Circular Stdev**
8/17	201	67
8/18	47	55
8/20	182	77
8/21	29	60
8/22	186	49
8/23	42	119
8/24	325	70
8/25	133	57
8/26	225	44
8/29	215	31
8/30	144	73
8/31	230	33
9/1	230	32
9/4	158	79
9/9	200	56
9/10	259	57
9/11	69	132
9/12	173	74
9/13	28	98
9/14	222	45
9/16	218	42
9/17	227	49
9/18	228	33
9/19	264	70
9/30	208	53
10/1	150	65
10/2	209	39
10/3	215	40
10/7	93	74
10/8	123	60
Entire Season	**217**	**56**

Appendix A Table 4. Summary of mean flight heights by hour, night, and for entire season.																		
Night of	Mean Flight Height (m) by hour after sunset												Entire Night				# of targets below 150 meters	% of targets below 150 meters
	1	2	3	4	5	6	7	8	9	10	11	12	Mean	Median	STDV	SE		
8/17	174	158	170	228	171	156	286	112	137	68	N/A	N/A	171	152	117	37	159	50%
8/18	134	144	144	169	209	162	174	170	122	86	N/A	N/A	154	138	101	32	74	56%
8/20	217	183	179	173	172	128	96	123	209	215	N/A	N/A	172	148	133	42	127	51%
8/21	151	rain	rain	137	192	190	180	393	181	132	N/A	N/A	178	162	94	33	29	43%
8/22	179	206	213	207	239	257	248	185	176	189	N/A	N/A	210	190	134	42	170	37%
8/23	246	218	181	154	149	139	127	118	212	139	N/A	N/A	174	157	119	38	65	49%
8/24	130	145	165	129	133	173	160	138	145	134	N/A	N/A	147	148	74	23	55	51%
8/25	119	142	127	175	267	255	196	278	161	145	N/A	N/A	197	176	124	39	49	42%
8/26	186	177	182	215	181	190	157	193	176	N/A[1]	N/A	N/A	186	175	114	38	326	41%
8/29	305	250	197	229	212	208	242	201	192	238	278	N/A	227	205	131	40	238	32%
8/30	147	179	131	121	217	163	248	336	128	128	--	N/A	175	137	140	44	45	55%
8/31	191	209	238	245	279	236	192	162	139	133	164	N/A	211	190	135	41	476	40%
9/1	164	169	151	143	206	185	177	193	111	195	234	N/A	172	153	127	38	215	50%
9/4	160	rain	144	205	257	190	173	311	109	170	152	N/A	166	153	94	30	71	49%
9/9	248	247	247	243	226	253	216	320	346	276	247	N/A	266	245	150	45	169	25%
9/10	207	227	256	283	268	269	248	201	164	145	134	N/A	245	234	130	39	213	27%
9/11	58	253	197	163	238	189	239	189	168	184	141	N/A	204	179	113	34	45	34%
9/12	233	245	224	198	205	194	168	176	211	128	178	N/A	202	179	133	40	212	40%
9/13	105	224	255	273	302	274	307	222	210	217	190	N/A	250	223	152	46	27	29%
9/14	196	190	155	163	163	156	157	144	125	150	132	26	161	143	103	30	587	54%
9/16	145	222	184	185	203	193	194	246	306	253	306	--	201	179	112	34	264	39%
9/17	240	211	202	220	278	280	293	270	216	240	243	274	241	223	131	38	241	29%
9/18	200	228	193	198	238	218	223	223	249	236	216	317	218	193	140	40	377	37%
9/19	212	223	233	155	199	273	156	213	232	136	111	--	209	179	139	42	50	41%
9/30	181	126	73	rain	rain	148	155	138	163	186	197	184	159	146	92	29	117	52%
10/1	111	114	116	169	146	160	145	149	120	219	162	173	150	157	48	14	23	47%
10/2	139	153	162	167	185	198	168	187	188	200	184	204	176	168	103	30	137	45%
10/3	160	203	168	182	92	79	131	237	201	rain	rain	rain	170	139	126	42	386	54%
10/7	110	207	415	189	222	234	187	207	213	200	78	164	208	192	139	40	59	43%
10/8	132	211	176	187	278	275	267	245	179	186	214	292	220	207	135	39	61	37%
Entire Night	**173**	**195**	**189**	**190**	**211**	**201**	**197**	**209**	**183**	**176**	**187**	**204**	**203**	**179**	**130**	**1**	**5067**	**40%**

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

N/A[1] indicates equiment failure during that hour

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

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	(Turbine Ht) % Targets Below Turbine Height	Reference
Fall 2004									
Sheffield, Caledonia Cty, VT	18	176	Forested ridge	91	19-320	200	566	(125 m) 1%	Woodlot Alternatives, Inc. 2006. Avian and Bat Information Summary and Risk Assessment for the Proposed Sheffield Wind Power Project in Sheffield, Vermont. Prepared for UPC Wind Management, LLC.
Casselman, Somerset Cty, PA	30	n/a	Forested ridge	174	n/a	n/a	436	(125 m) 7%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Dans Mountain, Allegany Cty, MD	34	318	Forested ridge	188	2-633	193	542	(125 m) 11%	Woodlot Alternatives, Inc. 2004. A Fall 2004 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Dan's Mountain Wind Project in Frostburg, Maryland. Prepared for US Wind Force.
Franklin, Pendleton Cty, WV	34	349	Forested ridge	229	7-926	175	583	(125 m) 8%	Woodlot Alternatives, Inc. 2005. A Fall 2005 Radar and Acoustic Survey of Bird and Bat Migration at the Proposed Liberty Gap Wind Project in Franklin, West Virginia. Prepared for US Wind Force, LLC.
Fall 2005									
Swallow Farm, PA	58	n/a	Forested ridge	166	n/a	n/a	402	(125 m) 5%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Kibby, Franklin Cty, ME (Range 1)	12	101	Forested ridge	201	12-783	196	352	(125 m) 12%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Fayette Cty, PA	26	n/a	Forested ridge	297	n/a	n/a	426	(125 m) 5%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Stamford, Delaware Cty, NY	48	418	Forested ridge	315	22-784	251	494	(110 m) 3%	Woodlot Alternatives, Inc. 2007. A Spring and Fall 2005 Radar and Acoustic Survey of Bird Migration at the Proposed Moresville Energy Center in Stamford and Roxbury, New York. Prepared for Invenergy, LLC. Rockville, MD.
Preston Cty, WV	26	n/a	Forested ridge	379	n/a	n/a	420	(125 m) 10%	Plissner, J.H., T.J. Mabee, and B.A. Cooper. 2006 A radar and visual study of nocturnal bird and bat migration at the proposed Preston Wind Development project, Virginia, Fall 2005. Report to Highland New Wind Development, LLC.
Highland, VA	58	n/a	Forested ridge	385	n/a	n/a	442	(125 m) 12%	Plissner, J.H., T.J. Mabee, and B.A. Cooper. 2006 A radar and visual study of nocturnal bird and bat migration at the proposed Highland New Wind Development project, Virginia, Fall 2005. Report to Highland New Wind Development, LLC.
Kibby, Franklin Cty, ME (Valley)	5	13	Forested ridge	452	52-995	193	391	(125 m) 16%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Mars Hill, Aroostook Cty, ME	18	117	Forested ridge	512	60-1092	228	424	(120 m) 8%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Radar, Visual, and Acoustic Survey of Bird Migration at the Mars Hill Wind Farm in Mars Hill, Maine. Prepared for Evergreen Windpower, LLC.
Deerfield, Bennington Cty, VT	32	324	Forested ridge	559	3-1736	221	395	(100 m) 13%	Woodlot Alternatives, Inc. 2006. Fall 2005 Bird and Bat Migration Surveys at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont. Prepared for PPM Energy, Inc.
Kibby, Franklin Cty, ME (Mountain)	12	115	Forested ridge	565	109-1107	167	370	(125 m) 16%	Woodlot Alternatives, Inc. 2006. A Fall 2005 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine. Prepared for TransCanada Maine.
Fall 2006									
Somerset Cty, PA	29	n/a	Forested ridge	316	n/a	n/a	374	(125 m) 8%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Bedford Cty, PA	29	n/a	Forested ridge	438	n/a	n/a	379	(125 m) 10%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
Stetson, Washington Cty, ME	12	77	Forested ridge	476	131-1192	227	378	(125 m) 13%	Woodlot Alternatives, Inc. 2007. A Fall 2006 Survey of Bird and Bat Migration at the Stetson Wind Project, Washington County, Maine. Prepared for Evergreen Wind V, LLC.
Lempster, Sullivan Cty, NH	32	290	Forested ridge	620	133-1609	206	387	(125 m) 8%	Woodlot Alternatives, Inc. 2007. A Fall 2007 Survey of Nocturnal Bird Migration, Breeding Birds, and Bicknell's Thrush at the Proposed Lempster Mountain Wind Power Project Lempster, New Hampshire. Prepared for Lempster Wind, LLC.
Fall 2007									
Laurel Mountain, Barbour Cty, WV	20	212	Forested ridge	321	76-513	209	533	(130 m) 6%	Stantec Consulting Services Inc. 2007. A Fall 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Laurel Mountain Wind Energy Project near Elkins, West Virginia. Prepared for AES Laurel Mountain, LLC.
Errol, Coos County, NH	29	232	Forested ridge	366	54 to 1234	223	343	(125 m) 15%	Stantec Consulting Inc. 2007. Fall 2007 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Windpark in Coos County, New Hampshire by Granite Reliable Power, LLC. Prepared for Granite Reliable Power, LLC.
Rollins, Lincoln, Penobscot Cty, ME	22	231	Forested ridge	368	82-953	284	343	(120 m) 13%	Woodlot Alternatives, Inc. 2008. A Fall 2007 Survey of Bird and Bat Migration at the Rollins Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
Roxbury, Oxford Cty, ME	20	220	Forested ridge	420	88-1006	227	365	(130 m) 14%	Woodlot Alternatives, Inc. 2007. A Fall 2007 Survey of Bird and Bat Migration at the Record Hill Wind Project, Roxbury, Maine. Prepared for Roxbury Hill Wind LLC.
Allegany, Cattaraugus Cty, NY	46	n/a	Forested ridge	451	n/a	230	382	(150 m) 14%	New York Department of Conservation [Internet]. c2008. Publicly Available Radar Results for Proposed Wind Sites in New York. Albany, NY: NYDEC; [updated May 2008; cited June 2009]. Available at http://www.dec.ny.gov/docs/wildlife_pdf/radarwindsum.pdf
New Creek, Grant Cty, WV	20	n/a	Forested ridge	811	263-1683	231	360	(130 m) 17%	Stantec Consulting Services Inc. 2008. A Fall 2007 Survey of Bird and Bat Migration at the New Creek Wind Project, West Virginia. Prepared for AES New Creek, LLC.
Fall 2008									
Georgia Mountain, VT	21	n/a	Forested ridge	326	56-700	230	371	(120 m) 7%	Stantec Consulting Services Inc. 2008. A Fall 2008 Survey of Bird Migration at the Georgia Mountain Wind Project, Vermont. Prepared for Georgia Mountain Community Wind.
Oakfield, Penobscot Cty, ME	20	n/a	Forested ridge	501	116-945	200	309	(125 m) 18%	Woodlot Alternatives, Inc. 2008. A Fall 2008 Survey of Bird and Bat Migration at the Oakfield Wind Project, Washington County, Maine. Prepared for Evergreen Wind, LLC.
Tenney, Grafton Cty, NH	45	509	Forested ridge	470	94-1174	260	342	(125m) 13%	Stantec Consulting Services Inc. 2008. Fall 2008 Radar Survey Report for the Groton Wind Project. Prepared for Groton Wind, LLC.
Highland, Somerset Cty, ME	20	216	Forested ridge	549	68-1201	227	348	(130.5m) 17%	Stantec Consulting. 2009. Fall 2008 Bird and Bat Migration Survey Report: Radar and Acoustic Avian and Bat Surveys for the Highland Wind Project Highland Plantation, Maine. Prepared for Highland Wind LLC
Fall 2009									
Sisk (Kibby Expansion) Franklin Cty, ME	20	210	Forested ridge	458	44-1067	206	287	(125m) 23%	Stantec Consulting Services. 2009. Fall 2009 Nocturnal Migration Survey Report. Prepared for TRC Engineers LLC.
Vermont Community Wind Farm, Orleans Cty, VT	20	227	Forested ridge	443	110-1029	215	330	(130m) 15%	Stantec Consulting Services. 2009. Fall 2009 Bird and Bat Survey Report. Nocturnal Radar, Acoustic, and Diurnal Raptor Surveys performed for the Vermont Community Wind Farm Project in Rutland County, Vermont. Prepared for Vermont Community Wind Farm, LLC.
Stetson, Washington Cty, ME	18	201	Forested ridge	457	106-1746	227	420	(119m) 2%	Stantec Consulting Services. 2010. Stetson I Mountain Wind Project Year 1 Post-Construction Monitoring Report, 2009. Prepared for First Wind Management, LLC.
Bull Hill, Hancock Cty, ME	20	232	Forested ridge	614	188-1500	260	357	(145m) 20%	Stantec Consulting Services. 2010. Summer and Fall 2009 Avian and Bat Survey Report for the Bull Hill Project. Prepared for Blue Sky East Wind, LLC.
Bowers, Washington Cty, ME	22	249	Forested ridge	344	95-844	231	453	(119m) 14%	Stantec Consulting Services Inc. 2010. 2010 Spring Avian and Spring/Summer Bat Surveys for the Bowers Wind Project. Prepared for Champlain Wind Energy, LLC.
Fall 2010									
Bingham, Somerset Cty, ME	20	232	Forested ridge	803	194-2463	234	377	(150m) 20%	Stantec Consulting Services Inc. 2010. 2010 Spring Avian and Spring/Summer Bat Surveys for the Bowers Wind Project. Prepared for Champlain Wind Energy, LLC.
Fall 2011									
Antrim, Hillsborough Cty, NH	30	327	Forested ridge	138	4-538	217	203	(150m) 40%	*this report*

Appendix B

Bat survey results

Appendix B Table 1. Summary of acoustic bat data and weather during each survey night at the Access Tree detector – Antrim Wind Project, Summer/Fall 2011.

Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
		BBSH			HB	MYSP	RBTB			UNKN							
06/01/11	1		2			3				1	3		**9**	11.3	16.4	1014	79
06/02/11	1		1			1				1			**3**	12.2	7.8	1011	61
06/03/11	1		2			2					1		**5**	9.0	10.4	1016	54
06/04/11	1		3			1							**4**	6.6	9.2	1019	57
06/05/11	1		3			6				7	1		**17**	5.3	12.8	1019	73
06/06/11	1		12			4				1	1		**18**	3.6	17.9	1016	81
06/07/11	1	1	7			30				3	3		**44**	6.1	20.3	1013	62
06/08/11	1		8			1				3	1		**13**	12.4	19.5	1012	65
06/09/11	1		9			1					1		**11**	7.9	16.8	1012	88
06/10/11	1	1	13			4				1			**19**	5.5	14.4	1014	83
06/11/11	1		1							1			**2**	7.4	8.2	1020	94
06/12/11	1					1							**1**	2.0	9.7	1015	94
06/13/11	1		6			9				4	1		**20**	5.1	10.6	1012	85
06/14/11	1		1										**1**	9.4	11.2	1013	88
06/15/11	1		5			20				3	3		**31**	8.0	14.7	1011	78
06/16/11	1	1	3			8				2	1		**15**	9.1	17.9	1013	78
06/17/11	1	1	1			6				4	3		**15**	5.6	14.6	1013	90
06/18/11	1	3				1				3	2		**9**	8.9	14.6	1010	80
06/19/11	1	1	2			4				1			**8**	6.5	13.6	1011	61
06/20/11	1	1	1			10					1		**13**	4.4	16.0	1013	67
06/21/11	1	4	9			43				3	2		**61**	3.4	18.5	1014	66
06/22/11	1		1			22				1			**24**	5.5	14.7	1014	96
06/23/11	1					6							**6**	6.8	11.7	1012	98
06/24/11	1												**0**	5.1	9.1	1011	97
06/25/11	1		2			6				2			**10**	4.8	14.8	1011	94
06/26/11	1	4	5			5	2			5	3		**24**	7.6	15.9	1014	82
06/27/11	1	4	2			8	2			5	2		**23**	4.3	19.5	1017	72
06/28/11	1		7								11		**18**	6.6	17.5	1014	77
06/29/11	1		13		1	13				9	3		**39**	10.9	13.6	1011	81
06/30/11	1		2			15	1			5	4		**27**	7.9	14.9	1013	63
07/01/11	1	1	6			29				11	2		**49**	4.8	16.1	1016	71
07/02/11	1		16			14			1	1	4		**36**	7.4	18.2	1018	72
07/03/11	1		17			6				4	2		**29**	7.1	18.1	1012	86
07/04/11	1		13			3				4	4		**24**	4.5	20.2	1010	80
07/05/11	1		15			5				1			**21**	6.9	20.7	1013	82
07/06/11	1		6	1						1	2		**10**	11.4	16.6	1013	73
07/07/11	0												**0**	3.7	17.4	1014	74
07/08/11	0												**0**	4.6	17.8	1013	87
07/09/11	0												**0**	6.3	15.5	1010	84
07/10/11	0												**0**	9.8	19.8	1018	66
07/11/11	0												**0**	8.5	22.5	1014	72
07/12/11	0												**0**	7.6	20.4	1005	71
07/13/11	1	1	2			9				2	1		**15**	7.6	12.3	1008	74
07/14/11	1	1	2			12				3	1		**19**	7.5	15.9	1016	69
07/15/11	1	11	62			1	2			28	7		**111**	6.5	18.0	1019	63
07/16/11	1	4	19			92	1			4			**120**	9.7	20.6	1021	65
07/17/11	1	3	42			18	1			19	4		**87**	12.3	21.6	1019	63
07/18/11	1	6	57			7	2		1	11	4		**88**	8.4	19.3	1013	78
07/19/11	1	2	17			5				1	1		**26**	4.2	20.2	1011	69
07/20/11	1		1										**1**	10.4	21.6	1012	72
07/21/11	0												**0**	11.0	25.7	1008	78
07/22/11	0												**0**	5.5	23.5	1010	60
07/23/11	0												**0**	8.6	22.4	1013	71
07/24/11	0												**0**	4.6	17.5	1014	68
07/25/11	0												**0**	5.7	13.9	1014	85
07/26/11	1	9	109		1	21	1			12	5		**158**	8.9	15.1	1008	84
07/27/11	1	3	30			15				6			**54**	5.1	15.8	1012	69
07/28/11	1	5	79			33	3			20	9		**149**	6.2	19.7	1018	71
07/29/11	1	22	243			15				8	15		**303**	9.3	18.8	1013	90
07/30/11	1	7	121			10				1	5		**144**	6.8	16.8	1012	76
07/31/11	1	17	182	1		10	2			11	13		**236**	7.1	20.8	1017	70
08/01/11	1	11	142			74				13	4		**244**	9.5	19.3	1011	80
08/02/11	1	4	44			27	1			3	1		**80**	7.1	14.9	1007	66
08/03/11	1	10	123			23	6			30	11		**203**	3.4	15.9	1008	74
08/04/11	1	6	107			50	2			15	8		**188**	4.3	15.8	1014	81
08/05/11	1	11	102			52				36	15		**216**	6.3	19.0	1019	77
08/06/11	1	1	3			33	1			12	3		**53**	6.7	18.1	1016	81
08/07/11	1	13	142			105				27	6		**293**	4.1	19.9	1008	91
08/08/11	1	29	66			15				1	3		**114**	5.8	17.8	1001	90
08/09/11	1	1	14			16	22		1	19	3		**76**	6.7	16.3	1004	89
08/10/11	1	11	179			99				14	1		**304**	7.7	16.1	1002	88
08/11/11	1	2	4			21	1			4	2		**34**	9.4	13.8	1010	65
08/12/11	1		2			192				10	2		**206**	4.3	17.9	1016	74
08/13/11	1	3	29			92	2			20	5		**151**	7.1	18.7	1019	74
08/14/11	1		2			117	10			12	1		**142**	6.0	15.3	1015	92
08/15/11	1					2	4			3			**9**	6.8	12.5	1010	98
08/16/11	1	2	8			221	10	1	1	29	3		**275**	8.3	15.7	1010	92
08/17/11	1		2			223	2			5	3		**235**	6.6	19.1	1020	78
08/18/11	1	2	44		1	14	6			8	6		**81**	8.5	18.7	1016	80
08/19/11	1	1	12			112	4			14	2		**145**	6.6	18.3	1014	80
08/20/11	1	1	3			48	3			8	1		**64**	6.3	19.8	1015	81
08/21/11	1		1			37	4			16	1		**59**	11.1	16.8	1012	89
08/22/11	1					11				1			**12**	8.6	12.2	1009	74
08/23/11	1					70				11			**81**	8.7	15.8	1016	77
08/24/11	1		1			22	7			20			**50**	10.1	17.2	1017	75
08/25/11	1	1	4			38	2			9	1		**55**	8.7	17.5	1012	89
08/26/11	1	2	4			149	2			10			**167**	4.3	19.7	1016	82
08/27/11	1	2	1			153	1			13			**170**	6.8	17.6	1013	91
08/28/11	1						7			23			**30**	15.2	12.1	992	96
08/29/11	1					53	1			5			**59**	4.5	14.0	1012	73
08/30/11	1		1	2		54	1			3			**61**	9.6	16.6	1020	84
08/31/11	1	1	1			36				6			**44**	3.4	16.1	1023	77
09/01/11	1					1	4			6	1		**12**	3.7	13.5	1024	84
09/02/11	1	2		3		48	5		1	10	1		**70**	8.2	15.1	1021	76
09/03/11	1	2	2	2		35	2	1		7			**51**	6.4	21.1	1014	85
09/04/11	1	1		1		4	1	1		1	1		**10**	8.5	19.0	1012	91
09/05/11	1					20				3			**23**	7.0	13.7	1011	86
09/06/11	1	1				24	2			6			**33**	6.7	13.0	1017	93
09/07/11	1	1		1			4			11	1		**18**	3.4	11.2	1024	98
09/08/11	1	1				15	2			4	1		**23**	4.0	15.0	1019	96
09/09/11	1		1			148				14			**163**	8.2	15.2	1012	83
09/10/11	1												**0**	6.4	11.4	1015	75
09/11/11	1	1				60				3			**64**	10.8	13.8	1020	80
09/12/11	1		3		1	18	10			9	2		**43**	7.3	17.5	1016	84
09/13/11	1		2		1	52	10			2	1		**68**	11.0	18.1	1013	86
09/14/11	1	1				46	2			9	1		**59**	3.5	16.8	1014	83
09/15/11	1	2											**2**	12.7	4.5	1013	91
09/16/11	1												**0**	7.0	4.7	1023	67
09/17/11	1												**0**	3.5	8.6	1032	77
09/18/11	1												**0**	4.5	7.4	1032	76
09/19/11	1					1							**1**	8.1	9.9	1026	77
09/20/11	1					28	6			6			**40**	7.9	12.7	1020	93
09/21/11	1	2	1			75	8			14			**100**	5.1	15.9	1025	84
09/22/11	1	1		2			5			2	1		**11**	4.6	17.8	1021	93
09/23/11	1					1	7			9			**17**	4.1	17.2	1020	95
09/24/11	1	1				2	1			1			**5**	6.2	18.1	1017	95
09/25/11	1		11							2	1		**14**	4.7	17.9	1019	90
09/26/11	1	1				22	3			2			**28**	2.8	18.1	1017	92
09/27/11	1	3		2		2	7			6	1		**21**	5.1	14.4	1017	88
09/28/11	1	2	1	2		6	4			9	2		**26**	6.7	13.5	1019	80
09/29/11	1	1					21			3			**25**	8.1	11.7	1008	97
09/30/11	1	3	1	1			8			3	1		**17**	4.9	13.7	1006	88
10/01/11	1						1			3			**4**	7.1	8.0	1005	98
10/02/11	1		1								1		**2**	3.2	11.2	1011	99
10/03/11	1												**0**	4.7	8.9	1017	91
10/04/11	1												**0**	11.6	9.0	1015	97
10/05/11	1												**0**	8.3	3.4	1017	76
10/06/11	1												**0**	1.4	7.0	1026	61
10/07/11	1		1										**1**	0.6	8.0	1031	69
10/08/11	1												**0**	1.7	16.0	1030	71
10/09/11	1		1				8			2	1		**12**	1.4	17.0	1028	71
10/10/11	1									1			**1**	1.7	17.0	1023	71
10/11/11	1									1			**1**	0.0	13.0	1024	79
10/12/11	1												**0**	0.6	10.0	1023	87
10/13/11	1	1								1			**2**	0.8	12.0	1013	99
10/14/11	1												**0**	1.4	14.0	1000	96
10/15/11	1												**0**	5.0	11.0	999	77
10/16/11	1		1										**1**	3.9	12.0	1006	55
10/17/11	1												**0**	2.2	9.0	1005	67
10/18/11	1												**0**	1.7	9.0	1011	70
10/19/11	1												**0**	1.4	9.0	1011	94
10/20/11	1												**0**	2.8	14.0	1001	91
10/21/11	1												**0**	2.0	9.0	1010	73
10/22/11	1												**0**				
10/23/11	1												**0**				
By Species		**254**	**2227**	**18**	**5**	**3302**	**237**	**3**	**5**	**763**	**225**	**0**	**7039**				
By Guild		**2499**			**5**	**3302**	**245**			**988**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B **Table 2**. Summary of acoustic bat data and weather during each survey night at the North Met High detector – Antrim Wind Project, Summer/Fall 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
06/01/11	1												**0**	11	16	1014	79
06/02/11	1												**0**	12	8	1011	61
06/03/11	1	1		1									**2**	9	10	1016	54
06/04/11	1												**0**	7	9	1019	57
06/05/11	1	1											**1**	5	13	1019	73
06/06/11	1	1		1							2		**4**	4	18	1016	81
06/07/11	1	12	20								11		**43**	6	20	1013	62
06/08/11	1				3						4		**7**	12	19	1012	65
06/09/11	1	13	2								1		**16**	8	17	1012	88
06/10/11	1	28	27								60		**115**	6	14	1014	83
06/11/11	1												**0**	7	8	1020	94
06/12/11	1												**0**	2	10	1015	94
06/13/11	1		2										**2**	5	11	1012	85
06/14/11	1												**0**	9	11	1013	88
06/15/11	1												**0**	8	15	1011	78
06/16/11	1												**0**	9	18	1013	78
06/17/11	1										5		**5**	6	15	1013	90
06/18/11	1												**0**	9	15	1010	80
06/19/11	1												**0**	7	14	1011	61
06/20/11	1												**0**	4	16	1013	67
06/21/11	1												**0**	3	19	1014	66
06/22/11	1												**0**	6	15	1014	96
06/23/11	1												**0**	7	12	1012	98
06/24/11	1												**0**	5	9	1011	97
06/25/11	1												**0**	5	15	1011	94
06/26/11	1												**0**	8	16	1014	82
06/27/11	1												**0**	4	19	1017	72
06/28/11	0												**0**	7	17	1014	77
06/29/11	0												**0**	11	14	1011	81
06/30/11	0												**0**	8	15	1013	63
07/01/11	0												**0**	5	16	1016	71
07/02/11	0												**0**	7	18	1018	72
07/03/11	0												**0**	7	18	1012	86
07/04/11	0												**0**	4	20	1010	80
07/05/11	0												**0**	7	21	1013	82
07/06/11	0												**0**	11	17	1013	73
07/07/11	0												**0**	4	17	1014	74
07/08/11	0												**0**	5	18	1013	87
07/09/11	0												**0**	6	16	1010	84
07/10/11	0												**0**	10	20	1018	66
07/11/11	0												**0**	8	23	1014	72
07/12/11	0												**0**	8	20	1005	71
07/13/11	1	1	5								2		**8**	8	12	1008	74
07/14/11	1				1								**1**	8	16	1016	69
07/15/11	1												**0**	7	18	1019	63
07/16/11	1	1	1								2		**4**	10	21	1021	65
07/17/11	1												**0**	12	22	1019	63
07/18/11	1												**0**	8	19	1013	78
07/19/11	1												**0**	4	20	1011	69
07/20/11	1	3					1				2		**6**	10	22	1012	72
07/21/11	1									1			**1**	11	26	1008	78
07/22/11	1	2	2		1						3		**8**	6	23	1010	60
07/23/11	1	5	5		2						15		**27**	9	22	1013	71
07/24/11	1	16	65	5		7		1		2	36		**132**	5	18	1014	68
07/25/11	1	1	2							2	3		**8**	6	14	1014	85
07/26/11	1												**0**	9	15	1008	84
07/27/11	1		1			1				1			**3**	5	16	1012	69
07/28/11	1		1								2		**3**	6	20	1018	71
07/29/11	1				1						2		**3**	9	19	1013	90
07/30/11	1										1		**1**	7	17	1012	76
07/31/11	1		2		1								**3**	7	21	1017	70
08/01/11	1						1						**1**	10	19	1011	80
08/02/11	1	1											**1**	7	15	1007	66
08/03/11	1	4	5	2		3				3	3		**20**	3	16	1008	74
08/04/11	1	5	2	3			1			1	7		**19**	4	16	1014	81
08/05/11	1	1									1		**2**	6	19	1019	77
08/06/11	1									1			**1**	7	18	1016	81
08/07/11	1									1			**1**	4	20	1008	91
08/08/11	1		1								2		**3**	6	18	1001	90
08/09/11	1										1		**1**	7	16	1004	89
08/10/11	1									2	2		**4**	8	16	1002	88
08/11/11	1												**0**	9	14	1010	65
08/12/11	1	2								1	1		**4**	4	18	1016	74
08/13/11	1	1									1		**2**	7	19	1019	74
08/14/11	1									2	1		**3**	6	15	1015	92
08/15/11	1												**0**	7	12	1010	98
08/16/11	1												**0**	8	16	1010	92
08/17/11	1						1						**1**	7	19	1020	78
08/18/11	1	1											**1**	8	19	1016	80
08/19/11	1						1						**1**	7	18	1014	80
08/20/11	1									2	1		**3**	6	20	1015	81
08/21/11	1									1			**1**	11	17	1012	89
08/22/11	1												**0**	9	12	1009	74
08/23/11	1												**0**	9	16	1016	77
08/24/11	1	1											**1**	10	17	1017	75
08/25/11	1												**0**	9	17	1012	89
08/26/11	1										3		**3**	4	20	1016	82
08/27/11	1												**0**	7	18	1013	91
08/28/11	1												**0**	15	12	992	96
08/29/11	1			1						1			**2**	5	14	1012	73
08/30/11	1				1					2			**3**	10	17	1020	84
08/31/11	1	3	2	3		2				4	3		**17**	3	16	1023	77
09/01/11	1			2							1		**3**	4	14	1024	84
09/02/11	1												**0**	8	15	1021	76
09/03/11	1	2									3		**5**	6	21	1014	85
09/04/11	1	1											**1**	9	19	1012	91
09/05/11	1												**0**	7	14	1011	86
09/06/11	1		2										**2**	7	13	1017	93
09/07/11	1			2									**2**	3	11	1024	98
09/08/11	1	2									2		**4**	4	15	1019	96
09/09/11	1										1		**1**	8	15	1012	83
09/10/11	1			1							1		**2**	6	11	1015	75
09/11/11	1	1											**1**	11	14	1020	80
09/12/11	1												**0**	7	17	1016	84
09/13/11	1				1						1		**2**	11	18	1013	86
09/14/11	1			4							2		**6**	3	17	1014	83
09/15/11	1										1		**1**	13	5	1013	91
09/16/11	1	1									1		**2**	7	5	1023	67
09/17/11	1			1							1		**2**	4	9	1032	77
09/18/11	1												**0**	5	7	1032	76
09/19/11	1												**0**	8	10	1026	77
09/20/11	1												**0**	8	13	1020	93
09/21/11	1									2	1		**3**	5	16	1025	84
09/22/11	1												**0**	5	18	1021	93
09/23/11	1												**0**	4	17	1020	95
09/24/11	1			1					1		1		**3**	6	18	1017	95
09/25/11	1										1		**1**	5	18	1019	90
09/26/11	1	1		1			2			1	1		**6**	3	18	1017	92
09/27/11	1	2	4	3						1	4		**14**	5	14	1017	88
09/28/11	1	3								1	1		**5**	7	14	1019	80
09/29/11	1												**0**	8	12	1008	97
09/30/11	1		1				2			1	1		**5**	5	14	1006	88
10/01/11	1									1			**1**	7	8	1005	98
10/02/11	1	1	1										**2**	3	11	1011	99
10/03/11	1						3			5			**8**	5	9	1017	91
10/04/11	1												**0**	12	9	1015	97
10/05/11	1												**0**	8	3	1017	76
10/06/11	1												**0**	1	7	1026	61
10/07/11	1												**0**	1	8	1031	69
10/08/11	1									1			**1**	2	16	1030	71
10/09/11	1												**0**	1	17	1028	71
10/10/11	1												**0**	2	17	1023	71
10/11/11	1												**0**	0	13	1024	79
10/12/11	1				2						2		**4**	1	10	1023	87
10/13/11	1												**0**	1	12	1013	99
10/14/11	1												**0**	1	14	1000	96
10/15/11	1												**0**	5	11	999	77
10/16/11	1												**0**	4	12	1006	55
10/17/11	1												**0**	2	9	1005	67
10/18/11	1												**0**	2	9	1011	70
10/19/11	1												**0**	1	9	1011	94
10/20/11	1												**0**	3	14	1001	91
By Species		**118**	**153**	**31**	**13**	**13**	**12**	**1**	**1**	**40**	**203**	**0**	**585**				
By Guild		**302**			**13**	**13**	**14**			**243**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 3. Summary of acoustic bat data and weather during each survey night at the North Met Low detector – Antrim Wind Project, Summer/Fall 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	**Operational?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**	**Barometric Pressure**	**Relative Humidity (%)**
06/01/11	1	2	2							1	4		**9**	11	16	1014	79
06/02/11	1												**0**	12	8	1011	61
06/03/11	1	1								1			**2**	9	10	1016	54
06/04/11	1												**0**	7	9	1019	57
06/05/11	1	9	3		1						2		**15**	5	13	1019	73
06/06/11	1	26	14								7		**47**	4	18	1016	81
06/07/11	1	12	9								5		**26**	6	20	1013	62
06/08/11	1	8	8		8						44		**68**	12	19	1012	65
06/09/11	1	16	21			1					47		**85**	8	17	1012	88
06/10/11	1	8	7		1					3	8		**27**	6	14	1014	83
06/11/11	1												**0**	7	8	1020	94
06/12/11	1												**0**	2	10	1015	94
06/13/11	1		4		1						1		**6**	5	11	1012	85
06/14/11	1												**0**	9	11	1013	88
06/15/11	1	9	7								11		**27**	8	15	1011	78
06/16/11	1	2	5			12				2	2		**23**	9	18	1013	78
06/17/11	1	2	1			1				2	1		**7**	6	15	1013	90
06/18/11	1	51	44			10	4			23	20		**152**	9	15	1010	80
06/19/11	1	27	119			3			4	5	9		**167**	7	14	1011	61
06/20/11	1	51	110	1		26	1		14	15	15		**233**	4	16	1013	67
06/21/11	1	4	6			1	2		1	5	4		**23**	3	19	1014	66
06/22/11	1					1							**1**	6	15	1014	96
06/23/11	1												**0**	7	12	1012	98
06/24/11	1												**0**	5	9	1011	97
06/25/11	1	58	32			10			7	10	7		**124**	5	15	1011	94
06/26/11	1	94	10			7			1	38	21		**171**	8	16	1014	82
06/27/11	1	26	4			12				26	8		**76**	4	19	1017	72
06/28/11	1	1	1			6			1	2	1		**12**	7	17	1014	77
06/29/11	1					2				8	1		**11**	11	14	1011	81
06/30/11	1	10	8			37			2	31	23		**111**	8	15	1013	63
07/01/11	1	111	109			96				64	30		**410**	5	16	1016	71
07/02/11	1	41	37			1					5		**84**	7	18	1018	72
07/03/11	1	3	1			2	1			13	3		**23**	7	18	1012	86
07/04/11	1	63	9			13	1		3	43	13		**145**	4	20	1010	80
07/05/11	1	61	17	1		19				4	27		**129**	7	21	1013	82
07/06/11	1	64	7			3				2	17		**93**	11	17	1013	73
07/07/11	1	26	38			1				3	19		**87**	4	17	1014	74
07/08/11	1	10	11			14				6	4		**45**	5	18	1013	87
07/09/11	1	18	18			26	9		16	13	5		**105**	6	16	1010	84
07/10/11	1	28	9			1				1	13		**52**	10	20	1018	66
07/11/11	1	4	5		1				1	1	1		**13**	8	23	1014	72
07/12/11	1	164	27			3			5	6	5		**210**	8	20	1005	71
07/13/11	1	6	15		1					2	8		**32**	8	12	1008	74
07/14/11	1	10	6			8	7		3	6	3		**43**	8	16	1016	69
07/15/11	1		1			4	2			1	1		**9**	7	18	1019	63
07/16/11	1	17	10		3						13		**43**	10	21	1021	65
07/17/11	1	234	23								55		**312**	12	22	1019	63
07/18/11	1	73	19			1	53		3	18	50		**217**	8	19	1013	78
07/19/11	1	207	103		1	1	12		36	45	87		**492**	4	20	1011	69
07/20/11	1	44	19			1	35		13	11	138		**261**	10	22	1012	72
07/21/11	1	181	6	1			10		21	13	21		**253**	11	26	1008	78
07/22/11	1	128	31		2		20		13	44	82		**320**	6	23	1010	60
07/23/11	1	402	50	1	3	1	22		20	27	204		**730**	9	22	1013	71
07/24/11	1	46	31			11	1			4	14		**107**	5	18	1014	68
07/25/11	1	4	3			3	1		1	5			**17**	6	14	1014	85
07/26/11	1	136	41		1	34	3		6	28	14		**263**	9	15	1008	84
07/27/11	1	338	155		4	4	5		7	6	65		**584**	5	16	1012	69
07/28/11	1	173	39		6	2			1	5	34		**260**	6	20	1018	71
07/29/11	1	233	87		1	25	43		10	66	40		**505**	9	19	1013	90
07/30/11	1	414	158		1	4	3		1	10	158		**749**	7	17	1012	76
07/31/11	1	230	73	1		1	4		1	7	89		**406**	7	21	1017	70
08/01/11	1	520	86	1			8		1	18	112		**746**	10	19	1011	80
08/02/11	1	115	72				7		3	9	29		**235**	7	15	1007	66
08/03/11	1	45	22			1	1		2	12	36		**119**	3	16	1008	74
08/04/11	1	27	10			2	4		1	14	48		**106**	4	16	1014	81
08/05/11	1	65	29	1			1			1	54		**151**	6	19	1019	77
08/06/11	1	26	21		1	1				1	9		**59**	7	18	1016	81
08/07/11	1	137	44			1	12		2	9	31		**236**	4	20	1008	91
08/08/11	1	364	108							2	44		**518**	6	18	1001	90
08/09/11	1						1			5			**6**	7	16	1004	89
08/10/11	1	11	6		1	2	6	1		10	2		**39**	8	16	1002	88
08/11/11	1	46	67			1	6		4	23	8		**155**	9	14	1010	65
08/12/11	1	124	33		1	1	7			21	87		**274**	4	18	1016	74
08/13/11	1	28	8		1	1	1			1	19		**59**	7	19	1019	74
08/14/11	1	6				1	3		2	7	1		**20**	6	15	1015	92
08/15/11	1												**0**	7	12	1010	98
08/16/11	1	42	19			7	14			16	22		**120**	8	16	1010	92
08/17/11	1	114	44		1		3		1	8	44		**215**	7	19	1020	78
08/18/11	1	32	11		2	1	3			2	15		**66**	8	19	1016	80
08/19/11	1	16	5			2	3		1		21		**48**	7	18	1014	80
08/20/11	1	182	45		1		2			1	147		**378**	6	20	1015	81
08/21/11	1										1		**1**	11	17	1012	89
08/22/11	0												**0**	9	12	1009	74
08/23/11	0												**0**	9	16	1016	77
08/24/11	0												**0**	10	17	1017	75
08/25/11	0												**0**	9	17	1012	89
08/26/11	0												**0**	4	20	1016	82
08/27/11	0												**0**	7	18	1013	91
08/28/11	0												**0**	15	12	992	96
08/29/11	0												**0**	5	14	1012	73
08/30/11	0												**0**	10	17	1020	84
08/31/11	0												**0**	3	16	1023	77
09/01/11	0												**0**	4	14	1024	84
09/02/11	0												**0**	8	15	1021	76
09/03/11	0												**0**	6	21	1014	85
09/04/11	0												**0**	9	19	1012	91
09/05/11	0												**0**	7	14	1011	86
09/06/11	0												**0**	7	13	1017	93
09/07/11	0												**0**	3	11	1024	98
09/08/11	0												**0**	4	15	1019	96
09/09/11	0												**0**	8	15	1012	83
09/10/11	0												**0**	6	11	1015	75
09/11/11	0												**0**	11	14	1020	80
09/12/11	0												**0**	7	17	1016	84
09/13/11	0												**0**	11	18	1013	86
09/14/11	0												**0**	3	17	1014	83
09/15/11	0												**0**	13	5	1013	91
09/16/11	0												**0**	7	5	1023	67
09/17/11	0												**0**	4	9	1032	77
09/18/11	0												**0**	5	7	1032	76
09/19/11	0												**0**	8	10	1026	77
09/20/11	0												**0**	8	13	1020	93
09/21/11	0												**0**	5	16	1025	84
09/22/11	0												**0**	5	18	1021	93
09/23/11	0												**0**	4	17	1020	95
09/24/11	0												**0**	6	18	1017	95
09/25/11	0												**0**	5	18	1019	90
09/26/11	0												**0**	3	18	1017	92
09/27/11	0												**0**	5	14	1017	88
09/28/11	0												**0**	7	14	1019	80
09/29/11	0												**0**	8	12	1008	97
09/30/11	0												**0**	5	14	1006	88
10/01/11	1						1			1			**2**	7	8	1005	98
10/02/11	0												**0**	3	11	1011	99
10/03/11	0												**0**	5	9	1017	91
10/04/11	0												**0**	12	9	1015	97
10/05/11	0												**0**	8	3	1017	76
10/06/11	0												**0**	1	7	1026	61
10/07/11	0												**0**	1	8	1031	69
10/08/11	0												**0**	2	16	1030	71
10/09/11	1									3			**3**	1	17	1028	71
10/10/11	1		1										**1**	2	17	1023	71
10/11/11	1												**0**	0	13	1024	79
10/12/11	1				1		2			3	3		**9**	1	10	1023	87
10/13/11	1												**0**	1	12	1013	99
10/14/11	1									1			**1**	1	14	1000	96
10/15/11	1												**0**	5	11	999	77
10/16/11	1												**0**	4	12	1006	55
10/17/11	1												**0**	2	9	1005	67
10/18/11	1												**0**	2	9	1011	70
10/19/11	1												**0**	1	9	1011	94
10/20/11	1												**0**	3	14	1001	91
By Species		**5786**	**2204**	**7**	**44**	**429**	**324**	**1**	**208**	**794**	**2192**	**0**	**11989**				
By Guild		**7997**			**44**	**429**	**533**			**2986**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B Table 4. Summary of acoustic bat data and weather during each survey night at the Wetland Tree detector – Antrim Wind Project, Summer/Fall 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
06/01/11	0												0	11	16	1014	79
06/02/11	0												0	12	8	1011	61
06/03/11	0												0	9	10	1016	54
06/04/11	0												0	7	9	1019	57
06/05/11	0												0	5	13	1019	73
06/06/11	0												0	4	18	1016	81
06/07/11	0												0	6	20	1013	62
06/08/11	0												0	12	19	1012	65
06/09/11	0												0	8	17	1012	88
06/10/11	0												0	6	14	1014	83
06/11/11	0												0	7	8	1020	94
06/12/11	0												0	2	10	1015	94
06/13/11	0												0	5	11	1012	85
06/14/11	0												0	9	11	1013	88
06/15/11	0												0	8	15	1011	78
06/16/11	0												0	9	18	1013	78
06/17/11	0												0	6	15	1013	90
06/18/11	0												0	9	15	1010	80
06/19/11	0												0	7	14	1011	61
06/20/11	0												0	4	16	1013	67
06/21/11	0												0	3	19	1014	66
06/22/11	0												0	6	15	1014	96
06/23/11	0												0	7	12	1012	98
06/24/11	0												0	5	9	1011	97
06/25/11	0												0	5	15	1011	94
06/26/11	0												0	8	16	1014	82
06/27/11	0												0	4	19	1017	72
06/28/11	0												0	7	17	1014	77
06/29/11	0												0	11	14	1011	81
06/30/11	0												0	8	15	1013	63
07/01/11	0												0	5	16	1016	71
07/02/11	0												0	7	18	1018	72
07/03/11	0												0	7	18	1012	86
07/04/11	0												0	4	20	1010	80
07/05/11	0												0	7	21	1013	82
07/06/11	0												0	11	17	1013	73
07/07/11	0												0	4	17	1014	74
07/08/11	0												0	5	18	1013	87
07/09/11	0												0	6	16	1010	84
07/10/11	0												0	10	20	1018	66
07/11/11	0												0	8	23	1014	72
07/12/11	0												0	8	20	1005	71
07/13/11	1												0	8	12	1008	74
07/14/11	1					2				1			3	8	16	1016	69
07/15/11	1					1				1	1		3	7	18	1019	63
07/16/11	1	1				1				1			3	10	21	1021	65
07/17/11	1	4	2			2		1		1	1		11	12	22	1019	63
07/18/11	1	2	1			2				1			6	8	19	1013	78
07/19/11	1	1				1				1			3	4	20	1011	69
07/20/11	1	3								1	2		6	10	22	1012	72
07/21/11	1	2	1							1	2		6	11	26	1008	78
07/22/11	1	1								2			3	6	23	1010	60
07/23/11	1	5				2					2		9	9	22	1013	71
07/24/11	1	4							1	1	2		8	5	18	1014	68
07/25/11	1									2	3		5	6	14	1014	85
07/26/11	1	2								1			3	9	15	1008	84
07/27/11	1					2			1		1		4	5	16	1012	69
07/28/11	1	15				6				2	2		25	6	20	1018	71
07/29/11	1	1				2				4			7	9	19	1013	90
07/30/11	1	2				1			1	3	2		9	7	17	1012	76
07/31/11	1	4				1				3			8	7	21	1017	70
08/01/11	1	1				1				4	1		7	10	19	1011	80
08/02/11	1	1				1				2			4	7	15	1007	66
08/03/11	1	1											1	3	16	1008	74
08/04/11	1	1							1				2	4	16	1014	81
08/05/11	1								1	1	3		5	6	19	1019	77
08/06/11	1	1											1	7	18	1016	81
08/07/11	1					1				2	1		4	4	20	1008	91
08/08/11	1	1								1			2	6	18	1001	90
08/09/11	1									1			1	7	16	1004	89
08/10/11	1	2							1	3	1		7	8	16	1002	88
08/11/11	1					2							2	9	14	1010	65
08/12/11	1	1				1				1			3	4	18	1016	74
08/13/11	1	7	2								3		12	7	19	1019	74
08/14/11	1									1			1	6	15	1015	92
08/15/11	1												0	7	12	1010	98
08/16/11	1					2				2			4	8	16	1010	92
08/17/11	1	2	1				2		1	3	2		11	7	19	1020	78
08/18/11	1		1			2				2	1		6	8	19	1016	80
08/19/11	1	1				1				2			4	7	18	1014	80
08/20/11	1	1	1								1		3	6	20	1015	81
08/21/11	1									2	1		3	11	17	1012	89
08/22/11	1									3	1		4	9	12	1009	74
08/23/11	1										1		1	9	16	1016	77
08/24/11	1									1			1	10	17	1017	75
08/25/11	1									1			1	9	17	1012	89
08/26/11	1									1	1		2	4	20	1016	82
08/27/11	1								1				1	7	18	1013	91
08/28/11	1												0	15	12	992	96
08/29/11	1					1				1			2	5	14	1012	73
08/30/11	1	2									1		3	10	17	1020	84
08/31/11	1												0	3	16	1023	77
09/01/11	1												0	4	14	1024	84
09/02/11	1												0	8	15	1021	76
09/03/11	1												0	6	21	1014	85
09/04/11	1												0	9	19	1012	91
09/05/11	1												0	7	14	1011	86
09/06/11	1												0	7	13	1017	93
09/07/11	1												0	3	11	1024	98
09/08/11	1												0	4	15	1019	96
09/09/11	1	1								1			2	8	15	1012	83
09/10/11	1										1		1	6	11	1015	75
09/11/11	1												0	11	14	1020	80
09/12/11	1												0	7	17	1016	84
09/13/11	1												0	11	18	1013	86
09/14/11	1												0	3	17	1014	83
09/15/11	1												0	13	5	1013	91
09/16/11	1												0	7	5	1023	67
09/17/11	1												0	4	9	1032	77
09/18/11	1												0	5	7	1032	76
09/19/11	1												0	8	10	1026	77
09/20/11	1												0	8	13	1020	93
09/21/11	1												0	5	16	1025	84
09/22/11	1												0	5	18	1021	93
09/23/11	1												0	4	17	1020	95
09/24/11	1												0	6	18	1017	95
09/25/11	1												0	5	18	1019	90
09/26/11	1												0	3	18	1017	92
09/27/11	1												0	5	14	1017	88
09/28/11	1												0	7	14	1019	80
09/29/11	1												0	8	12	1008	97
09/30/11	1												0	5	14	1006	88
10/01/11	1												0	7	8	1005	98
10/02/11	1												0	3	11	1011	99
10/03/11	1										1		1	5	9	1017	91
10/04/11	1												0	12	9	1015	97
10/05/11	1												0	8	3	1017	76
10/06/11	0												0	1	7	1026	61
10/07/11	0												0	1	8	1031	69
10/08/11	0												0	2	16	1030	71
10/09/11	0												0	1	17	1028	71
10/10/11	0												0	2	17	1023	71
10/11/11	0												0	0	13	1024	79
10/12/11	0												0	1	10	1023	87
10/13/11	0												0	1	12	1013	99
10/14/11	0												0	1	14	1000	96
10/15/11	0												0	5	11	999	77
10/16/11	0												0	4	12	1006	55
10/17/11	0												0	2	9	1005	67
10/18/11	0												0	2	9	1011	70
10/19/11	0												0	1	9	1011	94
10/20/11	0												0	3	14	1001	91
By Species		**70**	**9**	**0**	**0**	**35**	**2**	**1**	**8**	**61**	**38**	**0**	**224**				
By Guild		**79**			**0**	**35**	**11**			**99**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B **Table 5**. Summary of acoustic bat data and weather during each survey night at the Willard Tree detector – Antrim Wind Project, Summer/Fall 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
06/01/11	1	1	7		18						17		**43**	11	16	1014	79
06/02/11	1												**0**	12	8	1011	61
06/03/11	1	10	5							1	1		**17**	9	10	1016	54
06/04/11	1	4	4	1	9						11		**29**	7	9	1019	57
06/05/11	1	27	30		3						10		**70**	5	13	1019	73
06/06/11	1	11	9		2					2	12		**36**	4	18	1016	81
06/07/11	1	23	12		5						9		**49**	6	20	1013	62
06/08/11	1	9	7								17		**33**	12	19	1012	65
06/09/11	1	10	4		5	1	1				7		**28**	8	17	1012	88
06/10/11	1	14	6	4	7	1				1	11		**44**	6	14	1014	83
06/11/11	1												**0**	7	8	1020	94
06/12/11	1												**0**	2	10	1015	94
06/13/11	1		1										**1**	5	11	1012	85
06/14/11	1												**0**	9	11	1013	88
06/15/11	1	7	1		4					1	3		**16**	8	15	1011	78
06/16/11	1	21	5		3						5		**34**	9	18	1013	78
06/17/11	1	123	30		16					1	61		**231**	6	15	1013	90
06/18/11	1	18	8		10						6		**42**	9	15	1010	80
06/19/11	1	3	1								2		**6**	7	14	1011	61
06/20/11	1												**0**	4	16	1013	67
06/21/11	1												**0**	3	19	1014	66
06/22/11	1												**0**	6	15	1014	96
06/23/11	1												**0**	7	12	1012	98
06/24/11	1												**0**	5	9	1011	97
06/25/11	1	32	1	1		2					7		**43**	5	15	1011	94
06/26/11	1	22	2		3						10		**37**	8	16	1014	82
06/27/11	1												**0**	4	19	1017	72
06/28/11	1	2	3				3			7			**15**	7	17	1014	77
06/29/11	1	2			1						1		**4**	11	14	1011	81
06/30/11	1		8								7		**15**	8	15	1013	63
07/01/11	1	5					2			2			**9**	5	16	1016	71
07/02/11	0												**0**	7	18	1018	72
07/03/11	0												**0**	7	18	1012	86
07/04/11	0												**0**	4	20	1010	80
07/05/11	0												**0**	7	21	1013	82
07/06/11	0												**0**	11	17	1013	73
07/07/11	0												**0**	4	17	1014	74
07/08/11	0												**0**	5	18	1013	87
07/09/11	0												**0**	6	16	1010	84
07/10/11	0												**0**	10	20	1018	66
07/11/11	0												**0**	8	23	1014	72
07/12/11	1	2			1	4					1		**8**	8	20	1005	71
07/13/11	1		4								2		**6**	8	12	1008	74
07/14/11	1	1				2				1	2		**6**	8	16	1016	69
07/15/11	1	22	5			4				1	36		**68**	7	18	1019	63
07/16/11	1	11	4							1	3		**19**	10	21	1021	65
07/17/11	1	40	18							1	20		**79**	12	22	1019	63
07/18/11	1	14	4		1	1				1	7		**28**	8	19	1013	78
07/19/11	1	6	5	1		1				5	2		**20**	4	20	1011	69
07/20/11	1	134	33	1		3	1		1	3	91		**267**	10	22	1012	72
07/21/11	1	14	10			5	3		1	3	11		**47**	11	26	1008	78
07/22/11	1	16	8	1		2	3			4	6		**40**	6	23	1010	60
07/23/11	1	127	53			1	5		1	5	39		**231**	9	22	1013	71
07/24/11	1	21	22			4				1	8		**56**	5	18	1014	68
07/25/11	1	1	1				3			5	1		**11**	6	14	1014	85
07/26/11	1	50	27	1			3			4	13		**98**	9	15	1008	84
07/27/11	1	15	18			4			1	1	3		**42**	5	16	1012	69
07/28/11	1	216	149		4	6	1		2	9	62		**449**	6	20	1018	71
07/29/11	1	64	24				1			7	20		**116**	9	19	1013	90
07/30/11	1	13	15			3	1			2	5		**39**	7	17	1012	76
07/31/11	1	91	140			4	4			1	14		**254**	7	21	1017	70
08/01/11	1	20	27			1	1			3	8		**60**	10	19	1011	80
08/02/11	1	2	1			1			1	2	1		**8**	7	15	1007	66
08/03/11	1	12	4	1		1	1		1	7	3		**30**	3	16	1008	74
08/04/11	1	2	6			3	4			2	6		**23**	4	16	1014	81
08/05/11	1	118	102		6	1	5			4	44		**280**	6	19	1019	77
08/06/11	1	32	20				1			4	6		**63**	7	18	1016	81
08/07/11	1	9	11		1		4			5	4		**34**	4	20	1008	91
08/08/11	1	5	2				2			1	3		**13**	6	18	1001	90
08/09/11	1						1			2	1		**4**	7	16	1004	89
08/10/11	1	1	3		1	3	8			11	4		**31**	8	16	1002	88
08/11/11	1		2				9		3	28			**42**	9	14	1010	65
08/12/11	1				1	2	16			30			**49**	4	18	1016	74
08/13/11	1	97	30		1	1	9		2	6	123		**269**	7	19	1019	74
08/14/11	1	2	2				4			2	1		**11**	6	15	1015	92
08/15/11	1						7		3	4			**14**	7	12	1010	98
08/16/11	1	3	1				6		9	3	1		**23**	8	16	1010	92
08/17/11	1	50	39		4	1	45		3	19	22		**183**	7	19	1020	78
08/18/11	1	120	35	1	3	2	86		30	17	55		**349**	8	19	1016	80
08/19/11	1	39	46			5	25		4	9	35		**163**	7	18	1014	80
08/20/11	1	68	58		1	1	45		6	12	16		**207**	6	20	1015	81
08/21/11	1	2	3		1	1	43		75	22	1		**148**	11	17	1012	89
08/22/11	1		3	1		3	19		25	37	1		**89**	9	12	1009	74
08/23/11	1						136		30	89			**255**	9	16	1016	77
08/24/11	1	1	5		1		164		4	14	14		**203**	10	17	1017	75
08/25/11	1	7	2			1	120		36	26	18		**210**	9	17	1012	89
08/26/11	1	12	3				6		9	6	6		**42**	4	20	1016	82
08/27/11	1									2			**2**	7	18	1013	91
08/28/11	1						7		8				**15**	15	12	992	96
08/29/11	1	1					4		1	7			**13**	5	14	1012	73
08/30/11	1	44	59		2		71			13	15		**204**	10	17	1020	84
08/31/11	1	18	3				16			4	12		**53**	3	16	1023	77
09/01/11	1		4			1	6			11	1		**23**	4	14	1024	84
09/02/11	1	37	21			2	28	1		7	11		**107**	8	15	1021	76
09/03/11	1	3			1	2	16			9	6		**37**	6	21	1014	85
09/04/11	1	4	1			1	4			3	8		**21**	9	19	1012	91
09/05/11	1	1				1	4			7			**13**	7	14	1011	86
09/06/11	1									1			**1**	7	13	1017	93
09/07/11	1	1		1			2			1			**5**	3	11	1024	98
09/08/11	1	6	1	1	1	1	1			1	2		**14**	4	15	1019	96
09/09/11	1	10	7			1	6			4	3		**31**	8	15	1012	83
09/10/11	1	1								1			**2**	6	11	1015	75
09/11/11	1	1	1				49			18			**69**	11	14	1020	80
09/12/11	1	56	4		1		13			5	9		**88**	7	17	1016	84
09/13/11	1	68	10				31	1	1	13	39		**163**	11	18	1013	86
09/14/11	1	3	1			1	16			8	1		**30**	3	17	1014	83
09/15/11	1	1											**1**	13	5	1013	91
09/16/11	1	1											**1**	7	5	1023	67
09/17/11	1		1										**1**	4	9	1032	77
09/18/11	1						1						**1**	5	7	1032	76
09/19/11	1	1					83		2	4	1		**91**	8	10	1026	77
09/20/11	1					1	60			6			**67**	8	13	1020	93
09/21/11	1	54	31			1	112			22	26		**246**	5	16	1025	84
09/22/11	1	2					97			24			**123**	5	18	1021	93
09/23/11	1				1		17			8			**26**	4	17	1020	95
09/24/11	1	1					77			10			**88**	6	18	1017	95
09/25/11	1						10			7	1		**18**	5	18	1019	90
09/26/11	1	10	1	1			12			9	2		**35**	3	18	1017	92
09/27/11	1	5					4		1	4			**14**	5	14	1017	88
09/28/11	1	1					2			2			**5**	7	14	1019	80
09/29/11	1						13			12			**25**	8	12	1008	97
09/30/11	1	10					3			6	2		**21**	5	14	1006	88
10/01/11	1												**0**	7	8	1005	98
10/02/11	0												**0**	3	11	1011	99
10/03/11	0												**0**	5	9	1017	91
10/04/11	0												**0**	12	9	1015	97
10/05/11	0												**0**	8	3	1017	76
10/06/11	0												**0**	1	7	1026	61
10/07/11	0												**0**	1	8	1031	69
10/08/11	0												**0**	2	16	1030	71
10/09/11	0												**0**	1	17	1028	71
10/10/11	0												**0**	2	17	1023	71
10/11/11	0												**0**	0	13	1024	79
10/12/11	0												**0**	1	10	1023	87
10/13/11	0												**0**	1	12	1013	99
10/14/11	0												**0**	1	14	1000	96
10/15/11	0												**0**	5	11	999	77
10/16/11	0												**0**	4	12	1006	55
10/17/11	0												**0**	2	9	1005	67
10/18/11	0												**0**	2	9	1011	70
10/19/11	0												**0**	1	9	1011	94
10/20/11	0												**0**	3	14	1001	91
By Species		**2144**	**1234**	**16**	**118**	**87**	**1563**	**2**	**260**	**664**	**1055**	**0**	**7143**				
By Guild		**3394**			**118**	**87**	**1825**			**1719**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

Appendix B **Table 6**. Summary of acoustic bat data and weather during each survey night at the Willard Tree detector – Antrim Wind Project, Summer/Fall 2011.

		BBSH			HB	MYSP	RBTB			UNKN							
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)	Barometric Pressure	Relative Humidity (%)
06/01/11	1	18	21	3	1						1		**44**	11	16	1014	79
06/02/11	1												**0**	12	8	1011	61
06/03/11	1												**0**	9	10	1016	54
06/04/11	1												**0**	7	9	1019	57
06/05/11	1	23	11		1								**35**	5	13	1019	73
06/06/11	1	13	2		5						6		**26**	4	18	1016	81
06/07/11	1	17	20		2		4			1	5		**49**	6	20	1013	62
06/08/11	1	15	13								4		**32**	12	19	1012	65
06/09/11	1	8	5		20	2					3		**38**	8	17	1012	88
06/10/11	1	3	27		19						10		**59**	6	14	1014	83
06/11/11	1												**0**	7	8	1020	94
06/12/11	1												**0**	2	10	1015	94
06/13/11	1	1	1		1								**3**	5	11	1012	85
06/14/11	1												**0**	9	11	1013	88
06/15/11	1				72	1					3		**76**	8	15	1011	78
06/16/11	1	7	16		46	157				34	6		**266**	9	18	1013	78
06/17/11	1	9	25		178	5				1	12		**230**	6	15	1013	90
06/18/11	1	1	9		132	3				1	7		**153**	9	15	1010	80
06/19/11	1	7	4		45	2					10		**68**	7	14	1011	61
06/20/11	1	9	11		25					1	6		**52**	4	16	1013	67
06/21/11	1		7							2	2		**11**	3	19	1014	66
06/22/11	1		1										**1**	6	15	1014	96
06/23/11	1												**0**	7	12	1012	98
06/24/11	1												**0**	5	9	1011	97
06/25/11	1	2	8		1	1					1		**13**	5	15	1011	94
06/26/11	1	1	1		183	4				1	2		**192**	8	16	1014	82
06/27/11	1	22	27		133	1				1	7		**191**	4	19	1017	72
06/28/11	1	2	4			4	2			2			**14**	7	17	1014	77
06/29/11	1				166					1	5		**172**	11	14	1011	81
06/30/11	1				224	1				1	3		**229**	8	15	1013	63
07/01/11	1	10	10								1		**21**	5	16	1016	71
07/02/11	1	21	28		1	5	4				3		**62**	7	18	1018	72
07/03/11	1	5	5				62			2			**74**	7	18	1012	86
07/04/11	1		4		54	1	5				4		**68**	4	20	1010	80
07/05/11	1	13	7		4		2			1	3		**30**	7	21	1013	82
07/06/11	1	12	26		93	1					18		**150**	11	17	1013	73
07/07/11	1	3	12		2	1					8		**26**	4	17	1014	74
07/08/11	1	4	7		2						4		**17**	5	18	1013	87
07/09/11	1	5	4		23		1				6		**39**	6	16	1010	84
07/10/11	1	17	25		6	2	3			1	4		**58**	10	20	1018	66
07/11/11	1	35	93			6	24			27	5		**190**	8	23	1014	72
07/12/11	1	9	9		6	1	5			3	4		**37**	8	20	1005	71
07/13/11	1		3		1								**4**	8	12	1008	74
07/14/11	1	1	5								1		**7**	8	16	1016	69
07/15/11	1	38	323			2	1			3	6		**373**	7	18	1019	63
07/16/11	1	40	63			2	2			2	6		**115**	10	21	1021	65
07/17/11	1	14	28		1		1		1		6		**51**	12	22	1019	63
07/18/11	1	5	4		1	1	2				2		**15**	8	19	1013	78
07/19/11	1	5	4			3	2			2			**16**	4	20	1011	69
07/20/11	1	24	75		4	2	2			2	23		**132**	10	22	1012	72
07/21/11	1	13	25			1	3			3	6		**51**	11	26	1008	78
07/22/11	1	11	2		1		17			3	3		**37**	6	23	1010	60
07/23/11	1	8	3		3		2			2	2		**20**	9	22	1013	71
07/24/11	1	10	4			2				1	1		**18**	5	18	1014	68
07/25/11	1	2	1				1			1			**5**	6	14	1014	85
07/26/11	1	1	2			2	8			4	2		**19**	9	15	1008	84
07/27/11	1	4			1	1	1			2	1		**10**	5	16	1012	69
07/28/11	1	176								21	149		**346**	6	20	1018	71
07/29/11	1	1	3			1	19			11	1		**36**	9	19	1013	90
07/30/11	1	15	14				2			4	7		**42**	7	17	1012	76
07/31/11	1	18	33		7	2	5			2	5		**72**	7	21	1017	70
08/01/11	1	12	22			1	3			1	14		**53**	10	19	1011	80
08/02/11	1	3	4				4			1			**12**	7	15	1007	66
08/03/11	1	6	5		3	2	19			4	1		**40**	3	16	1008	74
08/04/11	1	1				3	15			3			**22**	4	16	1014	81
08/05/11	1	24	54		7		10			2	22		**119**	6	19	1019	77
08/06/11	1						16			6			**22**	7	18	1016	81
08/07/11	1		7							1	1		**9**	4	20	1008	91
08/08/11	1	1	5							2	2		**10**	6	18	1001	90
08/09/11	1				2	1							**3**	7	16	1004	89
08/10/11	1	1			3	2	29			6	1		**42**	8	16	1002	88
08/11/11	1				8	4	47			16			**75**	9	14	1010	65
08/12/11	1	9	4				27		1	19	1		**61**	4	18	1016	74
08/13/11	1	55	99		9	2	51		2	7	6		**231**	7	19	1019	74
08/14/11	1	1					43			14			**58**	6	15	1015	92
08/15/11	1						2						**2**	7	12	1010	98
08/16/11	1		4				40			8			**52**	8	16	1010	92
08/17/11	1	18	7				97			6	2		**130**	7	19	1020	78
08/18/11	1	20	18		158		50		1	12	16		**275**	8	19	1016	80
08/19/11	1	47	33		8		12		1	3	2		**106**	7	18	1014	80
08/20/11	1	32	27		1	1	28			3	3		**95**	6	20	1015	81
08/21/11	1	5	4				34			7	4		**54**	11	17	1012	89
08/22/11	1					1	11			4			**16**	9	12	1009	74
08/23/11	1			1			36			5	2		**44**	9	16	1016	77
08/24/11	1	21	41			1	2			2	4		**71**	10	17	1017	75
08/25/11	1		14				5		1	1			**21**	9	17	1012	89
08/26/11	1	19	16	1	2		3			5			**46**	4	20	1016	82
08/27/11	1	2	1				2			1			**6**	7	18	1013	91
08/28/11	1									2			**2**	15	12	992	96
08/29/11	1	4		1			1			1	1		**8**	5	14	1012	73
08/30/11	1		6		2		31			5	3		**47**	10	17	1020	84
08/31/11	1	3	10	2			1			3	8		**27**	3	16	1023	77
09/01/11	1	18	51	1			3				4		**77**	4	14	1024	84
09/02/11	1	32	9	2	1		16			7	1		**68**	8	15	1021	76
09/03/11	1	53	10				57			16	8		**144**	6	21	1014	85
09/04/11	1	25	6				42			8	6		**87**	9	19	1012	91
09/05/11	1						16			12			**28**	7	14	1011	86
09/06/11	1									1			**1**	7	13	1017	93
09/07/11	1									1			**1**	3	11	1024	98
09/08/11	1	1	6				1	1			1		**10**	4	15	1019	96
09/09/11	1	5	6		1		7						**19**	8	15	1012	83
09/10/11	1			1									**1**	6	11	1015	75
09/11/11	1	2					29			7	1		**39**	11	14	1020	80
09/12/11	1	11	4		1		224		2	13	1		**256**	7	17	1016	84
09/13/11	1	10	9			1	376		1	17	1		**415**	11	18	1013	86
09/14/11	1	1	4	2			249		1	13			**270**	3	17	1014	83
09/15/11	1												**0**	13	5	1013	91
09/16/11	1												**0**	7	5	1023	67
09/17/11	1			5		1				1			**7**	4	9	1032	77
09/18/11	1	1											**1**	5	7	1032	76
09/19/11	1				1		19			7			**27**	8	10	1026	77
09/20/11	1						145			3			**148**	8	13	1020	93
09/21/11	1	16	11	5			249			26	2		**309**	5	16	1025	84
09/22/11	1	1					320			27			**348**	5	18	1021	93
09/23/11	1						19			3			**22**	4	17	1020	95
09/24/11	1	2	2	6			42			4			**56**	6	18	1017	95
09/25/11	1	4	2				20			1			**27**	5	18	1019	90
09/26/11	1	9	3	3			33			9	1		**58**	3	18	1017	92
09/27/11	1	2		1			30			11	1		**45**	5	14	1017	88
09/28/11	1						3			6			**9**	7	14	1019	80
09/29/11	1						83			6			**89**	8	12	1008	97
09/30/11	1	3		4		1	40			5			**53**	5	14	1006	88
10/01/11	1										1		**1**	7	8	1005	98
10/02/11	0												**0**	3	11	1011	99
10/03/11	0												**0**	5	9	1017	91
10/04/11	0												**0**	12	9	1015	97
10/05/11	0												**0**	8	3	1017	76
10/06/11	0												**0**	1	7	1026	61
10/07/11	0												**0**	1	8	1031	69
10/08/11	0												**0**	2	16	1030	71
10/09/11	0												**0**	1	17	1028	71
10/10/11	0												**0**	2	17	1023	71
10/11/11	0												**0**	0	13	1024	79
10/12/11	0												**0**	1	10	1023	87
10/13/11	0												**0**	1	12	1013	99
10/14/11	0												**0**	1	14	1000	96
10/15/11	0												**0**	5	11	999	77
10/16/11	0												**0**	4	12	1006	55
10/17/11	0												**0**	2	9	1005	67
10/18/11	0												**0**	2	9	1011	70
10/19/11	0												**0**	1	9	1011	94
10/20/11	0												**0**	3	14	1001	91
By Species		**1158**	**1539**	**38**	**1671**	**238**	**2822**	**1**	**11**	**497**	**495**	**0**	**8470**				
By Guild		**2735**			**1671**	**238**	**2834**			**992**							
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**				

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

MEMORANDUM

Bald Eagle Nest Survey for the Antrim Wind Energy Project, Spring 2011

This memorandum serves to document the methods and findings of the spring 2011 bald eagle nest survey for the Antrim Wind Energy Project.

Protocol Development and Consultation

The following survey protocol, relevant to the Antrim Wind Energy Project, was provided to the United States Fish and Wildlife Service (USFWS), and the New Hampshire Fish and Game Department (NHFG) on March 17, 2011.

Survey Protocol

In general, rare raptor nest surveys will employ ground and aerial survey protocols. These protocols are described in detail in the following subsections.

In addition to these nest surveys, spring diurnal raptor migration studies (being conducted separately) will serve to document any rare raptor breeding behavior that is observed. Observations which indicate breeding include: observations of paired birds; habitual observations in the same general area; observations of rare raptors flying with food items; and observed territorial interactions with other birds.

Furthermore, in addition to formal observations recorded during rare raptor nest surveys and diurnal raptor migration surveys, any eagle and falcon activity observed in the Project vicinity will be documented as incidental observations whenever biologists are in the area.

If observations indicate suspected eagle or falcon nesting, NHF&G and USFWS biologists will be notified as soon as possible.

Ground-Based Nest Surveys

Ground-based nest surveys will focus on detecting peregrine falcon and golden eagle nesting activity. Ground surveys will be performed at any cliff habitats within 10 miles of the Project area that are deemed suitable for golden eagle or peregrine falcon nesting. The existence and location of such sites will be identified in consultation with NHF&G and USFWS.

Ground-based nest surveys at identified sites will be performed in early April, before leaf-out, as this timeframe provides optimal seasonal conditions for documentation of active nest use.

Surveys will be conducted at a suitable distance from the sites from or adjacent to existing roads by scanning each cliff face multiple times (10 to 60 times) with binoculars and spotting scopes. Surveyors will be looking for any sign of potential nest sites or activity. Perches or nest sites often have large "white-washed" areas below them from raptor liquid droppings, and the location of such perches will be documented. Personnel performing this work will be in close communication with NHF&G and USFWS throughout survey efforts. If any evidence of nesting is discovered, NHF&G and USFWS personnel will be informed immediately.

Aerial Nest Surveys

Prior to conducting aerial nest surveys, 2010 data on New Hampshire's bald eagle population and nest locations will be obtained.

The aerial rare raptor nest survey will be conducted using a helicopter, flying as low and slow as safety and practicality will allow. A single aerial survey will be conducted prior to leaf-on conditions. The area surveyed will include suitable waterbodies (for bald eagle nesting) and cliff sites (for golden eagle or peregrine falcon nesting, if identified) within a 10 mile radius of the proposed project. During the flight, two experienced observers will visually scan appropriate habitats for evidence of rare raptor nests.

Flights will only be conducted when conditions are conducive to the survey, including skies with at least one-mile visibility and winds less than 15 mph. The location of any nests or other pertinent information observed will be recorded. Information recorded will include areas surveyed, location of any nests observed, and status of nests (active/inactive). Active participation by regional NHF&G and USFWS biologists who are familiar with the area will be sought.

Surveyor Preparedness

Personnel performing rare raptor breeding surveys will be experienced in bird identification, and will be familiar with the logistics involved with working in remote settings. Personnel performing aerial nest surveys will be experienced in bird identification and experienced conducting wildlife observations from the air.

Data Collection

All observations from rare raptor breeding surveys will be recorded into field notebooks at the time of observation. These notes will be recorded by experienced field professionals who are versed in providing all pertinent information and detail. Manually recorded data will be translated into electronic format upon return to the office from the field.

As noted, this Rare, Threatened, and Endangered Raptor Nest Survey Protocol for the Antrim Wind Energy Project was provided to agencies on March 17, 2011. Recipients included the United States Fish and Wildlife Service (USFWS), and the New Hampshire Fish and Game Department (NHFG). No written comments on the protocol were received. On April 6, 2011, a consultation meeting was conducted to discuss wildlife studies for the Antrim Wind Energy Project. The aforementioned entities (and others) were invited to attend; of the invitees relevant to this study, only USFWS was represented at the meeting. The only comment relevant to the raptor nest survey protocol was this: USFWS requested that 2010 bald eagle nesting data be obtained.

During consultation, no potential golden eagle or peregrine falcon nest habitat was identified; therefore, no ground surveys as described in the March 17, 2011 protocol were warranted as part of the rare raptor nest survey.

The above protocol states that the area surveyed for bald eagle nesting will include "suitable waterbodies (for bald eagle nesting)" within a 10 mile radius of the proposed project. Suitable waterbodies for bald eagle nesting, for the purpose of this survey, were identified based on the following criteria:

Lakes to be surveyed must

- be located (or partially located) within a 10-mile radius of the proposed project;
- be greater than 35 acres in size; and
- be judged, during a desktop assessment of aerial photography, to potentially include adequate nesting habitat.

Due to the low saturation of breeding bald eagles in the State of New Hampshire, water bodies with low nesting potential (e.g. water bodies that are less than 35 acres in size, and which lack optimal nesting habitat) were not included in the survey. This is based on the assumption that higher quality habitats will be colonized by new breeding pairs before poorer habitats.

Based on the above criteria, a total of 34 lakes and ponds were identified to be searched during the aerial effort. Lakes that were surveyed are listed in Table 1.

Table 1: Waterbodies Surveyed for Bald Eagle Nesting Activity

Waterbody	Size (Acres)
Ashuelot Pond	367
Barney Pond	192
Black Pond	86
Bolster Pond	63
Center Pond	81
Chesham Pond	90
Childs Bog	115
Contention Pond	93
Deering Reservoir	322
Dublin Pond	236
Edward MacDowell Reservoir	104
Franklin Pierce Lake	483
Granite Lake	232
Gregg Lake	200
Halfmoon Pond	75
Highland Lake	696
Howe Reservoir	117
Hunts Pond	49
Island Pond	179
Lake Skatutakee	44
Loon Pond	154
Millen Lake	143
Nubanusit Brook Reservoir	138
Nubanusit Lake	717
Otter Lake	135
Pickerel Creek Pond	46
Powder Mill Pond	419
Silver Lake	346
Skatutakee Lake	190
Spoonwood Pond	158
Tolman Pond	39
Whittemore Lake	41
Willard Pond	110
Woodward Pond	137

Results

2010 Information for Bald Eagle Nest Sites within 10-Miles of the Proposed Project Area

Pursuant to comments received from USFWS during the April 6, 2011 consultation meeting, 2010 bald eagle nesting data was obtained.

Data from the New Hampshire Audubon (New Hampshire Audubon 2010) identified one historic bald eagle nest site within a 10-mile radius of the proposed Antrim Wind Energy Project. An historic bald eagle territory and nest site, most recently occupied in 2010, was identified on Nubanusit Lake, approximately 4 miles southwest of the project area.

The historic bald eagle territory at Nubanusit Lake has been occupied for 14 years (1997-2010) since monitoring began in 1988. Nesting was documented in 12 of these years. This 14-year-long occupation constitutes the second most persistent bald eagle territory documented within the State of New Hampshire since 1988 (a territory at Lake Umbagog has been occupied during 22 years of monitoring). Nesting was most recently confirmed at Nubanusit Lake in 2010; the resident eagles successfully fledged three chicks before their nest collapsed late in the summer season. (New Hampshire Audubon 2010).

The Nubanusit Lake bald eagle territory is one of 22 occupied territories identified in New Hampshire in 2010. The number of occupied bald eagle territories has been increasing in New Hampshire: the 22 occupied territories in 2010 represent a "record-high", and a one-year increase of 10% compared to the previous high of 20 occupied territories documented in 2009. (New Hampshire Audubon 2010).

Aerial Survey Results

On May 6, 2011, an aerial survey was conducted in an effort to identify and document bald eagle nesting activity within a 10-mile radius of the proposed Antrim Wind Energy Project. During the survey, two biologists (both experienced in conducting aerial avian and wildlife surveys) visually inspected the shoreline and islands of 34 lakes and ponds that were identified as having potential bald eagle breeding habitat (see table 1). The survey was performed from a helicopter, flying as low and slow as conditions and safety allowed. Weather during the survey was sunny and clear with light and variable winds, increasing slightly in the afternoon.

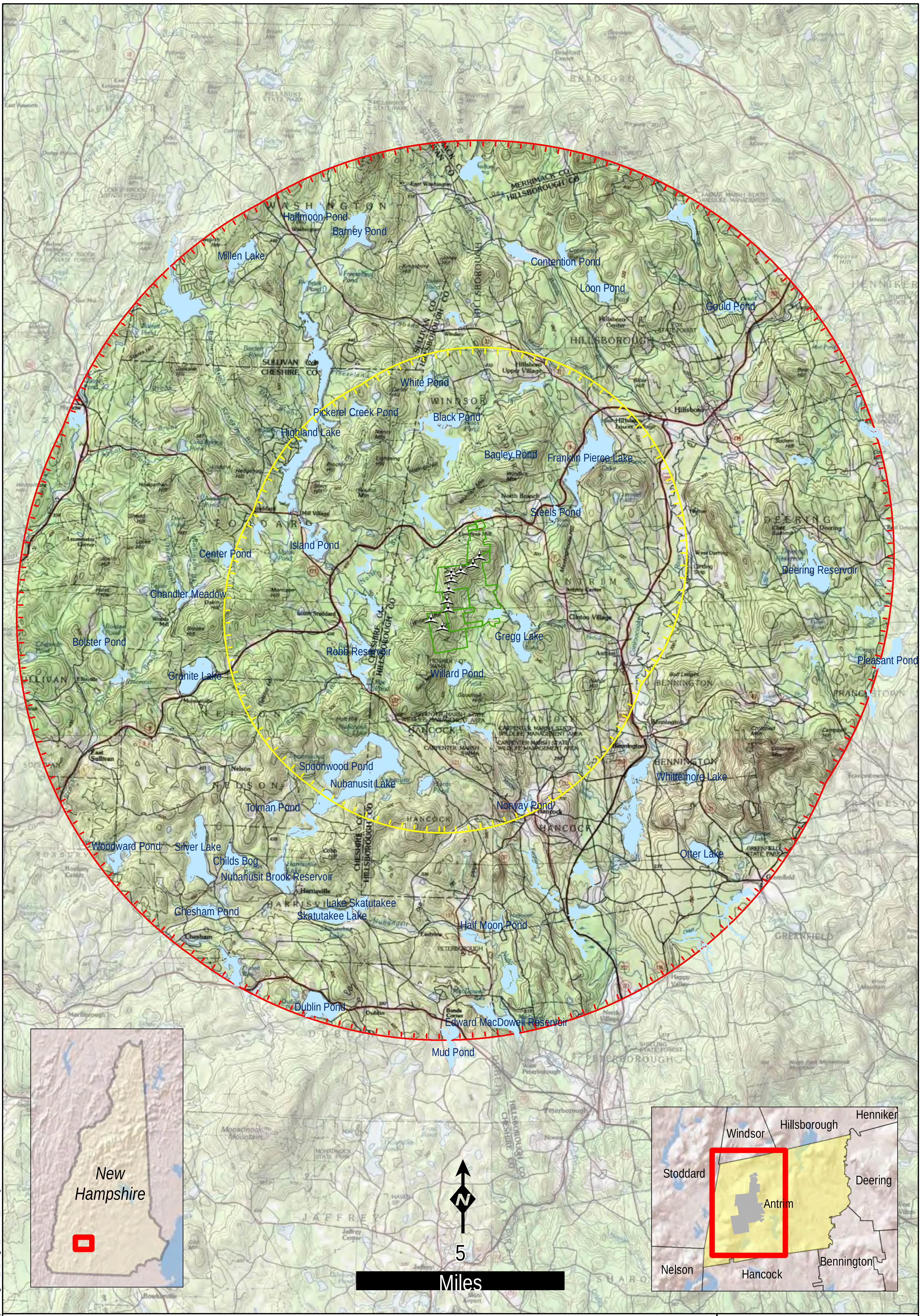
During the survey, bald eagles were observed at two locations: Millen Lake and Nubanusit Lake.

- **Millen Lake:** One immature bald eagle was observed at Millen Lake, which is located approximately 9 miles northwest of the proposed project; no adults or nesting activity were observed.
- **Nubanusit Lake:** Bald eagle nesting was confirmed at Nubanusit Lake. One adult bald eagle was observed sitting on a nest at the northeast end of Nubanusit Lake. Two chicks (in gray down) were also visible on the nest. In order to minimize disturbance, the nest was not approached to determine the presence of any additional young. A second adult bald eagle was later observed in flight over the lake. The active bald eagle nest was located on the north shore, on the far west end of the north arm of Nubanusit Lake.

No other bald eagle activity was observed during the 2011 rare raptor nest survey.

References

New Hampshire Audubon. 2010. **Status of Breeding Bald Eagles in New Hampshire in 2010.** Unpublished report prepared by Christian J. Martin, New Hampshire Audubon Senior Biologist, for New Hampshire Fish and Game Department, Nongame and Endangered Wildlife Program. November 1, 2010. Accessed online May 2011 at: http://www.nhaudubon.org/wp-content/uploads/2011/02/2010-NH-Breeding-BAEA-Final-Report-no-app.pdf



Legend

- Proposed Turbine Locations
- Project Parcels
- Proposed Substation Location
- 5 Mile Buffer of Proposed Project
- 10 Mile Buffer of Proposed Project
- Lakes (>35 ac) within 10 miles of Proposed Project

Hillsboro and Stoddard 7.5-Minute USGS Topographic Quadrangles

EOLIAN RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

ANTRIM, NEW HAMPSHIRE

Figure 1: Eagle Habitat Survey Area

Produced by: TRC | 3/15/2011

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Fall 2011 Mist-Net Survey Report

for the Antrim Wind Energy Project
In Antrim, New Hampshire

Prepared for

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December 2011

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Figures

Tables

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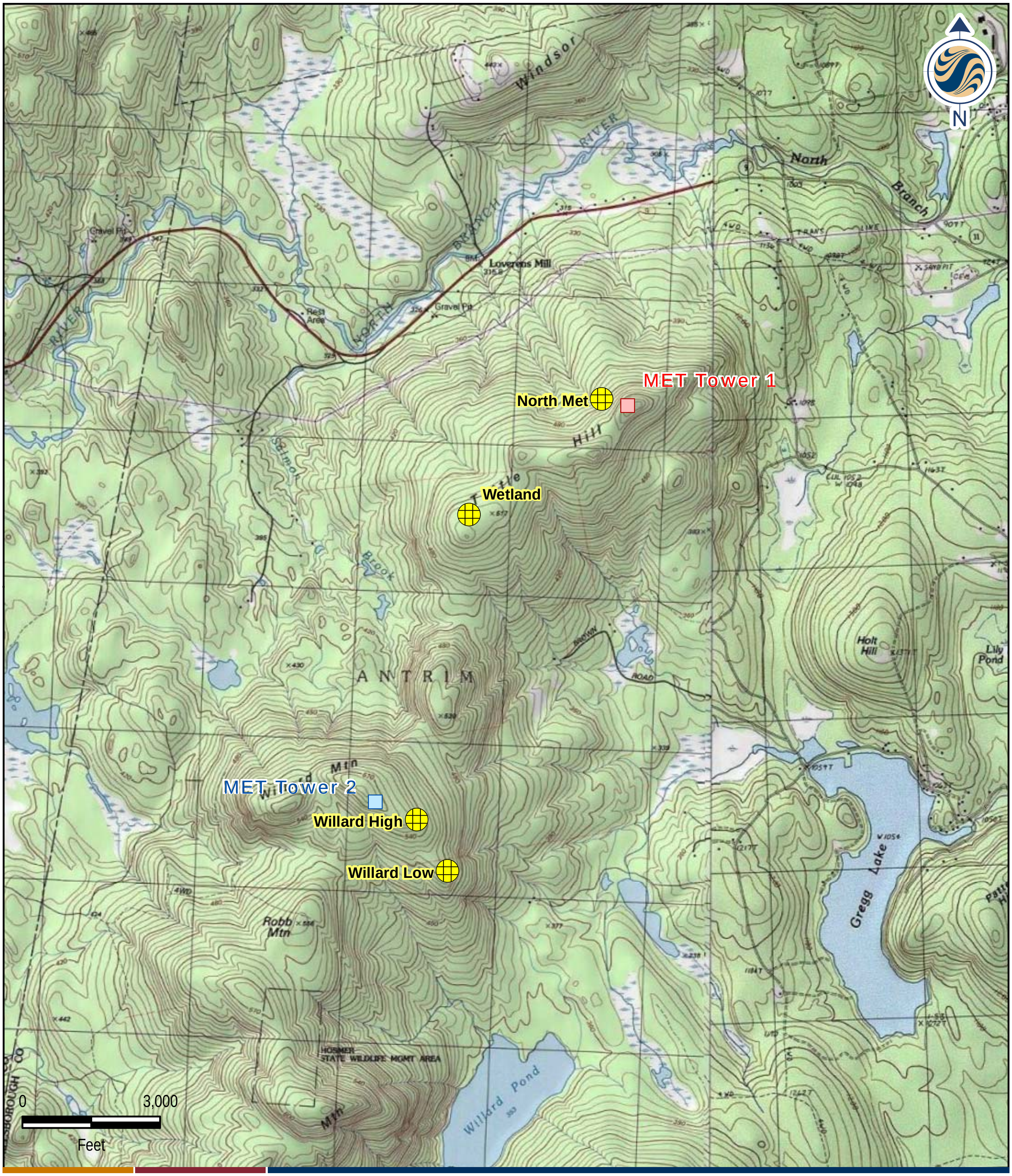
[1] *This report was prepared by Stantec Consulting Services Inc. for TRC and Eolian Renewable Energy. The material in it reflects Stantec's judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions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

1.0 Introduction

Based upon their normal geographical range, eight species of bats occur in New Hampshire, including the little brown bat (*Myotis lucifugus*), northern long-eared bat, (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), tri-colored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*; BCI 2001). Although none of these species are currently federally-listed, many are of interest. In New Hampshire, the eastern small-footed bat is state-listed as endangered, and the eastern red bat, silver-haired bat, hoary bat, northern long-eared bat, and tri-colored bat are state species of special concern. New Hampshire may soon list the little brown bat and the northern long-eared bat as threatened or endangered due to significant population declines as a result of White-nose Syndrome (WNS).

Both acoustic sampling and mist net surveys can be used at proposed wind facilities to survey for bats. Pre-construction acoustic surveys at the proposed Antrim Wind project area (Project) occurred from April 7 to October 23, 2011. In spring of 2011, the New Hampshire Fish and Game Department (NHFGD) expressed an interest in adding mist netting to the study plan at the Project. While acoustic surveys provide baseline information on bat activity levels and general species composition, and also allow for simultaneous data collection at multiple locations, at varying heights above ground level, and across long time periods, species identification can be difficult for species whose echolocation call characteristics overlap. In particular, species belonging to the genus *Myotis* have very similar echolocation call characteristics, making visual species identification from acoustic data difficult. While a mist net survey does not have the ability to survey the same spatial or temporal extent as acoustic surveys, it does allow for the ability to collect precise species information on captured individuals.



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Legend

- Mist Netting Location
- Met Tower 1
- Met Tower 2

Client/Project
TRC Companies, Inc.
Antrim Wind Energy Project
Antrim, New Hampshire

Figure No.
1

Title
Mist Netting Location Map

December 1, 2011

2.0 Methods

The primary objective of summer mist netting was to document the bat species present along the ridges of the Project area. The Indiana bat (*Myotis sodalis*) is the only bat species for which a mist net survey protocol has been developed. Although Indiana bats are not known to occur in New Hampshire, other *Myotis* species in the Northeast share many behavioral and ecological traits with Indiana bats. In lieu of an accepted survey protocol for bats native to New Hampshire, the Indiana bat survey protocol developed by the United States Fish and Wildlife Services (USFWS; 2007) was followed. The acceptable Indiana bat survey period occurs between May 15 and August 15. Sites should be surveyed for a minimum of two nights, and a minimum of two net-sets per site are required, resulting in a minimum of four net-nights (2 net-sets per site x 2 survey nights per site). Net sets should be placed across presumptive travel corridors (e.g., streams or logging trails), and should fill the entire airspace side-to-side and from ground level to canopy height. A successful survey night occurs when temperatures are above 10° Celsius (C; 50° Fahrenheit [F]), wind speeds are low, and there is no precipitation. In addition to the methods derived from the Indiana bat protocol, it was decided that two additional nights of netting would occur at any site where a northern long-eared bat was captured.

Capture effort consisted of erecting two mono-filament nylon mist-net sets (Avinet, Inc., Dryden, NY) spaced at least 30 meters (m; (98 feet [‘]) apart at each net site. Nets ranged from 6 to 12 m (19.7 to 39.4’) in length, and were vertically stacked three nets (7.8 m [25.6’]) high in order to completely fill the flight corridor. Net sets were placed perpendicular to potential travel corridors such as logging trails, breaks in a tree line, or over streams or wetlands.

The Project area is located on two distinct mountain peaks: Tuttle Hill and Willard Mountain. Four survey sites were identified based on proximity to probable bat habitat and on opportunities to place mist net sets across presumptive travel corridors along the ridgeline (Figure 1-1). There no suitable mist net sites on the immediate summit of Willard Mountain because timber harvesting activity created largely open areas lacking sufficient canopy coverage and forest gaps necessary to funnel bats into mist nets. Therefore, mist net survey sites on Willard Mountain were located downslope where more suitable locations were found. Similarly, on Tuttle Hill, the North Met site was located downslope of the meteorological (met) tower clearing where conditions were more suitable for mist net placement. However, the wetland survey site was located on the Tuttle Hill ridgeline.

North Met (elevation = 476 m [1,562’]): The North Met survey site was located approximately 100 m downslope from the North Met tower. Two mist net sets were deployed across the access road leading to the tower; each set contained 3 mist nets and each mist net was 6 m long. The forest edge along the access road was composed of mixed hardwood/softwood tree species at one mist net set, and primarily softwood tree species at the second set. The surrounding softwood forest was dominated by even-aged stands of spruce (*Picea rubens*), white pine (*Pinus strobus*), and red oak (*Quercus rubra*), with beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and cherry (*Prunus* sp.) also present. Dominant tree species had a diameter-at-breast height (dbh) range of 8 to 15 inches and a canopy height of 20 to 25 m.

The forest understory was primarily open and the forest canopy was primarily closed, with canopy gaps over the access road.

Figure 2-1. The North Met survey site at Antrim.

Wetland (elevation = 519 m [1,702']): The Wetland survey site was located in the same opening as the Wetland acoustic detector. Two mist net sets were deployed across the opening on either end. Each set contained three mist nets; one set was 9 m long and the second was 12 m long. The surrounding mixed hardwood/softwood forest was dominated by uneven-aged stands of red maple (*Acer rubrum*), with white pine, spruce, and yellow birch also present. Dominant tree species had a dbh range of 5 to 10 inches and a canopy height of approximately 20 m. The forest understory was primarily cluttered, and the forest canopy was intermediate between open and closed, with canopy gaps scattered throughout the stand.

Figure 2-2. The Wetland survey site at Antrim.

Willard High (elevation = 553m [1,814']): The Willard High survey site was located approximately 300 m downslope from the summit of Willard Mountain. Two mist net sets were deployed across a foot path running within the forest stand located adjacent to the Met tower clearing at the summit of Willard Mountain. Each set contained 3 mist nets, and each mist net was 6 m long. The forest stand was composed of mixed hardwood/softwood tree species, dominated by even-aged stands of spruce and red maple with white birch (*Betula papyrifera*), red oak, and cherry also present. Dominant tree species had a dbh range of 10 to 20 inches and a canopy height of approximately 15 m. The forest understory was primarily open at one mist net set and primarily cluttered at the second set, and the forest canopy was primarily closed with canopy gaps over the trail.

Figure 2-3. The Willard High survey site at Antrim.

Willard Low (elevation = 507m [1,663']): The Willard Low survey site was located approximately 400 m downslope from the Willard High survey site. Two mist net sets were deployed across the access road. Each set contained 3 mist nets; one set was 9 m long and the second was 12 m long. This area was logged heavily approximately one to two years ago, with scattered standing trees remaining in the large clearing. Red oak and red maple dominated the trees left standing in the clearing; white pine, spruce, and white birch could also be found in the surrounding forest stand. Dominant tree species had a dbh range of 10 to 20 inches and a canopy height of approximately 20 m.

Figure 2-4. The Willard Low survey site at Antrim.

Bats captured during surveys were identified to species by a biologist permitted by the NHFGD. The weight, age, sex, reproductive condition, and forearm length was recorded for all captured individuals. Individuals were outfitted with metal arm bands supplied by NHFGD. In order to assist with ongoing studies into effects of WNS, physical abnormalities were noted and a score was given based on the severity of those abnormalities following a system developed by John Reichard at Boston University: *Wing-Damage Index Used for Characterizing Wing Condition of Bats Affected by White-Nose Syndrome*. The scoring system ranks abnormalities from 0 (few to none) to 3 (high) based on the amount of depigmentation of the wing, the presence of scars on wing membranes, or the presence of flaking skin along the forearms. In order to minimize the spread of WNS, Stantec followed the most current decontamination procedures outlined by the USFWS. Prior to the start of field work, all nets and equipment that had previously come into contact with bats were sanitized in 10 percent bleach solution. Disposable paper bags were used for weighing bats and were discarded after one use. Calipers were sanitized after each use. Disposable latex gloves were worn over handling gloves and changed regularly throughout the night.

3.0 Results

Surveys began when minimum nightly temperatures were warm enough to initiate netting activity (above 50°F) to conform to Indiana bat survey protocol and to ensure surveys occurred during the known summer residency period. The first survey night was conducted on July 12, 2011, and the last survey night was conducted on July 28, 2011, during which time a total of 8 survey nights were conducted. One bat was captured during 41 survey hours at four survey sites (Table 3-1).

Table 3-1. Summary of 2011 mist net survey effort and results.				
Site	**# Net-nights***	**# Cumulative net hours**	**# Bats captured**	**Capture Rate****
North Met	4	10	1	0.25
Wetland	4	10.5	0	0.0
Willard High	4	10.25	0	0.0
Willard Low	4	10.25	0	0.0
Overall Results	***16***	***41***	***1***	**--**
* Net-nights is a sampling unit during which a single net set is deployed during a single survey night. When two net sets are used during a survey night, the sampling effort equals two net-nights, etc.				
** Number of bats captured per net-night				

The single bat capture was a juvenile male big brown bat, captured at the North Met survey site at 9:45 pm on July 27, 2011. It weighed 17.25 grams, had a forearm length of 45 millimeters, and was outfitted with NHFGD band # 43152. It had no evidence of WNS in the form of membrane depigmentation or scarring, and was therefore given a WNS score of 0.

4.0 Discussion

The primary objective of the summer mist-net survey was to document bat species present in the Project area. Mist net sites were placed along the higher elevation ridgelines within the Project area where turbines are being proposed so that individuals captured could be considered to be using the ridges, and therefore at risk of direct impacts from the wind facility. However, only one individual was captured. It is not surprising that a low capture rate was observed at high elevation survey locations. Mist net surveys can be biased toward those species that fly beneath the forest canopy such as North American *Myotis* species (Hayes and Gruver 2000, Kalcounis et al. 1999, Weller and Lee 2007). In New England, these same species are generally found in higher concentrations at lower elevations where temperatures can be warmer and more stable, leading to lower costs for reproductive females (Brack et al 2002).

Still, bats are present and active at higher elevations, albeit in lower concentrations. Therefore, the capture of only a single individual seems best explained by the effects of WNS. As stated previously, mist net surveys can be biased toward species that fly beneath the forest canopy, and these same species are affected by WNS. WNS is causing unprecedented mortality among at least six species of hibernating bats in North America (Frick et al. 2010): eastern small-footed bat, little brown bat, northern long-eared bat, tricolored bat, big brown bat, and Indiana bat (USGS 2010). Three additional species have evidence of the fungus but no reports of mortality: cave myotis (*Myotis velifer*), southeastern bat (*M. austroriparius*) and gray bat (*M. grisescens*;

Turner et al. 2011). All 25 bat species in the United States that rely on hibernation have the potential to be affected by WNS (USGS 2010).

An estimated 1 million bats or more have died since mortalities were first recorded in 2007, and currently WNS has been identified in 16 states and 4 Canadian provinces, with 3 additional states having unconfirmed cases (Turner et al. 2011). Total mortality averaged 95 percent at closely monitored WNS hibernacula that had multiple years of infection in New York, Massachusetts, and Vermont in 2009 (Turner and Reeder 2009), and an analysis of 42 sites in five states (NY, PA, VT, VA, and WV) found an overall population decrease of 88 percent, ranging from a 12 percent decline for small-footed bats to a 98 percent decline for northern long-eared bats (Turner et al. 2011). These observed decreases in little brown bat populations follow predictions by Frick et al. (2010) that the little brown bat may become regionally extinct in the Northeast in 7 to 30 years (Turner et al. 2011).

As a result of decreasing populations, the USFWS is updating its Indiana bat survey methods to include a combination of mist netting and acoustic surveys in order to assess species presence. This new survey protocol will rely on the use of software to quantitatively identify acoustic data to species. It is likely that a combination of species identification via mist netting and acoustic methods will provide greater evidence of species composition in WNS-affected areas.

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AVIAN AND BAT PROTECTION PLAN
for the
ANTRIM WIND ENERGY PROJECT

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1 INTRODUCTION

Antrim Wind Energy, LLC (AWE) is dedicated to producing clean, reliable, renewable power while demonstrating respect and stewardship for the natural environment. As the sponsor of the Antrim Wind Energy Project (Project), AWE submits the following Avian and Bat Protection Plan (ABPP) as evidence of its approach to responsible wind energy development. AWE believes that the Project will be a net-benefit to the health and prosperity of the host community and the wider New England region.

1.1 Project Description

The Antrim Wind Energy Project (the Project) is proposed to be located in the northwest portion of the Town of Antrim, in Hillsborough County, New Hampshire. The Project site is located on a ridgeline that starts approximately 0.75 miles south of NH Route 9 and runs south-southwest, for approximately 2.5 miles.

The Project will produce electricity using wind turbine electrical generators installed on tubular steel towers. The turbines will be horizontal axis, upwind rotor turbines typical of those currently in use in utility-scale wind projects in New England and throughout the United States. The Project will consist of ten (10) turbines in the 3 MW size class with an expected plant generating capacity of 30 MW (rated). Proposed access to the Project site is from Route 9 up the north slope of Tuttle Hill ridge.

The entirety of the Project is located in the sparsely settled rural conservation zoning district in Antrim on approximately 1,850 acres of private lands leased by AWE from five landowners. Post-construction, the total direct impact area (including access and spur roads, work pads, staging areas, turbine pads, substation and operations & maintenance building) will be approximately 57 acres.

The Project's proposed Point of Interconnection (POI) is Public Service of New Hampshire's (PSNH) 115kV Line L163, which sits in a PSNH transmission corridor contained within the Project's leased boundary. The POI is located approximately halfway between Route 9 and the northern most turbine location. The interconnection facility will consist of a new three breaker ring bus substation to be built adjacent to the existing 115kV line and along the Project's main access road. See Attachment A for a detailed site map. Importantly, no new high voltage transmission lines will be constructed as a result of the Project.

1.2 Corporate Policy on Avian and Bat Protection

AWE recognizes the that wind power generation has the potential to impact avian and bat species, and values the importance of minimizing these impacts for the sake of the ecosystems, species and the communities they benefit. AWE also understands that renewable power generation, as an alternative to fossil fuel energy sources, benefits the environment and its inhabitants as a whole. By instituting a comprehensive Avian and Bat Protection Plan (ABPP), AWE believes that the benefits of the Antrim Wind Energy Project will far outweigh its impacts and will provide significant positive contributions to both the human and natural environments.

In that spirit, AWE is committed to working cooperatively with state and federal agencies [and non-governmental organizations] to promote the reasonable protection of avian and bat species during all phases of the Project's development, construction and operation. AWE is dedicated to incorporating the latest, state of the art knowledge and best management practices in the field of avian and bat protection at wind farms into its pre-construction assessments, project design, construction, post-construction monitoring, and long-term adaptive management.

Over the course of the Project's operating life, AWE pledges to design and operate the Antrim Wind Energy Project in a manner which provides decades of clean, renewable energy to the public while effectively reducing project impacts to avian and bat species, thereby balancing the health of the environment with society's growing need for electricity.

1.3 Purpose of the ABPP

In fulfillment of AWE's commitment to environmental stewardship, AWE has developed this site-specific Avian and Bat Protection Plan (ABPP) to reduce potential impacts to birds and bats as a result of construction and operation of the Antrim Wind Energy Project. In formulating the ABPP, AWE incorporated recommendations and guidance from the following sources: the U.S. Fish and Wildlife Service (USFWS) Draft Land-Based Wind Energy Guidelines (USFWS 2011a); USFWS's Avian Protection Plan Guidelines (APLIC and USFWS, 2005); and the Edison Electric Institute's Avian Power Line Interaction Committee (APLIC). This ABPP is also draws upon: the results of pre-construction bird and bat studies conducted at the project site; results from relevant post-construction surveys conducted to date at similar facilities; the latest science regarding options for effectively avoiding and minimizing potential impacts to birds and bats; and direct correspondence with the USFWS and the New Hampshire Fish and Game Department (NHFGD).

Potential impacts to birds and bats that are typically associated with wind power facilities include: direct, turbine-associated mortality through either collision or barotrauma; and indirect impacts such as habitat loss, displacement and increased energy demands due to turbine avoidance.

The ABPP is structured around an adaptive management framework and includes detailed provisions for avoiding, reducing, and, if warranted, mitigating for these potential impacts to birds and bats. The ABPP will be a living document throughout an initial Evaluation Phase (described in Section 7). During the Evaluation Phase, AWE will work with USFWS and NHFGD to evaluate the findings of post-construction studies, formulate recommendations and definitions, and incorporate them into the ABPP on a prospective basis. The monitoring, reporting and adaptive management programs described in this ABPP will allow this plan to respond and adapt to both actual results and unforeseen or changing (biological or technological) circumstances over the life of the Project.

1.4 Goals and Objectives

The goal of this ABPP is to minimize Project's impacts to birds and bats in a scientifically sound, and commercially reasonable manner. AWE intends to achieve this goal by incorporating into the ABPP the following actions:

- Study baseline mortality and injury rates during the first year of project operation, and work with USFWS and NHFGD to establish management strategies and, if applicable, acceptable mortality thresholds;
- Implement a permanent (for the life of the Project) informal wildlife mortality monitoring and reporting program and an immediate alert procedure for biologically significant events;
- Implement a tiered consultation strategy to guide decision-making and allow for modifications to the ABPP, based on actual results and unexpected events over the life of the Project; and
- Study the effectiveness of a curtailment strategy on minimizing bat mortality and work with USFWS and NHFGD to determine if and how curtailment might be applied as a long-term management strategy for the Project.
- Permanently conserve approximately 685 acres of valuable forestland in the immediate vicinity of the Project to preserve important and diverse habitat types for birds, bats and other species.

2 PROTECTION OF AVIAN AND BAT SPECIES IN NEW HAMPSHIRE

There are several laws which protect avian and bat species in the United States and in New Hampshire. T hese include:

- The federal Endangered Species Act;
- The New Hampshire Endangered Species Conservation Act;
- The federal Migratory Bird Treaty Act and;
- The Bald and Golden Eagle Protection Act.

The legal protection status of avian and bat species in New Hampshire, pursuant to these laws, is described in the following subsections.

2.1 Federal and State Endangered Species Acts

The federal Endangered Species Act (ESA) protects threatened and endangered plants and animals and the habitats in which they are found. Protection of birds and mammals under the ESA is administered by the USFWS. The law requires federal agencies, in consultation with the USFWS, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife.

The State of New Hampshire has its own Endangered Species Conservation Act (NH RSA 212-A[1]) that protects all non-domesticated species of wildlife indigenous to the state. The list of New Hampshire's endangered and threatened wildlife is maintained by the NHFGD.

According to the New Hampshire Endangered Species Conservation Act (NH ESCA) "Endangered" species are those in danger of being extirpated from the state, while

[1] Note that under RSA 212-A:13, III, the provisions of RSA 212-A or any rule promulgated under that statute shall not interfere in any way with the siting or construction of any energy facility as defined in RSA 162-H:2.

"Threatened" species face the possibility of becoming "endangered." Some of New Hampshire's listed species are also listed under the federal ESA.

In addition to those species listed as threatened or endangered, New Hampshire also maintains a list of species of "special concern". Species listed as "special concern" include: (a) those that could become "threatened" in the foreseeable future if conservation actions are not taken or that were recently recovered enough to be removed from the endangered and threatened category, and; (b) those for which a large portion of their global or regional range (or population) occurs in New Hampshire and where actions to protect these species habitat will benefit the species' global population. Species that do not meet the criteria for "endangered", "threatened", or "special concern", but that are still biologically rare, as indicated by the State and Global Ranks, are also listed as rare in New Hampshire.

Table 1 lists New Hampshire's rare bird and bat species and identifies each species rank and listing.

Table 1: Rare Bird and Bat Species of New Hampshire

Name	Rank		Listing	
	Global	***State***	***Federal***	***State***
Rank Prefix: **G** = Global Rank; **S** = State Rank; **T** = Global or State Rank for a subspecies or variety **Rank Suffix:** **1** = Critically imperiled; **2** = Imperiled; **3** = Vulnerable; **4** = Apparently secure ; **5** = Secure; **B** = Breeding population; **N** = Non-breeding population; **H** = Occurred historically, not seen recently; **X** = Extirpated; **NR/U** = Not ranked / Unknown; **Q** = Questionable taxonomy; **?** = Uncertain **Listing Codes:** **E** = Endangered**;** **T** = Threatened**;** **SC** = Special Concern				
Birds				
American Bittern (Botaurus lentiginosus)	G4	S3B	--	--
American Kestrel (*Falco sparverius*)	G5	S3B	--	SC
American Pipit (*Anthus rubescens*)	G5	S2B	--	SC
American Three-toed Woodpecker (*Picoides dorsalis*)	G5	S2	--	T
Arctic Tern (Sterna paradisaea)	G5	S1B	--	SC
Bald Eagle (Haliaeetus leucocephalus)	G5	S2	--	T
Bank Swallow (*Riparia riparia*)	G5	S3B	--	SC
Bicknell's Thrush (*Catharus bicknelli*)	G4	S2S3B	--	SC
Cerulean Warbler (*Dendroica cerulea*)	G4	S3B	--	SC
Cliff Swallow (Petrochelidon pyrrhonota)	G5	S3B	--	SC
Common Loon (*Gavia immer*)	G5	S2B	--	T
Common Moorhen (Gallinula chloropus)	G5	S2B	--	SC
Common Nighthawk (*Chordeiles minor*)	G5	S1B	--	E
Common Tern (*Sterna hirundo*)	G5	S2B	--	T
Eastern Meadowlark (*Sturnella magna*)	G5	S3B	--	SC
Golden Eagle (Aquila chrysaetos)	G5	SHB	--	E
Golden-winged Warbler (*Vermivora chrysoptera*)	G4	S2B	--	SC
Goshawk (Accipiter gentilis)	G5	S3	--	--
Grasshopper Sparrow (*Ammodramus savannarum*)	G5	S2B	--	T
Great Blue Heron (Rookery) (*Ardea herodias*)	G5	S4B	--	--
Henslow's Sparrow (*Ammodramus henslowii*)	G4	SHB	--	--
Horned Lark (Eremophila alpestris)	G5	S3B	--	SC
King Rail (Rallus elegans)	G4	SHB	--	--
Least Bittern (*Ixobrychus exilis*)	G5	S1B	--	SC
Least Tern (Sterna antillarum)	G4	SHB	--	E
Loggerhead Shrike (*Lanius ludovicianus*)	G4	SHB	--	--
Marsh Wren (Cistothorus palustris)	G5	S3B	--	--
Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*)	G5	S3B	--	SC
Northern Harrier (*Circus cyaneus*)	G5	S1B	--	E
Olive-sided Flycatcher (*Contopus cooperi*)	G4	S3B	--	SC

Name	Rank		Listing	
	Global	***State***	***Federal***	***State***
Osprey (Pandion haliaetus)	G5	S3B	--	SC
Peregrine Falcon (Falco peregrinus anatum)	G4T4	S2	--	T
Pied-billed Grebe (*Podilymbus podiceps*)	G5	S2B	--	T
Piping Plover (Charadrius melodus)	G3	S1B	T	E
Purple Martin (*Progne subis*)	G5	S1B	--	SC
Roseate Tern (Sterna dougallii dougallii)	G4T3	S1B	E	E
Rusty Blackbird (*Euphagus carolinus*)	G4	S3B	--	SC
Saltmarsh Sharp-tailed Sparrow (*Ammodramus caudacutus*)	G4	S3B	--	SC
Seaside Sparrow (Ammodramus maritimus)	G4	S1B	--	SC
Sedge Wren (Cistothorus platensis)	G5	S1B	--	E
Sora (Porzana carolina)	G5	S3B	--	SC
Spruce Grouse (Falcipennis canadensis)	G5	S3	--	SC
Upland Sandpiper (Bartramia longicauda)	G5	S1B	--	E
Vesper Sparrow (Pooecetes gramineus)	G5	S2S3B	--	SC
Whip-poor-will (Caprimulgus vociferus)	G5	S3B	--	SC
Willet (Catoptrophorus semipalmatus)	G5	S3B	--	SC
Bats				
Eastern Red Bat (Lasiurus borealis)	G5	S3?B	--	SC
Hoary Bat (Lasiurus cinereus)	G5	S3B	--	SC
Indiana Bat (Myotis sodalis)	G2	SNA	E	--
Northern Long-eared Bat (Myotis septentrionalis)	G4	S3	--	SC
Silver-haired Bat (Lasionycteris noctivagans)	G5	S3B	--	SC
Small Footed Bat (Myotis leibii)	G3	S1	--	E
Tricolored Bat (Pipistrellus subflavus)	G5	S1N,SUB	--	SC
Bat Hibernacula				
Bat hibernaculum (*Bat Hibernaculum*)	GNR	S1	--	--

Source: New Hampshire Natural Heritage Bureau, 2011

2.2 Avian Protection

2.2.1 *The Migratory Bird Treaty Act*

The federal Migratory Bird Treaty Act (MBTA, as amended (16 U.S.C. 703–711; 40 Stat. 755) prohibits the "take" of migratory birds, their eggs, feathers or nests. The MBTA defines "take" to include by any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof. A total of 836 bird species are protected by the MBTA; 58 of these are currently legally hunted as game birds (USFWS 2011b). A migratory bird is any species or family of birds that live, reproduce or migrate within or across international borders at some point during their annual life cycle.

The United States Fish and Wildlife Service USFWS is primarily responsible for ensuring the implementation and enforcement of the MTBA.

2.2.2 *Bald and Golden Eagle Protection Act*

Bald eagles and golden eagles are protected under the MBTA, described above. In addition, these species are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c). The Bald and Golden Eagle Protection Act (Eagle Act) is the primary law protecting bald and golden eagles in the U.S. and in New Hampshire. The Eagle Act prohibits take of bald and golden eagles. T he statutory definition of "take" means to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest or disturb eagles.

The USFWS is primarily responsible for ensuring the implementation and enforcement of the Eagle Act. On September 11, 2009, the USFWS issued its final rule regarding take permits for bald and golden eagles (50 CFR Parts 13 and 22). According to this rule, wind power projects which are deemed likely to incur take of eagles or their nests would need to obtain a programmatic take permit.

2.3 Bat Protection

Eight species of bats occur in New Hampshire, based upon their normal geographical range (NHFGD 2010). These are:

- little brown bat (*Myotis lucifugus*)
- northern long-eared bat, (*Myotis septentrionalis*)
- eastern small-footed bat (*Myotis 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*).

As shown in Table 1, several of these species are of interest to the NHFGD: the eastern small-footed bat is state-listed as endangered, and five species (eastern red bat, silver-haired bat, hoary bat, northern long-eared bat, and tri-colored bat) are species of special concern in the state. Little is known about the distribution of any of these species in New Hampshire and very is little is known about their summer breeding habitat (NHFGD 2005; DeGraff and Yamasaki 2001). With the exception of the small-footed bat, which possibly uses rocky crevices on cliffs or crevices on buildings for summer roosting, the five state-listed species of special concern all apparently roost in trees (NHFGD 2005).

In addition to the species listed above, a single record exists for the federally endangered (and New Hampshire S1 ranked) Indiana Bat in New Hampshire. Aside from this record, there is no known population of Indiana bats in New Hampshire and this species is not managed within the state (because there is too little distribution data available to develop conservation or management strategies) (Veilleux and Reynolds 2005). Although the *New Hampshire Wildlife Action Plan* (NHFGD 2005) identified the Indiana bat (*M. sodalis*) as potentially occurring in the state, current available resources suggest that it is not present or is unlikely to be present (NHFGD 2011a, Reynolds 2007).

Of important note, New Hampshire may soon list the little brown bat and the northern long-eared bat as state endangered or threatened, due to rapid and dramatic population decline caused by White-nose Syndrome (WNS). This emerging disease has spread throughout the New England states in the past five years and has resulted in the unprecedented decline of all 6 bat species that hibernate in caves or mines in the northeast (NHFGD 2011b).

3 RISK ASSESSMENT METHODOLOGY

AWE has applied a tiered approach to assessing potential risk to avian and bat species associated with the proposed Antrim Wind Energy Project. This approach is described in detail in the USFWS Draft Land-Based Wind Energy Guidelines (USFWS 2011a).

Tier 1 and Tier 2 preliminary site evaluation assessments have been performed to determine site suitability, and are described herein (see Section 4). Numerous Tier 3 environmental field studies have also been performed; the scope and duration of these Tier 3 field studies and evaluations are also described herein (see Section 5).

Moving forward, this Avian and Bat Protection Plan describes the results of Tier 3 studies and how those will be applied to inform project design, construction and operation. Furthermore, the ABPP defines post-construction monitoring and reporting commitments, and proposes a plan to study and assess operational curtailment as a potential mitigative strategy, if warranted, following an evaluation phase. Finally, an adaptive management plan is proposed for addressing potential changes and unexpected events over the life of the Project.

4 PRELIMINARY SITE EVALUATION AND SITE CHARACTERIZATION

AWE's Tier 1 and 2 preliminary site evaluations assessed numerous factors that are critical to the appropriate siting of an economically viable and environmentally benign wind project. In general, the most viable wind sites include: sufficient projected wind speeds at turbine hub height to produce power in commercial quantities; proximity to adequate transportation; proximity to electric transmission or distribution infrastructure capable of handling the new generation; adequate setbacks from residences or other inhabited structures to ensure public safety; the absence of known sensitive ecological resources that may be disturbed such as critical wildlife habitats, major wetlands, and other sensitive areas ; and previous environmental impacts and/or commercial activities on site. Based on these criteria, the proposed site of the Antrim Wind Energy Project constitutes a well-sited wind power project location.

During its preliminary investigation, AWE confirmed that there are no current conservation restrictions on the site that would limit the development of the Project. In addition, desktop GIS review of known environmental factors did not reveal the presence of any known critical habitats or endangered species. In a letter summarizing the review by the USFWS, dated October 13, 2011, the USFWS confirmed that:

> *"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. 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."*

Importantly, the proposed Project site is located approximately ½ mile from a PSNH transmission corridor where the Project proposes to interconnect to the grid. This eliminates the need for a new transmission corridor and line, thereby avoiding numerous potential impacts associated with such development (e.g. avian electrocution, wire strikes, habitat alteration, edge effects, etc.) The site is also located approximately ¾ mile from Route 9, a substantial state highway that can handle transportation of turbine components and construction equipment. The proximity of this existing highway minimizes the need for extensive access improvements, again reducing the potential impacts associated with creating such access (such as habitat alteration, fragmentation, etc.)

Furthermore, the site does not support sensitive high elevation alpine habitats, thereby eliminating any potential impacts to such sensitive habitats. Finally, much of the northern slope of Tuttle Hill has been heavily logged in the past decade and, as recently as 2010, logging operations (unrelated to the Project) have impacted the site. The fact that much of the proposed Project area is already altered by industrial logging activity reduces the potential incremental impact of the Project on existing natural habitats. The Tier 1 and 2 preliminary site assessments validated AWE’s conclusion that this is an appropriate site for continued development of a wind energy facility.

5 PRE-CONSTRUCTION AVIAN AND BAT ASSESSMENTS

In the spring of 2011, AWE initiated consultation with various regulatory agencies to identify the scope of wildlife studies to be performed relevant to the Project as part of AWE's Tier 3 analyses. Consulting agencies included USFWS, NHFGD, New Hampshire Natural Heritage Bureau (NHNHB), New Hampshire Department of Environmental Services (NHDES), United States Army Corps of Engineers (USACE), and United States Environmental Protection Agency (USEPA). As a result of this consultation, the following pre-construction biological studies were identified as necessary to assess the potential impacts of the proposed Project on avian and bat species:

- Breeding bird surveys;
- Diurnal raptor migration surveys;
- Radar surveys for nocturnal avian migration;
- Rare raptor nesting surveys;
- Acoustic bat monitoring; and
- Bat mist nesting surveys.

All pre-construction studies were designed to be consistent with the methods and protocols typically recommended by state and federal regulatory agencies for proposed wind power projects. They were also designed to be consistent with surveys conducted in the past at other similar projects in New Hampshire and throughout New England. The specific protocol for each study was designed in consultation with USFWS and NHFGD. The scope, duration and results of avian and bat studies associated with the proposed Antrim Wind Energy Project are described in the following subsections (5.1, 5.2). A summary of potential risks to specific species as a result of the Project's construction and operation is provided in Section 5.3.

The results and findings of pre-construction studies have been compiled in stand-alone formal reports which will be included with Antrim Wind Energy, LLC's Application for a Certificate of Site and Facility submitted to the New Hampshire Site Evaluation Committee (SEC). The results and findings of these studies have been incorporated into the Project's preliminary planning and design (e.g. wetlands have been avoided, which provide important habitat and foraging opportunities for avian and bat species). They will also be accounted for, to the extent necessary and feasible, during the Project's final design and construction plans to avoid, reduce, and minimize potential impacts on birds and bats. The Tier 3 findings also provide the baseline, pre-construction reference data upon which the post-construction monitoring, reporting and adaptive management efforts will be based.

5.1 Avian monitoring

5.1.1 Breeding Bird Surveys

A breeding bird survey for the Antrim Wind Energy Project was performed in June of 2011. The goal of this survey was to document the pre-construction presence, diversity and relative abundance of breeding bird species in the proposed area of development. T he specific objectives of the breeding bird survey were to:

- produce a comprehensive list of breeding bird species in the Project area;
- compile a species index and relative abundance for birds breeding in the Project area;
- calculate frequency of occurrence for each species;
- characterize habitat that is available for species which occur in the Project area; and
- qualitatively assess the general patterns of breeding bird use in the vicinity of the proposed Project.

The breeding bird survey used point count methods based on those used for the Vermont Institute of Natural Science's ***Mountain Birdwatch*** program (VINS 2005) and Bird Studies Canada's ***High Elevation Landbird Program*** (*HELP*) (Whittam & Ball 2002, and 2003).

Point counts were conducted at 12 locations along the ridge of Tuttle Hill and Willard Mountain. Point count locations were spaced at least 250 m apart and were located in representative habitat types within and adjacent to the proposed Project area . Six of the points were located in close proximity to areas that will be directly disturbed by the proposed development; the other six were located outside of the area of direct disturbance. Each point count location was visited twice during the study period. All surveys were conducted at dawn (between 4:30 AM and 8:30 AM).

Habitat parameters associated with point count locations were quantified using methods described by James and Shugart (James and Shugart 1970), who developed a methodology specifically for making habitat measurements associated with estimating bird populations. This methodology is still used by the national Breeding Bird Survey (USGS 2009), as well as other current studies.

A total of 131 individual birds, representing 25 different species, were documented during the formal breeding bird surveys. Biologists observed an additional 14 species incidentally while present in the Project area to perform the breeding bird survey, but not during the formal survey procedure. These observations constitute a total of 39 bird species recorded in the Project vicinity during the breeding season of 2011. Table 2 below summarizes the list of breeding bird species identified formally during breeding bird surveys, as well as the incidental observations.

The most frequently observed bird species, in terms of relative abundance, were ovenbird and blackburnian warbler: 17 individuals of each species were observed, constituting a 12.98% relative abundance for each. The next most abundant species were red-eyed vireo (n=14) and myrtle warbler (n=12), at 10.69% and 9.16% relative abundance, respectively. The relative abundance of each species documented is presented in Table 2.

The assemblage and relative abundance of birds observed is typical for New England, given the habitats found within and adjacent to the study area. No rare birds or birds of conservation concern were observed during formal breeding bird surveys. Incidental observations of the common nighthawk, a state listed endangered species, were made in the vicinity of Willard Mountain and Tuttle Hill in June of 2011. One of these observations was auditory and consisted of aerial vocalizations in the area of Willard Mountain. The other observation was visual, and consisted of several nighthawks foraging over the valley to the north of Tuttle Hill. All of the nighthawks heard and observed at both locations were outside of the proposed Project area.

Table 2: Breeding Bird Species Identified Within the AWE Project Vicinity

Breeding Bird Species Observed within the Antrim Wind Energy Project Vicinity				
Common Name	Latin Name	Residence*	Number Observed	Relative Abundance
Species Observed During Formal Breeding Bird Surveys				
American Goldfinch	*Carduelis tristis*	L/US	1	0.76%
Black and White Warbler	*Mniotilta varia*	NT	5	3.82%
Blackburnian Warbler	*Dendroica fusca*	NT	17	12.98%
Black-capped Chickadee	*Poecile atricapillus*	L	2	1.53%
Black-throated Blue Warbler	*Dendroica caerulescens*	US/NT	10	7.63%
Blue Jay	*Cyanocitta cristata*	US/L	4	3.05%
Cedar Waxwing	*Bombycilla cedrorum*	L/US	2	1.53%
Chesnut-sided Warbler	*Dendroica pensylvanica*	NT	2	1.53%
Common Yellowthroat	*Geothlypis trichas*	NT	2	1.53%
Eastern Wood Pewee	*Empidonax*	NT	4	3.05%
Golden-crowned Kinglet	*Regulus calendula*	L/US	2	1.53%
Hairy Woodpecker	*Picoides villosus*	L	6	4.58%
Hermit Thrush	*Catharus guttatus*	US	9	6.87%
Magnolia Warbler	*Dendroica magnolia*	NT	3	2.29%
Morning Dove	*Zenaida macroura*	US/L	1	0.76%
Myrtle Warbler	*Dendroica coronata*	US/NT	12	9.16%
Ovenbird	*Seiurus aurocapillus*	US/NT	17	12.98%
Purple Finch	*Carpodacus purpureus*	L/US	1	0.76%
Red-breasted Nuthatch	*Sitta canadensis*	L/US	2	1.53%
Red-eyed Vireo	*Vireo olivaceus*	NT	14	10.69%
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	NT	3	2.29%
Scarlet Tanager	*Piranga olivacea*	NT	3	2.29%
Slate-colored Junco	*Junco hyemalis*	L/US	5	3.82%
Winter Wren	*Troglodytes troglodytes*	US	2	1.53%
Veery	*Catharus fuscescens*	NT	2	1.53%
Total Species Observed During Formal Surveys		***25***		
Total Individuals Observed During Formal Surveys			***131***	
Species Recorded as Incidental Observations during Summer 2011				
American Redstart	*Detophaga ruticilla*	NT		
Barred Owl	*Strix varia*	US/L		
Blue-headed Vireo	*Vireo solitarius*	US/NT		
Broad-winged Hawk	*Buteo platypterus*	NT		
Brown Creeper	*Certhia americana*	na		
Common Nighthawk	*Chordeiles minor*	NT		
Cooper's Hawk	*Accipiter cooperii*	US/L		
Least Flycatcher	*Empidonax minimus*	NT		
Pileated Woodpecker	*Picadae*	L		
Red-tailed Hawk	*Buteo jamaicensis*	US/L		
Ruffed Grouse	*Bonasa umbellus*	L		
TurkeyVulture	Cathartes aura	US		
Wild Turkey	*Meleagris gallopavo*	L		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	US		
Total Species Observed Incidentally		***14***		
Total Breeding Bird Species Recorded in 2011		***39***		
* L – Local year round resident; US – Migrates within US; NT – Neotropical migrant				

5.1.2 Diurnal Raptor Migration Surveys

Surveys for diurnal migrating raptors were performed during the spring and fall seasons of 2011. The purpose of these migration surveys was to document the numbers, species, and flight patterns of migrating raptors within and immediately adjacent to the proposed Project area. The main objectives of daytime avian migration surveys were to:

- Assess species composition, relative abundance, distribution, and spatial patterns of use by raptors migrating during daytime hours in and around the proposed Project area;
- Identify routes used by daytime migrating raptors passing through/near the proposed Project area;
- Document flight heights and use of topographical features in and near the proposed Project area;
- Evaluate potential impacts of project development and operation on migrating raptors; and
- Evaluate potential for collisions at proposed turbine sites.

The protocol for diurnal raptor migration surveys at the proposed Antrim Wind Energy Project followed standards set forth by the Hawk Migration Association of North America (HMANA 2011), and by HawkWatch International (HawkWatch International 2011, Hoffman and Smith 2003). The study methods were also consistent with similar studies conducted at other proposed wind energy facilities in New Hampshire.

Spring surveys for migrating raptors were performed in mid March through late May, 2011. Fall surveys were performed between mid September and late November, 2011. Early survey dates (in March), and late survey dates (in November) were intended to capture the passage of species, such as bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*), whose migration period is temporally extended.

Surveys were performed on multiple survey dates during each season. Sampling was performed based upon favorable weather for migration. In spring, fair weather days with southerly or southwesterly winds were favored. In fall, surveys favored fair weather days with strong north to northwest winds, particularly following the passage of a cold front.

On each survey date, data was generally collected for eight consecutive hours between 9 AM to 5 PM. This timeframe encompasses the peak hours of thermal development and associated raptor movement. Detailed raptor observation data were collected continuously during each survey onto specialized data sheets; the flight path of each raptor observed was also recorded on a topographical map of the survey area. Weather conditions (including wind speed and direction, temperature, cloud cover, visibility, etc.) were also recorded at the commencement of and periodically throughout daily observations.

The spring 2011 diurnal raptor migration survey for the proposed Antrim Wind Energy Project consisted of 65 total hours of observation across 9 dates between March 25 and May 15. The fall survey consisted of 147.5 total hours of observation across 21 dates between September 1 and November 20.

In spring, a total of 441 individual raptors[2], representing eleven species were identified within the immediate vicinity of the proposed Antrim Wind Energy Project. The vast majority of individuals observed were turkey vultures, which comprised 54% (n=237) of all observations. The next most abundant species observed were broad winged hawks and red-tailed hawks at 18% (n-77) and 14% (n=60) relative abundance, respectively. Table 3 lists all species observed in spring 2011and their relative abundance.

In fall, a total of 978 individual raptors, representing 10 species were identified. The vast majority of these were broad-winged hawks, which comprised approximately 70% (n=689) of all observations. A total of 471 of these individuals were recorded on one date: September 18. The majority of these broad-wings passed in a few large aggregations (“kettles”). For a relative comparison, on the same date (September 18),

[2] For the purpose of this study, the term “raptors” refers to all members of Order Falconiformes; this order currently includes the family Cathartidae (New World vultures), which includes turkey vultures.

Carter Hill Observatory (in Concord, NH) recorded a total of 7,212 broad-winged hawks and Pack Monadnock Observatory (in Peterborough, NH) recorded 5,208. Large, temporally concentrated fall movement of broad-winged hawks is typical in New England. Red-tailed hawks and turkey vultures were the next most frequently observed species at approximately 8% and 6% relative abundance, respectively. Table 3 lists all species observed and their relative abundance are listed in Table 3.

Table 3: Species List and Relative Abundance of Diurnally Migrating Raptors, Spring and Fall 2011.

Common Name	Binomial Nomenclature	Total Individuals Observed		Percent Relative Abundance	
		Spring	Fall	Spring	Fall
Accipiter spp. (small)	(n/a)	2	23	0.45%	2.35%
American Kestrel	*Falco sparverius*	1	0	0.23%	0.00%
Bald eagle	*Haliaeetus leucocephelus*	3	11	0.68%	1.12%
Broad-winged hawk	*Buteo platypterus*	77	689	17.46%	70.45%
Buteo spp.	(n/a)	30	22	6.80%	2.25%
Cooper's hawk	*Accipiter cooperii*	3	15	0.68%	1.53%
Falcon spp.	(n/a)	1	1	0.23%	0.10%
Golden eagle	*Aquila chrysaetos*	0	3	0.00%	0.31%
Merlin	*Falco columbarius*	0	3	0.00%	0.31%
Northern Goshawk	*Accipiter gentilis*	1	0	0.23%	0.00%
Northern Harrier	*Circus cyaneus*	5	0	1.13%	0.00%
Osprey	*Pandion haliaetus*	5	5	1.13%	0.51%
Peregrine Falcon	*Falco peregrinus*	1	0	0.23%	0.00%
Raptor spp.	(n/a)	13	48	2.95%	4.91%
Red-shouldered hawk	*Buteo lineatus*	0	1	0.00%	0.10%
Red-tailed hawk	*Buteo jamaicensis*	60	75	13.61%	7.67%
Sharp-shinned hawk	*Accipiter striatus*	2	19	0.45%	1.94%
Turkey v ulture	*Cathartes aura*	237	63	53.74%	6.44%
TOTAL		441	978		

The overall passage rate in spring 2011was 6.78 raptors per hour of effort (441 raptors/65 hours) with a range of 1.88 to 14.25. The overall passage rate in fall was 6.63 raptors per hour of effort (978 raptors/147.5 hours) with a range of 0 to 61.75. These passage rates were compared to data from the five most comparable (in terms of proximity and geographic similarity) hawk watch sites for which data was available across the same sampling period. The spring average at Antrim (6.78 raptors per hour of effort) is similar to the spring average of 5.78 raptors per hour of effort among five regional hawk watch sites. The spring maximum of 14.25 raptors per hour of effort is well below the regional maximum of 49.08. The fall average of 6.63 raptors per hour of effort is well below the regional average of 21.83; likewise, the fall max of 61.75 raptors per hour of effort is significantly lower than the regional max of 730 raptors per hour of effort.

Flight height (above ground level) was estimated for raptors that used the ridge area and upper slopes of Tuttle and Willard Mountains, as these are the areas where potential development has been considered or proposed over the course of project development. The remaining birds were recorded as "outside" of the proposed Project area. Flight height estimates were grouped into 3 categories: 0-50 feet above the ground, 50-500 feet above the ground, and 500+ feet above the ground. Estimation of raptor elevation can be influenced by such factors as perspective, distance, topography, and individual observer perception. For this reason, the flight height categories were designed conservatively to produce the most conservative potential risk estimate, with field observers also erring on the side of caution around the 50-500-foot category.

Of 441 total raptors observed in spring 2011, 216 (49%) flew over the area of potential development. Of the birds that did fly over the area of potential development (n=216), 162 of them (or 37% of all birds observed) were judged to have flown within the 50-500-foot above ground range. Of the 162 birds that flew within this range, 108 of them were turkey vultures.

Of 978 total raptors observed in fall 2011, 460 of them (47%) were observed to fly over the area of potential development. Of the birds that did fly over the area of potential development (n=460), 296 of them (30% of all raptors recorded) were judged to have flown within the 50-500-foot above ground range. Of the 296 birds that flew within this range, 168 of them were broad-winged hawks; 104 of these passed in kettles on the single date of September 18.

Threatened or Endangered raptor species that were observed during spring and fall migration surveys for the proposed Antrim Wind Energy Project include:

- bald eagle (State Threatened);
- golden eagle (State Endangered);
- peregrine falcon (State Threatened); and
- northern harrier (State Endangered).

A total of 14 bald eagles were recorded (3 in spring and 11 in fall); 7 of these never flew within the proposed Project area. Of those bald eagles that did fly within the proposed Project area (n=7), 6 were judged to have passed within the 50-500 foot above-ground range. A total of 3 golden eagles were observed in the fall of 2011; one of these never flew within the proposed Project area. The remaining 2 golden eagles were judged to have passed within the 50-500 foot above-ground range within the proposed Project area. The single peregrine falcon that was observed in the spring of 2011 did not pass within the proposed Project area. Northern Harriers were documented on 5 occasions in the spring of 2011; three of these never flew within the proposed Project area, while 2 (a male and female together) were judged to have passed within the 50-500 foot above-ground range.

In addition to the threatened and endangered species listed above, three state listed species of special concern were also observed; these are American kestrel, northern goshawk, and osprey. One American kestrel was observed in the spring: it did not fly within the proposed Project area. One northern goshawk was also observed in the spring: it did not fly within the proposed Project area. Ten total osprey were observed (5 in the spring and 5 in the fall). None of the 5 osprey recorded in the spring flew within the proposed Project area. In the fall, one osprey did not fly within the proposed Project area, one flew in the 0-50-foot above ground range, and 3 were judged to have passed within the 50-500 foot above-ground range.

Overall, the observed species assemblage, relative abundance, and passage parameters were as expected for southern New Hampshire. Potential risk to these species as a result of the proposed Project is discussed in Section 5.3.

5.1.3 Nocturnal Migration Surveys

Nocturnal radar surveys for avian migration were performed for the proposed Antrim Wind Energy Project in 2011. These studies served to assess and characterize nocturnal avian migration patterns in the proposed Project area. The objective of the study was to document the overall passage rates for nocturnal avian migration in the vicinity of the Project area, including the level of migration activity, and migrants' flight direction and flight altitude.

A Furuno 12 kilowatt (kW) X-band marine radar was operated from one location (near the meteorological tower on the northeastern end of Tuttle Hill) within the Project area from sunset to sunrise each survey night for the duration of each survey period as outlined below, weather permitting. Marine radars cannot detect targets in heavy or consistent rain, so sampling occurred on nights with generally clear weather.

Spring radar surveys were conducted from sunset to sunrise on 30 nights between April 18 and May 26, 2011 resulting in 284 total hours surveyed. Fall radar surveys were conducted during 30 nights between August 17 and October 8, 2011 resulting in 327 total hours surveyed.

Video samples were analyzed using specialized digital analysis software. Data analysis included the removal of insects based on flight speed and the calculation of migration passage (traffic) rates over the radar location. Passage rates (expressed in targets/kilometer/hour) were summarized hourly for each night as well as the overall mean and median nightly passage rates for the entire season. The mean flight direction of recorded targets was calculated for each night of data collected. These were also summarized by night and for the entire season. Mean flight height of targets and percentage of targets below maximum turbine height was determined using the vertical data and summarized by hour, night, and season.

Results from this study were compared to results from other similar studies performed in similar locations in the northeast to present the range of results found at publicly available pre-construction studies and show where the Antrim falls within that range. . Of these studies, further comparisons were made to those projects that were conducted at locations in the same region as Antrim (New England) and were conducted at projects that are now either permitted or operational. These include (but may not be limited to):

- Granite Wind Project in Errol, Coos County, New Hampshire (Stantec Consulting Services Inc. 2007a and b) – Permitted and under construction;
- Groton Wind Project in Groton, New Hampshire (Stantec Consulting Services Inc. 2008a and b) - Permitted;
- Lempster Wind Project in Lempster, New Hampshire (Woodlot Alternatives, Inc. 2006a and 2007a) – Permitted and Operational;
- Sisk Wind Project in Franklin County, Maine (Stantec Consulting Services Inc. 2009) - Permitted;
- Sheffield Wind Project in Caledonia County, VT (Woodlot Alternatives, Inc. 2006b) – permitted and operational; and
- Stetson Wind Project in Washington County, Maine (Woodlot Alternatives, Inc. 2007b) – permitted and operational.

Spring Results

The overall mean passage rate for the entire spring survey period was 223 ± 23 targets per kilometer per hour (t/km/hr), and nightly passage rates varied from 6 ± 3 t/km/hr on May 17 to 1215 ± 299 t/km/hr on May 20.

Individual hourly passage rates varied between nights and throughout the season, and ranged from 0 t/km/hr during various hours of various nights, to 2279 t/km/hr during the 7th hour of May 20. For the entire season, mean passage rates increased rapidly between hours one and two after sunset, then gradually increased to the 6th hour after sunset before steadily declining until sunrise.

Mean flight direction through the Project area in the spring was generally northeast (44° ± 49°), but varied between nights.

The seasonal mean flight height of targets was 305 ± 1 meters (m; 1000 ft [']) above the radar site, and nightly flight heights ranged from 135 ± 31 m to 486 ± 85 m. Flight heights, when analyzed for the anticipated 150 m (492') height of the proposed turbines; indicate that the percentage of targets flying below turbine height ranged from 7 to 63 percent with a seasonal average of 30 percent.

These results are within the range of those recorded at other radar studies conducted at other proposed wind projects in the northeast. Of note, the spring average passage rate at the Project (223 ± 23 t/km/hr) is at the low end of the range of results from among other spring radar studies conducted at proposed wind projects on forested ridges in the east. Results from other projects range from 147 t/km/hr at the Stetson Wind Project in Washington County, Maine (Woodlot Alternatives, Inc. 2007b) to 1020 t/km/hr at the New Creek Wind Project in Grant County, WV (Stantec Consulting Services Inc. 2008c).

The spring average flight height (305 ± 1 m) is near the mid-range of average flight heights recorded at other radar studies conducted on forested ridges in the east, and is above the proposed turbine height (150 m). Comparative results range from 210 m at the Stetson Wind Project in Washington County, Maine (Woodlot Alternatives, Inc. 2007b) to 552 m at the Sheffield Wind Project in Caledonia County, VT (Woodlot Alternatives, Inc. 2006b). Both of these projects have been permitted and are now operational.

Fall Results

The overall passage rate for the entire fall survey period was 138 ± 9 targets per kilometer per hour (t/km/hr). Fall nightly passage rates varied from 4 ± 2 t/km/hr on October 1 to 538 ± 71 t/km/h on August 26. Individual hourly passage rates varied between nights and throughout the season, and ranged from 0 t/km/hr during various hours of various nights to 839 t/km/hr during the 2nd hour of August 26. For the entire season, mean passage rates increased rapidly between the 1st and 3rd hours after sunset, then gradually declined until sunrise.

Mean flight direction through the Project area in the fall was generally southwest (217° ± 56°), but varied between nights.

The fall seasonal mean flight height of targets was 203 ± 1 m (666') above the radar site. The average nightly flight height ranged from 147 ± 23 m on August 24 to 266 ± 45 m on September 9. The percent of targets observed flying below 150 m was 40 percent for the season and varied nightly from 25 percent (169 targets) on September 9 to 56 percent (74 targets) on August 18 (Figure 2-9). For the entire fall season, the mean hourly flight heights were lowest during 1st and 10th hour after sunset.

The fall average flight height (203 ± 1 m) is among the lowest average flight heights recorded among other fall radar studies conducted at proposed wind projects on forested ridges in the east. Comparative study results ranged from 287 m at the Sisk Wind Project in Franklin County, Maine (Stantec Consulting Services Inc. 2009) to 583 m at the Liberty Gap Wind Project in Pendleton County, West Virginia (Woodlot Alternatives, Inc. 2005). Of note, the recorded flight height at the proposed Project of 203 ± 1 m is still above the proposed turbine height (150 m) for the Project. The nightly average flight height was below the proposed turbine height on only one night (August 24) and at the proposed turbine height on only one night (October 1) out of a 30 night season. It should be noted, however, that passage rates on these nights were very low: 38 t/km/hr on August 24 and 4 t/km/hr on October 1.

The fall average passage rate at the Project (138 ± 9 t/km/hr) is at the low end of the range of results of other fall radar studies conducted at proposed wind projects on forested ridges in the east. Comparative study results range from 91 t/km/hr at the Sheffield Wind Project in Caledonia County, VT (Woodlot Alternatives, Inc. 2006b) to 811 t/km/hr at the New Creek Wind Project in Grant County, WV (Stantec Consulting Services Inc. 2008c).

5.1.4 Rare Raptor Nesting Survey

An assessment of rare raptor nesting within a 10-mile radius of the proposed Antrim Wind Energy Project was conducted in 2011, consistent with USFWS recommendations. The purpose of rare raptor nest surveys associated with the proposed Project was to determine the current status of bald eagle, golden eagle, and peregrine falcon breeding activity in the Project area and surrounding vicinity. S pecific study objectives included:

- confirm presence or absence of bald eagle, golden eagle and peregrine falcon nesting activity at any known nest sites (current or historical) or suitable habitat within roughly a 10-mile radius of the proposed Project;
- monitor the proposed Project vicinity for bald eagle, golden eagle, or peregrine falcon activity that may indicate nesting at previously undocumented sites through incidental observations during other field surveys; and
- map (if found) bald eagle, golden eagle, or peregrine nest site locations within or adjacent to the proposed Project vicinity.

A desktop research exercise, including data inquiries, was conducted to ascertain the location of any historic nest locations or potential nesting habitats for the species being assessed. This exercise found that no territorial golden eagles have been documented during the breeding season in New Hampshire in nearly three decades. All of the State's historic golden eagle nesting sites are located in the White Mountains or in the Lake Umbagog region, all of which are considerably north of the proposed Project area. It was also found that the State's current peregrine falcon population occupies territories which occur mostly in the White Mountains. A few additional nests occur on cliffs in the far northern portion of the state, and one nest is located in an urban site (on a building) in the city of Manchester, in southern New Hampshire. All known peregrine falcon breeding sites in New Hampshire are on cliffs with the exception of the site in the City of Manchester. T he closest known peregrine falcon nesting site relative to the proposed Antrim Wind Energy Project is the urban location in the City of Manchester; this location is over 25 miles away from the proposed Project. No high quality nesting habitat for golden eagles or peregrine falcons was identified within 10 miles of the proposed

Project. For these reasons, the potential for nesting establishment by golden eagles or peregrine falcons within 10 miles of the Project area was estimated to be extremely low. Conversely, it was determined that there are several areas of potential bald eagle breeding habitat within a 10 mile radius of the proposed Antrim Wind Energy Project. Given the recent success and expanding population of this species, establishment of nest sites (and breeding home ranges) within 10 miles of the Project area was deemed possible. Furthermore, data from the New Hampshire Audubon identified one historic bald eagle nest site within a 10-mile radius of the proposed Project. This nest site, located in an historic bald eagle territory on Nubanusit Lake in Nelson, NH, was occupied most recently in 2010,. Based on the findings of this exercise, and associated consultation with the agencies, it was decided that the rare raptor nest survey for this area should focus on bald eagle nesting.

Pursuant to this consultation, on May 6, 2011, an aerial survey was conducted in an effort to identify and document bald eagle nesting activity within a 10-mile radius of the proposed Antrim Wind Energy Project.

During the aerial survey, two biologists (both experienced in conducting aerial avian and wildlife surveys) visually inspected the shoreline and islands of 34 lakes and ponds that were identified as having potential bald eagle breeding habitat (i.e. ponds greater than 35 acres in size) and which were located (at least partially) within a 10-mile radius of the proposed Project area. The survey was performed from a helicopter which flew as low and as slowly as possible. The survey was performed during favorable weather conditions, which consisted of calm to light winds and clear conditions with unlimited visibility.

During the survey, bald eagle nesting was confirmed at Nubanusit Lake. One adult bald eagle was observed sitting on a nest located on the north shore, on the far west end of the north arm of Nubanusit Lake. At least two chicks (in gray down) were also confirmed on the nest during the flight. This nest is located approximately 3.24 miles from proposed turbine #9, which is the closest proposed turbine associated with the Project.

Nubanusit Lake is a known historic bald eagle nesting territory which has been occupied for 15 years (1997-2011). Nesting was documented in 13 of these years. This 15-year-long occupation constitutes the second most persistent bald eagle territory documented within the State of New Hampshire since 1988 (a territory at Lake Umbagog has been occupied during 22 years of monitoring (New Hampshire Audubon 2010). The female at this territory was banded as a fledgling (in Massachusetts) in 1992 and has been confirmed present at Nubanusit Lake since 1999; in October of 2011, this female was found mortally injured at 19 ½ years of age (New Hampshire Audubon 2011). It is expected that a new female will occupy the matriarchal vacancy at Nubanusit Lake.

The Nubanusit Lake bald eagle territory is one of 22 occupied territories identified in New Hampshire as of 2010. The number of occupied bald eagle territories has been increasing in New Hampshire: the 22 occupied territories in 2010 represent a "record-high" as of that year, and a one-year increase of 10% compared to the previous high of 20 occupied territories documented in 2009. (New Hampshire Audubon 2010).

5.2 Bat monitoring

5.2.1 Acoustic Monitoring

Passive acoustic bat surveys for the proposed Antrim Wind Energy Project were performed in 2011. The purpose of this passive acoustic bat echolocation monitoring survey was to sample and document bat activity patterns and species composition within the Project area during spring, summer and fall seasons, when bats are known to be active.

A total of six bat detectors were deployed in the Project area by April 15, 2011. Two detectors were deployed in the guy wires of an existing meteorological tower at the east end of the Tuttle range. The remaining four detectors were deployed throughout the Project area, suspended from trees along forested corridors and adjacent to wetlands where bats would likely travel or forage. The detectors were removed in late October, 2011.

Anabat II detectors (Titley Electronics Pty Ltd.) were used for data collection based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats known to occur in New Hampshire. Detectors were programmed to begin monitoring at one half hour before sunset each night and end monitoring at one half hour after sunrise each morning.

All data collected was visually inspected to screen out bat calls, and each call file was qualitatively identified to guild and to species, when possible. This method of guild identification represents a conservative approach to bat call identification. Once all call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled to provide an index of bat activity. Detailed weather data as recorded by the meteorological tower on Tuttle Hill was obtained. These data were applied to describe bat activity levels in relation to site-specific weather variables that have been documented to affect rates of bat mortality at operational wind projects in the Northeast.

Spring Results

Spring acoustic bat surveys were conducted between April 7 and June 1, 2011. The six detectors recorded a total of 1,483 bat call sequences yielding an overall detection rate of 4.9 bat call sequences per detector-night.

Rate of detection varied among individual detectors (ranging from 5 sequences at the high detector on the met tower, to 760 sequences at a lower elevation, forested site). Detection rates also varied by night, ranging from 0.1 sequences per detector-night, to 14.1 sequences per detector-night. These types of variation are typical of this type of survey.

Bats within the *Myotis* genus comprised the greatest overall percentage of detected call sequences (32 %) recorded in the spring; however, most of these sequences were recorded at a single detector over only a few nights. The big brown bat/silver-haired bat guild was the second most commonly identified guild, comprising 31 percent of the total call sequences recorded. Most call sequences within this guild were identified as big brown bats or big brown/silver-haired bats, and only a small fraction were classified as silver-haired bats. Hoary bats comprised 12 percent of bat call sequences recorded; this species was recorded at all six detectors. The eastern red bat/tri-colored bat guild was the least commonly detected guild, comprising only 1 percent of the recorded call sequences. Twenty-four percent of call sequences were classified as "unknown" due to their relatively short length or quality.

Overall, spring 2011 acoustic bat surveys documented variable activity levels within the Project area, with May activity increasing relative to April's.

<u>Summer/Fall Results</u>

Summer/fall acoustic bat surveys were conducted between June 1 and October 23, 2011. The six detectors recorded a total of 35,450 bat call sequences yielding an overall detection rate of 52.4 bat call sequences per detector-night.

Among sampling locations, detection rates ranged from 2.6 to 126.2 bat call sequences per detector-night. Typical of this type of survey, activity levels varied considerably among nights within the survey period and among detectors. Bats within the big brown bat/silver-haired bat (BBSH) guild comprised the greatest overall percentage of detected call sequences (48%, n=17,006). The majority of BBSH calls were recorded at the low detector positioned on the met tower. The eastern red bat/tri-colored bat guild comprised 15 percent of the recorded call sequences. The Myotis guild comprised 12 percent and the hoary bat guild comprised 5 percent of the recorded call sequences. Twenty of the call sequences were classified as "unknown" due to their relatively short length or quality.

Of note, hoary bats were detected at five of the six detectors during the summer/fall study period, and species belonging to the *Myotis* guild and the eastern red bat/tri-colored bat guild were recorded by all six detectors.

Overall, summer/fall 2011 acoustic bat surveys documented variable activity levels within the Project area, although results suggest that activity was highest in July and August.

5.2.2 Bat Mist Netting Survey

A bat mist netting survey was conducted for the proposed Project in the summer of 2011, subsequent to a consultation with the NHDFG and the USFWS on June 21, 2011 to agree upon protocol for a mist net survey at the proposed Project. The primary objective of this summer survey was to document the potential presence of the eight bat species known to occur in the region.

Since there currently is no prescribed protocol for each bat species known to occur in New Hampshire, the federal Indiana Bat Survey Protocol was followed. (USFWS 2007). The bat mist net survey was conducted at four survey sites, as agreed upon during consultation with the agencies. Two of these sites were located at the south end of the proposed area of Project development, on or near Willard Mountain; one site was located in a wetland near the center of the proposed Project area; and one site was located near the existing meteorological tower on Tuttle Hill, at the northeast end of the proposed Project area. There were no suitable mist net sites on the immediate summits of Tuttle Hill or Willard Mountain, so sites were placed slightly off the peaks where better canopy closure provided more suitable mist net set locations.

The location of mist net sites was based on habitat features that may be selected by foraging little brown and northern long-eared bats, as well as eastern small-footed bats.

Good-quality bat capture sites were sought; such sites are located in potential travel corridors such as forest roads, trails, streams, or other linear corridors that serve to funnel traveling bats into mist nets.

Mist net surveys were conducted on eight survey nights, which commenced on July 12, 2011 and were completed on July 28, 2011. During each sampling event, two mist net sets were erected over trails, roads, or across forest gaps. Each mist net set contained three vertically-stacked nets.

One bat was captured during 41 total survey hours among the four survey sites. This juvenile, male, big brown bat (Eptesicus fuscus), weighing 17.25 grams, was captured on July 27, 2011 at the northeastern survey site (located downslope from the meteorological tower on Tuttle Hill). This bat was banded with NHFG band # 43152. No other bats were captured during the bat mist netting survey.

Low capture rates were not unexpected for this survey location. Mist net surveys can be biased toward those species that fly beneath the forest canopy such as North American *Myotis* species; as such, the relative abundance of expected captures is expected to trend toward *Myotis* species. In New England, high concentrations of *Myotis* species are generally expected at low elevations, where temperatures tend to be warmer and more stable than at higher elevations; however, *Myotis* bats are still expected to be present and active in lower concentrations at higher elevations such as ridge tops. For these reasons, it was expected that this study would result in the capture of at least some myotis bats. The capture of only one bat (which was not a *Myotis* species) was not the expected outcome of this effort. While not known definitely, the capture of only a single individual may be evidence of diminished populations of bats as a result of white-nose syndrome (WNS).

White-nose syndrome (WNS) is an emerging disease that has spread throughout the New England states in the past five years and has resulted in the unprecedented decline of all 6 bat species that hibernate in caves or mines in the northeast. *Myotis* species have been most affected by this disease. New Hampshire may soon list the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*Myotis septentrionalis*) as state endangered or threatened, due to rapid and dramatic population decline caused by WNS.

5.3 Potential Project Impacts to Birds and Bats

Potential impacts to birds and bats during operation of the proposed Project include indirect impacts such as habitat loss through displacement or increased energy demands through turbine avoidance during migration, and direct, turbine-associated mortality through either collision or barotrauma. Indirect impacts, particularly habitat impacts, have largely been addressed in the siting and design phases of the Project, as previously described. Energy expenditures as a result of turbine avoidance are expected to be negligible, given the small area and overall footprint of the Project (10 turbines arranged on approximately 60 acres of development). For these reasons, this ABPP focuses on the direct impact of collision and barotrauma. Direct mortality impacts to birds and bats that may potentially be expected at the Project are discussed below.

It is important to note that in advance of the submittal of AWE's application to the SEC and the development of this ABPP, AWE has secured binding letters of intent with four landowners and the Harris Center for Conservation Education to enact local land conservation agreements which will protect approximately 685 acres of land adjacent to the proposed Project. This undeveloped land encompasses forest, wetlands and streams in the immediate vicinity of the Project. Conservation of this land will permanently preserve large tracts of valuable foraging and nesting/roosting habitat for bird and bat species as well as other wildlife species.

5.3.1 Potential Impacts to Birds

In the past, developers have conducted extensive pre-construction risk assessments to calculate expected mortality at their proposed facilities. Recent studies have shown, however, that there is little correlation between pre-construction risk assessments and actual documented mortality of avian species at wind farms (Ferrer et al. 2011, de Lucas et al. 2008, Sharp et al. 2011). As such, it is difficult to predict expected mortality rates at a proposed facility. In response to this trend, this ABPP is designed to allow AWE to work continuously with USFWS and NHFGD in order to adapt to actual results and unknown circumstances, so that unexpected events and changes over time may be addressed.

In general, avian mortality documented during post-construction studies at ten wind facilities in New England and New York is low, with a total of 528 avian fatalities (not corrected for searcher or removal biases) documented among all ten facilities. (Costa 2011). The majority of these fatalities were passerines (n=389). The range of fatality estimates for known wind farms studies in Maine and New Hampshire was reported at 0.44 to 5.95 birds per turbine per study period. (Costa 2011).

Large, episodic avian mortality events have been documented at certain wind projects as well as at tall communication towers, lighted buildings, and other structures. (Shire et al. 2000, Gehring et al. 2009, Avery 1979). In general, the majority of avian collision at existing wind projects tends to occur during spring and fall migration, and appears to involve nocturnally migrating songbirds. As such, impacts to nocturnal migrants tend to occur exclusively at night. Nocturnal avian mortality events have been correlated with inclement weather events and certain artificial lighting scenarios. Project lighting plans, as described in this ABPP, have been designed to minimize lighting-associated mortality events.

While most avian mortality at wind farms tends to be associated with nocturnally migrating songbirds, collisions are also known to occur during the breeding season. Risk of collision for breeding birds is expected to occur primarily during evening or morning courtship behavior, daytime foraging and territory establishment, and during initial flying by juvenile birds.

Pre-construction avian studies for the Project generally found avian assemblage and use to be comparable to that of similar (in terms of topography and habitat) areas in New Hampshire and New England. Based on observations at operational wind projects in the region, bird collisions at the Antrim Wind Energy Project are expected to occur at a low frequency. Impacts are not expected to occur at a degree which would adversely affect populations.

Of note, an active bald eagle's nest was documented in 2011, approximately 3.24 miles to the southwest of proposed turbine #9, on Willard Mountain. Of important consideration, a recent study shows that bald eagles exhibit a high rate of avoidance of operational wind turbines (Sharp et al. 2011). In fact, no bald eagle mortalities have been documented at wind farms in New England to date. Therefore, it is expected that any bald eagles in the Project's vicinity are likely to successfully avoid contact with turbines.

5.3.2 Potential Impacts to Bats

As previously discussed, of eight species of bats expected to occur in the state of New Hampshire, one (the eastern small-footed bat) is state-listed as endangered, and five (eastern red bat, silver-haired bat, hoary bat, northern long-eared bat, and tri-colored bat) are state species of special concern. Furthermore, New Hampshire may soon list the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*Myotis septentrionalis*) as state endangered or threatened, due to rapid and dramatic population decline caused by White-nose syndrome (WNS).

White-nose syndrome is an emerging disease that has spread throughout the New England states in the past five years and has resulted in the unprecedented decline of all 6 bat species that hibernate in caves or mines in the northeast. *Myotis* species have been most affected by this disease.

The total bat fatality recorded among 14 total study seasons (between 2006 and 2010) of post-construction studies at 10 wind farms in New England and New York was 1114 (not corrected for searcher or removal biases). The majority of these fatalities appear to have been recorded in New York, where the number of bat fatalities ranged from 0.7 to 40.4 bats per turbine per study period; in Maine and New Hampshire, the number of bat fatalities recorded ranged from 0.17 to 5.51 bats per turbine per study period. (Costa 2011).

Long distance migratory bat species are thought to be the most vulnerable to collision mortality at wind projects in general based on results of mortality surveys at operational projects. (Costa 2011). Long-distance migratory bats that are expected to occur within range of the Project include the eastern red bat, silver-haired bat and hoary bat. Although the majority of documented bat fatalities at existing wind projects is related to long-distance migratory species, some mortality among resident bat species is also associated with the spring and fall migration periods, and during the summer pup rearing period.

Bat fatalities at wind farms are also known to be affected by other factors, such as weather variables. It has been shown that most bat fatalities tend to occur during low wind speeds over relatively short periods of time. (Arnett et al. 2008). Operational measures which curtail turbine cut-in at low wind speeds between dusk and dawn have been shown to reduce bat mortality at some wind farms. Baerwald, et al. (2009) found that curtailment of turbines at low wind speeds reduced bat fatalities by between 57% and 60%. Studies performed at the Casselman Wind Project in Pennsylvania found that curtailment reduced bat fatalities at individual turbines at rates from 44% to 93%. (Arnett et al. 2010). Arnett et al. (2010) concluded that curtailing operations offers an effective mitigation strategy for reducing bat fatalities at wind energy facilities. For this reason, this ABPP proposes a study to assess an operational curtailment strategy to minimize bat fatality at the Project, should actual fatalities materialize and mitigation is deemed appropriate. T his proposed study is described in detail in Section 8.

Based on the accumulated knowledge of bat mortality at wind farms in New England, mortality at the Project is expected to be low. In light of the WNS epidemic, however, the level of biologically significant mortality may change and therefore will be addressed during the adaptive management process as implemented by this ABPP.

6 DEVELOPMENT AND CONSTRUCTION PHASE AVOIDANCE AND MINIMIZATION

Several avoidance and minimization measures have been or will be executed during Project siting, design, construction and maintenance in order to minimize risk to avian and bat species. These are described in the following subsections.

6.1.1 Project Siting and Design

The following paragraphs describe measures previously employed or to be employed during siting, design, construction and operation that will avoid or minimize potential impacts to birds and bats upon construction and operation of the Project.

Project Siting

As previously discussed in Section 4, AWE applied rigorous screening criteria to establish a well-sited Project that minimizes potential impacts associated with access, transmission and alteration of natural habitats. The close proximity of the proposed Project to existing infrastructure minimizes the overall area of disturbance and eliminates the need for new transmission lines. Furt hermore, the Project will be constructed on previously impacted lands (as recently as 2010 by industrial timber harvesting), thereby greatly reducing the overall impact of Project construction and development on natural habitats.

Structure Layout and Design

Final turbine layout and facility design has taken into account the findings of the Tier 3 biological assessments and has avoided identified sensitive areas (such as wetlands and vernal pools) to the extent feasible. The final design also effectively balances financial considerations with minimization of impacts to avian and bat species.

Collector System Design and Interconnection Proximity

The Project will interconnect to PSNH's 115 kV Line L163 via a three breaker ring bus substation located adjacent to the Project access road and contained within the Project's leased boundary. The interconnection substation will be a standard three phase 115 kV transmission level substation designed and constructed by PSNH. A 34.5 kV - 115 kV collector substation will be located adjacent to the interconnection substation and provide an interface between PSNH and the Project. A single 34.5 kV three phase collector line will be constructed from the collector substation to the individual turbines. This collector line will be a combination of overhead and underground facilities. All collector system facilities (substation & lines) will be designed and constructed consistent with industry standards, PSNH and ISO-NE requirements, applicable local, state and federal codes and good utility practice.

Furthermore, the Project collector lines and substation will be designed and constructed to meet or exceed the most recent recommendations of the Edison Electric Institute's Avian Power Line Interaction Committee (APLIC), as necessary and applicable.

Operational Lighting

Operational lighting will be minimized to the maximum extent practicable. Project design will incorporate minimum intensity lighting on all Project structures where feasible.

No steady burning lights will be left on at the facility buildings and substation unless necessary for safety or security; in such cases, manual lighting, motion detector lighting or infrared light sensors will be used whenever possible to avoid continuous lighting. Any required facility lights will be shielded downward to minimize skyward illumination, and will not use high intensity, steady burning, bright lights such as sodium vapor or spotlights. Motion detector or manual lights will be used above tower doors and at the operations and maintenance building for nighttime maintenance visits.

AWE will implement a protocol to confirm that manual lighting controls on buildings and Project facilities are always off at night unless required for specific ongoing tasks or in the event of an emergency response.

Turbine and Met Tower Lighting

Turbine lighting will be minimized to the maximum extent practicable. Lighting will be limited to that required by the Federal Aviation Administration (FAA) or as required to meet other safety concerns. Permanent meteorological tower(s) will also utilize the minimum lighting as required by the FAA.

The minimum amount of pilot warning and obstruction avoidance lighting specified by the FAA will be used. Based on FAA determinations for the Project, six (out of 10 total) turbines will be lit, and all lights within the facility will illuminate synchronously. FAA lights are anticipated to be flashing red strobes (L-864) that operate only at night. The lowest intensity lighting as allowed by the FAA will used.

To the extent possible, USFWS recommended lighting schemes will be used on the nacelles to the extent they are consistent with FAA requirements, including reduced intensity lighting and lights with short flash durations that emit no light during the "off phase".

AWE will implement a protocol to confirm that manual turbine lighting controls are always off at night unless required for specific ongoing tasks or emergency response.

6.1.2 *Project Construction and Maintenance*

The following construction phase measures will be executed during Project construction. These measures will result in avoidance of construction activities in the vicinity of sensitive habitats during critical periods in avian and bat life cycles, and minimization of impacts to wildlife habitat and resources.

Tree Clearing

Tree clearing activities will be timed, to the extent possible, to minimize impacts to bats and birds. The preferred times for tree clearing will be during frozen ground conditions (November 1 – March 31) or times when the ground is dry (July 1 through September 15). This timing will help to avoid mortality of roosting bats, most nesting birds, and their respective young. The actual timing, however, will ultimately be dictated by the date of permit application approvals and other commercial agreements that depend on those approvals.

Furthermore, prior to any tree removal, the limits of proposed clearing will be clearly demarcated with flagging tape, orange construction fencing, or similar. This will prevent inadvertent over-clearing and minimize the extent of tree removal.

Minimization of Soil Disturbance and Promotion of Natural Revegetation

Clearing and construction activities will apply practices which reduce soil disturbance and allow for the reestablishment of natural vegetation. Where possible, vegetation will be cleared without grubbing or removal of stumps or tree roots. All construction equipment will be restricted to designated travel areas to reduce impacts. Construction clearings, storage yards, staging areas, or temporary roads that are not needed for long-term operation of the Project will be allowed to revegetate after commissioning of the Project. If turbines require substantial maintenance during operations, the Project will employ the same measures as used during construction to limit clearing of vegetation and disturbance of soil.

Invasive Species Avoidance

Best management practices will be used to avoid the introduction and spread of invasive species. C onstruction vehicles and equipment that arrive from other areas will be regularly cleaned. In an effort to preserve natural habitat to the extent possible, areas to be revegetated will be re-seeded with native seed (to the extent possible pending seed availability) following construction. Re-seeding will be consistent with state permit requirements to avoid the introduction of invasive plant species.

Protection of Water Quality

Best Management Practices for construction activities will minimize degradation of water quality from storm water runoff and sediment from construction. A plan note will be incorporated into the construction contract requiring that contractors adhere to all provisions of National Pollutant Discharge Elimination System (NPDES) permits and the Storm Water Pollution and Prevention Plan (SWPPP). Federal and state measures will be adhered to for handling toxic substances to minimize danger to water and wildlife resources from spills.

Minimization of Fire Potential

Fire potential will be minimized: spark arrestors will be used on equipment as appropriate, and smoking will be restricted to designated areas on site.

6.1.3 *Avian and Bat Enhancement Options*

AWE is providing for the permanent conservation of 685 acres of undeveloped forest land immediately adjacent to the Project area. This significant conservation amenity represents a contribution to preserving wildlife and habitat in the area, and will help sustain local wildlife populations. It also represents a direct benefit to local bird and bat species which rely on undeveloped forested areas for foraging, nesting and roosting.

Furthermore, the Project represents a new source of clean, renewable energy that will displace output from fossil fuel generation plants, which produce environmental pollutants that negatively affect regional air and water quality. AWE commissioned Resource Systems Group, Inc. to perform a study to evaluate air pollutants that will be avoided or displaced as a result of operation of the proposed Project. The study found that there are significant avoided air emissions that may be expected to result from the operation of the proposed Project. Among these displaced emissions are over 59,000 tons of carbon dioxide, and an additional 150 tons of sulfur dioxide, nitrogen oxides, particulate matter and other toxins on average each year. The Project is also expected to save approximately 17,500,000 gallons of fresh water each year due to the displacement of fossil fuel energy sources that use water for cooling or creating steam to power turbines. These enhancements to air and water quality, together with the conservation amenity, will constitute a significant net benefit to the environment and the species which depend on it, including birds and bats.

7 POST-CONSTRUCTION EVALUATION AND MANAGEMENT

Management of risk to avian and bat species will begin with a post-construction Evaluation Phase. The Evaluation Phase will coincide with the first year of operations, beginning on the Project's Commercial Operations Date (COD). The COD is expected to occur by September 2014. Objectives during the Evaluation Phase will include:

- documenting baseline mortality rates and patterns for birds and bats;
- evaluating potential mitigation options including the effectiveness of turbine curtailment at low wind speeds to reduce mortality; and,
- assessing the cost of implementing such a curtailment program.

Management objectives to be assessed during the Evaluation Phase will be analyzed separately across the following management groups:

- long-distance migratory bats,
- other bat species,
- nocturnally migrating birds,
- breeding birds,
- bald and golden eagles, and
- diurnally migrating raptors.

For each management group, the overall management objective is to avoid, minimize and/or reduce mortality rates in a scientifically sound and commercially reasonable manner.

The Evaluation Phase will require rigorous post-construction field evaluations, including a post-construction mortality survey, a post-construction acoustic bat monitoring survey, and a curtailment evaluation study. These studies are described below in Section 7.1.

At the conclusion of the Evaluation Phase, AWE will work with consulting agencies (USFWS and NHFGD) to develop more specific management objectives for each identified species group, if warranted. Management determinations will take into account: baseline mortality rates in comparison to those documented at other wind projects; potential ecological impacts of baseline mortality rates, including cumulative impacts; and the degree to which management actions are feasible and effective in reducing mortality.

Management of risk to avian and bat species over the life of the Antrim Wind Energy Project will be guided by an adaptive management strategy. This strategy is described in detail in Section 9.

7.1 Evaluation Phase Field Studies

Evaluation Phase field studies will include: a post-construction avian and bat mortality study; an acoustic bat monitoring study; and a curtailment evaluation study. Taken together, these studies will correlate bat activity with mortality rates at specific turbines and assess the effectiveness of reduced cut-in speeds (curtailment) at reducing bat mortality. These studies will also serve to establish baseline mortality rates for all avian and bat species at the Project and assist AWE, USFWS and NHFGD in establishing thresholds of mortality that will trigger the adaptive management process.

7.1.1 Post-Construction Avian and Bat Mortality Study

Throughout the Evaluation Phases, the Project will perform a one-year formal post-construction avian and bat mortality monitoring study. The post-construction avian and bat mortality monitoring effort will include:

- Standardized searches for birds and bats from April 15 through June 7 (“spring”) and from July 7 through October 15 (“fall”);
- Searcher efficiency trials to estimate the percentage of carcasses found by searchers; and
- Carcass removal trials to estimate the length of time that carcasses remain in the field for possible detection.

The results of the initial formal study will help inform the need for any future adaptive management initiatives. Following the first year of operations, mortality (and injury) will be informally documented and reported over the life of the Project under the provisions of a Wildlife Mortality Monitoring Program (see Section 9).

7.1.2 Acoustic Bat Surveys

During the Evaluation Phase, the Project will conduct post-construction acoustic bat surveys between May 1 and October 15. Acoustic survey data will be used to correlate bat activity levels measured at rotor height to corresponding bat mortality levels.

Acoustic detectors will be deployed on the nacelle of a select number of study turbines distributed throughout the Project area and will be programmed to record on a nightly basis from at least 30 minutes prior to sunset until 30 minutes after sunrise.

Data will be analyzed and summarized by detector, detector night, and for the spring, summer, and fall seasons, including categorization by species and guild where appropriate. Where appropriate, bat call sequences will be individually marked and categorized by species group or “guild” based on visual comparison to reference calls.

7.1.3 Curtailment Evaluation Study

During pre-construction consultation, representatives from USFWS and NHFGD expressed concern over the potential for the Project to cause bat mortality, at a time when certain bat species are being affected by White Nose Syndrome (WNS: see Section 2.3). NHFGD suggested that turbine curtailment may be a viable means of avoiding and minimizing bat mortality at the proposed Project. For this reason, AWE will assess the effectiveness of a curtailment strategy to reduce impacts to bats during the evaluation phase. This study effort will help AWE, NHFGD and USFWS better understand the effectiveness of curtailment at an operating wind project in the State of New Hampshire, where documented bat mortality at wind developments has been low.

For bats, the highest risk periods include nights with low wind speeds (less than 5.0 m/s), particularly during the fall migration and swarming period. The highest numbers of fatalities among bat species at wind facilities have occurred in late summer and early fall, coinciding with the migratory period, which occurs between mid-August and late September in the eastern U.S. (Kunz *et al.* 2007, Arnett *et al.* 2008).

The results of mortality surveys at operational wind projects to date suggest that long-distance migratory bat species are more vulnerable to collision mortality than other bat species, with three species apparently at the greatest risk: the foliage-roosting hoary bat; eastern red bat; and the cavity-roosting silver-haired bat (Kunz *et al.* 2007, Arnett *et al.* 2008). All three of these bat species have the potential to occur in the Project area.

This curtailment study will follow conditions set forth at other recently approved wind developments in the northeast, including the Bull Hill Wind Project, in Maine. Initially, the Project will test only one curtailment scenario, based on applying the following parameters to 5 of the project's 10 turbines:

- Higher Cut-In Speed: cut-in speed will be raised to 5.0 meters/second (m/s) at turbine hub height. The cut-in speed of 5.0 m/s was selected based on results from studies recently completed at the Casselman Wind Farm in Somerset County, Pennsylvania (Arnett *et al*. 2010). The remaining turbines will be allowed to operate at a normal cut-in speed (approximately 3.5 m/s) without curtailment or operational modifications in place. These turbines will represent an experimental control;
- Timing: Operational control limitations will be applicable from July 15th through September 30th during nighttime hours (roughly ½ hour after sunset until sunrise, when bats are active). This period is meant to coincide with higher documented mortality events at other operational wind projects, as well as the formal mortality surveys during the Evaluation Phase.

The operational control measures will be implemented through the Project's supervisory control and data acquisition (SCADA) system. The SCADA system provides an effective means to manage and document turbine curtailment based on real-time wind data from the site.

The curtailment study will provide AWE, NHGFD, and USFWS the data necessary to determine whether a curtailment strategy has the potential to reduce significantly any future bat fatality at the Project in a commercially reasonable manner. Based on the results of the curtailment study, the Project will be able to:

- assess the potential biological benefits, in terms of expected reduction in mortality;
- Estimate the long term cost and financial viability of implementing curtailment as a long term mitigation strategy; and
- recommend an operational control program, if warranted, which balances the Project's financial viability with positive outcomes in avoiding and reducing bat fatality at the Project.

The results and recommendations of this study will be subject to the phased consultation process described under the adaptive management strategy (see Section 9). This process will determine if curtailment should be implemented as an operational mitigative measure. This study and adaptive management consultation will guide the ultimate operational curtailment plan, if deemed necessary.

8 OPERATIONAL MITIGATIVE ACTIONS

8.1 Conservation and Environmental Benefits

AWE is providing for the permanent conservation of 685 acres of undeveloped forest land immediately adjacent to the Project area. This represents a significant contribution to preserving wildlife and habitat in the vicinity of the Project. This conservation area represents a direct benefit to local bird and bat species which rely on undeveloped forested areas for foraging, nesting and roosting, and will help to sustain local wildlife populations.

Furthermore, the Project represents a new source of clean, renewable energy that will displace output from fossil fuel generation plants, which produce environmental pollutants that negatively affect regional air and water quality. AWE commissioned Resource Systems Group, Inc., to perform a study to evaluate air pollutants that will be avoided or displaced as a result of operation of the proposed Project. The study found that there are significant avoided air emissions that may be expected to result from the operation of the proposed Project. Among these displaced emissions are over 59,000 tons, of carbon dioxide, and an additional 150 tons of sulfur dioxide, nitrogen oxides, particulate matter and other toxins each year on average. The Project is also expected to save approximately 17,500,000 gallons of fresh water each year due to the displacement of fossil fuel energy sources that use water for cooling or creating steam to power turbines.

There are specific environmental benefits to these reductions in emissions. For example, a reduction in nitrogen oxide emissions can contribute to reducing the occurrence of high ozone days in New England and eastern Canada. Reductions in sulfur dioxide emissions can reduce the impact of acid precipitation on regional forests and lakes. The expected reduction in carbon dioxide emissions represents a significant reduction in the production of greenhouse gases. Collectively, these expected reductions in the production of toxic air emissions support AWE's position that the proposed Project will provide net benefit (or a positive net impact) in terms of air quality. In turn, improved air quality will positively affect the physical environment and its fauna, including birds and bats. Direct losses of individual birds and bats as a result of Project operations are expected to be low, and are not expected to impose population level impacts; however, bird and bat populations as a whole are expected to benefit from diminished toxic air emissions. For these reasons, AWE believes that net benefits to avian and bat populations as a result of Project operation are possible.

8.2 Additional Mitigative Actions for Bats

Bat fatalities directly attributable to the Antrim Wind Energy facility are expected to be low, based on the results of pre-construction surveys and the precedents at other facilities in the state and in New England (Costa 2011). Despite this expectation, AWE is offering to assess and implement (if Evaluation Phase studies and consultation deem such measures feasible, practical and effective) an operational curtailment protocol as a means of reducing risk to bat species. AWE offers this mitigative action approach in lieu of committing to a multiple-year mortality study. AWE believes that such a multiple-year study is inappropriate because it will either:

- Cost more than life-of Project curtailment to determine that fatality is low and that no mitigation is needed, or;
- Cost more than life-of project curtailment to determine that fatality is biologically significant and that mitigation is necessary.

Alternatively AWE believes that the curtailment study is a better use of limited post-construction biological funds. Not only will it have more scientific and commercial value, but it will enable the Project to implement, if deemed necessary during the Evaluation Phase, timely operational mitigative measures which are known to reduce risk to bats, rather than simply to perform studies that will result in no-action (at best) or the same (at worst).

In light of recent population declines as a result of white-nose syndrome in bats, even low mortality of some species could possibly become biologically significant over the life of the Project. The operational mitigative strategy assessed within this ABPP, in the form of curtailment, may help to avoid and reduce impacts to bats most susceptible to the WNS such as the *Myotis* species. This strategy may also reduce risk to the resident and migratory bats which may use the Project area.

The actual implementation of an operational mitigative strategy in the form of turbine curtailment will be assessed during an Evaluation Phase, following the completion of the curtailment study. Questions about if and how long-term curtailment measures should be implemented at the Project will be made in consultation with USFWS and NHFGD via the adaptive management process described in Section 9.

8.2.1 Curtailment Evaluation Phase

At the conclusion of the curtailment study during the Evaluation Phase, AWE will collaborate with USFWS and NHFGD to review results of monitoring, effectiveness of the management treatment, and cost and feasibility of management treatment options. The ultimate goal of the ABPP is to avoid and minimize levels of mortality for each species group such that they meet a reasonable threshold. Given the lack of existing baseline mortality data from the Project and the lack of data on the effectiveness of various curtailment strategies in a variety of landscapes, meaningful and defensible mortality thresholds cannot be established for the Project until the results of evaluation phase studies are available. Ultimately, the determination of what is “reasonable” will depend on the baseline mortality rate at the Project, and how it compares to mortality rates at similar projects. This “reasonableness” test will have to take into account the cost of potential management options in terms of Project financial viability, and balance these considerations with positive outcomes in terms of reducing bat fatalities.

The Evaluation Phase of the ABPP is intended to provide AWE, USFWS and NHFGD with a sufficient quantity and quality of data to identify specific treatment options that meet management objectives while minimizing cost of implementation. This evaluation will also insure the consideration that management actions to be implemented will be effective throughout the life of the Project without precluding the Project's financial viability.

8.2.2 Curtailment Implementation Phase

Should AWE, NHFGD and USFWS agree that an operational control measure is warranted based on the results of the Evaluation Phase, the parties will determine the most appropriate curtailment parameter for implementation. Depending on patterns and species composition of bird and bat mortality documented during the Evaluation Phase, parameters of curtailment (such as cut-in wind speed, daily and nightly timing of curtailment, seasonal timing of curtailment, and numbers of turbines to curtail), may be adjusted to best manage potential risk to particular species or species groups while maintaining Project viability and maximizing the clean energy benefit realized by the Project. If any unforeseen, biologically significant events occur over the life of the Project, then manipulation of curtailment strategy may be considered (among other potential solutions, as appropriate) during the phased consultation process. Again, any changes in the curtailment strategy must balance Project financial viability with positive outcomes for birds and/or bats, and must be agreed upon by all parties participating in the phased consultation process.

Throughout the implementation phase, AWE will record and retain turbine operation and weather data to document the amount of time that turbines are curtailed at various seasons. This information will provide a means of tracking the cost of the management actions implemented at the Project and will provide consistent data on the degree to which "high risk" conditions for each species group are being avoided.

Turbine curtailment and a considerable conservation effort are the primary management actions provided under this ABPP. However, AWE may propose to modify

Project curtailment procedures should viable future technology, such as acoustic or visual deterrents or blade design innovations, be developed that will reasonably and cost effectively reduce impacts to birds and bats. Any such potential changes to Project operations will be proposed and/or initiated by AWE and will need to be vetted and agreed to by all parties participating in the phased consultation process. If this occurs, additional monitoring may be warranted to document the effectiveness of any new measures. Any such proposed changes to operation and management strategy may be incorporated by AWE in the annual report under the WMMP, and will initiate the phased consultation process.

In the event that bat mortality at the Project is found to be very low during the implementation period, and that operational controls are not making a significant contribution to lowering mortality, AWE reserves the right to propose alteration or suspension of the curtailment regime. Likewise, if conditions change over the life of the Project which cause operational controls to financially jeopardize continued operation, then AWE may propose financially viable alternatives to the current regime. Any such proposal would be subject to the phased consultation process.

8.3 Additional Mitigative Actions for Birds

AWE has worked cooperatively with the relevant agencies and implemented the most current available scientific knowledge, technology and survey methods into the development and definitive planning of the Project. Furthermore, AWE has committed to pursuing the most feasible risk avoidance and minimization techniques for avian species through: 1) the development and construction phase measures described in Section 6; 2) the post-construction studies and consultation described in Section 7; 3) the adaptive management strategy of this ABPP, which includes a Wildlife Mortality Monitoring Program, an Immediate Alert Procedure, and a phased consultation strategy (see Section 9); and 4) the permanent conservation of 685 acres of forested that provide valuable habitat for avian species as well as other wildlife. For these reasons, AWE does not believe any further operational mitigation for avian species is warranted at this time.

9 ADAPTIVE MANAGEMENT STRATEGY

The state of knowledge regarding avian and bat interactions at wind farms on the forested ridges of the northeast is still evolving. Likewise, the technology available to mitigate risks to birds and bats at wind farms is continuously developing as the science matures. Furthermore, the population status of a given species is dynamic, as exemplified by the population impacts to bats incurred by white-nose disease and the increase in bald eagle populations in the northeast in recent years. As such, the biological significance of individual losses can change over time.

In order to continuously address changing circumstances in the area of avian and bat interaction at wind farms, and potentially changing circumstances at the proposed Project, AWE will implement an adaptive management strategy for managing risk to birds and bats over the life of the Project. Adaptive management allows decisions and actions to be tailored to specific problems and circumstances (e.g., a specific species, location, weather pattern, wind speed, or season) at the specific point in time at which they occur.

The adaptive management process needs to take into account impacts to Project operations. Any additional controls will need to be supported not only by science, but by economic considerations that ultimately determine the Project's viability. Project adaptation should not only be geared toward additional controls, but also should take into account positive outcomes such as the documentation of minimal impacts to wildlife.

Adaptive management will be guided by: formal post construction study results documented during the year-one Evaluation Phase; a continuous Wildlife Mortality Monitoring Program (WMMP), equipped with an Immediate Alert Procedure (IAP) for reporting of unusual mortality events; and a phased consultation strategy. The WMMP, the IAP and the phased consultation strategy are described in detail in the following subsections.

9.1 Wildlife Mortality Monitoring Program

After formal monitoring is complete, AWE will implement a Wildlife Mortality Monitoring Program (WMMP) for all project site personnel. This program will provide for the proper identification, handling and reporting of dead or injured birds and bats that are found during Project operation. The WMMP will be described in a stand-alone document that will be developed during the Evaluation Phase. The WMMP document will describe, in detail, the actions to be taken upon discovery of any dead or injured bird or bat at the Project. The WMMP will also incorporate the Immediate Alert Procedure described in this ABPP (see Section 9.2, below).

The WMMP will also include: provisions for cataloging and reporting annual findings; a list of key contacts; a training initiative for wind farm personnel; detailed handling and documentation forms and procedures; and provisions for permit compliance. The WMMP will be an evolving document, subject to annual updates.

9.1.1 Training

Under the WMMP, all appropriate personnel (including managers, supervisors, inspection and maintenance crews, etc.) will be trained in the identification, handling and reporting of dead or injured avian and bat species. This training will encompass the reasons, need, and method by which employees should report an injury or mortality, dispose of carcasses, and comply with applicable regulations, including the consequences of non-compliance.

All appropriate new-hires will be trained to execute the WMMP prior to working on-site. Appropriate staff will be subject to annual refresher training. Supplemental training also may be appropriate where there are material changes in regulations, permit conditions, or internal policies. Any updates to the WMMP will be distributed and discussed during annual training.

9.1.2 *Key Resources*

AWE will maintain a list of key resources to address avian and bat injury or mortality issues. This list will include a list of experts who may be called upon to aid in resolving various issues. Listed parties may include: Internal contacts, avian and bat study consultants, state and federal agency contacts, and local wildlife rehab facilities. The key resources list will be updated annually and presented during annual training.

9.1.3 *Reporting*

All injuries and mortalities discovered at the Project will be documented in an electronic database developed to serve the needs of the WMMP. Each year, these data will be compiled into an annual summary report. This annual report will assess the year's injury and mortality data, and will include a discussion, as appropriate, on other performance indicators relevant to this ABPP. If necessary, the report will also make recommendations for improvement. This ABPP summary report will be provided annually, by January 30, to the USFWS and NHFGD.

The WMMP will also include an Immediate Alert Program (IAP) which will inform regulating agencies of significant mortality events within 24 hours of discovery. Reports made under the IAP will trigger a phased process of consultation under the adaptive management process. The IAP and the phased consultation strategy it activates are described in detail, below.

9.1.4 *Quality Control*

Annual reporting under the WMMP will provide a mechanism for AWE and the agencies to review existing practices and ensure quality control.

9.1.5 *Permit Compliance*

Any Project staff that may be handling birds or bird carcasses will have appropriate federal and/or state wildlife handling permits. AWE will assure that wildlife rehabilitation centers and consulting staff also have appropriate permits if they will be responsible for transporting dead or injured birds protected by the MBTA and/or the BGEPA.

AWE operating personnel or designated contractors will be responsible for making sure that the Project maintains copies of all applicable permits and permit conditions. AWE operating personnel or designated contractors will also be responsible for maintaining all copies of annual permit reports to the USFWS and to any state agencies where required.

Copies of any necessary permits will be contained in the WMMP document, and will be kept current during annual updates.

9.2 Immediate Alert Procedure

An Immediate Alert Procedure (IAP), as defined and summarized in this ABPP, will be fully developed in consultation with USFWS and NHDFG, and will be incorporated as part of the WMMP. The IAP provides a mechanism for the reporting, assessment and resolution of biologically significant incidents.

For the purpose of this ABPP, biologically significant incidents are defined as those that involve the individual injury or death of a listed species or an eagle, or the large scale injury or death of any avian or bat species or groups. In the event that an avian or bat species that is federally or state listed as “threatened” or “endangered” is discovered, injured or dead, the IAP will be triggered. If a single bald or golden eagle is discovered, the IAP will be triggered. Likewise, in the event that a large-scale mortality event is discovered, the IAP will be triggered.

Listed species will be defined in the WMMP, and changes to that list will be incorporated in annual updates to the WMMP. Likewise, the definition of what constitutes a large-scale event will be developed in consultation with agencies and incorporated in the WMMP; this definition is also subject to re-assessment over time and may be adjusted, as appropriate over the life of the WMMP. To date, USFWS has been applying a trigger threshold of 60 birds/bats found throughout a project during one search period, and/or more than 6 birds/bats found at one turbine in one search period. These thresholds are based on information to date which suggests that 6 birds per turbine per search period is approximately average for forested ridges in the region (personal communication, December 27, 2011: Sarah Nystrom: Northern States Bald and Golden Eagle Coordinator, U.S. Fish and Wildlife Service - Northeast Region). Depending on baseline mortality rates observed at the Project, this threshold may be adjusted during consultation.

In general, the IAP, when triggered, will require notification of a biologically significant event to NHFGD and USFWS within 24 hours of discovery. AWE will immediately implement a "root cause analysis" to determine the likely cause of the event. This analysis will be presented during a consultation with NHFGD and USFWS which will occur within a fourteen-day period following the reported incident.

This meeting will constitute Phase 1 of a phased consultation strategy (described in detail, below). At this meeting, the participants will determine an appropriate course of action to address the specific event at hand. Decisions may range from no-action to a course of further evaluation and potential mitigation. During consultation as a result of the IAP, AWE and consulting agencies will consider the most current, relevant knowledge, information and technology to determine an appropriate response.

9.3 Phased Consultation Process

Generally, the phased consultation process will be initiated by an alert from AWE as prescribed by the IAP. Under unforeseen circumstances, however, the phased consultation process may be initiated based on the results of annual reporting under the provisions of the WMMP. The phased consultation process is also the mechanism by which evaluation phase studies and recommendations will be assessed. This process must seek solutions which balance Project financial viability and ability to operate with positive outcomes for avian and bat species.

9.3.1 *Phase 1 Consultation: Action/No Action Determination*

During Phase 1 consultation, AWE, USFWS and NHFGD will meet to determine whether the reported event (or other matter of concern) is isolated, and if further action is feasible or required. If it is agreed that no further action is required, the consultation shall be closed. If further action is required, Phase 2 consultation shall proceed. The consultation shall proceed to Phase 2 or be closed within 60 days of the initial IAP event.

9.3.2 *Phase 2 Consultation: Resolution/Research Initiative Determination*

Phase 2 consultation will occur, as needed, at the initial consultation meeting. If appropriate action measures are readily defined and agreed upon by all parties at this meeting, then the agreed-upon strategy will be implemented and consultation will be closed.

If it is determined that further research is needed to address the matter at hand, then Phase 3 Consultation shall proceed within 45 days of initiating Phase 2.

9.3.3 *Phase 3 Consultation: Desktop Research and Recommendations*

Phase 3 consultation will consist of a desktop analysis of action alternatives. This analysis will determine potential action alternatives based on the most current scientific knowledge and available technology relevant to the subject at hand. This assessment will also take into account the fiscal viability of the Project and the financial and/or operational impact of any measures considered.

This effort will result in the production of a formal report to be submitted to the agencies by a date determined during Phase 2 consultation. The Phase 3 report will include descriptions of the action alternatives considered, and will present final action recommendations.

The results of Phase 3 consultation will dictate the course of research or mitigative actions, if any. If Phase 3 consultation results in a no-action decision, then consultation shall be closed. If Phase 3 consultation identifies and agrees upon mitigative measures to be taken, then those measures shall be implemented and consultation shall be closed.

If Phase 3 consultation agrees upon a strategy, but determines that a final plan of execution must be developed based on desktop research, then such a plan will be produced and assessed at the Phase 3 level.

If Phase 3 consultation determines that field research is necessary, then Phase 4 consultation shall proceed.

9.3.4 Phase 4 Consultation: Field Assessments

A final plan for research, as applicable, will be developed, approved and executed during Phase 4. The results of any field studies conducted during Phase 4 shall be submitted and treated as in Phase 3 consultation.

As in Phase 3, if consultation results in a no-action decision, then consultation shall be closed. If mitigative measures are identified and agreed upon by all parties, then those measures shall be implemented and consultation shall be closed.

If consultation agrees upon a strategy, but determines that a final plan of execution must be developed based on desktop research, then such a plan will be produced and assessed at the Phase 3 level. If it is determined that more field research is necessary, then Phase 4 consultation shall continue.

9.3.5 Closure of Consultation

Consultation shall continue until resolution is reached among all parties. Upon resolution, AWE will prepare a formal letter and submit it to the agencies. This letter will summarize the history of consultation regarding the specific matter at hand, explain the resolution, and declare that formal consultation has been closed. The agencies shall respond in a formal letter which indicates their acceptance of resolution and closure. The failure of agencies to provide such a letter within 60 days of AWE's letter of closure shall be construed as an acceptance of resolution and closure.

10 PERMIT COMPLIANCE

Permit compliance will occur in several stages of project development and operation. In general, any project staff that may be handling birds or bird carcasses will have appropriate federal and/or state wildlife handling permits. AWE will assure that wildlife rehabilitation centers and consulting staff also have the appropriate permits or permission to handle or transport dead or injured birds protected by the MBTA and/or the BGEPA.

Handling, possession, and/or scientific collection permits will likely be needed for the post-construction mortality study. All necessary permits will be obtained and maintained by the contractor performing the study.

AWE operating personnel or designated contractors will be responsible for ensuring that the Project maintains copies (electronic and hard copy) of applicable permits and permit conditions. AWE operating personnel or designated contractors will also be responsible for maintaining all copies of annual permit reports to the USFWS and to any state agencies where required.

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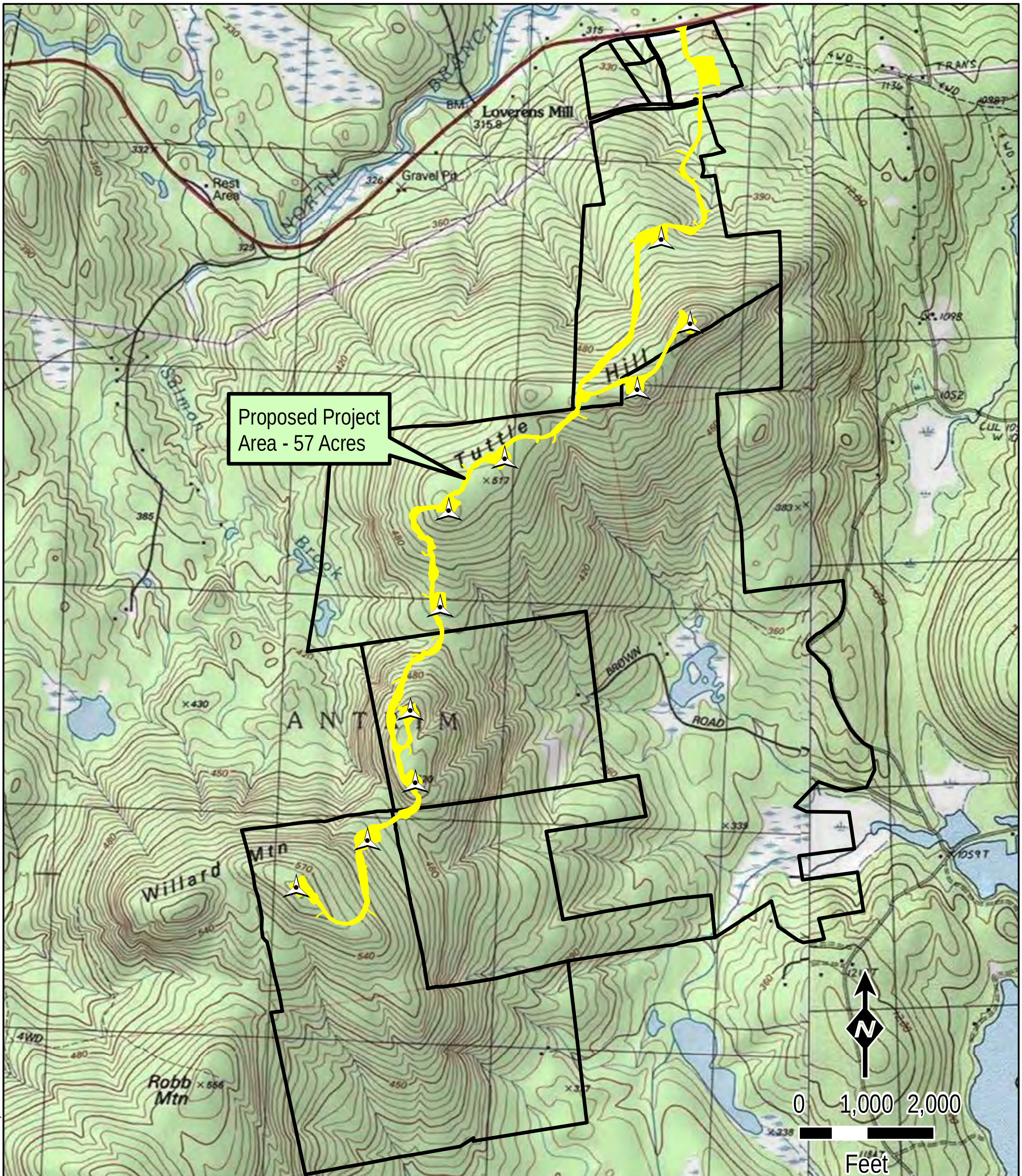
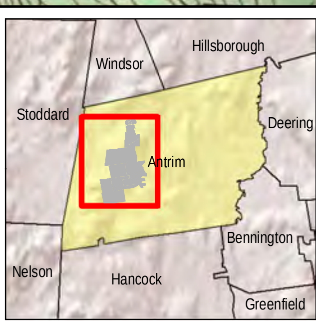
Attachment A

Site Map





Legend

- Proposed WTG
- Proposed Project Area - 57 Acres
- Project Parcels

EOLIAN
RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

354 KEENE ROAD, ANTRIM, NH

Project Location Map

Produced by: TRC | 1/23/2012

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