Daytime Raptor Migration Survey Report for the Antrim Wind Energy Project

Spring and Fall 2011

Prepared for:

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January 2012
Revised July 2015

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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 is proposed to include 9 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.

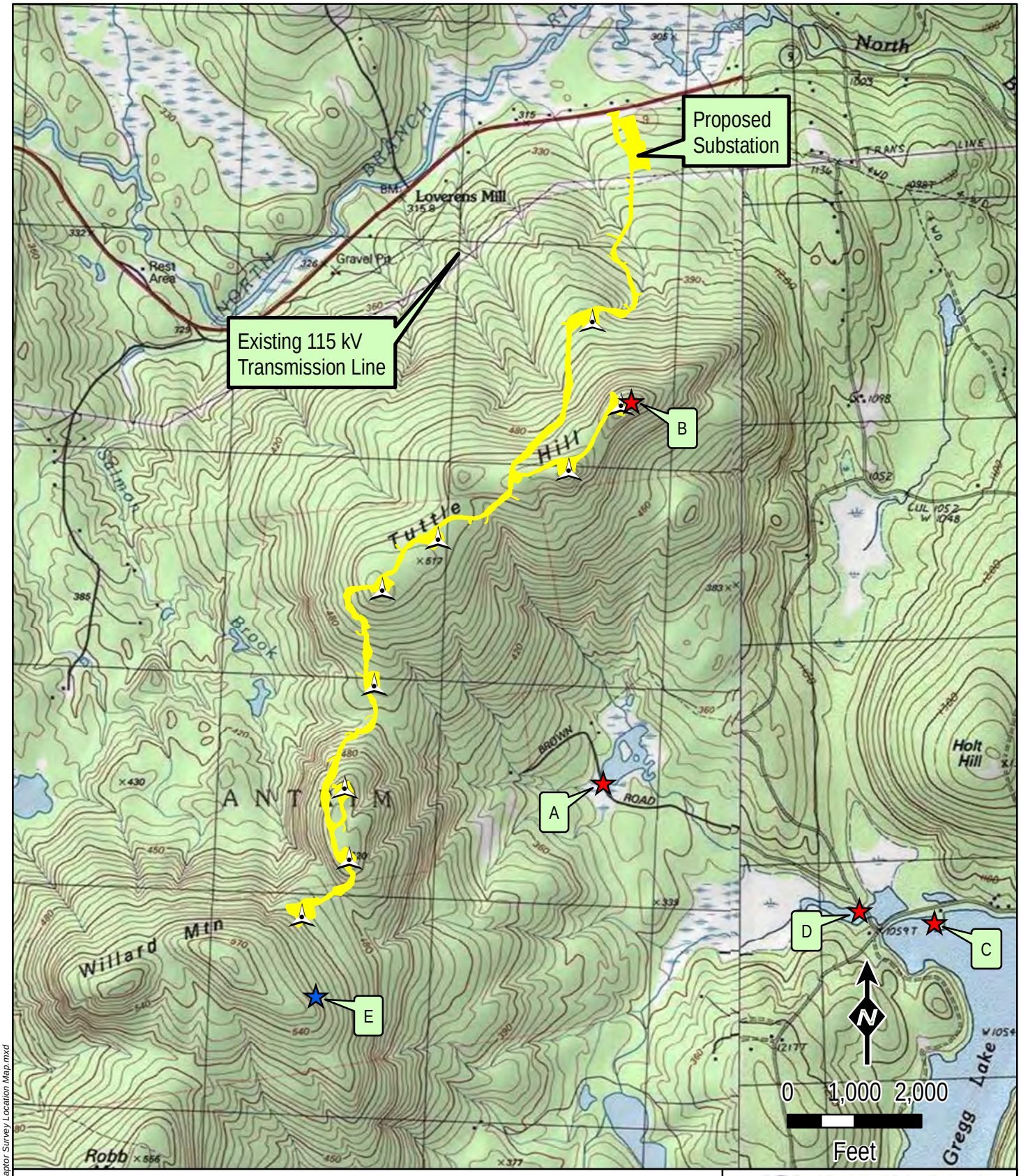
AWE has contracted TRC Companies (TRC) to conduct a diurnal raptor migration survey for the Project to determine what effects, if any, the proposed Project may have on raptor species migrating in the Project vicinity.

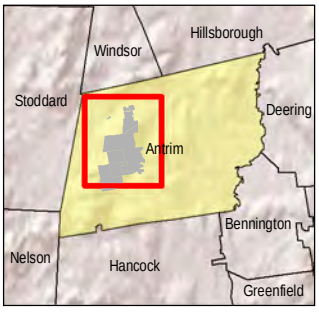
1.2 Goals and Objectives

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

EOLIAN
RENEWABLE ENERGY

ANTRIM WIND ENERGY PROJECT

354 KEENE ROAD, ANTRIM, NH

Figure 1

Raptor Survey Location Map

Produced by: TRC | 7/7/2015

V:\PROJECTS\AUGUSTA\Eolian\ANTRIM\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)

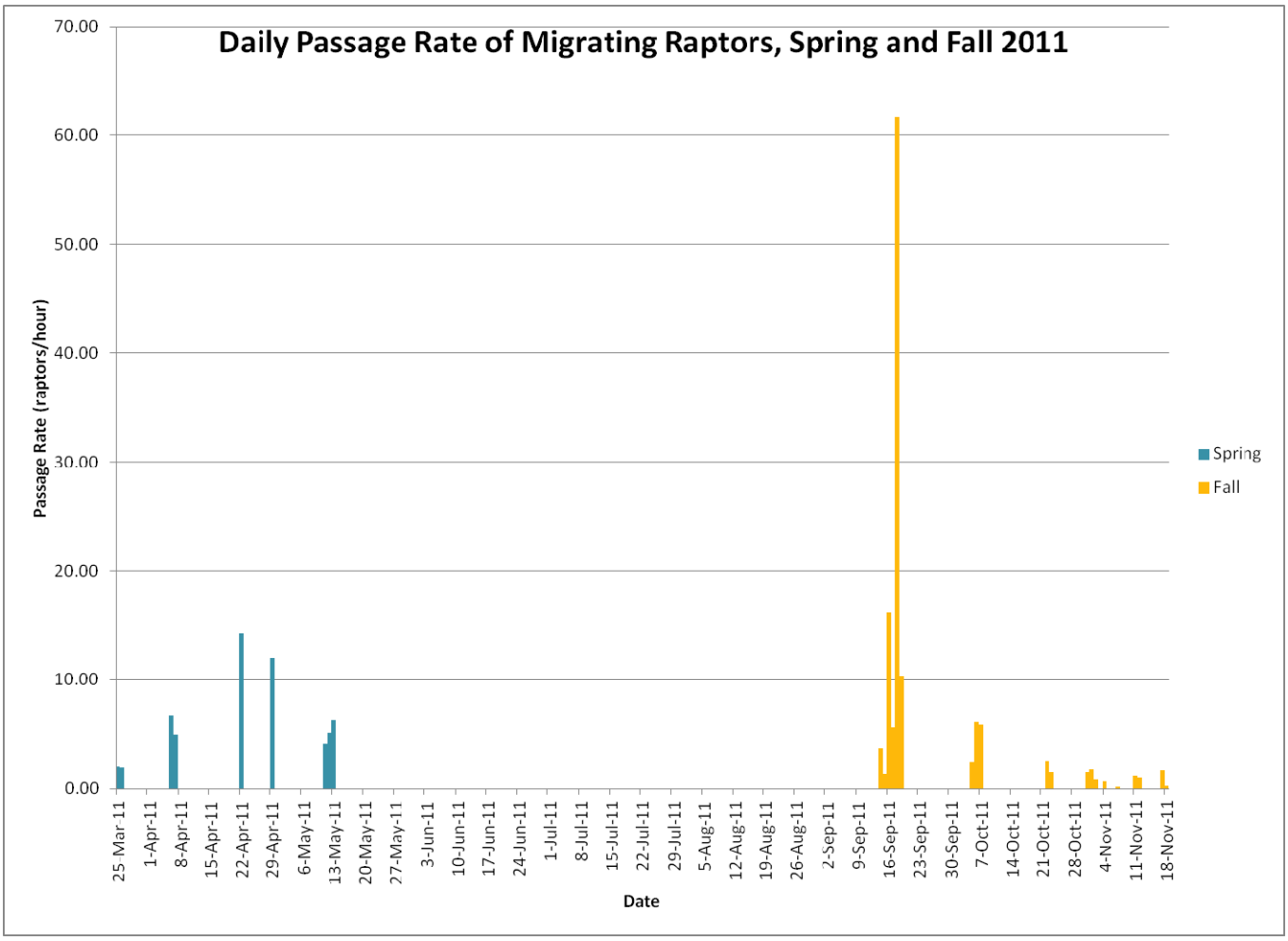
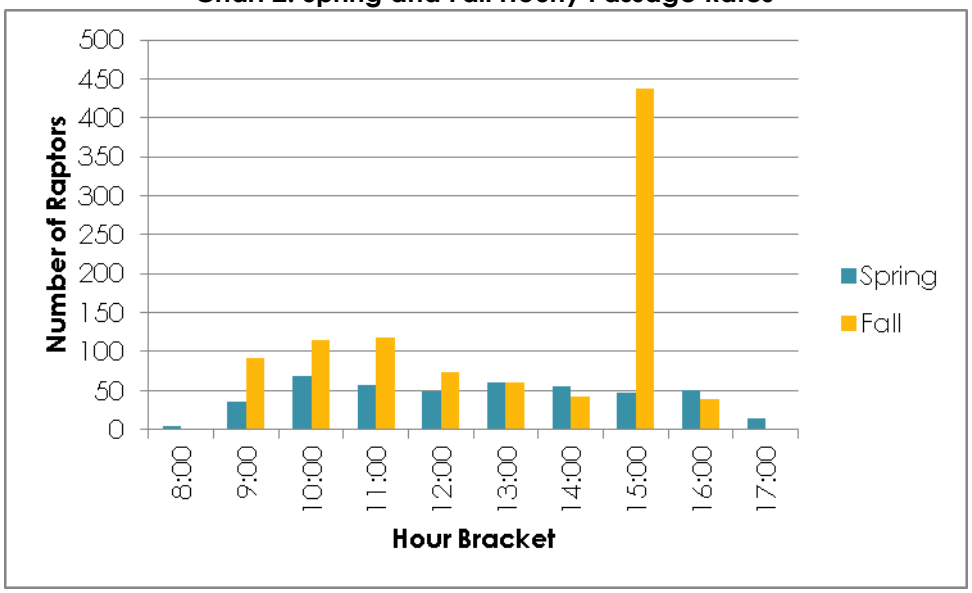


Chart 2: Spring and Fall Hourly Passage Rates



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

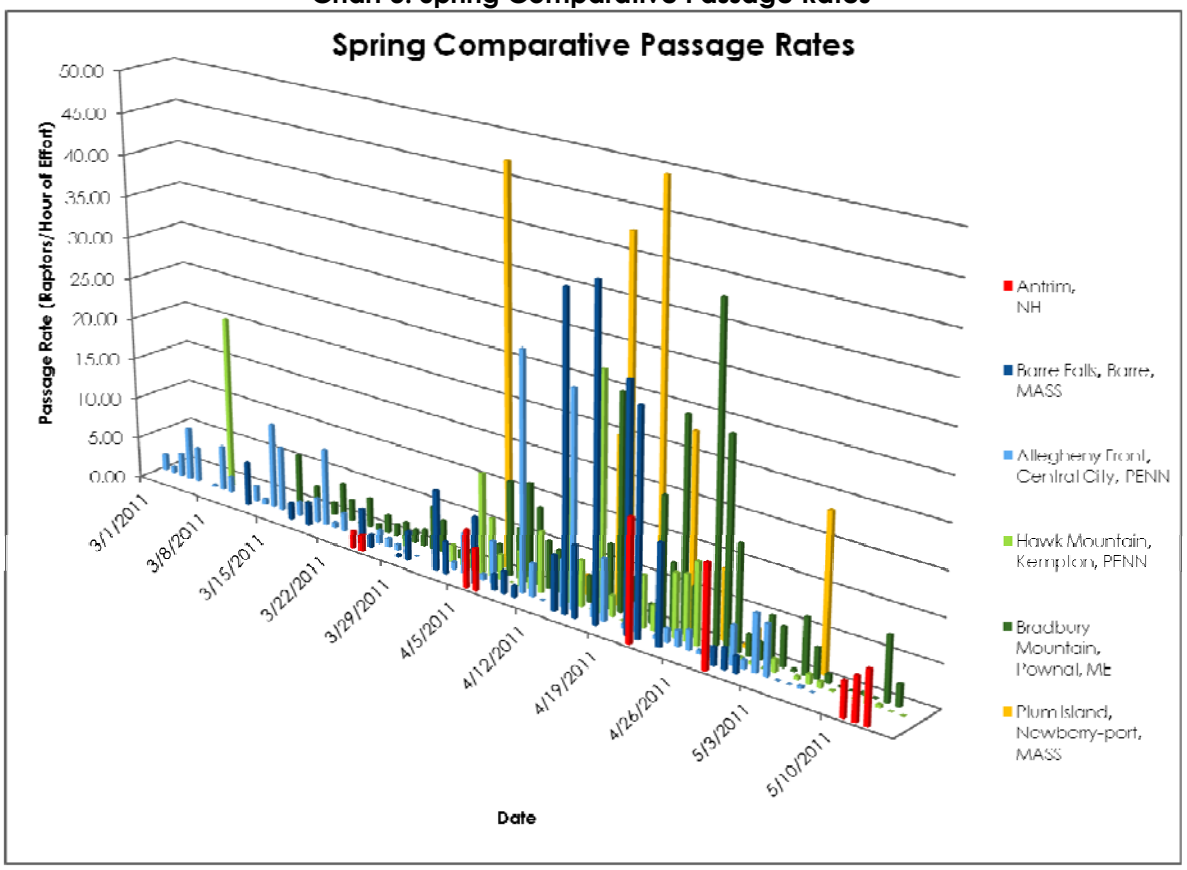
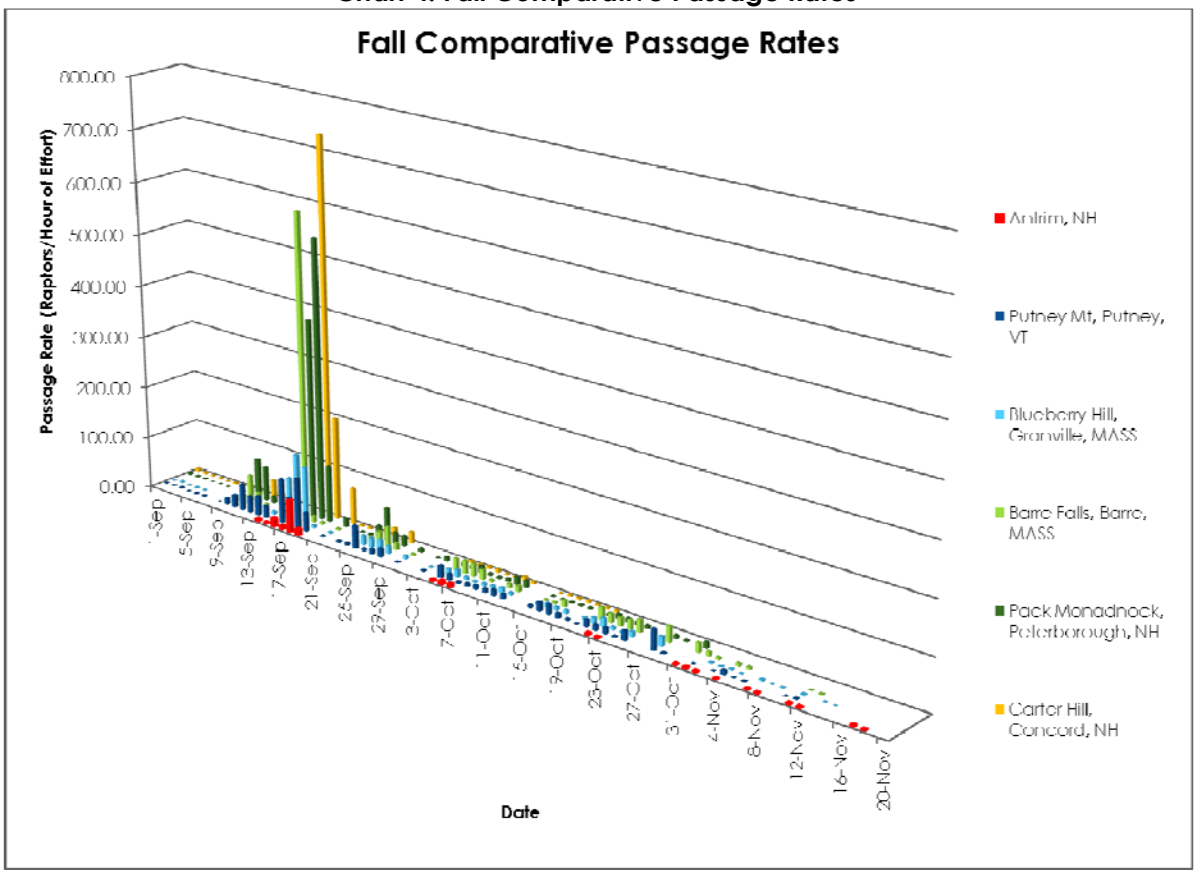


Chart 4: Fall Comparative Passage Rates



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

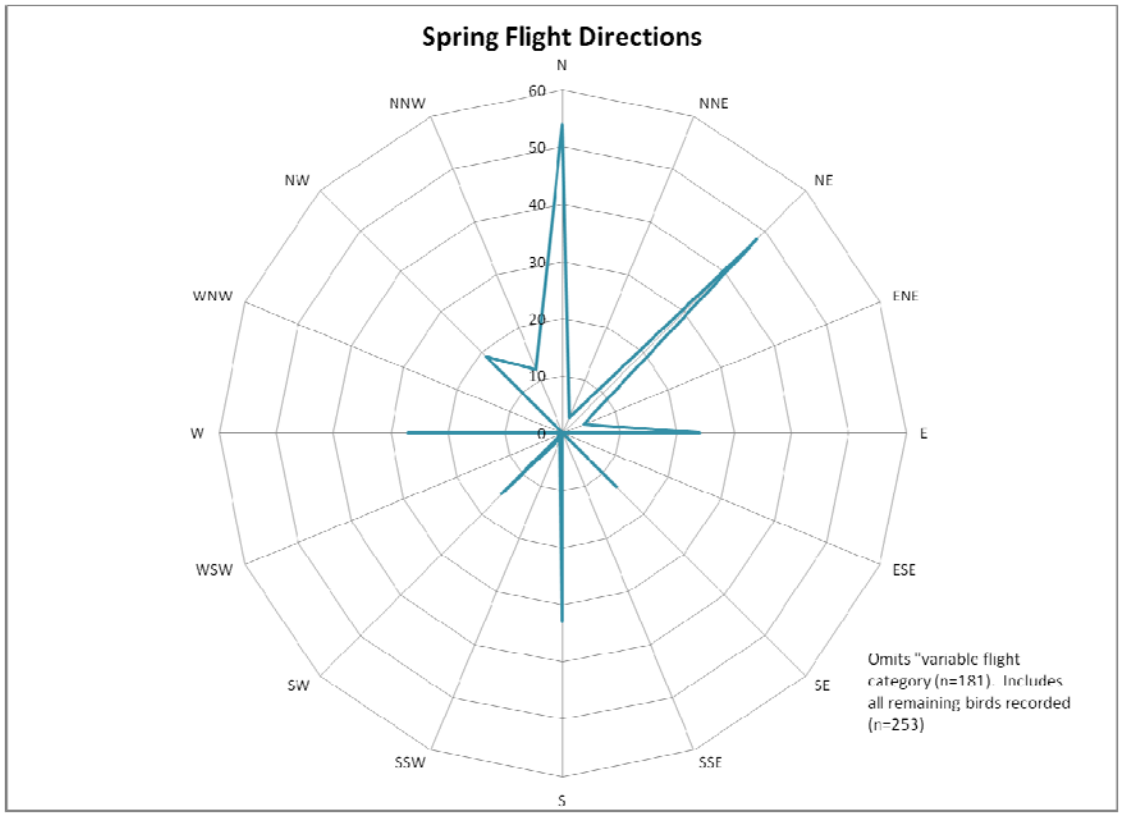
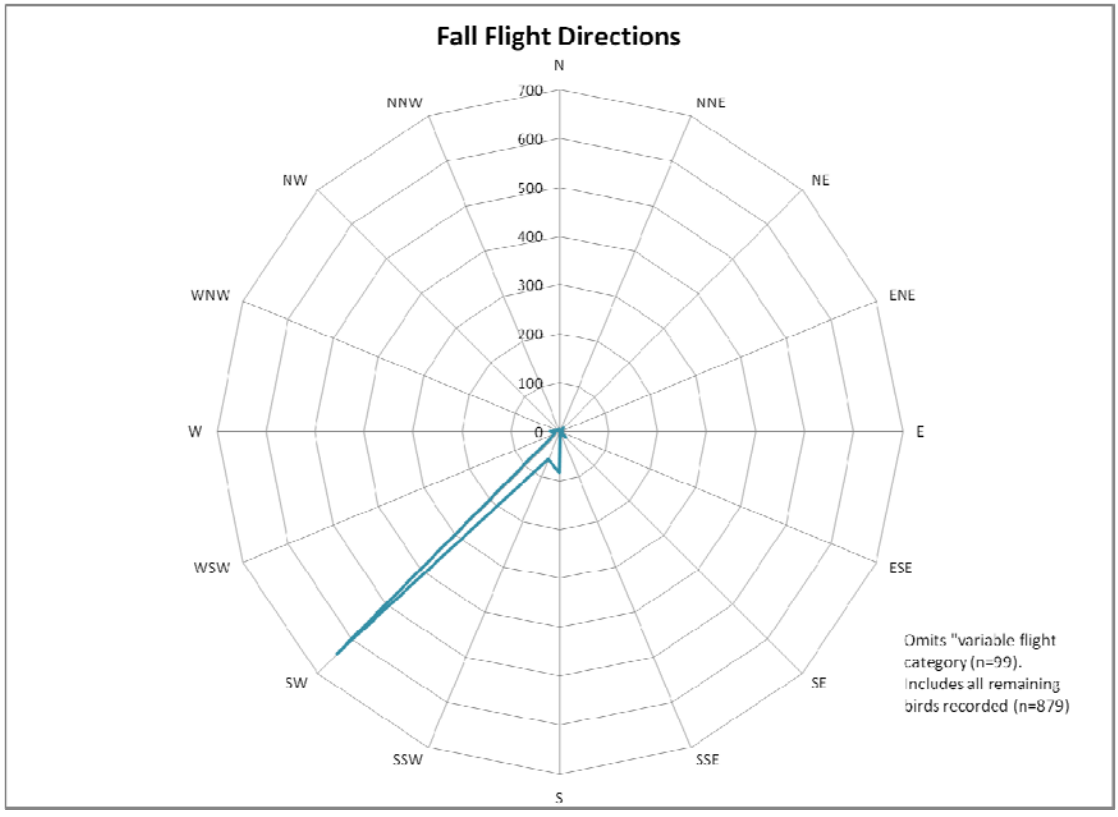


Chart 6: Fall Flight Directions



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 (J,A,U)	Gender (M,F,U)	Time of Observation		Flight Direction	Flight Height Code	Behavior Code	Horizontal Position Code	Notes
					Start	End					
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
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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