A Spring 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Deerfield Wind Project in Searsburg and Readsboro, Vermont

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Executive Summary

Woodlot Alternatives, Inc. (Woodlot) conducted spring 2005 field surveys of bird and bat migration activity at the proposed Deerfield Wind project in Searsburg and Readsboro, Vermont. The surveys are part of the planning process by Deerfield Wind, LLC and the US Forest Service for the project, which will include the erection of 20 to 30 wind turbines on mountaintops and ridgelines within the Green Mountain National Forest. The project includes an expansion of the windpower facilities currently operating in Searsburg.

Surveys included daytime surveys of migrating raptors and nighttime surveys of birds and bats using radar and bat echolocation detectors. The results of the field surveys provide useful information about site-specific migration activity and patterns in the vicinity of project. This survey data supplements surveys conducted during the fall of 2004. This analysis is a valuable tool for the assessment of risk to birds and bats during migration through the area.

Spring raptor migration surveys included 14 field-days (7 days at each of 2 survey sites) of visual observation between April 9 and April 29, 2005. A total of 82 raptors, representing 11 species, were observed during the surveys. Raptor observation rates were approximately one raptor per observation hour, which is lower than other hawk count available from the region. Approximately 21% of the raptors observed were flying less than 100 m (328') above the ground, the maximum height of the proposed wind turbines. One federally listed Threatened species (bald eagle) and one state-listed Endangered species (peregrine falcon) were observed. Overall, passage rates are relatively low compared to other sites in the region.

Twenty nights of radar surveys were conducted. Nightly passage rates varied from 74 ± 14 t/km/hr to 973 ± 164 t/km/hr, and the overall passage rate for the entire survey period was 404 ± 82 t/km/hr. This is considerably higher than passage rates documented during the fall 2004 surveys. Mean flight direction over the project area was 69° ± 47°.

The mean flight height of all targets was 523 m ± 59 m (1,716' ± 194') above the radar site. The average nightly flight height ranged from 307 m ± 30 m (1,007' ± 98') to 823 m ± 99 m (2,700' ± 322'). The percent of targets observed flying below 100 m (328') also varied by night, from 0% to 12%. The seasonal average percentage of targets flying below 100 m was 4%. Flight heights were very similar to those documented during the fall 2004 surveys, which included a mean flight height of 566 m ± 23 m and 3% of targets below 100 m.

No significant barriers to nocturnal bird movement are suspected to occur in the area. The mean flight direction, qualitative analysis of the surrounding landscape, and mean flight altitude of targets passing over the project area indicates that bird migration in this area is broad front. Additionally, the flight height of targets indicates that the vast majority of bird migration in the area occurs well above the height of the proposed wind turbines.

Spring field surveys also included the deployment of two Anabat II (Titley Electronics Pty Ltd) bat detectors between April 19 and June 15, 2005 (55 nights). A total of only four bat call sequences were recorded during the spring survey period. The overall detection rate of bat calls

was 0.07 calls/night. All four calls were identified to the genus *Myotis*, based on comparison to libraries of known reference calls created using the same equipment. The low numbers of bats detected during spring 2005 is likely related to harsh climatic conditions at the site during the early spring.

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1.0 Introduction

1.1 Project Context

Deerfield Wind, LLC has proposed to develop the Deerfield Wind/Searsburg Expansion Project, a wind power facility located on Federal land in the Towns of Searsburg and Readsboro, Vermont, (Figure 1-1) now known as the Deerfield Wind Project. The project would be constructed on approximately 80 acres of land in the Manchester District of the Green Mountain National Forest, adjacent to Green Mountain Power Corporation's (GMP) existing Searsburg Wind Facility, constructed in the mid 1990s. The expansion project will occur in two areas. The Eastern Expansion Area is located east of State Route 8, immediately south of the existing 11-turbine, 6 megawatt (MW) facility, and the Western Expansion Area is located on the west side of Route 8. The proposed expansion project consists of adding 20 to 30 wind turbines, capable of producing approximately 30 to 40 MW. A unique feature of this proposal is that it will rely, in part, on the existing Searsburg facilities and infrastructure, including the substation and access road.

1.2 Project Area Description

The project area is located in Searsburg and Readsboro, Vermont, approximately 15 miles north of the Massachusetts border. It is in the Southern Green Mountains Biophysical Region of Vermont. This region is an area of varied topography, with high peaks, plateaus, steep sided valleys, and foothills. Mountaintops in this region are somewhat randomly located, in sharp contrast to the long, linear arrangements of the highlands of northern Vermont. The mountaintops are characterized by thin soils and abundant, exposed, acidic bedrock but the lower slopes and valleys in this region contain deep glacial till soils.

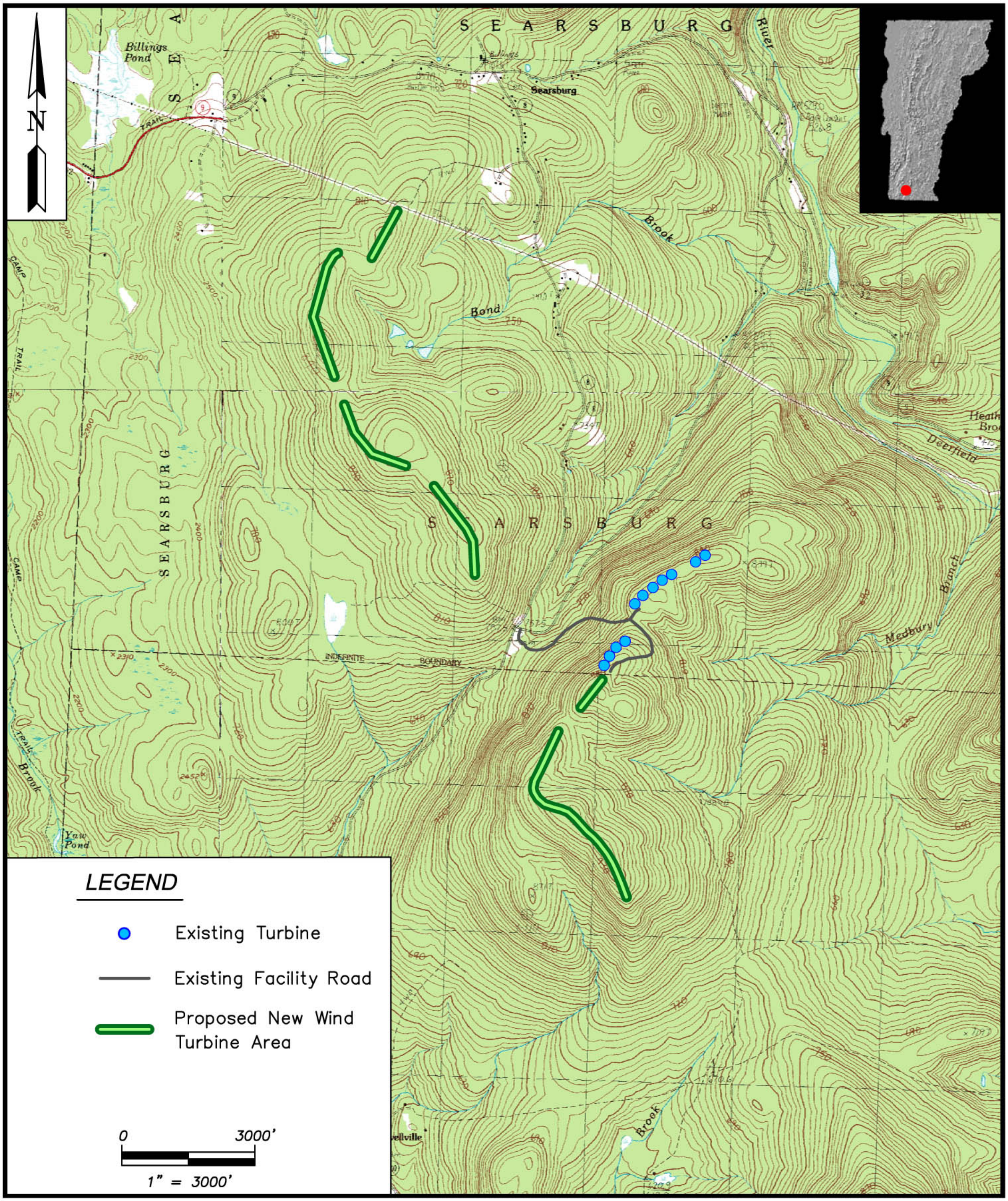
The climate of the region is generally cool. Higher elevations are typically colder than low valleys, with average July temperatures in the mid 60ºFs. The growing season is short, approximately 90 days, and the average winter temperature is around 17ºF. Clouds and fog are common and the area receives a relatively large amount of precipitation. Combined, between 127 cm to 178 cm (50" to 70") of rain and snow fall in the region annually (Thompson and Sorenson 2000).

Northern hardwoods and boreal woodland species dominate the forests of the region. The higher elevations exhibit typical mountain forest zonation, with northern hardwood forests ascending into yellow birch and red spruce forests, which then grade into higher elevation forests dominated by spruce and fir. Valleys are predominantly forested with northern hardwoods and various amounts of white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). Low, south-facing slopes typically contain red oak (*Quercus rubra*).

The Deerfield Wind Project area is located on two mountaintops, with elevations ranging from 850 m (2,790') to 950 m (3,120'). The Eastern Expansion Area is on a higher ridgeline that is more steeply sided than the Western Expansion Area. Northern hardwood forests are dominant on the lower slopes of both mountains and along much of the ridgeline at the Western Expansion

Area. Montane yellow birch – red spruce forest and red spruce – northern hardwood forests are more common at higher elevations.

Small areas of montane spruce – fir forest also occur, primarily near the highest elevations of the Eastern Expansion Area.



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DATE:	August 2005
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Figure 1-1
Study Area Location Map
Deerfield Wind Project
Searsburg, Vermont

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1.3 Survey Overview

Woodlot Alternatives, Inc. (Woodlot) conducted field investigations for bird and bat migration at the Deerfield Wind Project area during the spring of 2005. The overall goals of the investigations were to:

- document the occurrence and flight patterns of diurnally-migrating raptors (hawks, falcons, harriers, eagles, and vultures) in the project area, including number and species, general flight direction, and approximate flight height;
- document the overall passage rates of nocturnally migrating birds in the vicinity of the project area, including the number of migrants, their flight direction, and their flight altitude; and to
- document the presence of bats in the area, including the rate of occurrence and, when possible, species presence.

The field surveys included day-time raptor migration surveys, a radar study of bird and bat migration activity, and recordings of bat echolocation calls. Surveys were conducted from April 9 to June 15, 2005, although effort for the different aspects of the work varied within this time period. A total of 14 days of raptor survey-days, 20 nights of radar surveys, and 55 nights of bat detector recordings were completed.

Raptor surveys were conducted from the same two locations surveyed in the fall of 2004, which included a location in a met tower opening at the Western Expansion Area and a location at the existing wind turbine facility. Methods employed were the same as those used by the Hawk Migration Association of North America (HMANA).

Radar surveys were conducted at the southern end of the existing wind turbine facility, which is the same location as one of the three sites sampled during fall 2004 surveys. Radar data provide insight on the flight patterns of birds (and bats) migrating over the project area, including abundance, flight direction, and flight altitude.

Bat surveys included the use of two Anabat II (Titley Electronics Pty Ltd) bat detectors to record the location and timing of bat activity. Detectors were deployed for 55 nights from April 19 to June 15, 2005. The detectors were deployed within the guy wire system of the met tower at heights of 7 m and 15 m (22’ and 50’) above the ground. Deployment in this fashion provided information on the bat community in the project area and, to some extent, their flight characteristics.

2.0 Diurnal Raptor Surveys

2.1 Introduction

The project area is located in the central portion of the Eastern Continental Hawk Flyway. Geography and topography are major factors in shaping migration dynamics in this flyway. The northeast to southwest orientation of the northern North American coast and the inland mountain ranges influences hawks migrating in eastern Canada and New England to fly southwestward to their wintering grounds in the fall and northeastward in the spring (Kerlinger 1989, Kellogg 2004).

Daytime raptor migration surveys have been conducted in the project area during several years. Surveys were first conducted in 1993 and 1994 as part of studies for the existing wind facility in Searsburg (Martin 1993, 1994). Additional surveys were conducted in 2004 for the Deerfield Wind Project. Surveys conducted in spring 2004 (Roy and Pelletier 2005) supplement these previous surveys and represent the first spring survey of raptor migration in the area.

2.2 Methods

Field Surveys

Raptor surveys were conducted at two locations in the project area: one at the existing facility and one at the meteorological measurement tower (met tower) in the Western Expansion Area (Figure 2-1). Surveys at the existing facility were conducted at turbine number 8, near the southern end of the facility. On a clear day, the site provided a view of the ridges and valleys to the north, a view west over the Western Expansion Area, and a view east of the seven northern turbines and across to Mount Snow and Haystack Mountain. Southern views were limited by the topography and forested environment surrounding the observation point. At the Western Expansion Area, surveys were conducted from the ground in a small clearing. Forested harvesting in the area had resulted in a young stand of trees surrounding the survey site. Hence, views were limited in all directions. Broken views over treetops were available to the south and east.

Raptor surveys occurred on 7 days from April 9 to April 29, 2005, for a total of 84 hours of observation (42 hours at both the existing facility and western expansion site). Simultaneous surveys were conducted at both sites during six of the seven survey dates at the sites. Surveys were generally conducted from 9 am to 3 pm in order to include the time of day when the strongest thermal lift is produced and the majority of raptor migration activity typically occurs. Surveys were targeted for days with favorable flight conditions produced by low-pressure systems bringing southerly winds, and days following the passage of a weather front were targeted as survey days.

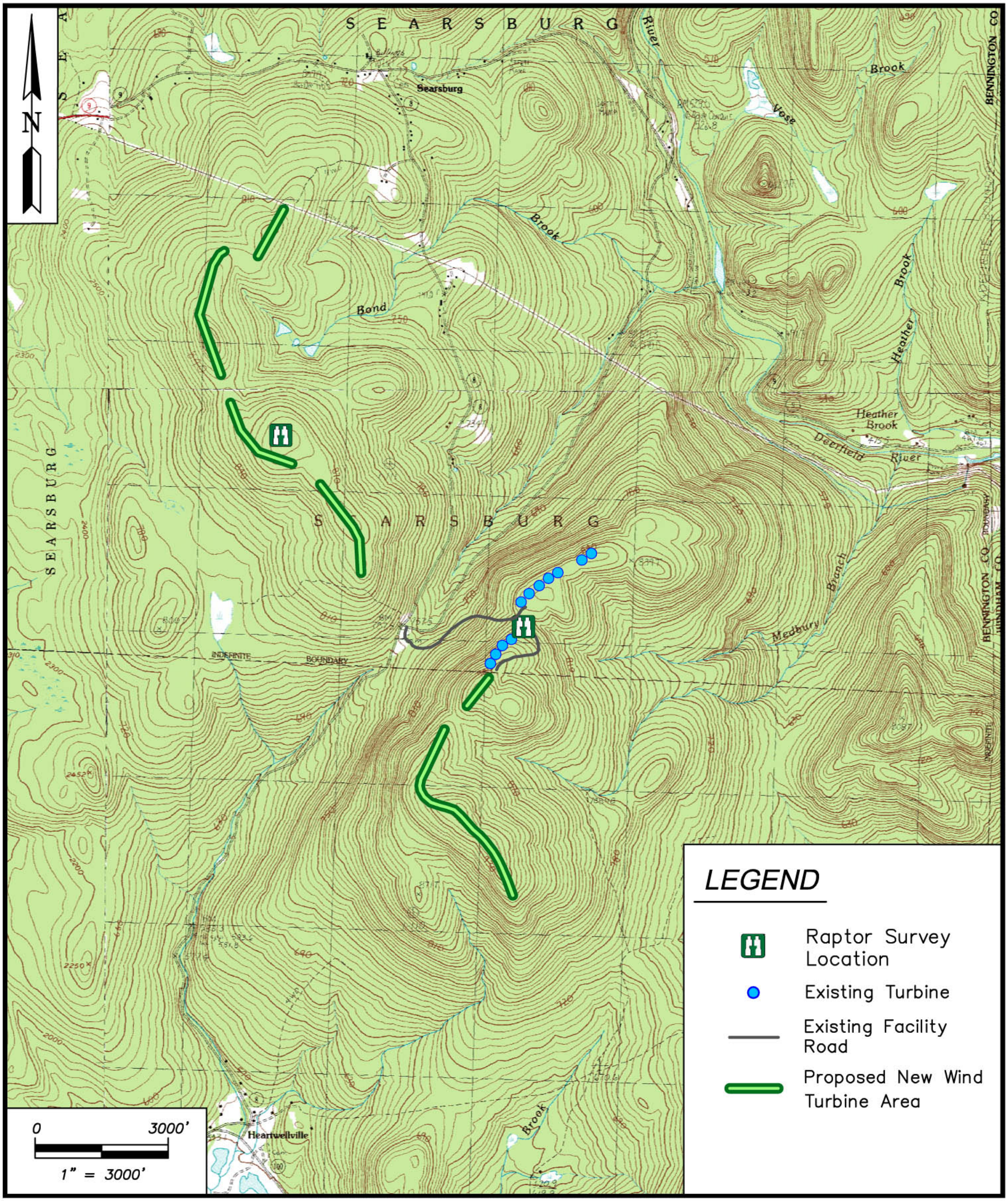

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Figure 2-1
Raptor Survey Location Map
Deerfield Wind Project
Searsburg, Vermont

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Surveys were based on methods used by HMANA. Observers scanned the sky and surrounding landscape for raptors flying into the survey areas. Raptor observations were recorded onto HMANA data sheets, which summarize the data for each species by hour. Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, as an unidentified raptor.

More detailed notes on each observation, including location and flight path, flight height, and activity of the animal, were also recorded. Height of flight was categorized as less than or greater than 100 m (328') above ground, which is the approximate height of the proposed wind turbines. Nearby objects with known heights, such as meteorological towers (met towers), wind turbines, and surrounding trees, were used to gauge flight height. Information regarding the raptors' behavior and whether a raptor was observed in the same locations throughout the study period was noted to differentiate between migrant and resident birds. When possible, general flight paths of individuals observed were plotted on topographic maps of the project area. Hourly weather observations, including wind speed, direction from which the wind was coming, temperature, percent cloud cover, and precipitation, were recorded on HMANA data sheets.

Data Analysis

Field observations were summarized by species for each survey day and for the whole survey period. This included a tally of the total number of individuals observed for each species, the observation rate (birds per hour), and an estimate of how many of those observations were suspected to be resident birds. The total number of birds, by species, was also calculated as was the species composition of birds observed flying below and above 100 m (328'). Finally, the mapped flight locations of individuals were reviewed to identify any overall patterns for migrating raptors.

Observations from the project area were compared to data from local or regional HMANA hawk watch sites available on the HMANA web site or from HMANA yearly reports. Those HMANA watch sites included Derby Hill in Mexico, NY; Braddock Bay in Hilton, NY; Hamburg, NY; Barre Falls, MA; Blueberry Hill, MA; and Bradbury Mountain, ME.

2.3 Results

Raptor surveys occurred during 14 observation-days from April 9 to April 29, 2005, for a total of 84 hours of observation (42 hours at each location). A total of 82 raptors, representing 11[1] species, were observed during that time, yielding an overall observation rate of 0.98 birds/hour (Appendix A Table 1; Figure 2-2).

Slightly more raptors were observed at the Western Expansion Area (44) than at the existing facility (38) and the passage rates observed were 1.05 and 0.90 birds/hour at each site,

[1] Additional individuals that were not definitively identified were observed during the survey. While these were likely of the same species positively documented during the surveys, they have not been used in the calculation of the total number of species observed.

respectively. Turkey vultures (*Cathartes aura*)[2] were the most commonly observed species. Broad-winged hawks (*Buteo platypterus*) were the next most abundant species, followed by sharp-shinned hawks (*Accipiter striatus*), and then red-tailed hawks (*Buteo jamaicensis*). Thirteen individuals were not identifiable due either to distance from the observation site or very brief occurrences within surveyors' view. One federally listed Threatened species, the bald eagle (*Haliaeetus leucocephalus*), was observed. One state-listed Endangered species, peregrine falcon (*Falco peregrinus*), was also observed. Two additional species of conservation concern in Vermont, Cooper's hawks (*Accipiter cooperii*) and osprey (*Pandion haliaetus*), were observed. Both species are listed by the State as Special Concern. No big migration pushes or large kettles of hawks, which are typically observed during fall hawk migration, were recorded.

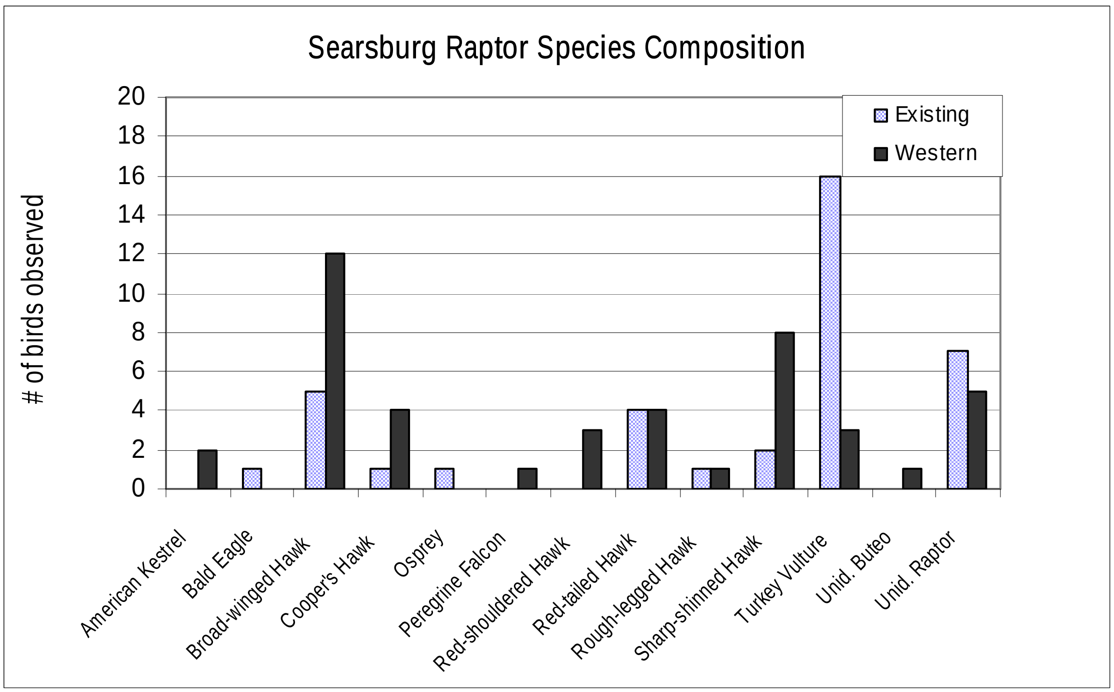


Figure 2-2. Species composition of raptors observed during raptor surveys.

The timing of raptor observations varied during each day. Typically, observations began slowly, with very few observations occurring during the first 2 hours of the survey period, increased rapidly during the third and fourth hours of observation, and decreased again after 1:00 pm (Figure 2-3). This pattern was consistent for most of the species observed in the project area although on some days a later peak during the last 1 to 2 hours of the day was observed (Appendix A Table 2).

[2] While turkey vultures are not true raptors they are diurnal migrants that exhibit flight characteristics similar to hawks and other raptors and are typically included during hawk watch surveys.

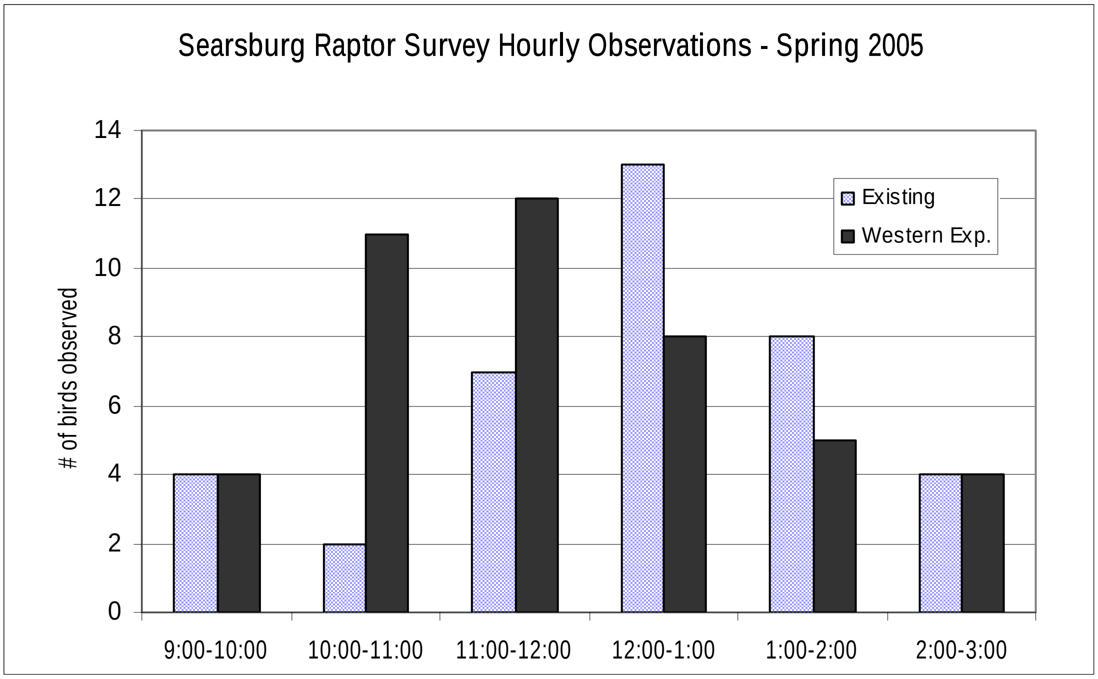


Figure 2-3. Hourly observation rates

Flight heights were categorized as below or above 100 m (328'), the approximate height of the turbines. Overall, approximately 22% of the raptors observed were flying less than 100 m above the ground. Differences in flight altitudes between species were observed (Figure 2-4; Appendix A Table 3).

Most large and small species, such as the accipiters, buteos, and falcons were consistently flying above 100 m (328'). Sharp-shinned hawks were also consistently flying above the blade sweep area. Exceptions to this included turkey vultures and red-tailed hawks, of which 42% and 25%, respectively, were flying less than 100 m above the ground.

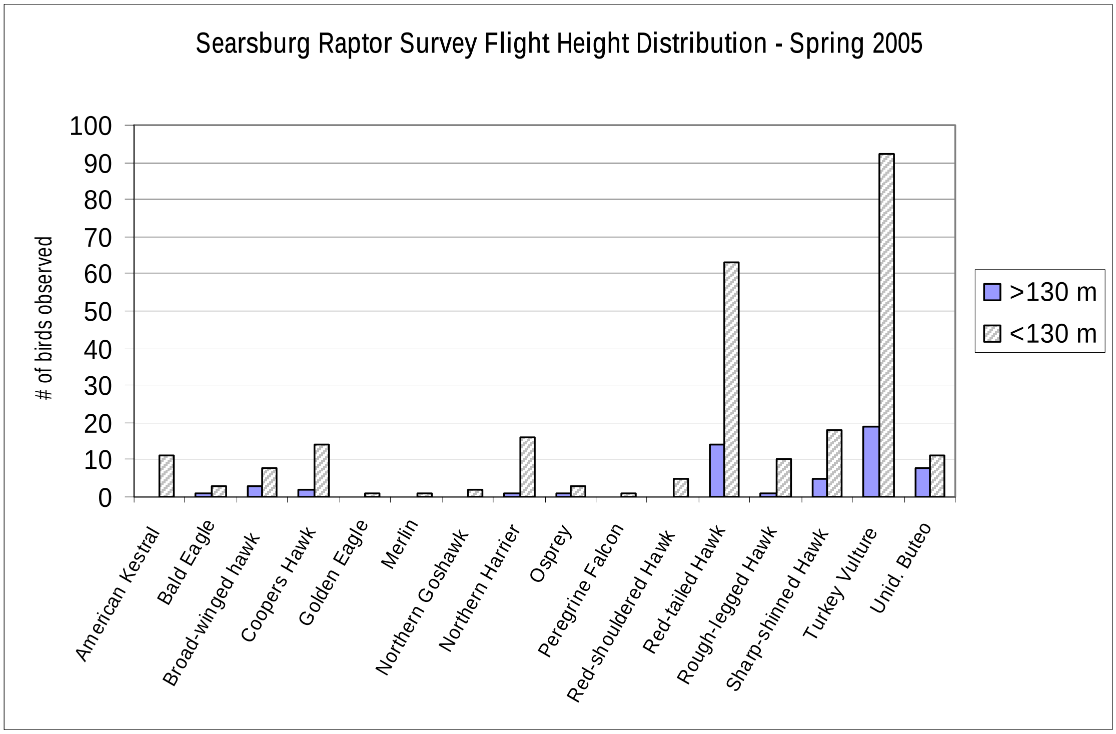
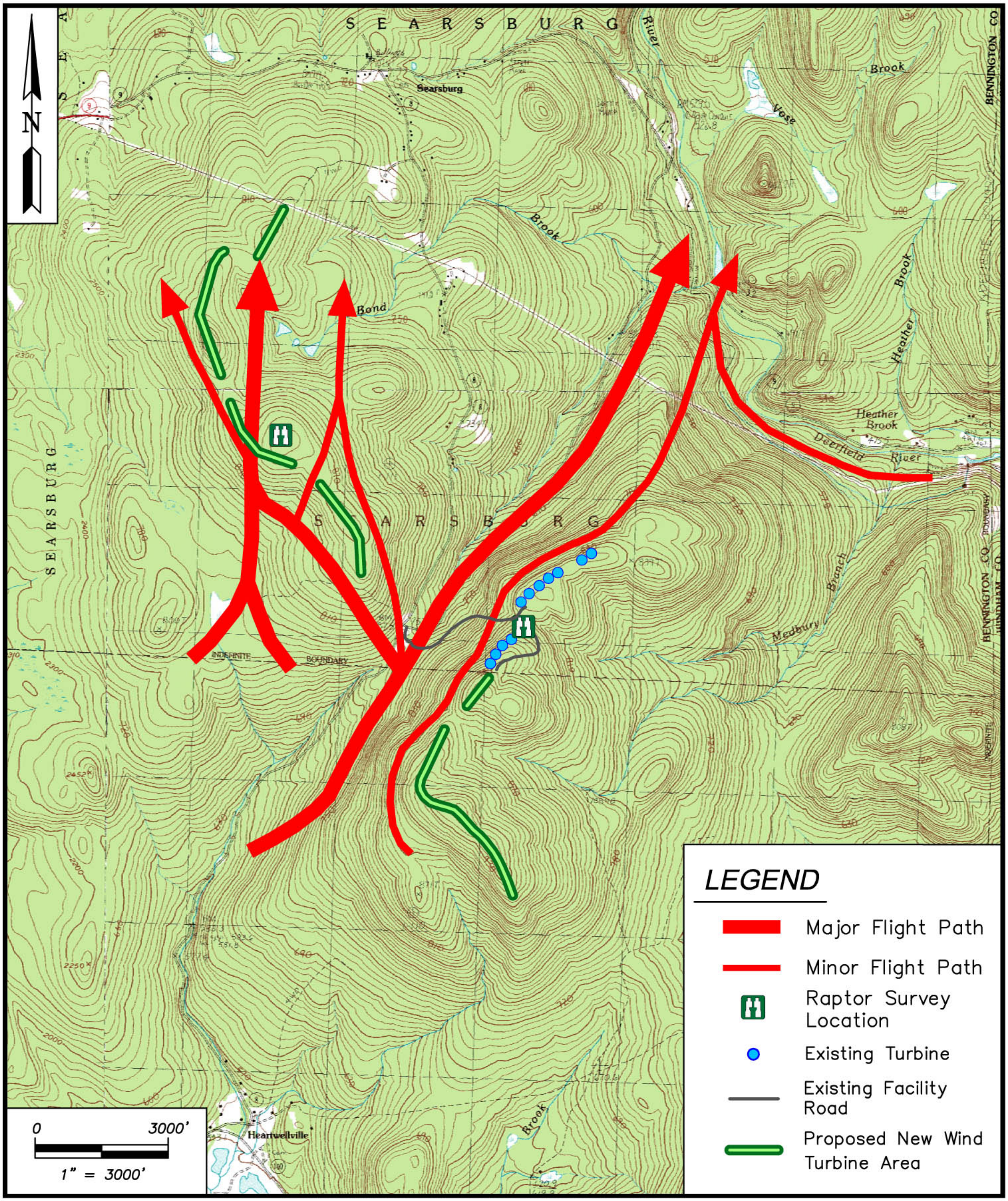


Figure 2-4. Raptor flight height distribution

The flight habits of raptors in the project area were variable, though the locations of those observations often occurred in similar locations. Most migrants passing through the project area were flying on a south to north orientation. Many of the birds, particularly red-tailed hawks, sharp-shinned hawks, and American kestrels, flew in different directions over the observation site and were typically observed kiting (hovering over the ground) and hunting over the project area. Individuals believed to be undertaking long-distance migratory movements (most of the raptors observed) had much more direct flight paths (S to N). Sharp-shinned hawks were occasionally observed along hillsides and in various directions suggesting a resident bird.

Raptors were typically observed flying over valleys and side slopes. There appeared to be two paths, or flyways, of more concentrated hawk flights and several other paths where fewer flights occurred. These paths are typically called flyways. One major flyway was located in the valley between the existing facility and the western expansion site. This ran on a south to north orientation. Birds in this area typically did one of two things: fly north-northeastward to the Deerfield River valley or northwestward along the southern slopes of the Western Expansion Area ridgeline to join the second major flyway. That flyway originated south of the Western Expansion Area. Birds in this area typically crossed the Western Expansion Area ridgeline just west of the peak of that ridge, and then continued northward. A number of other flyways with fewer observations were also observed. The general locations of raptors observed migrating over the project area are depicted in Figure 2.5.



PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS	DATE: August 2005	*Figure 2-5*
	SCALE: 1" = 3000'	*Raptor Flight Paths*
	JOB NO. 105028	*Deerfield Wind Project*
	FILE: 105028-00-Raptor.dwg	*Searsburg, Vermont*

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2.4 Discussion

A total of 82 raptors were observed during 14 days (7 day at each site) of field surveys. Eleven different species were recorded with an observation rate of 0.98 birds/hour. Turkey vultures were the most abundant species observed at the site and compromised 23% of the observations. Broad-winged hawks comprised 21% of observations. Unlike the fall, where large kettles of broad-winged hawks were observed, no large kettles (≥ 5) of broad-winged hawks were observed during spring surveys. One federally Threatened species (bald eagle) and one state-listed Endangered species (peregrine falcon) were observed this spring. Most birds observed were considered migrants, although several birds may have been residential birds based on their activity and behavior.

The passage rates observed at the Deerfield Wind Project area are relatively low compared to other sites in the region, where raptor migration surveys were conducted in the spring of 2004 and 2005. Observation rates at these sites ranged from approximately 9 to 70 birds/hour (Appendix A Table 4). The most active site was Braddock Bay in Hilton, New York, with a total of 30,793 raptors counted (68.8 birds/hour). At Derby Hill in Mexico, NY, 23,623 birds (61.1 birds/hour) were observed. In Hamburg, NY, 13,141 raptors (33.2 birds/hour) were observed. Sites in Massachusetts and Maine had lower observation rates, ranging from 8.5 birds/hour at Barre Falls, MA, to 22.5 birds/hour at Bradbury Mountain, ME. These areas may have very different landscape features (proximity to large bodies of water) than the Deerfield Wind Project area but do offer comparative regional information on raptor migration.

There could be several reasons for the greater passage rates at other sites, including survey effort, geographical location, and visibility. Geographical location can affect the magnitude of raptor migration at a particular site. Two well-known examples include Cape May, New Jersey, and Hawk Mountain, Pennsylvania. The location of these sites relative to large, regional landscape features result in large concentrations of migrating raptors. This likely happens at a smaller scale, as large river valleys and dominant ridgelines might result in more suitable migration conditions (i.e., strong thermal development, crosswinds, and updrafts). Organized hawk count locations typically target these areas of known, concentrated raptor migration activity. The nearby sites for which data is available (see figure in Appendix A Table 4) generally fall into this scenario.

Survey effort varies from site to site. Hawkwatch locations are usually surveyed when the weather is optimal for raptor migration and typically during the peak of the migration season. This level of effort increases observation rates because relatively few hours of survey time are being targeted for the time periods when the majority of birds are migrating. However, there are various peak migration periods for different species. Hence, the rationale for sampling across an extended sampling period is to observe each individual species' peak flight (March through May). Alternatively, sampling only during sub-optimal migration weather would decrease observation rates. During the surveys completed at the project site, several days with sub-optimal migration weather (north winds) were sampled and fewer hawks were typically observed on those days.

Visibility at a site can affect results of raptor surveys. The most ideal hawk migration sites often provide wide, open views of not only the surrounding airspace but also the surrounding slopes and ridgelines. These sites include open mountaintops, cleared land on mountain peaks, very steep topography such as the top of a cliff, and sometimes observation towers. These views downward and over the surrounding hillsides are often needed to observe those species that hug hillsides and migrate at lower altitudes such as sharp-shinned hawks, Cooper's hawks, and American kestrels. During migration, raptors hunt along their migration pathway and these hillsides provide both cover and thermal lift.

The flight heights of raptors observed in the project area indicate that birds do occur in the height zone of the blade-swept area of the proposed turbines. Approximately 22% of raptors were observed flying below 100 m (328'). There were differences between species, generally with all accipiters, falcons and most buteos flying at lower altitudes. Typically, smaller species were observed at lower flight altitudes. This was not the case this spring, as broad-winged hawks and sharp-shinned hawks were most frequently observed migrating above the height zone of wind turbines at the site. Most other raptor species recorded were observed above the height zone for majority of their flight paths. Overall, it may be easier to detect large species flying at low and high altitudes, therefore, smaller species may sometimes be underrepresented (Kerlinger 1989). Additionally, the limited views at the survey locations (particularly at the Western Expansion Area) probably restricted the opportunity to observe small species flying low over the surrounding tree canopy.

Migration of raptors is a dynamic process due to various internal and external factors. Flight pathways and their movements along ridges, slide slopes, and across valleys may vary. Raptors may shift and use different ridge lines and cross different valleys from year to year or season to season. Weather and wind are big factors which influence migration pathways. The flight paths of raptors observed in the project area varied between survey dates and were influenced by varying wind direction and weather. Wind strongly affects the propensity to concentrate raptors along linear features (such as rivers and ridges). The precise location of the migrants relative to the linear feature are what helps create concentrations of migrating birds along linear features and can be related to lateral drift caused by crosswinds (Richardson 1998). Raptors used a couple of major flyways that originated out of a large valley to the south. Most raptors were observed catching updrafts out the valley and flying on a south to north orientation. Other minor flyways originated from the river valley and birds flew NW over the Western Expansion Area, catching updrafts along side slopes. There were no detectable differences in flight heights between major and minor flight pathways.

2.5 Conclusions

The results of the field surveys indicate that spring raptor migration in the Deerfield Wind Project area is low relative to other sites in the region. This is likely due to a lack of large landscape features that could concentrate migration activity at the project area. Rather, the surrounding landscape consists of a series of interrupted ridges and individual peaks, with no consistent use pattern by migrating raptors.

Resident birds that remain in the project were observed. Birds suspected to be resident to the project area were often repeatedly observed in a specific area and generally flew at lower heights, as they were typically undertaking small-scale movements while foraging. Additionally, these individuals were occasionally observed actively foraging, which is atypical of birds undertaking long-range movements. Most (78%) migrants were observed flying above the height of the proposed turbines. Differences between species were observed and could be due to typical flight height preferences or on limitations in the distance that different species are visible. Despite this, the lower occurrence of migrants at low flight heights reduces the potential for migrating raptors to come into close contact with the proposed development.

3.0 Nocturnal Radar Survey

3.1 Introduction

The vast majority of North American land birds migrate at night. The strategy to migrate at night may be to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995). Conversely, species using soaring flight, such as raptors, migrate during the day to take advantage of warm rising air in thermals and laminar flow of air over the landscape, which can create updrafts along hillsides and ridgelines. Night migration may also provide a more efficient medium to regulate body temperature during active, flapping flight and could reduce the potential for predation while in flight (Alerstam 1990; Kerlinger 1995).

Collision with unseen obstacles is a potential hazard to night-migrating birds. Additionally, some lighted structures may actually attract birds to them under certain weather conditions, which can be associated with collision or exhaustion of birds, both of which often result in mortality (Ogden 1996). For example, birds have been documented colliding with tall structures, such as buildings and communication towers, particularly when weather conditions are foggy (Crawford 1981; Avery *et al.* 1976, 1977). Wind turbines can also pose a potential threat to migrating birds as they are relatively tall structures, have moving parts, and may be lit, depending on their height and location (Erickson *et al.* 2000).

Factors that could affect potential collision risk of nocturnally-migrating birds by wind turbines can include weather, magnitude of migration, height of flight, and movement patterns in the vicinity of a wind project, along with the height of turbines and other site-specific characteristics of a wind project. Radar surveys were conducted at the proposed Deerfield Wind Project area to characterize nocturnal spring migration patterns in the area. The goal of the surveys was to document the overall passage rate in the vicinity of the project area, including the number of migrants, their flight direction, and their flight altitude. This information will be used to help evaluate the potential effect of the proposed wind energy facilities on local and migrating avian populations.

3.2 Methods

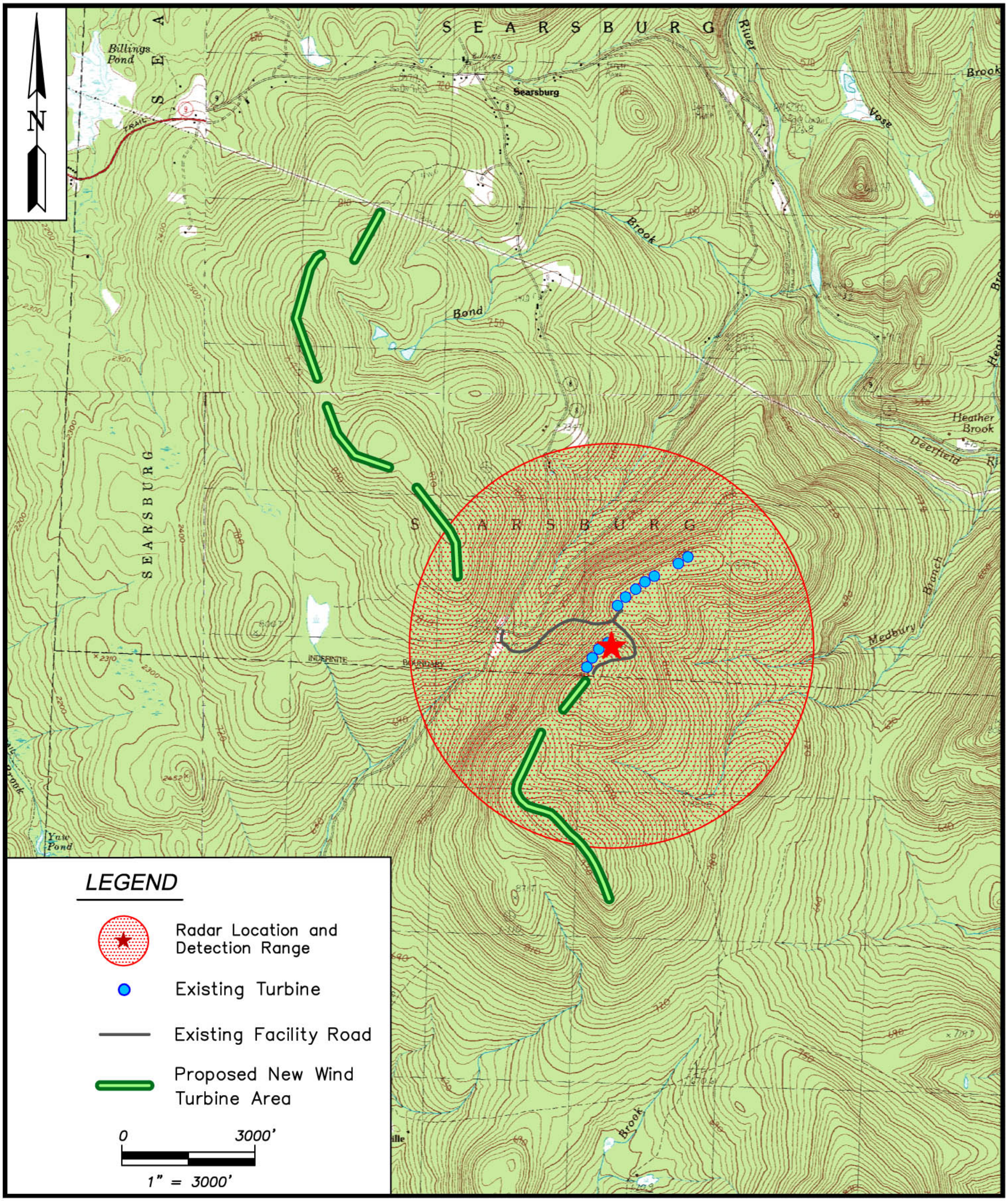
Field Methods

A single marine surveillance radar similar to that described by Cooper *et al.* (1991) was used during field data collection. A mobile radar lab with a Furuno FR1510-MKIII® radar was deployed to the site. The radar has a peak power output of 12 kilowatts and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen are called targets. To detect small targets such as birds and bats, the radar's anti-rain and anti-sea settings were turned down and the gain was turned up. The radar was operated at its shortest pulse length to increase the detection of small targets. The radar has an echo trail function that maintains past echoes of trails. This function has several time periods that can be used, after which echoes are successively erased from the radar screen. 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 20º (10º above and below horizontal), and the front end was inclined approximately 5º to increase the proportion of the beam directed into the sky. The antenna was mounted onto the bucket of a boom van. The van's boom could extend to approximately 8 m (26') above the ground and was used to lift the radar antenna during horizontal sampling. The vehicle was positioned daily in the same location and direction at the existing facility (Figure 3-1) to yield a consistent data set with respect to true north.

The radar was operated in two modes for each survey hour. In the first (surveillance) mode, the antenna spins horizontally to survey the airspace around the radar and detects targets moving through the area. By analyzing the echo trail, the number, flight direction, and speed of targets can be determined. In the second (vertical) mode of operation, the antenna is rotated 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data but do provide information on the number and altitude of targets passing through the vertical, 20º radar beam.

The radar was operated at a range of 1.4 km (0.75 nautical miles). At this range, the echoes of small birds can be easily detected, observed, and tracked. At greater ranges, larger birds can be detected, but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, reducing the ability to observe the movement pattern of individual targets. The geographical limits of the range setting used are depicted in Figure 3-1.



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DATE: August 2005	
SCALE: 1" = 3000'	
JOB NO. 105028	
FILE: 105028-00-Location.dwg	

Figure 3-1
Radar Location Map
Deerfield Wind Project
Searsburg, Vermont

REV.

Radar surveys were conducted from sunset to sunrise. Twenty nights of surveys were conducted between April 26 and May 29, 2005. Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during periods of inclement weather. Therefore, surveys were targeted largely for nights without rain. However, to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts that included occasional showers were sampled.

Data Collection

The radar display was connected to computer video recording software. During surveillance mode, 15 one-minute samples of the radar display were recorded for each survey hour. During vertical mode, a single 10-minute video sample was recorded for each survey hour. The video samples were recorded on the following schedule for each 1-hour period after sunset:

- Seven 1-minute horizontal samples during the first 15 minutes after sunset;
- One 10-minute vertical sample during the next 30 minutes; and
- Eight 1-minute horizontal samples during the last 15 minutes of the hour.

During the 30-minute period when vertical data were recorded, additional information was also recorded, including weather observations and ceilometer observations. Recorded weather data included wind speed and direction, cloud cover, temperature, and precipitation. Ceilometer observations involved directing a one million candlepower spotlight vertically into the sky in a manner similar to that described by Gauthreaux (1969). The ceilometer beam was observed by eye for 5 minutes to document and characterize low-flying (below 30 m) targets. The ceilometer was held in-hand so that any birds, bats, or insects passing through it could be tracked for several seconds, if needed. On nights with a full moon and clear skies, the ceilometer beam was too diffused to readily detect birds and bats. On those nights, moonwatching (Lowery 1951) was used, which involved watching the face of the moon with binoculars for 5 minutes and recording any observations of birds or bats flying in front of the moon. Observations from each ceilometer or moonwatching period were recorded by hand, including the number of birds and bats observed and the general level of insect activity. This information was used during data analysis to help distinguish insects from bird and bat targets.

Data Analysis

The video samples were analyzed using a digital video analysis software tool developed by Woodlot. For horizontal samples, targets were identified as birds and bats rather than insects based on their speed. The speed of targets was compared with wind speed and direction; targets traveling faster than approximately 7 m per second were identified as a bird or bat target. The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat. The results for each sample were output to a spreadsheet. For vertical samples, the software tools recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location. The results for each sample were output to a spreadsheet. These datasets were then used to calculate passage rate, flight direction, and flight altitude of targets.

Hourly passage rates (in 1-hour increments post sunset) were calculated by tallying the total number of targets in the 1-minute samples for each hour and correcting for the number of samples collected in that hour. That estimate was then corrected for the radar range setting that was used in the field and was expressed as targets/km/hour (t/km/hr) ± 1 SE. The hourly rates were used to calculate passage rates for each night and the entire season.

Mean target flight directions (± 1 circular SD) were summarized in a similar manner by hour, night, and for the entire season. Flight direction analysis and statistical analyses were conducted using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this are based on Batschelet (1965), which takes into account the circular nature of the data. Nightly wind direction was also calculated using similar methods and data collected from the central met tower near the radar site. Mean wind speed was calculated using linear statistics (Zar 1999).

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 SE) were calculated by hour, night, and overall season. The percent of targets flying below 100 m (328’) (the approximate maximum height of proposed wind turbines) was also calculated hourly, for each night, and for the entire survey period.

3.3 Results

Radar surveys were conducted during 183 hours on 20 nights between April 26 and May 29, 2005 (Table 3-1). The radar site generally provided good visibility of the surrounding airspace and targets were observed in most areas of the radar display unit. Trees in the vicinity of the radar site appeared as ground clutter in small areas to the north, east, and southeast. In data analysis, these spots appeared to have little effect on overall target visibility due to the radar location at a high elevation peak in the existing facility.

Table 3-1. Survey dates, level of effort, and weather - Searsburg

Night of	Sunset	Sunrise	Hours of Survey	Weather	Winds
Apr 26	7:47 PM	5:52 AM	5	partly clear to cloudy, gusty	S
Apr 28	7:49 PM	5:50 AM	10	mostly clear to cloudy, foggy and some light rain, gusty	variable
Apr 29	7:50 PM	5:48 AM	11	cloudy and calm	W to NW
May 1	7:52 PM	5:46 AM	10	clear, cold, moderate wind	NW
May 2	7:53 PM	5:44 AM	10	party cloudy and foggy, cold, moderate wind	NW
May 3	7:55 PM	5:43 AM	10	party cloudy, moderate wind	NW
May 4	7:56 PM	5:42 AM	10	cloudy to clear, mostly calm	NW to W
May 6	7:58 PM	5:39 AM	10	cloudy, moderate wind	SE to E
May 14	8:06 PM	5:30 AM	9	partly to mostly cloudy, light wind, light rain	S to SW
May 15	8:07 PM	5:29 AM	10	cloudy, very foggy, light wind	SE
May 16	8:08 PM	5:28 AM	10	partly cloudy then clear, strong gusts	NW
May 17	8:09 PM	5:27 AM	10	mostly cloudy, light wind	NW
May 18	8:10 PM	5:26 AM	8	cloudy then clear, light wind with strong gusts late, some rain	N
May 19	8:11 PM	5:25 AM	10	cloudy, calm	-
May 20	8:12 PM	5:25 AM	10	partly cloudy then clear	NE to E
May 22	8:14 PM	5:23 AM	7		
May 26	8:18 PM	5:20 AM	8	cloudy, strong gusts, heavy drizzle	N
May 27	8:19 PM	5:19 AM	9	mostly cloudy, strong wind, warm, some rain	NW to N
May 28	8:20 PM	5:19 AM	7	cloudy, cold, strong winds	
May 29	8:20 PM	5:18 AM	9	partly clear to cloudy, gusty	NW

Note: Additional nights of survey were attempted but foul weather prevented the initiation of surveys.

Passage Rates

A total of 2,406 one-minute radar video samples were analyzed during the passage rate and flight direction analysis and included a total of 48,257 targets. Nightly passage rates varied from 74 ± 14 t/km/hr on May 22 to 973 ± 164 t/km/hr on May 19, and the overall passage rate for the entire survey period was 404 ± 82 t/km/hr (Figure 3-2; Appendix B Table 1). For the entire season, passage rates were highest during the third hour after sunset, followed by a relatively steady decline for the remainder of the night (Figure 3-3). On individual nights, however, this trend in peak passage rate varied.

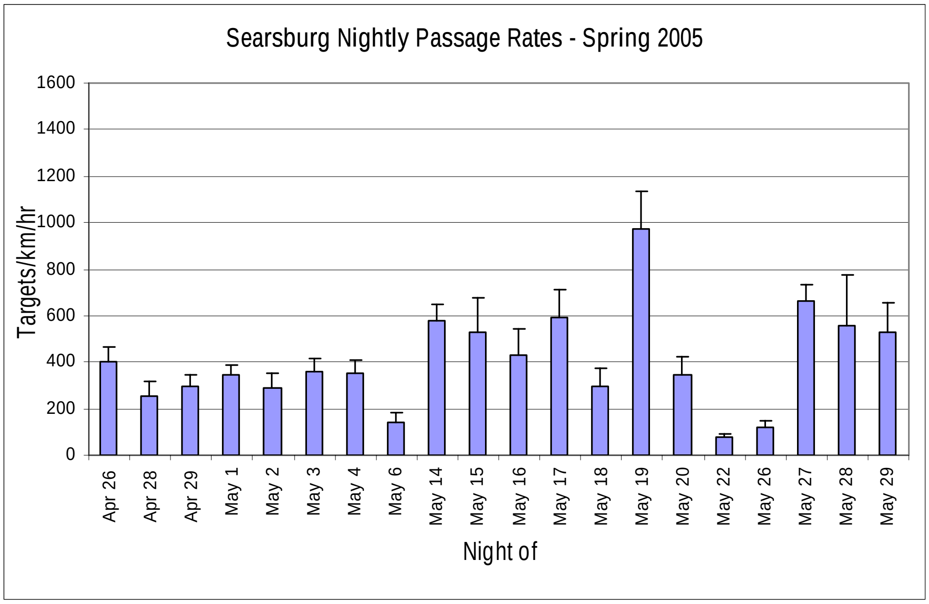


Figure 3-2. Nightly passage rates (error bars = 1 SE) observed

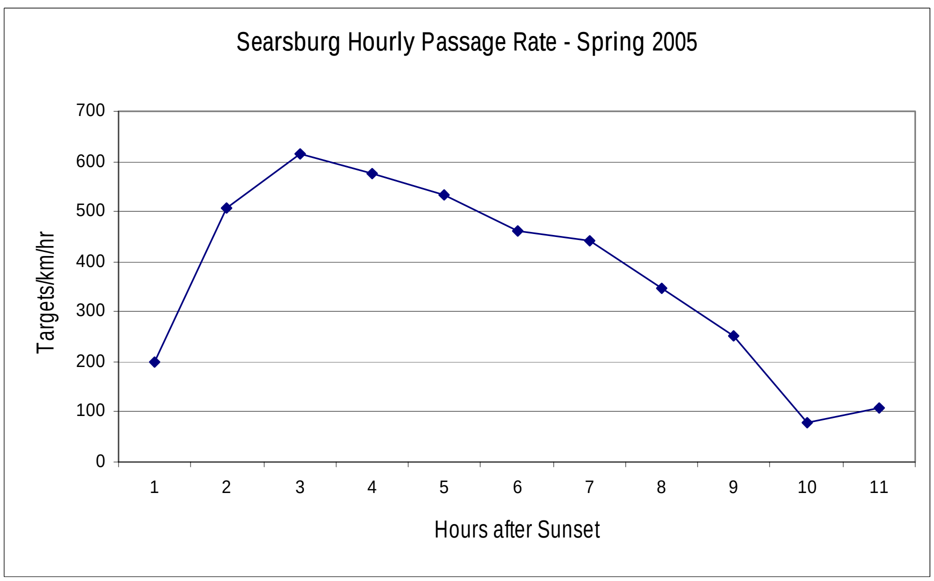
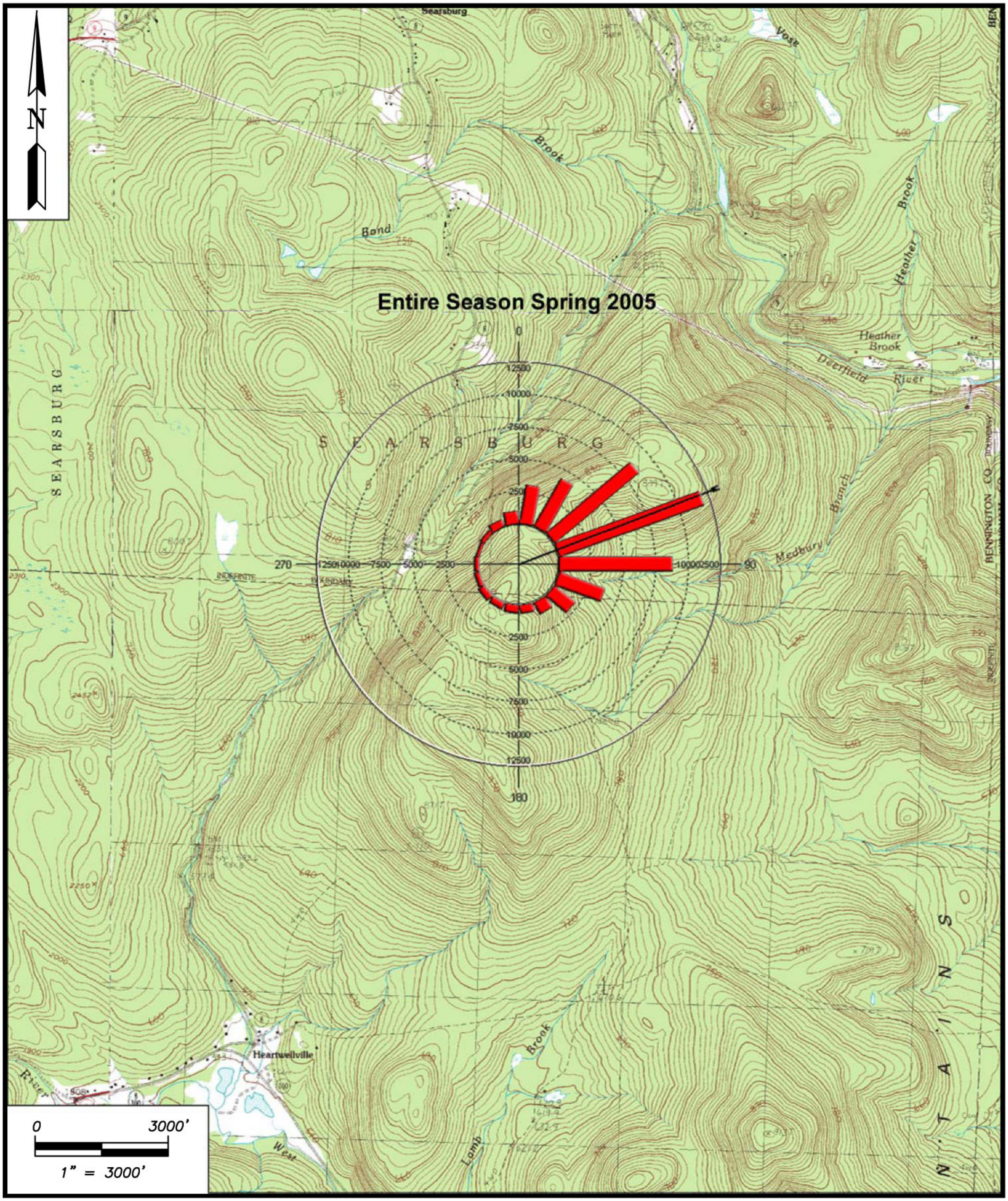


Figure 3-3. Hourly passage rates for entire season

Flight Direction

Mean flight direction through the project area was northeast, at 69º ± 47º (Figure 3-4; Appendix B Table 2). There was considerable nightly variation in mean direction, although within each night there was less variation (Figure 3-5).



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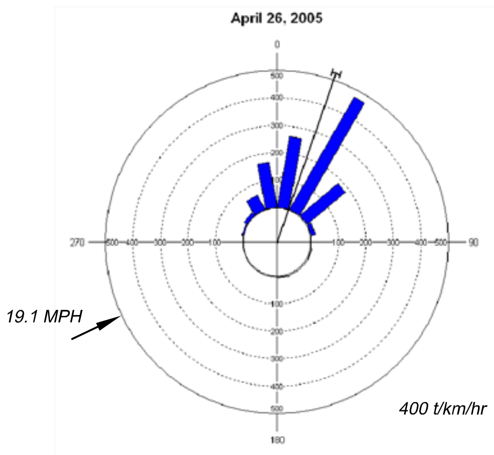
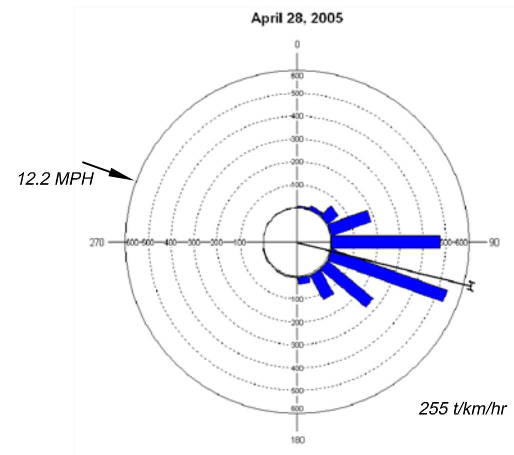
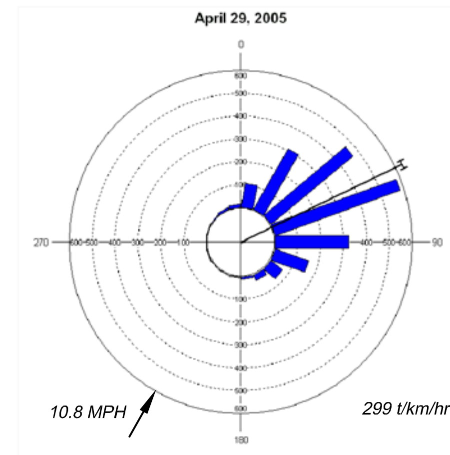
DATE:	August 2005
SCALE:	1" = 3000'
JOB NO. 105028	
FILE: 105028-00-Location.dwg	

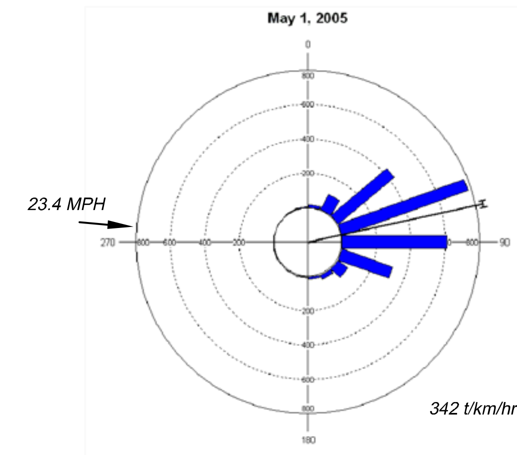
Figure 3-4
Spring 2005 Target Flight Direction
Deerfield Wind Project
Searsburg, Vermont

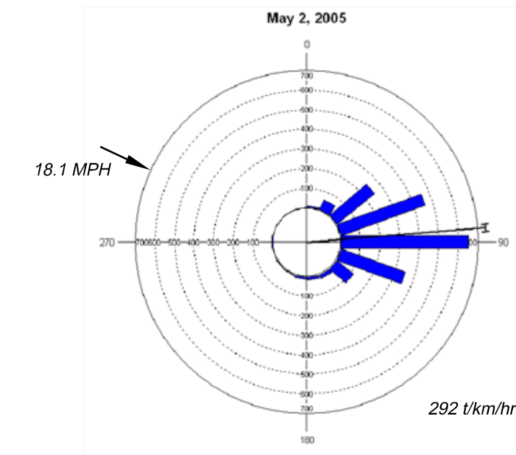
REV.

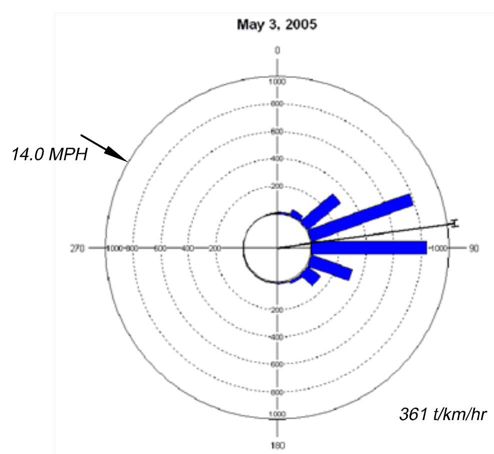


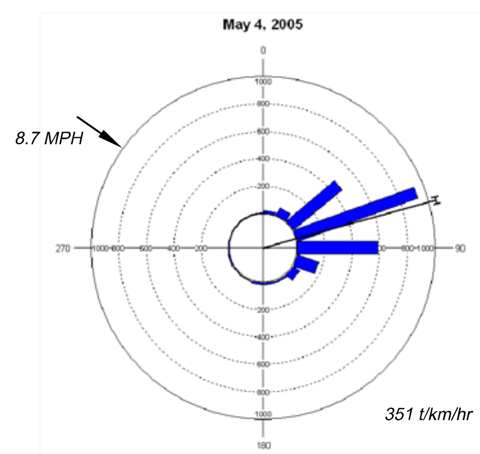


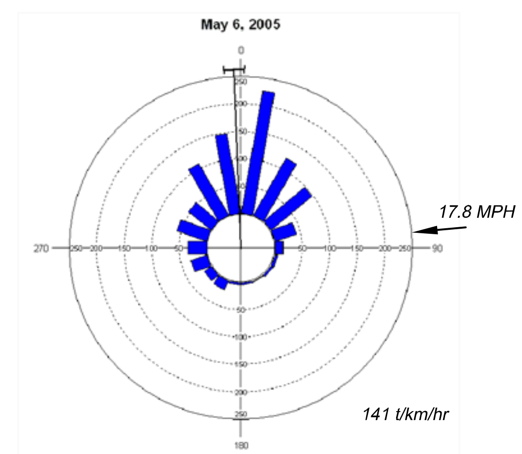


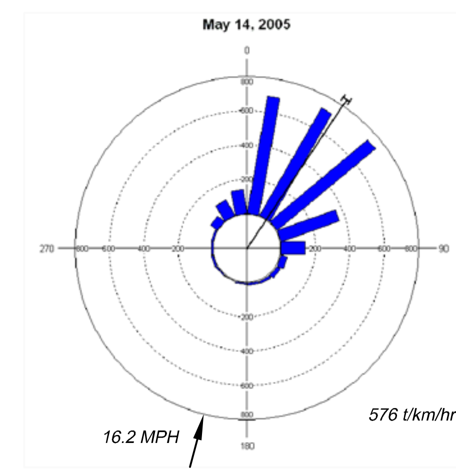


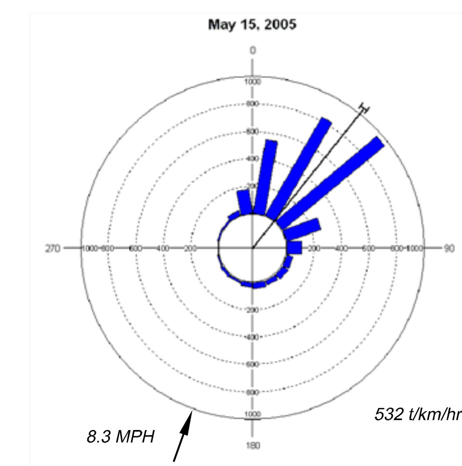


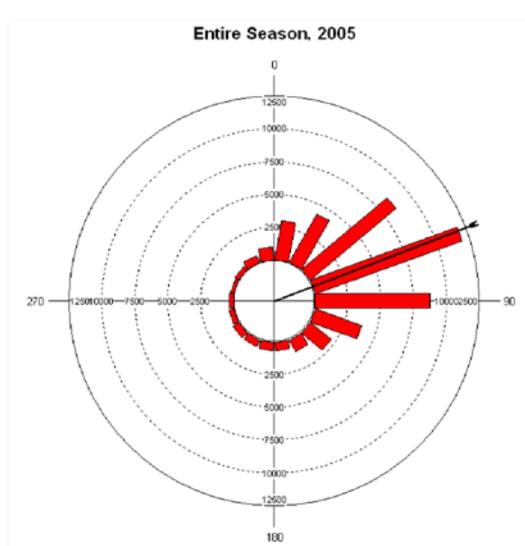












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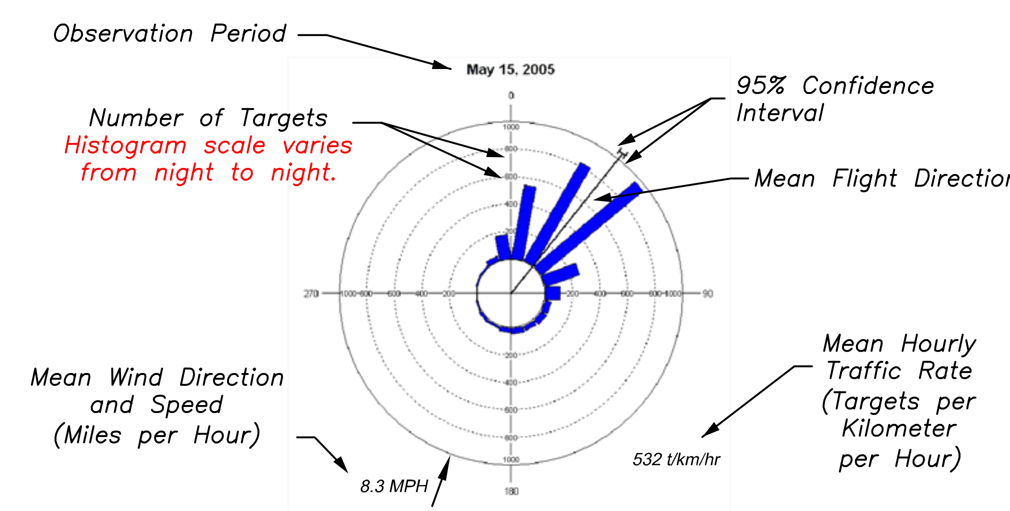


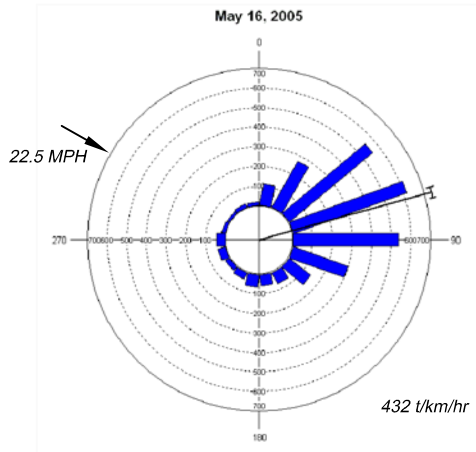
Data rose shows bird targets in directions of 20° increments.

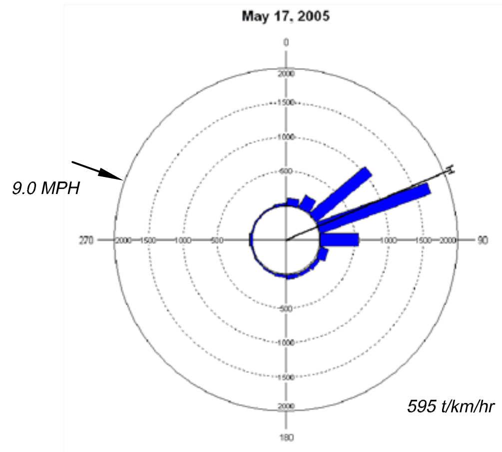
Sheet 1 of 2

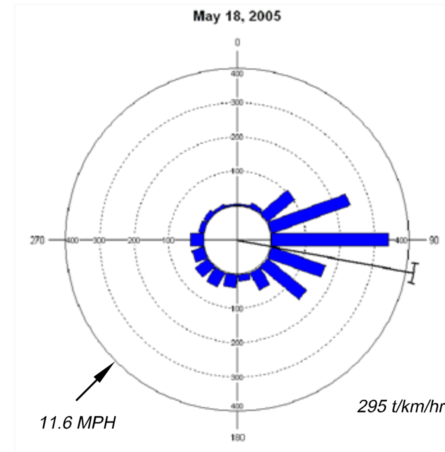
SHEET TITLE:	Nightly Mean Flight Direction
SCALE:	N/A
DATE:	August 2005
PROJECT:	Deerfield Wind Project
ADDRESS:	Searsburg, Vermont
PREPARED BY:	WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS
PROJ. NO.	105028
FIGURE NO.	3-5

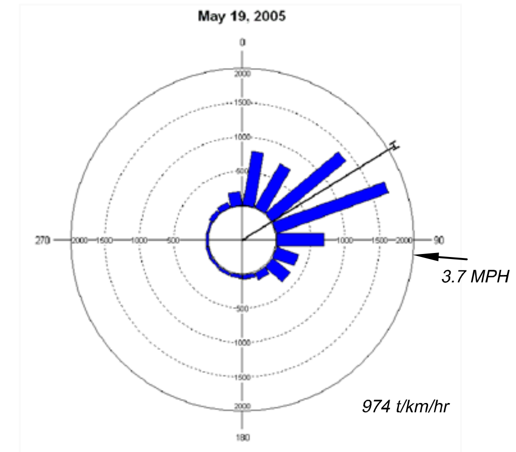
NO. | REVISIONS | DATE

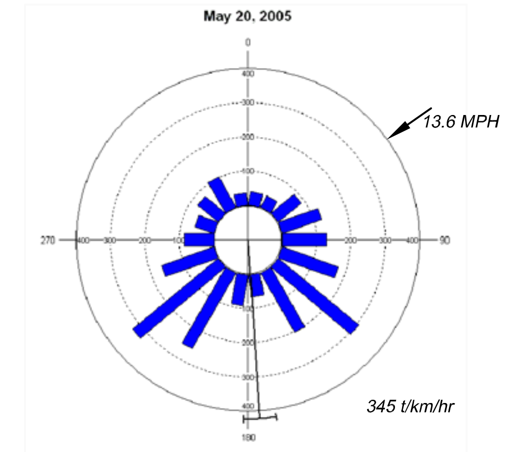
105028-00-Traffic.dwg

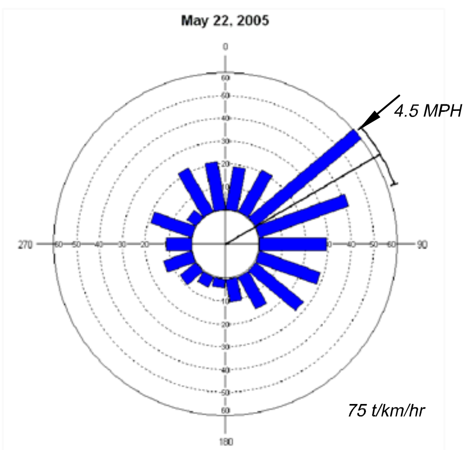


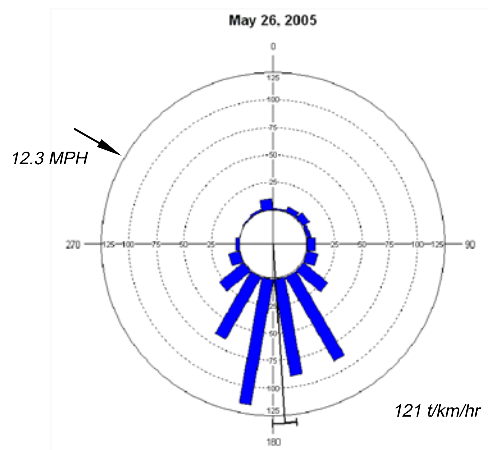


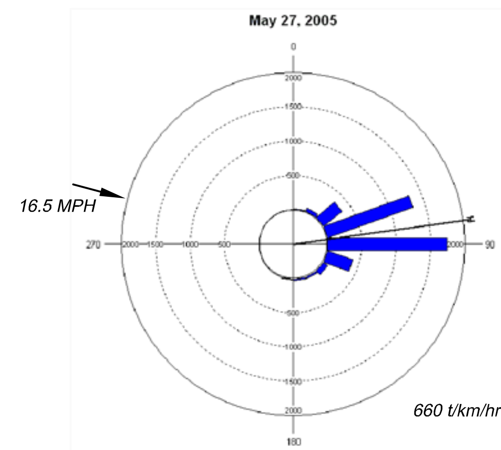


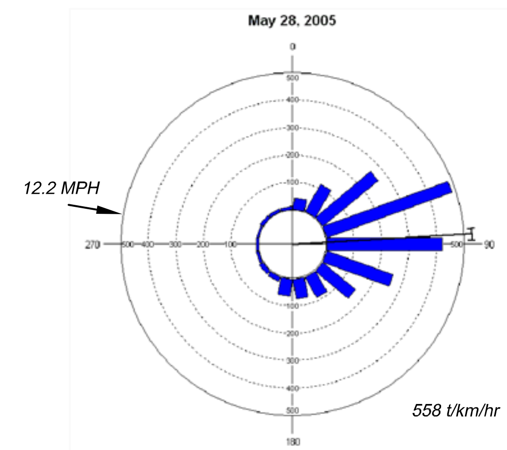


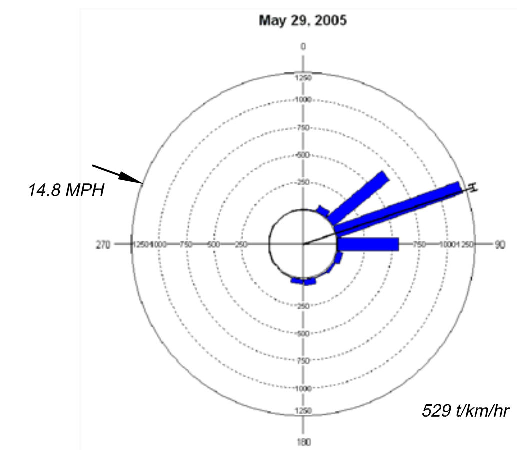


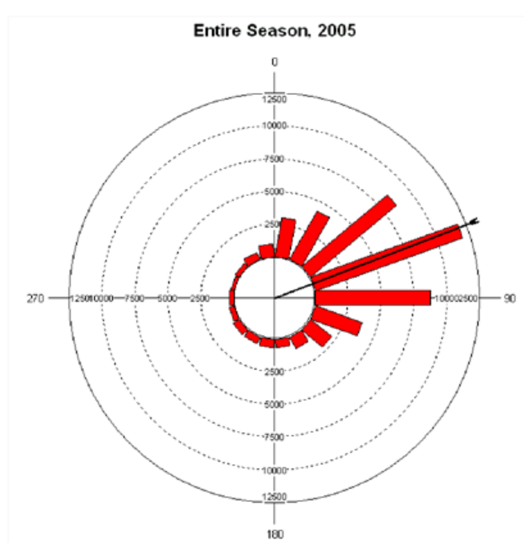












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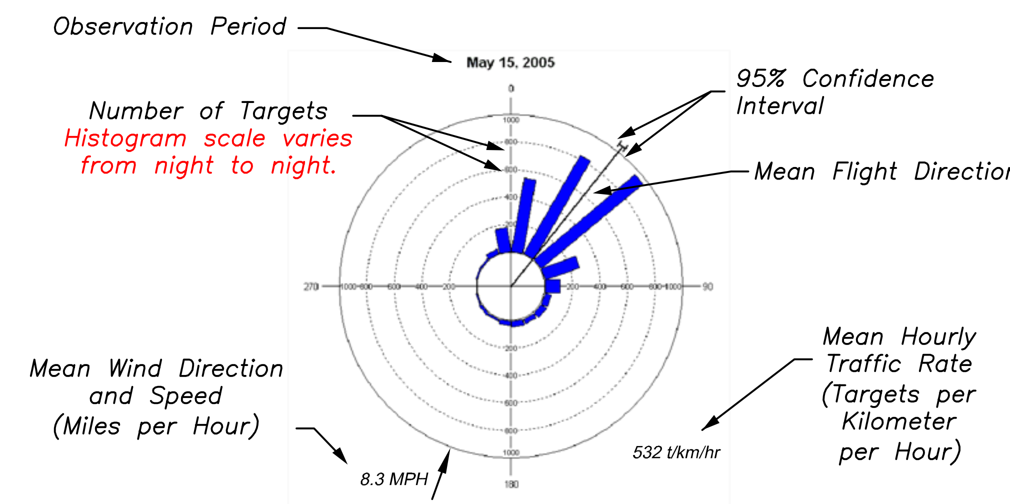


Data rose shows bird targets in directions of 20° increments.

Sheet 2 of 2

NO.	
REVISIONS	
DATE	
SHEET TITLE:	Nightly Mean Flight Direction
SCALE:	N/A
DATE:	August 2005
PROJECT:	Deerfield Wind Project
ADDRESS:	Searsburg, Vermont
PREPARED BY:	WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS
	105028-00-Traffic.dwg
PROJ. NO.	105028
FIGURE NO.	3-5

Flight Altitude

A total of 4,238 targets were identified during the analysis of vertical radar data. The mean flight height of all targets was 523 m ± 59 m (1,716' ± 194') above the radar site. The average nightly flight height ranged from 307 m ± 30 m (1,007' ± 98') on May 2 to 823 m ± 99 m (2,700' ± 325') on May 16 (Figure 3-6, Appendix B Table 2). The percent of targets observed flying below 100 m (328') also varied by night, from 0% to 12% (Figure 3-7). The seasonal average percentage of targets flying below 100 m was 4%.

Hourly flight height peaked from about 3 to 4 hours after sunset (Figure 3-8). Within 100 m (328') height zones, the greatest percentage of targets was documented equally (14%) from 300 m to 400 m (984' to 1,312'), and from 200 to 300 m (656' to 984'), 59% were observed from 200m to 700 m (656' to 2,297'), and 72% were observed from 100 m to 800 m (328' to 2,625') above the radar site (Figure 3-9).

Ceilometer Observations

Ceilometer data collected during the radar survey yielded a total of 159 5-minute sample periods (13.25 hours). Those observations, however, resulted in relatively few bird and no bat observations. Only three birds were observed flying through the ceilometer beam.

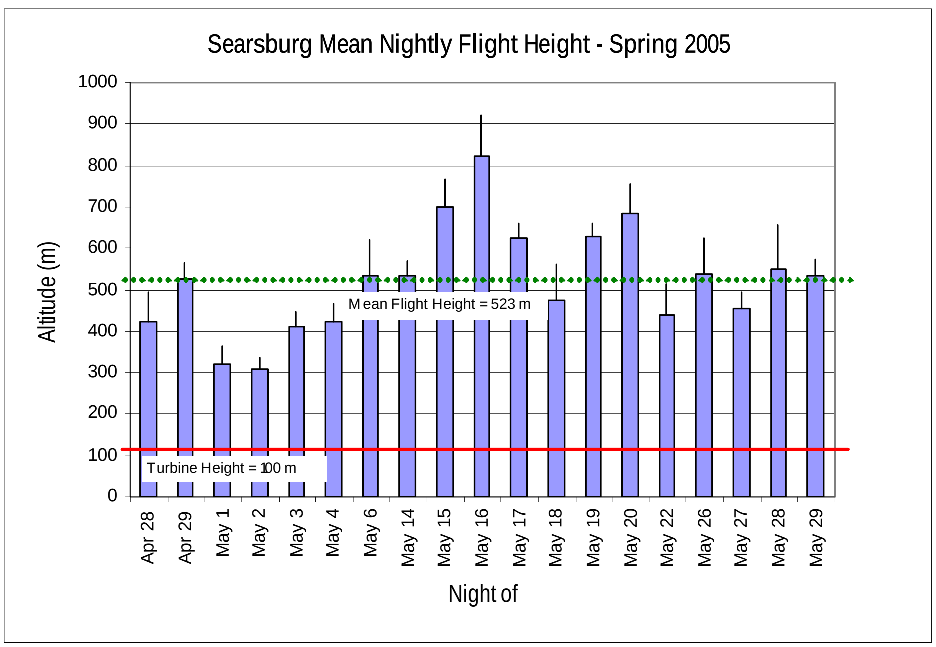


Figure 3-6. Mean nightly flight height of targets

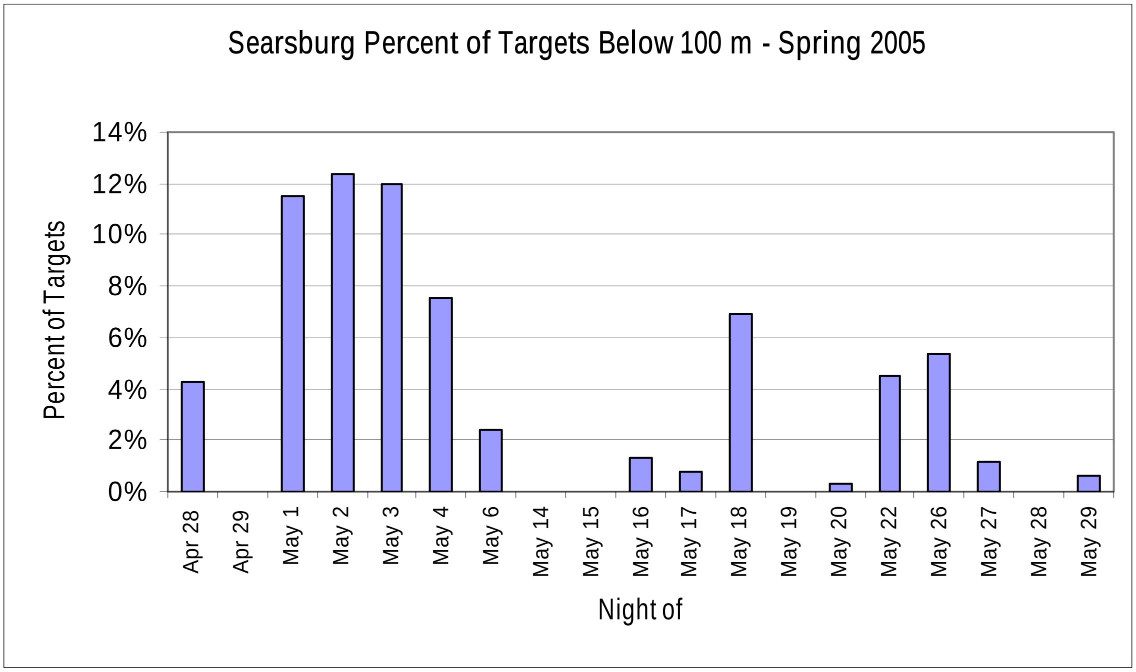


Figure 3-7. Percent of targets observed flying below a height of 100 m (328')

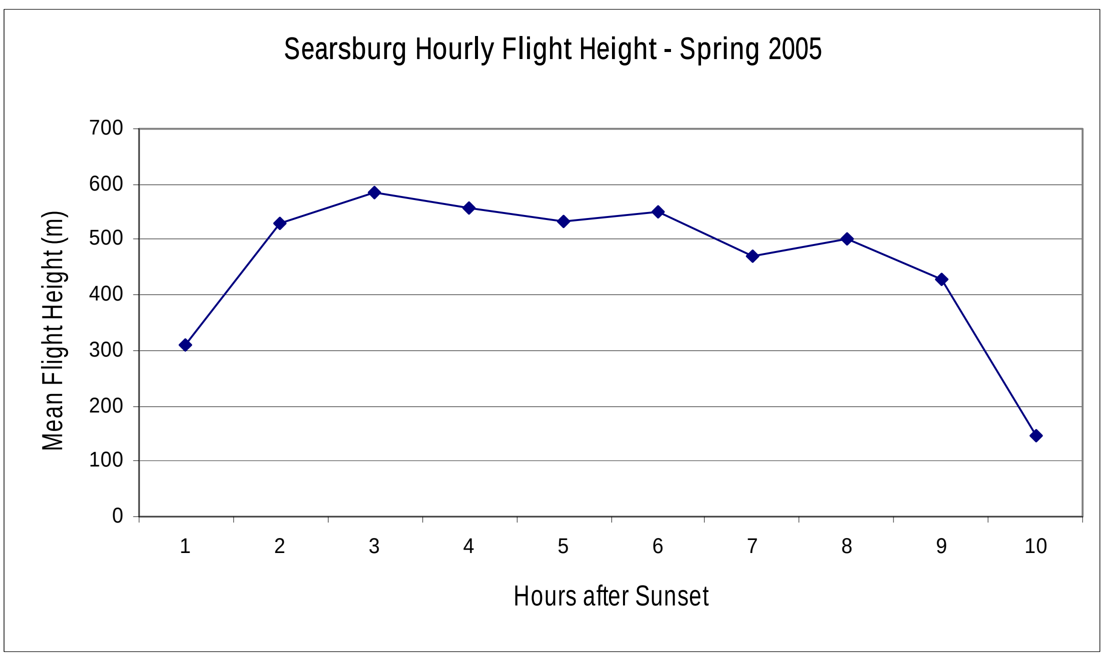


Figure 3-8. Hourly target flight height distribution

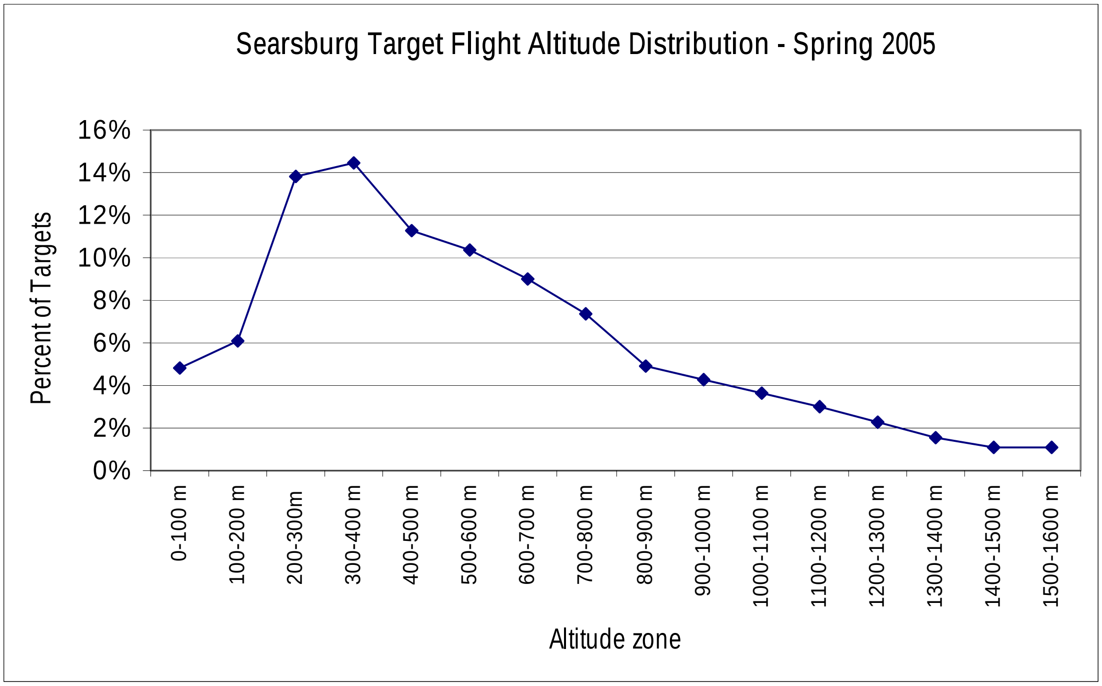


Figure 3-9. Target flight height distribution within 100 m height zones

3.4 Discussion

Spring 2005 radar surveys documented migration activity and patterns in the vicinity of the Deerfield Wind Project area. In general, migration activity and flight patterns varied between and within nights. Nightly variation in the magnitude and flight characteristics of nocturnally-migrating songbirds is not uncommon and is often attributed to weather patterns such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Gauthreaux 1971, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991).

Passage Rates

As indicated above, weather patterns are probably the largest factor affecting the magnitude of bird migration, particularly at inland sites. In the spring, an approaching low pressure system typically produces light southerly winds from the west or southwest. Bird migration is often more abundant during these periods because of favorable wind direction for spring migration until the system passes (Richardson 1972). Consequently, nightly migration traffic rates can be expected to vary and peak when the best migration weather occurs. The variable nightly passage rates documented at Deerfield Wind are consistent with this. For example, passage rates were generally higher on clear nights, which were typically associated with colder temperatures. Passage rates were variable on cloudy nights and generally low on nights with fog and passing showers, indicative of the role that weather can play in bird migration activity.
Few surveys using the same methods and equipment and conducted during the same time period are available for comparison. In a similar study overlooking Lake Erie in western New York, Cooper *et al.* (2004) documented spring 2003 passage rates between 15 and 1,702 t/km/hr with

an overall passage rate of 395 t/km/hr. The same researchers documented mean spring season passage rates of 159 t/km/hr near Carthage, NY (upstate NY east of Lake Ontario) and 41 t/km/hr at Wethersfield, NY (east of Buffalo and Lake Erie) during previous years of surveys (Table 3-2; Cooper *et al.* 2004).

Table 3-2. Summary of regional spring migration studies using radar (Cooper *et al.* 2004).

Location	Passage Rate
Chautauqua, NY	395
Carthage, NY	159
Wethersfield, NY	41

There are limitations in comparing that data with data from 2005, as year-to-year variation in continental bird populations invariably affects how many birds migrate through an area. Additionally, those studies utilized different amounts of survey effort some slightly different equipment, which limits their comparability. Despite this, nightly mean passage rates observed at the Deerfield Wind Project area were generally within the range of those studies. Differences in the overall passage rates could be due to several factors.

First, surveys conducted during different years can yield different results, as the size of continental bird populations likely vary somewhat from year to year. Second, the location of the Deerfield Wind project is different than those surveys and consequently may have a different number of birds moving through the area. Third, spring weather conditions may have been different during these same time periods in different years effecting passage rates in that area.

Flight Direction

Some research suggests that bird migration may be affected by landscape features, such as coastlines, large river valleys, and mountain ranges. This has been documented for diurnally-migrating birds, such as raptors, but is not as well established for nocturnally migrating birds (Sielman *et al.* 1981, Bingman *et al.* 1982, Bruderer and Jenni 1990, Richardson 1998, Fortin *et al.* 1999, Williams *et al.* 2001, Diehl *et al.* 2003, Woodlot unpublished data).

Evidence suggesting topographic effects to night-migrating birds has typically included areas of extremely varied topography, such as the Alps and possibly the most rugged areas of the northern Appalachians. The landscape around the project area consists of valleys and peaks with elevation differentials of 400 m to 500 m (1,312’ to 1,637’). This is considerably less than in those other areas where potential topographic effects on flight direction have been suggested. The mean flight direction of 69º ± 47º would take migrants across the project area ridgelines (Figure 3-10). Movement directed by topography would be expected to direct migrants parallel to ridgelines, rather than across them.

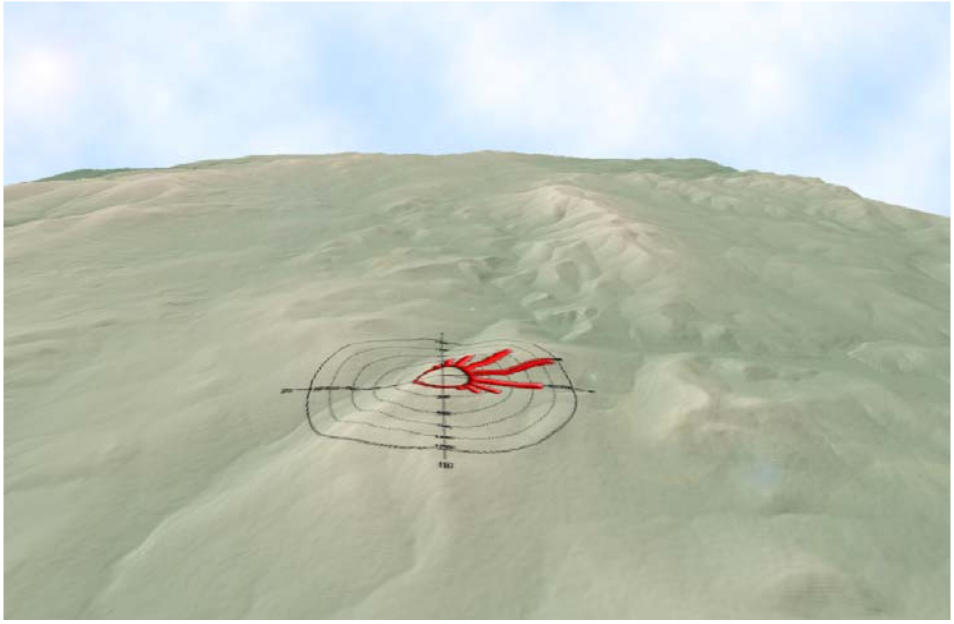


Figure 3-10. Three-dimensional view of project area showing mean target flight direction over the survey location.

Flight Height

The altitude at which nocturnal migrants fly has been one of the least understood aspects of bird migration. Bellrose (1971) flew a small plane at night along altitudinal transects to visually document the occurrence and altitude of migrating songbirds. He found the majority of birds observed were between 150 m and 450 m above the ground level but on some nights the majority of birds observed were from 450 m to 762 m above the ground. Radar studies have largely confirmed those visual observations, with the majority of nocturnal bird migration appearing to occur less than 500 m to 700 m above the ground (Able 1970, Alerstam 1990, Gauthreaux 1991, Cooper and Ritchie 1995).

Recent studies at other proposed wind facilities in the northeast and mid-Atlantic states are consistent with this as well. Cooper *et al*. (2004) documented a mean overall flight altitude of 528 m ± 3 m during a spring migration survey in Chautauqua, New York, with only 4% of targets flying below 125 m. These results are nearly identical to the spring 2005 Deerfield Wind results, with a seasonal mean flight height of 523 m ± 59 m above the radar. The percentage of targets flying less than the proposed turbine height above the ground was also very similar, though that turbine height is smaller for the Deerfield Wind project that those proposed at Chautauqua.

The high mean flight altitude of targets documented during this study likely further supports the presumption that topographic features are not affecting migration patterns, particularly flight direction. The mean flight altitude being so high above the radar indicates that most birds are flying so high that their flight is unimpeded by topographic features, such as hillsides or mountaintops, as they pass over valleys, ridges, and mountaintops.

Fall 2004 Surveys

The spring 2005 surveys represent the second season of radar surveys at Deerfield Wind. The fall 2004 survey documented a much lower passage rate than the spring survey (Table 3-3). This is generally inconsistent with what would be expected, as bird populations in spring would be typically be lower after winter. Differences in weather patterns could account for this as regional systems may direct the movement of migrants over different parts of the landscape from season to season. The concentrated migratory window could also increase passage rate. In general, if fewer nights are available for migration, such as a spring migration window of 1.5 to 2 months of spring versus 2.5 to 3 months of fall, the density of migrants on those nights would be expected to be higher. Flight direction in the spring was generally opposite that documented in the fall

Interestingly, flight altitude was nearly identical in the spring (mean of 523 m) and the fall (mean of 566 m) surveys. There was more variation in flight height observed in the spring and, consequently, the percentage of targets flying less than 100 m (328') above the radar was slightly higher in the spring (4%) than in the fall (3%).

Table 3-3. Comparison of Results from Radar Surveys in Fall 2004 and Spring 2005

	Fall 2004	**Spring 2005**
Overall Passage Rate	178 ± 24 t/km/hr	404 ± 14 t/km/hr
Flight Direction	212º ± 55º	69º ± 47º
Flight Height	566 ± 23 m	523 ± 59 m
Seasonal Average below 100 m	3%	4%

Additionally, the fall surveys included data collection at three locations, the existing facility (ridge site), the Western Expansion Area (ridge site), and a stream valley west of the project area (low elevation valley site). Radar surveys at all three sites showed similar flight patterns in the magnitude of migration, flight direction, and, to some extent, flight height (Roy and Pelletier 2005). The similarity in the data collected at these three site in variable landscape settings further supports the conclusion that bird migration over the project area is not being affected by local topographic features.

3.5 Conclusions

Radar surveys during the spring 2005 migration period have provided important information on nocturnal bird migration patterns in the vicinity of the Deerfield Wind Project area. The results of the surveys indicate that bird migration patterns are generally similar to patterns observed at other sites in the region.

Migration activity varied throughout the season, which is probably largely attributable to weather patterns. The mean passage rate (404 ± 82 t/km/hr) is generally similar than that observed at similar spring studies. Passage rates were more than twice that observed during surveys conducted in fall of 2004. Migration activity throughout each night typically peaked 3 hours after sunset, and steadily declined throughout the remaining hours of night, with the exception of the last hour before sunrise during which a slight increase in rate was observed. Nightly and hourly passage rates varied throughout the course of a night. Weather was suspected to be the main factor rather than topography in this variation, although there was no significant correlation with wind speed or wind direction.

Flight direction for the entire season was 69°, which is generally opposite from fall 2004 surveys (212°). Flight direction data indicate that nocturnal migrants are not avoiding the project area for any topographic-related reasons. Rather, the majority of targets had flight paths that would lead them across some of the ridges of the proposed wind farm. Flight heights, however, indicate that the majority of the migrants are flying at altitudes well above the turbine height. The northeasterly flight direction is consistent with other spring studies.

The average flight altitude above the ground was 523 m ± 59 m, which is nearly identical to the fall survey results. Only 4% of the targets observed during vertical radar operation were flying below an altitude of 100 m (328'), the height of the proposed turbines. This indicates that the risk of collision to night-migrating birds is limited to a small subset of nocturnally-migrating birds and bats passing through the project area. Any avoidance behavior of nocturnal migrants would further reduce the risk of collisions with wind turbines.

4.0 Bat Survey

4.1 Introduction

Wind projects have been cited as a potential threat to migrating bats for a number of years, especially since a study at the Mountaineer Wind Energy Facility in Tucker County, West Virginia, documented 475 dead bats between April 20 and November 9, 2003 (Johnson and Strickland 2004). Subsequent fieldwork in 2004 at the Mountaineer site and nearby Meyersdale Wind Facility has revealed even higher rates of bat collision mortality with operating wind turbines (Arnett *et al.* 2005). These studies have raised numerous concerns regarding the potential for collision mortality associated with wind turbines to impact bat populations (Williams 2003). The concerns lie primarily with wind farms in the eastern United States, where documented bat fatality rates have been considerably higher (bats per turbine per year) than at western wind farms (Williams 2003, Arnett *et al.* 2005).

Researchers currently have a limited understanding of the specific factors influencing rates of bat collision mortality, although evidence from the timing of fatalities documented at existing wind facilities and other structures suggests that migrating bats are at the highest risk (Johnson and Strickland 2004, Johnson *et al.* 2003, Whitaker and Hamilton 1998). A number of plausible hypotheses explaining the high rates of bat mortality have been presented by bat researchers, but none of these have been adequately tested. The most likely mechanisms explaining bat collision center on the possibility that ridges act as corridors for migrating or feeding bats, that bats are unable to detect turbines visually or by echolocation, or that bats may be attracted to wind turbines due to artificially high insect concentrations, light attraction, or acoustic attraction (Arnett *et al.* 2005).

Nine species of bats occur in Vermont, based upon their normal published geographic ranges. These are the little brown bat (*Myotis lucifugus*), northern long-eared bat (*M. septentrionalis*), Indiana myotis (*M. sodalis*), eastern small-footed myotis (*M. leibii*), silver-haired bat (*Lasionycteris noctivagans*), eastern pipistrelle (*Pipistrellus subflavus*), big brown bat (*Eptesicus fuscus*), Eastern red bat (*Lasiurus borealis*), and hoary bat (*L. cinereus*) (Whitaker and Hamilton 1998). While the Indiana myotis is listed as Endangered in Vermont, the eastern small-footed bat is considered Threatened and both the silver-haired bat and the eastern pipistrelle are rare in Vermont. Additionally, the Indiana myotis is federally listed as Endangered.

Results of winter population surveys in 23 known bat hibernacula have revealed declines in Vermont's Indiana myotis wintering population, an increase in the little brown bat wintering population, and few changes in the small winter populations of all other species that overwinter in the state: small-footed bats, northern long-eared bat, big brown bat, and eastern pipistrelle (Trombulak *et al.* 2001). The largest known Indiana myotis hibernaculum in Vermont is located in the Town of Manchester, in the southern part of the state. The Deerfield Wind Project area is located in southwestern Vermont, within the published normal range of the Indiana myotis (Whitaker and Hamilton 1998).

To document bat occurrence in the area of the Deerfield Wind Project, Woodlot conducted acoustic monitoring surveys from April 19 to June 15, 2005. Visual ceilometer observations were also made between April 26 and May 30, 2005, concurrent with a nocturnal radar study. Acoustic surveys were the primary survey type used in this study, and were designed to document bat passage rates in different habitat types and from the ground level to heights of 16 m (45').

A primary goal of these surveys was to attempt to document the presence of bats migrating and foraging in and near the rotor zone of the proposed wind project. Because recent research indicates that migrating bats appear to have a higher risk of collision with wind turbines than birds, most mortality at a wind farm would be expected to occur during the fall and spring bat migrations, the timing of which depends upon the bat species and the location.

4.2 Methods

Field Surveys

Anabat II detectors were used for the duration of this study. Anabat detectors are frequency-division detectors, dividing the frequency of ultrasonic calls made by bats (a factor of 16 was used in this study[3]) so that they are audible to humans. These detectors are able to detect all bat species known to occur in New England using this setting. Data from the Anabat detectors were

[3] The frequency division setting literally divides ultrasonic calls detected by the detector by the division setting in order to produce signals at frequencies audible to the human ear.

logged onto compact flash media using a CF ZCAIM (Titley Electronics Pty Ltd) and downloaded to a computer for analysis.

The acoustic surveys were designed primarily to document the occurrence and detection rates of bats near the ground and at heights near the low end of the blade-swept area of the proposed turbines. To do this, two detectors were suspended from the guy wires of met towers just southeast of the existing facility (Figure 4-1). The detectors were suspended at heights of 15 m and 7 m (50' and 22') above the ground. The upper detector was deployed for 50 consecutive nights from April 19 to June 15. The lower detector was deployed for 43 nights from April 26 to June 15. Detectors were programmed to record data from 7:00 pm to 7:00 am every night.

Data Analysis

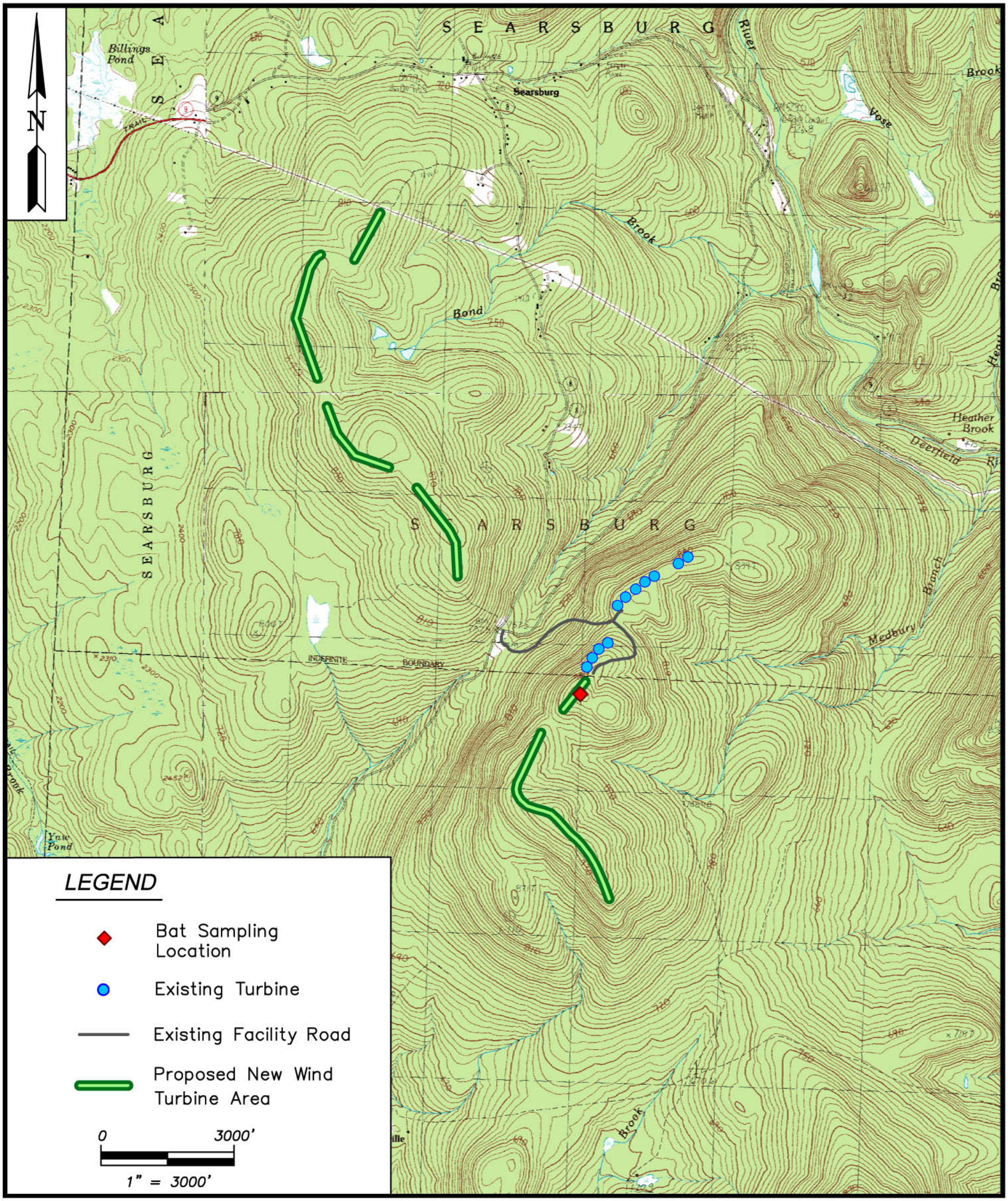
Potential call files were extracted from data files using CFCread© software, with default settings in place. This software screens all data recorded by the bat detector and extracts call files based on the number of pulses recorded within a certain time period. Every potential call file was visually inspected, with any distinct grouping of recognizable calls or call fragments being considered a bat call sequence. Call sequences were identified based on visual comparison of call sequences with reference libraries of known calls collected by Chris Corben, and Lynn Robbins using the Anabat system. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). However, the accuracy of this method depends upon experience and the relevance of reference call files used. Because we were using reference calls obtained by other researchers, most of which were of western origin, we were conservative in our identifications. We labeled poor quality recordings or brief fragments as unknown, except in cases where we were reasonably sure that the fragment was exclusively within the *myotid* frequency range. *Myotids* were not identified to species, due to the similarity of calls between species within this genus.

In addition to *myotids*, silver-haired and big brown bats have calls that can easily be confused, although we did separate the species, based on minimum frequency and call slope. Generally speaking, call sequences with relatively flat profiles and minimum frequencies that were 27 kHz were identified as silver-haired bats, whereas calls with a steeper profile and minimum frequencies ranging from slightly below 25 kHz to about 30 kHz were identified as big brown bats. Because silver-haired bats' calls can also be more steeply sloped, the most likely error in identification using this technique would be to underestimate the number of detected silver-haired bats.

Once all of the call files were identified, nightly tallies of detected calls by species were compiled for each detector. Mean detection rates (calls/night) were calculated for each night. Detection rates indicate only the number of calls detected and do not necessarily reflect the number of individual bats in an area.

Ceilometer Surveys

As noted in Section 3.2, ceilometer surveys took place for 5 minutes during each hour of radar sampling. While species identification was not possible, targets were classified as either bats or birds and helped provide insight into the composition of the migrant animal population that occurred at low altitudes. The ceilometers were held in-hand so that animals passing through the light beam were followed for several seconds.



PREPARED BY:
WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

DATE:	August 2005
SCALE:	1" = 3000'
JOB NO. 105028	
FILE: 105028-00-Location.dwg	

Figure 4-1
Bat Survey Location Map
Deerfield Wind Project
Searsburg, Vermont

REV.

4.3 Results

Acoustic Monitoring

Two detectors were deployed for 43 to 50 nights each, from April 19 to June 15. However, only a single bat detector—the one deployed at 15 m (50')—was operating correctly during that time. This detector malfunctioned between April 24 and May 11. The second detector was deployed at a height of 7 m (25') between April 26 and June 15, but did not function properly for the duration of the study period. Consequently, one detector was recording from April 19 to 23 and from May 12 to June 15.

A total of 4,655 files were recorded by the detector. Analysis of these files indicated that static, perhaps some type of harmonic static, was generated on certain nights. It is unclear what the cause of the static was, as tests of the detector indicated that it was working correctly. Despite the static bat calls were recorded, including some from those nights with the static files.

Only four bat call sequences were recorded (Table 4-1) during that time. The overall detection rate was 0.07 calls per night. All recorded calls were identified as *myotids*. Images of these calls are provided in Appendix C. No bats were observed during ceilometer surveys conducted in association with the radar survey. Because so few bat calls were recorded, no obvious relationship with weather or other factors that could affect bat activity were observed.

Table 4-1. Spring bat survey results.

Night of	Time	Height	Species	Weather Information		
				Wind Speed (mph)	Wind Dir.	Temp (F)
May 12	1:24 AM	15 m	*Myotis* spp.	NW	11.5	54
May 27	10:26 PM	15 m	*Myotis* spp.	SW	6.9	44
June 4	12:44 AM	15 m	*Myotis* spp.	n/a	n/a	55
June 14	10:38 PM	15 m	*Myotis* spp.	n/a	n/a	73

4.4 Discussion

Bat mortality at wind projects in the eastern United States has recently been identified as a potential risk to certain bat populations (Williams 2003). The study of this issue, however, poses difficulties, including insufficient scientific understanding of bat migration patterns and navigation systems, inadequate amounts of data on mortality rates and interactions between bats and turbines at existing wind farms, a lack of accurate population estimates for many bat species, and limited monitoring methods available that provide credible, comprehensive, and reliable data on bat movements.

This study aimed to document passage rates of bats in the vicinity of some of the proposed wind turbines for the Deerfield Wind project. Spring sampling revealed very low levels of bat activity during the two-month period of sampling. Bats were recorded on only 4 of the 55 nights when detectors were deployed. Due to the low numbers of detections, hourly and nightly passage rates were not calculated. The overall detection rate was only 0.07 bats calls recorded per night.

The four detected calls were all identified as *myotids*. Attempts to differentiate between species within this genus, which includes the federally listed Endangered Indiana myotis, were not made, due to the similarity of calls between species within this genus. Searsburg is located within the summer range of Indiana myotis, and is within the portion of Vermont known to contain active Indiana myotis hibernacula. Significant uncertainty in the full extent and use of those ranges, however, does exist.

The overall low numbers of bats detected could indicate a small bat population in the region, avoidance of the area by bats, or poor conditions for bats. The site is located in a mountainous region of Vermont, where climatic conditions are harsh and unpredictable in the spring. The low numbers of detections could also be the result of sampling effort, since only one detector was operating during the study period, and because Anabat detectors are able to detect bats in only a small area. However, even transforming the total number of calls into a detection rate (which makes the data somewhat more comparable to other similar studies) results in a very low detection rate.

Emerging information on the potential susceptibility of bats to wind turbine-induced mortality indicates that some species may be particularly vulnerable to collisions with turbines. The tree roosting bats, (hoary and eastern red bats), along with the eastern pipistrelle, appear to have a higher risk of collision with wind turbines, based on mortality data collected at existing facilities. Although these species are all relatively uncommon, they have constituted disproportionably large percentages of bat fatalities at existing facilities. These species are often documented at higher flight heights than other species, such as the *myotids*, that fly within or below the tree canopy. Due to the height of the met towers at the site, the detectors were only a few meters above the canopy. Consequently, the collected data was only of *myotids*.

Using our current methods, acoustic detectors are unable to sample bat passage rates in the central and upper regions of the rotor zone, which are at heights of approximately 70 m (230’) and 100 m (328’). It is not known whether or not certain bat species migrate at these higher altitudes. Because the detectors sampled only to roughly 30 m (100’) (approximately 15 m above the 15 m height of the detector) the methods used would not have detected bats that may have been flying at higher altitudes, within the rotor-swept area.

Additionally, the methods used only allow the detection of bats that are producing ultrasonic signals. One possible explanation for why migrating bats may collide with turbines is that they do not use their echolocation system while migrating. This would either mean that bats do not monitor reflected echolocation signals, or that they do not produce ultrasonic signals when migrating, in which case they would be invisible to acoustic bat detectors. This possibility must be taken into account when interpreting data from acoustic monitoring surveys.

4.5 Conclusions

Acoustic bat surveys revealed very low numbers of bats detected at the Searsburg site during April, May, and June 2005. Bats were detected on only 4 out of 35 detector-nights sampled.

The low number of detected bats could indicate a small bat population in the region, avoidance of the area by bats, poor conditions for bats, or a variety of other factors.

No definitive determination of the presence or absence of any rare bats from the project area can be made. Although detected calls were identified as belonging to the genus *Myotis*, these calls were most likely those of the little brown bat and northern long-eared bat, based on the relative abundance of these two species over the other *myotids*.

The many factors that may influence bat collision rates with wind turbines are largely unknown. Many of the theories explaining bat collisions, such as acoustic attraction and insect concentration, suggest that the operation of the turbines may actually attract bats. The detectors deployed during the spring were approximately 245 m (800') from the existing turbines. If bats are attracted to turbines, detection rates at Deerfield Wind would probably be expected to be greater than what was observed.

Because acoustic monitoring surveys detect only those bats that are producing ultrasonic signals, and because this survey technique samples a very small air space relative to the rotor zone of a single wind turbine let alone an entire wind facility, results from these surveys must be interpreted with caution. Acoustic sampling reveals activity patterns and species presence in the air space near the rotor zone of wind turbines, but cannot monitor the entire rotor zone of a turbine, and cannot predict how bats might interact with an operational turbine.

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Appendix A

Appendix A Table 1. Summary of Daily Raptor Migration Surveys

Species	Existing						*Existing Total*	Western Exp.						*Western Exp. Total*	**Entire Season**
	4/9/2005	4/10/2005	4/19/2005	4/21/2005	4/22/2005	4/28/2005		4/9/2005	4/10/2005	4/20/2005	4/21/2005	4/22/2005	4/29/2005		
American Kestrel										1		1		*2*	**2**
Bald Eagle						1	*1*								**1**
Broad-winged Hawk			1	2	1	1	*5*			3		9		*12*	**17**
Cooper's Hawk					1		*1*			3		1		*4*	**5**
Osprey						1	*1*								**1**
Peregrine Falcon												1		*1*	**1**
Red-shouldered Hawk									1			2		*3*	**3**
Red-tailed Hawk				3	1		*4*					4		*4*	**8**
Rough-legged Hawk				1			*1*				1			*1*	**2**
Sharp-shinned Hawk					2		*2*		2	3		3		*8*	**10**
Turkey Vulture	3	3	6	1	3		*16*	1		1			1	*3*	**19**
Unid. Buteo												1		*1*	**1**
Unid. Raptor	2		1	1		3	*7*			2		3		*5*	**12**
Entire Season	5	3	8	8	8	6	*38*	1	3	13	1	25	1	*44*	**82**

Appendix A Table 2. Summary of Hourly Raptor Observations

Species	Existing						Existing Total	Western Exp.						Western Exp. Total	**Entire Season**
	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00		9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00		
American Kestrel										1			1	*2*	**2**
Bald Eagle			1				*1*								**1**
Broad-winged Hawk	1		1		1	2	*5*		5	5		1	1	*12*	**17**
Cooper's Hawk			1				*1*			1	1	1	1	*4*	**5**
Osprey					1		*1*								**1**
Peregrine Falcon										1				*1*	**1**
Red-shouldered Hawk									3					*3*	**3**
Red-tailed Hawk		1	2			1	*4*		1	2		1		*4*	**8**
Rough-legged Hawk					1		*1*		1					*1*	**2**
Sharp-shinned Hawk	1	1					*2*	3		1	2	1	1	*8*	**10**
Turkey Vulture			1	11	4		*16*	1		1	1			*3*	**19**
Unid. Buteo												1		*1*	**1**
Unid. Raptor	2		1	2	1	1	*7*		1		4			*5*	**12**
Entire Season	4	2	7	13	8	4	*38*	4	11	12	8	5	4	*44*	**82**

Appendix A Table 3. Species distribution below turbine height

Species	< 100 m	> 100 M	Entire Season
American Kestrel		2	2
Bald Eagle		1	1
Broad-winged Hawk	1	16	17
Cooper's Hawk	1	4	5
Osprey		1	1
Peregrine Falcon		1	1
Red-shouldered Hawk		3	3
Red-tailed Hawk	2	6	8
Rough-legged Hawk		2	2
Sharp-shinned Hawk		10	10
Turkey Vulture	8	11	19
Unid. Buteo		1	1
Unid. Raptor	6	6	12
Entire Season	18	64	82

Appendix A Table 4. Summary of Regional Spring (March - May) Migration Surveys*

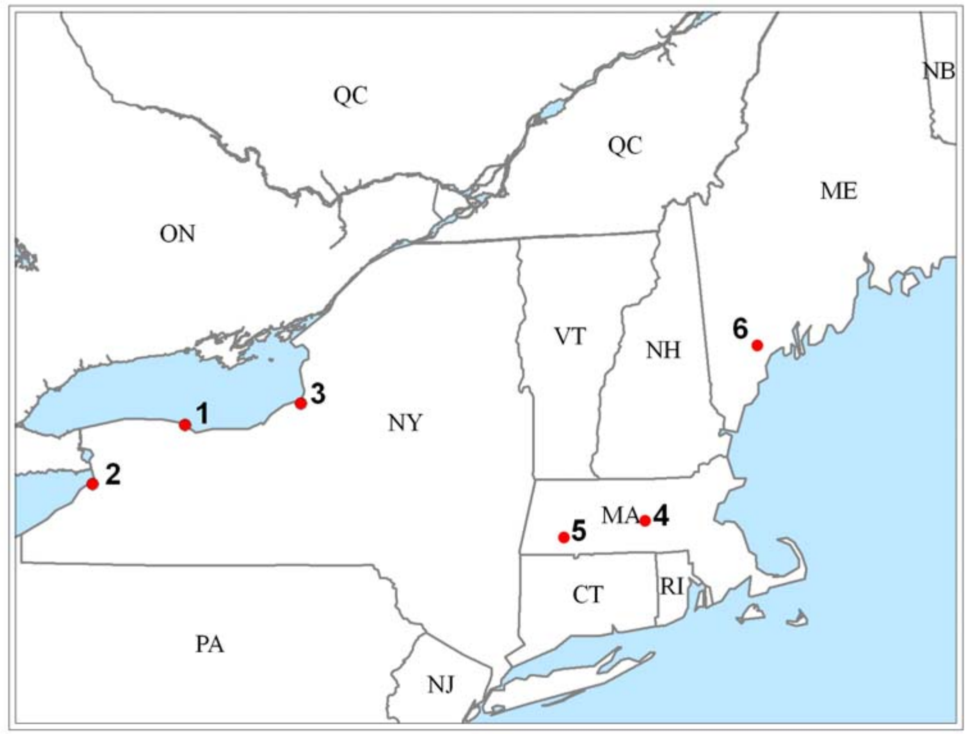
Site Number**	Year	Location	Observation Hours	BV	TV	OS	BE	NH	SS	CH	NG	RS	BW	RT	RL	GE	AK	ML	PG	SW	UR	UB	UA	UF	UE	TOTAL	BIRDS/ HOUR
1	**2005**	**Braddock Bay, NY**	447.75	1	8993	100	113	700	1382	392	46	200	16294	1999	318	31	188	21	12	3	0	0	0	0	0	30,793	68.8
2	**2005**	**Hamburg, NY**	396.25	0	7838	109	42	76	525	124	2	299	2503	1368	42	3	95	3	6	0	106	0	0	0	0	13,141	33.2
3	**2005**	**Derby Hill, NY**	386.75	1	6834	278	137	423	1510	330	26	501	8928	4022	369	49	158	29	4	0	24	0	0	0	0	23,626	61.1
4	**2004**	**Barre Falls, MA**	169	1	92	203	13	23	234	19	0	18	536	132	0	1	132	12	1	0	21	0	0	0	0	1,438	8.5
5	**2004**	**Blueberry Hill, MA**	121	1	98	125	13	24	128	18	0	18	515	132	0	3	81	0	1	0	10	0	0	0	0	1,167	9.6
6	**2004**	**Bradbury Mountain, ME**	66	0	0	168	8	16	364	14	0	1	668	24	0	0	182	14	2	0	0	0	0	0	0	1,488	22.5

* Data obtained from HMANA website.

** See map to right for site location.

Abbreviation Key:

TV - Turkey Vulture
OS - Osprey
BE - Bald Eagle
NH - Northern Harrier
SS - Sharp-shinned Hawk
CH - Cooper's Hawk
NG - Northern Goshawk
RS - Red-shouldered Hawk
BW - Broad-winged Hawk
RT - Red-tailed Hawk
GE - Golden Eagle
AK - American Kestrel
ML - Merlin
PG - Peregrine Falcon
UR - unidentified Raptor
UB - unidentified Buteo
UA - unidentified Accipiter
UF - unidentified Falcon



Appendix B

Appendix B Table 1. 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**	**Mean**	**SE**
Apr 26	--	510	530	407	369	186	--	--	--	--	--	400	62
Apr 28	291	657	553	189	113	103	224	203	174	47	--	255	61
Apr 29	103	440	539	445	358	381	400	290	157	67	107	299	49
May 1	70	286	260	323	314	363	426	460	589	334	--	342	43
May 2	43	127	454	554	529	391	341	233	144	101	--	292	59
May 3	72	347	504	463	351	580	519	350	301	122	--	361	53
May 4	27	226	414	551	546	521	454	347	299	121	--	351	58
May 6	189	384	397	167	94	71	51	16	19	19	--	141	46
May 14	379	774	910	826	573	483	579	--	454	206	--	576	72
May 15	237	733	1071	1229	1109	248	168	253	241	27	--	532	144
May 16	307	956	913	829	466	304	293	173	72	5	--	432	110
May 17	46	496	786	917	987	963	850	590	307	5	--	595	117
May 18	96	132	193	--	--	545	496	597	286	16	--	295	79
May 19	244	1059	1363	1293	1497	1411	1210	1100	531	29	--	974	164
May 20	589	594	520	607	471	283	204	120	54	11	--	345	75
May 22	13	62	47	94	111	123	77	--	--	--	--	75	14
May 26	138	98	51	119	193	238	--	13	--	--	--	121	30
May 27	490	646	690	884	916	746	747	594	224	--	--	660	70
May 28	396	1383	1674	--	129	170	113	43	--	--	--	558	214
May 29	61	224	430	456	1029	1091	801	501	163	--	--	529	124
Entire Season	200	507	615	575	534	460	442	346	251	79	107	**407**	**82**

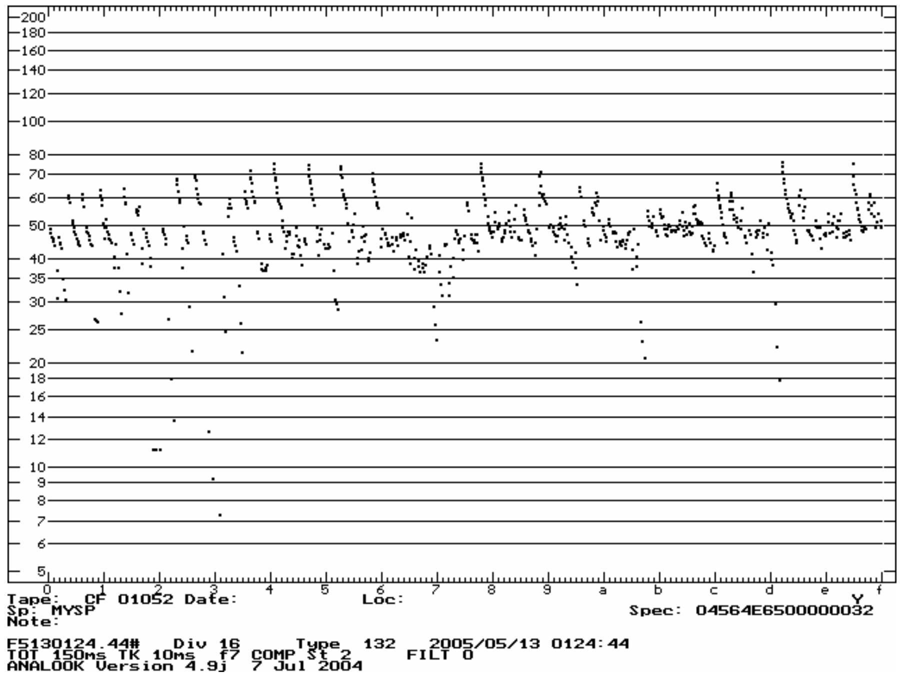
-- indicates no data for that hour

Appendix B Table 2. Mean Nightly Flight Direction

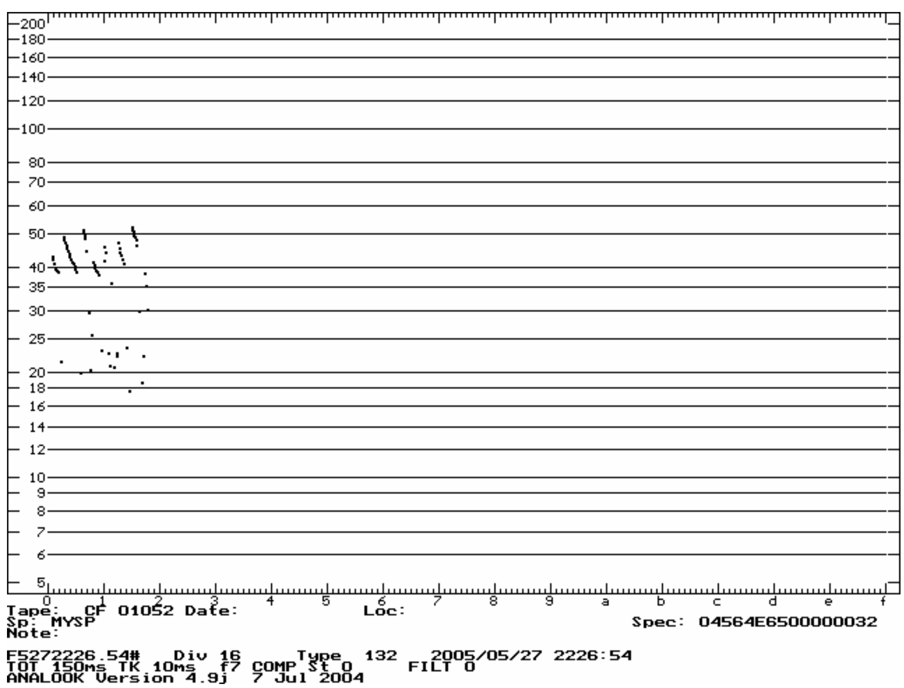
Night of	Mean Flight Direction	Circular Stdev
Apr 26	19	24
Apr 28	104	27
Apr 29	64	32
May 1	78	26
May 2	85	27
May 3	82	24
May 4	74	28
May 6	358	52
May 14	34	35
May 15	38	38
May 16	74	49
May 17	67	34
May 18	101	58
May 19	58	45
May 20	176	89
May 22	60	80
May 26	176	43
May 27	82	20
May 28	87	46
May 29	71	27
Entire Season	69°	47°

Appendix B Table 3. Summary of mean flight heights by hour, night, and for entire season													% of targets below 100 meters
Night of	Mean Flight Height (altitude in meters) by hour after sunset										Entire Night		
	1	2	3	4	5	6	7	8	9	10	Mean	SE	
Apr 28	--	356	585	694	476	142	231	259	630	--	422	72	4%
Apr 29	257	497	701	653	557	576	542	556	494	405	524	39	0%
May 1	381	205	589	285	376	412	264	136	217	350	321	41	11%
May 2	--	423	417	--	235	305	271	242	--	257	307	30	12%
May 3	602	314	300	441	309	347	447	382	548	--	410	36	12%
May 4	--	358	232	315	529	600	478	398	469	--	422	42	8%
May 6	358	562	577	510	348	698	224	999	--	--	534	85	2%
May 14	522	654	673	603	448	458	513	--	397	--	533	36	0%
May 15	365	735	863	611	522	--	803	892	819	--	701	66	0%
May 16	246	624	1016	917	933	1110	1062	994	508	--	823	99	1%
May 17	--	535	689	686	771	713	535	555	513	--	625	35	1%
May 18	--	717	--	--	--	637	427	312	284	--	475	87	7%
May 19	813	526	677	685	608	590	677	575	488	--	627	33	0%
May 20	653	878	918	837	758	569	420	444	--	--	685	68	0%
May 22	--	282	--	231	457	426	494	--	751	--	440	75	5%
May 26	--	828	295	464	539	567	--	--	--	--	539	86	5%
May 27	--	390	448	481	639	493	286	376	536	--	456	38	1%
May 28	778	551	--	--	--	609	265	--	--	--	551	107	0%
May 29	--	640	407	483	--	638	518	410	643	--	534	40	1%
Entire Season	311	530	587	556	531	549	470	502	429	145	523	59	4%
-- indicates no data for that hour													

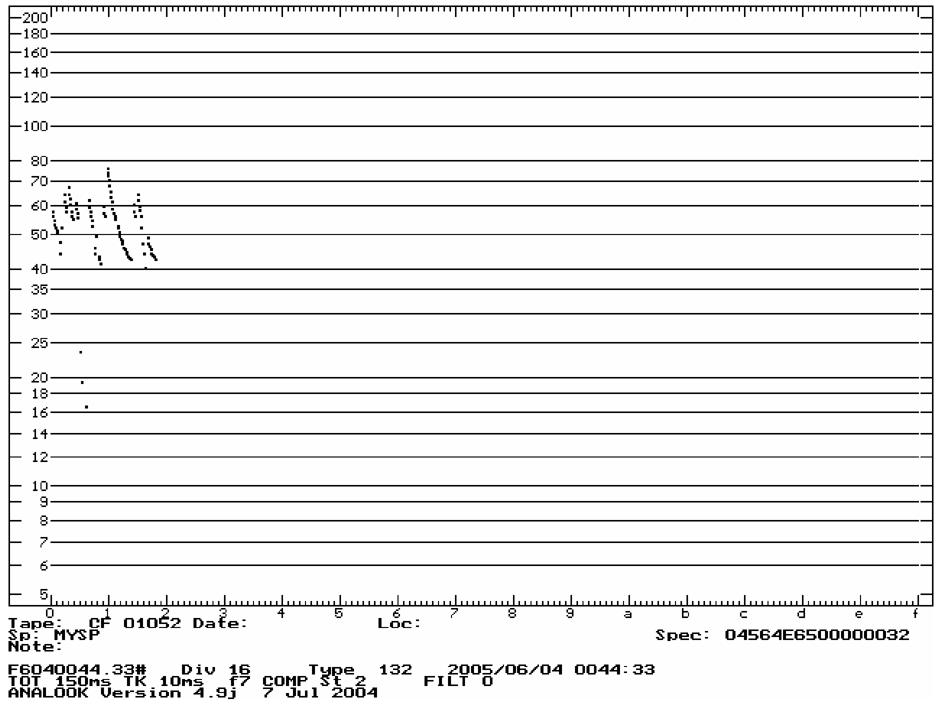
Appendix C



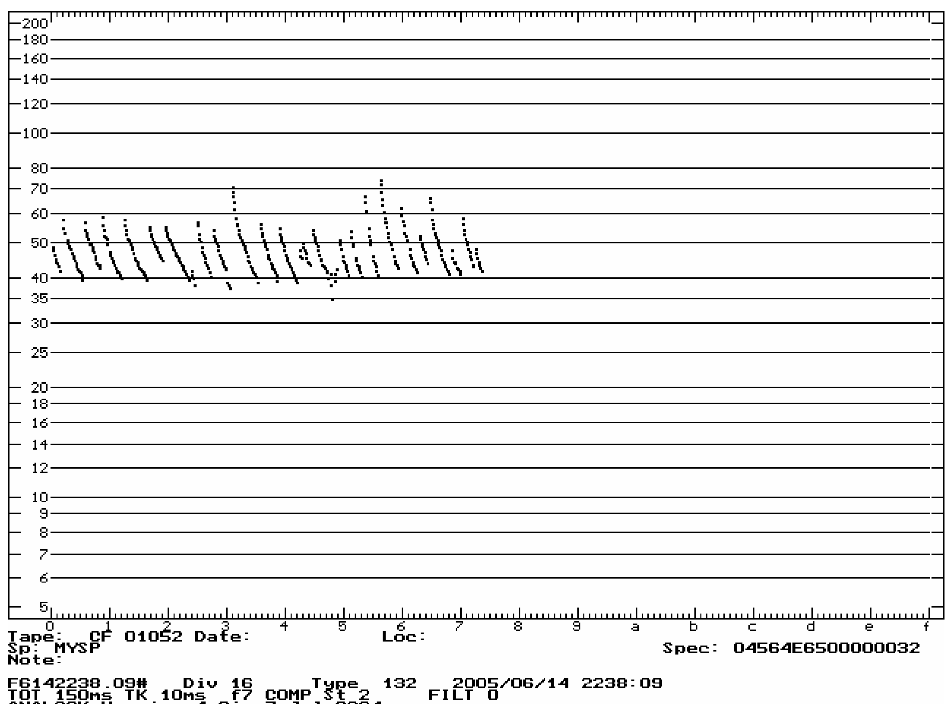
Appendix C Figure 1. *Myotid* call recorded the night of May 12, 2005 at 1:24 am.



Appendix C Figure 2. *Myotid* call recorded the night of May 27, 2005 at 10:26 pm.



Appendix C Figure 3. *Myotid* call recorded the night of June 4, 2005 at 12:44 am.



Appendix C Figure 4. *Myotid* call recorded the night of June 14, 2005 at 10:38 pm.