

**A Spring 2005 Radar, Visual, and Acoustic Survey of  
Bird and Bat Migration at the  
Proposed  
Marble River Wind Project  
in Clinton and Ellenburg, New York**

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## Executive Summary

Woodlot Alternatives, Inc. conducted field surveys of bird and bat migration activity at the Marble River Wind Project in Clinton and Ellenburg, NY, during spring 2005. The surveys are part of the planning process by Marble River, LLC and Horizon Wind Energy for a proposed wind project, which will include the erection of 109 wind turbines in open farm fields, with a maximum “tip height” of 120 meters (m) (394’). 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 the Marble River project area. This information is valuable for the assessment of risk to birds and bats during migration through the area.

### *Raptor Migration*

The spring field surveys included 10 days of visual observation between April 5 and May 6, 2005. A total of 170 raptors, representing 11 species, were observed during the surveys. The overall passage rate was 2.83 birds per hour. Approximately 76% of the raptors observed were flying less than 120 m (394’) above the ground.

### *Bird Migration*

The spring field survey targeted 45 nights of radar surveys from April 15 to May 30, 2005 to collect 1-minute video samples in horizontal operation, which documents the abundance, flight path and speed of avian targets moving through the project area, and 10-minute samples in vertical operation, which documents the altitude of targets. Inclement weather on six nights precluded radar operation. Consequently, a total of 39 nights of data were collected.

A total of 780 one-minute horizontal radar video samples, including 8,221 targets, were analyzed to determine passage rate and flight direction. Nightly passage rates varied from  $3 \pm 3$  t/km/hr to  $728 \pm 136$  t/km/hr, with the overall passage rate for the entire survey period at  $254 \pm 45$  t/km/hr. Mean flight direction through the project area was  $40^\circ \pm 66^\circ$ .

The mean flight height of all targets was  $422 \text{ m} \pm 54 \text{ m}$  ( $1,384' \pm 177'$ ) above the radar site. The average nightly flight height ranged from  $172 \text{ m} \pm 37 \text{ m}$  ( $564' \pm 121'$ ) to  $831 \text{ m} \pm 23 \text{ m}$  ( $2,726' \pm 75'$ ). The percent of targets observed flying below 120 m (394’) also varied by night, from 0 to 47 percent. The seasonal average percentage of targets flying below 120 m (394’) was 11 percent.

The mean flight direction, qualitative analysis of the surrounding topography and landscape, and mean flight altitude of targets passing over the project area indicates that avian migration in this area involves a broad front type of landscape movement. This type of broad front movement, particularly in conjunction with the high-elevation passage levels, demonstrates a limited avian mortality risk during spring migration. 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.

### *Bat Migration*

The spring field survey included deployment of 1 to 2 Anabat II detectors on 46 separate nights, yielding a total of 46 detector-nights. Sampling occurred from April 14 to May 30. On nights when only one detector was operated, the detector was deployed at a height of approximately 30 m (100’) in a

meteorological measurement tower (met tower). On nights when two detectors were operating simultaneously, the second detector was deployed at a height of approximately 15 m (50') from the same tower. The detectors were set to collect data from 7:00 pm to 7:00 am, which meant that sampling occurred from before sunset to after sunrise on each night of sampling.

A total of 12 bat call sequences were recorded during the spring survey period. Calls were detected throughout the sampling period, although 5 of the 12 calls were detected between May 10 and May 13. Due to the low numbers of calls detected, hourly passage rates were not calculated. In general, most bat call sequences were detected between sunset and midnight.

When possible, recorded bat calls were identified to species, genus (in the case of *Myotis*), or as "unknown," based upon the shape of the call sequence, the slope, and the maximum and minimum frequencies. Recorded calls were compared to reference libraries of known calls created using the same equipment. All of the 12 calls recorded at Marble River belonged to the genus *Myotis*.

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## **1.0 Introduction**

### **1.1 Project Context**

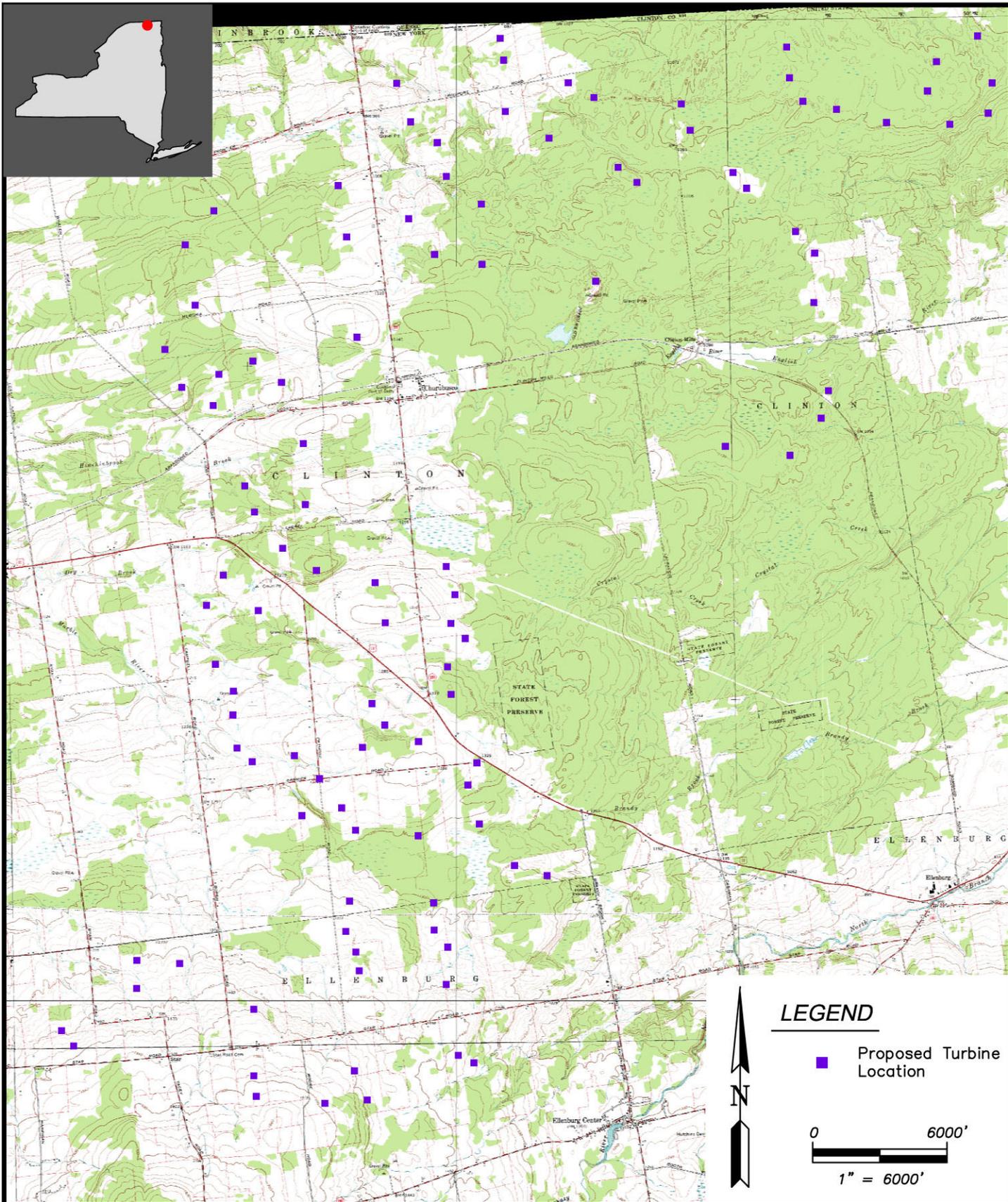
The proposed project is a 218-megawatt (MW) wind power facility, consisting of 109 2.0-megawatt (MW) wind turbines and associated support facilities. Eighty-nine of these turbines are proposed for the Town of Clinton, and 20 in the Town of Ellenburg. The proposed substation is located in the south central portion of the site in a wooded area, approximately 762 m (2,500') east of Patnode Road and immediately north of the New York Power Authority (NYPA) transmission line

Birds are known to have collided with tall structures, such as buildings and communication towers, particularly when weather conditions are foggy (Crawford 1981; Avery *et al.* 1976, 1977). Depending on their height and location, wind turbines can also pose a potential threat to migrating birds because they are relatively tall structures, have moving parts, and may be lit.

The surveys for this project were conducted to provide data that will be used to help assess the potential risk to birds and bats from this proposed project. The scope of the surveys was based on standard methods that are developing within the wind power industry and consultation with the New York Department of Environmental Conservation (NYDEC). A Work Plan was submitted to NYDEC in May of 2005 and an agreement reached on ecological studies to be performed.

### **1.2 Project Area Description**

The proposed project area includes approximately 19,310 acres of leased private land in the Towns of Clinton and Ellenburg in Clinton County, New York (Figure 1-1). The site is in the vicinity of the Hamlet of Churubusco, and is bordered by County Line Road to the west, West Hill Road to the south, Canaan Road to the east, and the U.S./Canadian Border to the north. The Adirondack Park boundary ("blue line") lies approximately 1,800 feet south of the nearest proposed turbine. Land use within the area is dominated by active farms, managed forestland, and single-family rural residences that generally occur along the road frontage. The central and southern portions of the project area are characterized by active and reverting agricultural land, while the northern portion of the site is dominated by undeveloped wetlands and intensively managed (logged) forestland.



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**Figure 1-1**  
*Study Area Location Map  
Marble River Wind Project  
Clinton and Ellenburg, New York*

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### **1.3 Survey Overview**

Woodlot Alternatives, Inc. (Woodlot) conducted field investigations for bird and bat migration 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, and eagles) in the project area, including number and species, general flight direction, and approximate flight height;
- document the overall passage rates for avian nocturnal migration in the vicinity of the project area, including the number of migrants, their flight direction, and their flight altitude; and
- document the presence of bats in the area, including the rate of occurrence and, when possible, species presence.

The field surveys included diurnal raptor migration surveys, a radar study of nocturnal bird and bat migration activity, and recordings of bat echolocation calls in several landscape settings and heights. Surveys were conducted from March to May 2005, although effort for the different aspects of the work varied within this time period. A total of 10 days of raptor surveys, 39 nights of radar surveys, and 46 nights of bat detector recordings were completed.

Raptor surveys were conducted near an open field that provided a good view of potential spring migration activity. Methods employed were the same as those used by the Hawk Migration Association of North America (HMANA).

Radar surveys were conducted from the vicinity of a meteorological measurement tower (met tower), which provided wind data for the time period of sampling. 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 Anabat II (Titley Electronics Pty Ltd) bat detectors to record the location and timing of bat activity. One or two detectors were used during the survey, resulting in a total of 46 detector-nights that were recorded over the course of the 46 nights when the detectors were deployed. The detectors were deployed within the guy wire system of the met tower at heights of 15 m and 30 m (50' and 100') or, if one detector was used, at 30 m (100') above the ground. Deployment in this fashion provided information on the bat community in the project area and, to some extent, their flight characteristics.

For each survey period, weather conditions were recorded at the survey location to provide information about temperature, cloud cover, wind direction and wind speed. Regional cloud ceiling height information was obtained daily from the Aviation Routine Weather Report (METAR) data from the Plattsburgh Regional Airport (KPLB) in Plattsburgh, NY (NOAA 2005).

This report is divided into three primary sections that discuss the methods and results for each field survey. Each section includes summary graphs of the survey results and supporting data tables are also provided.

## **2.0 Diurnal Raptor Surveys**

### **2.1 Introduction**

The project area site is located in the northeastern portion of the Central Continental Hawk Flyway that abuts 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. General raptor migration in the pathway is southwestward to their wintering grounds and northeastward in the spring (Kerlinger 1989, Kellogg 2005).

In particular, this site lies to the south of the Canadian border and just north of the Adirondack Mountains whose ridges with their updrafts provide “leading lines” for migrating hawks to follow. In this way, raptors are able to use the northern ends of ridges or mountains to gain altitude via thermal development or ridge-generated updrafts before gliding as far as possible to another suitable lift site (Kerlinger 1989). During spring migration, raptors fly north over the Adirondack Mountains and encounter a different landscape. The topography of the area changes from mountainous features to a relatively flat and uniform landscape mosaic of farm fields and forests. Due to this lack of mountainous topography, migrating hawks are more dispersed throughout the landscape.

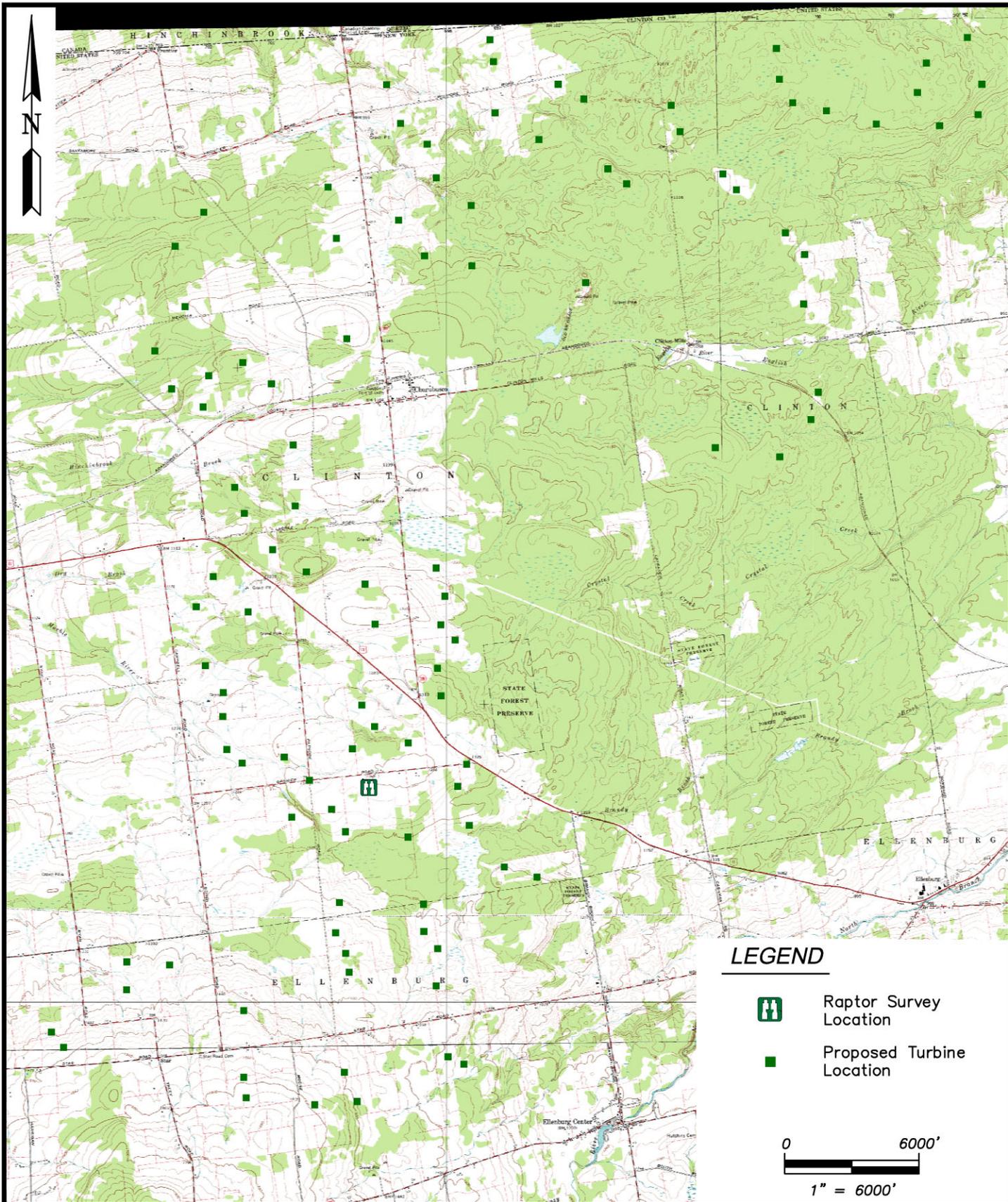
Because northern NY lies at the northern range of many species breeding grounds, there are fewer birds passing through this area compared to other more southern locations in the North American hawk flyways. Raptors migrating through northern NY typically migrate over a broad front. Raptor migration through the project area is not as concentrated as in other flyways because long, continuous ridges are not as common at the project site as in other regions of the Central and Eastern Continental Hawk Flyway. Because migration at this site occurs over a broad front, flight lines are more difficult to identify (Street 2003).

Woodlot conducted a raptor survey to quantify raptor migration in the vicinity of the proposed project location. Information collected included species, approximate flight height, general direction and flight path, as well as other notable flight behavior.

### **2.2 Methods**

#### *Field Surveys*

Raptor surveys were conducted in a farm field along Gagnier Road in Ellenburg, NY (Figure 2-1). This site, at an elevation of 396 m (1,300'), provided a view in all directions. The Adirondack Mountains are located due south of the project area. Lyon Mountain (3,803'), one of the northernmost peaks of the Adirondack Mountains, provides the backdrop for the observation site. To the north, a forested field border slightly obstructs the view. Eastern and western views consisted of farm fields, forest fragments, and distant ridges. Raptor surveys occurred on 10 days from April 5 to May 6, 2005, and were generally conducted from 9 am to 3 pm so as 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.



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**Figure 2-1**  
*Raptor Survey Location Map*  
*Marble River Wind Project*  
*Clinton and Ellenburg, New York*

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Surveys were based on methods defined by the HMANA. Observers scanned the sky and surrounding landscape for raptors flying into the survey areas. Observations were recorded onto HMANA data sheets, which summarize the data by hour. Detailed notes on each observation, including location and flight path, flight height, and activity of the animal, were recorded. Height of flight was categorized as less than or greater than 120 m (394') above ground, which is the approximate maximum height of the proposed wind turbines. Nearby objects with known heights, such as the met towers and surrounding trees, were used to gauge flight height. Information regarding the raptors' behavior and activity at the same locations throughout the study period was noted to differentiate between migrant and resident birds. General flight paths of individuals observed were plotted on topographic maps of the project area.

Hourly weather observations, including wind speed, direction, temperature, percent cloud cover, and precipitation, were recorded on HMANA data sheets. 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, they were classified as unidentified raptor.

#### *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, and by hour, was also calculated as was the species composition of birds observed flying below and above 120 m (394'). Finally, the mapped flight locations of individuals were reviewed to identify general patterns of migrating raptors.

Observations from the project area were compared to other site totals from data from local or regional HMANA hawk watch sites available on the HMANA web site. Those HMANA watch sites included Derby Hill in Mexico, NY, Braddock Bay in Hilton, NY, and Hamburg, NY.

## **2.3 Results**

Surveys were conducted for a total of 60 hours during the 10 survey days. A total of 170 raptors, representing 11<sup>1</sup> species, were observed during that time, yielding an overall observation rate of 2.83 birds/hour (Appendix A Table 1; Figure 2-2). Turkey vultures (*Cathartes aura*)<sup>2</sup> were the most commonly observed species. Red-tailed hawks (*Buteo jamaicensis*) were the next most abundant species, followed by northern harriers (*Circus cyaneus*), and then by broad-winged hawks (*Buteo platypterus*). Nine individuals were not identifiable due either to distance from the observation site or very brief occurrences within the view of the surveyors. These were mostly from the genus *Buteo*, although one unidentified eagle was observed. One state-listed endangered Golden Eagle (*Aquila chrysaetos*) was observed. Seventeen state-listed threatened northern harriers were observed. The 4 species of concern observed were 8 Cooper's hawks (*Accipiter Cooperi*), 13 sharp-shinned hawks (*Accipiter striatus*), 2 osprey (*Pandion haliaetus*), and 1 northern goshawk (*Accipiter gentilis*). No big migration pushes or large kettles of hawks were observed from this site.

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

<sup>2</sup> 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.

Most surveys were conducted on clear days when the wind was light to moderate. During the earlier surveys in April, the temperature ranged from 1 to 13° C (35 – 55° F) while temperatures during surveys in late April and early May ranged from 10 to 21° C (50 – 70° F). Surveys on most days occurred after the passage of cold fronts. The development of thermals on these days was evident as temperatures increased and cumulus clouds formed. On some of the survey days, visibility was inhibited by morning fog (accompanied by light snowfall one day) that cleared as temperatures and wind speed increased. Some survey effort did occur on days when the weather and wind were sub-optimal for raptor migration due to inaccurate weather forecasting or relatively weak cold fronts.

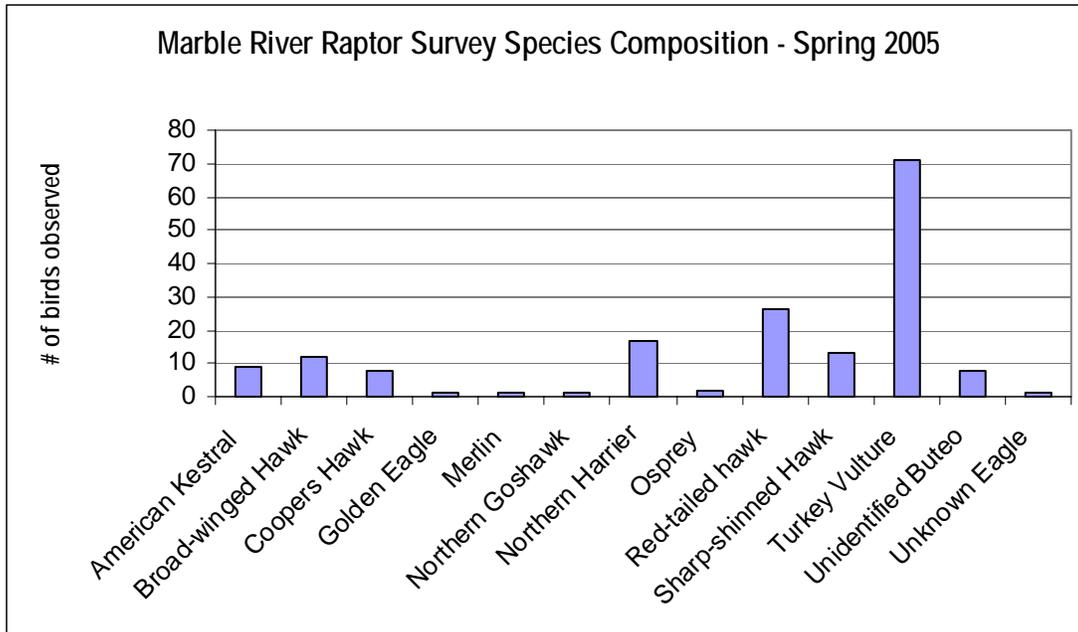


Figure 2-2. Species composition of raptors observed during raptor surveys.

This site had 10 probable residential raptors. There were 3 pairs of northern harriers, a pair of red-tailed hawks, and a pair of turkey vultures that may have been residential birds. Red-tailed hawks and northern harriers were frequently observed kiting and hunting over the project areas. Other observations of some American kestrels (*Falco sparverius*) and sharp-shinned hawks were noted to possibly be repeated sightings of the same individuals. In these cases, a particular individual may have been observed flying back and forth across a section of hillside, performing aerial displays, or perching in an area repeated during the same day.

The timing of raptor observations varied during each day. The observation rate of raptors during the survey was approximately 2.83 birds/hour. Typically, observations began slowly, with very few observations occurring during the first hour of the survey period, increased rapidly during the second hour of observation, and decreased again after 12:00 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). Most raptors were observed between the hours of 10:00 and 11:00 am.

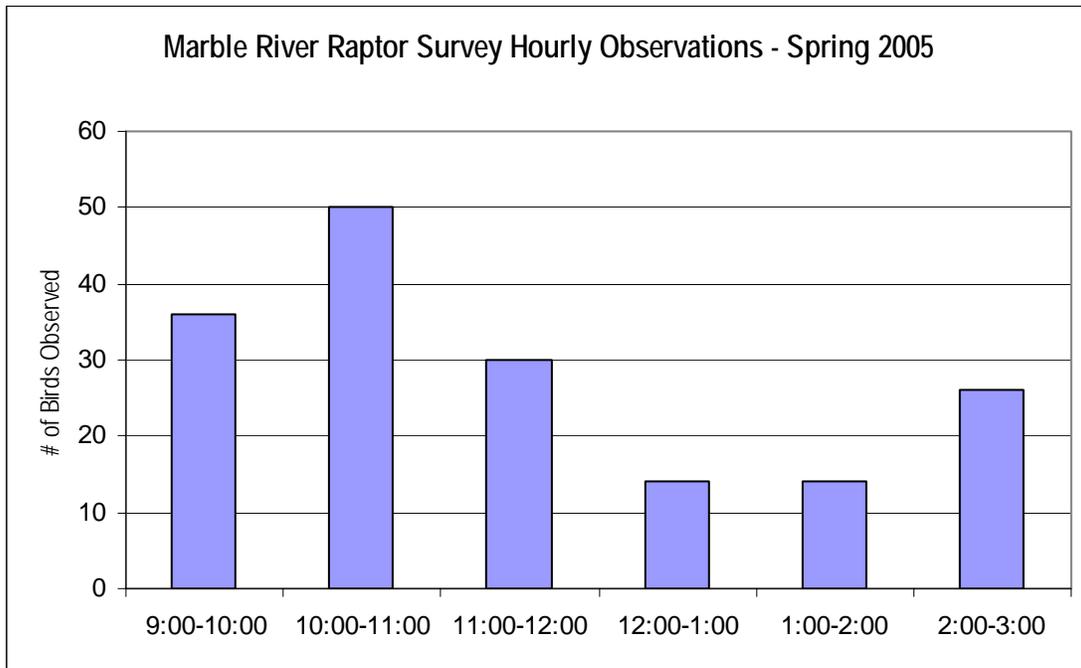


Figure 2-3. Hourly observation rates.

Flight heights were categorized as below or above 120 m (394'), the approximate height of the turbines. Overall, approximately 76 percent of the raptors observed were flying less than 120 m above the ground. Differences in flight altitudes between species were observed (Figure 2-4; Appendix A Table 3). Turkey vultures were frequently observed flying within the blade sweep area. Differences in flight altitudes between species were observed (Figure 2-4; Appendix A Table 3). Both small and large species, such as the accipiters, falcons, and buteos were consistently observed flying low. The most frequently observed species, turkey vultures, had a flight height below 120 m approximately 90 percent of the time. The flight heights of the golden eagle and merlin (*Falco columbarius*) were both below 120 m. Other species with the majority of flight heights below 120 m included northern harriers, American kestrels and Cooper's hawks. Meanwhile, most flights of broad-winged hawks, northern goshawk, and osprey were above 120 m.

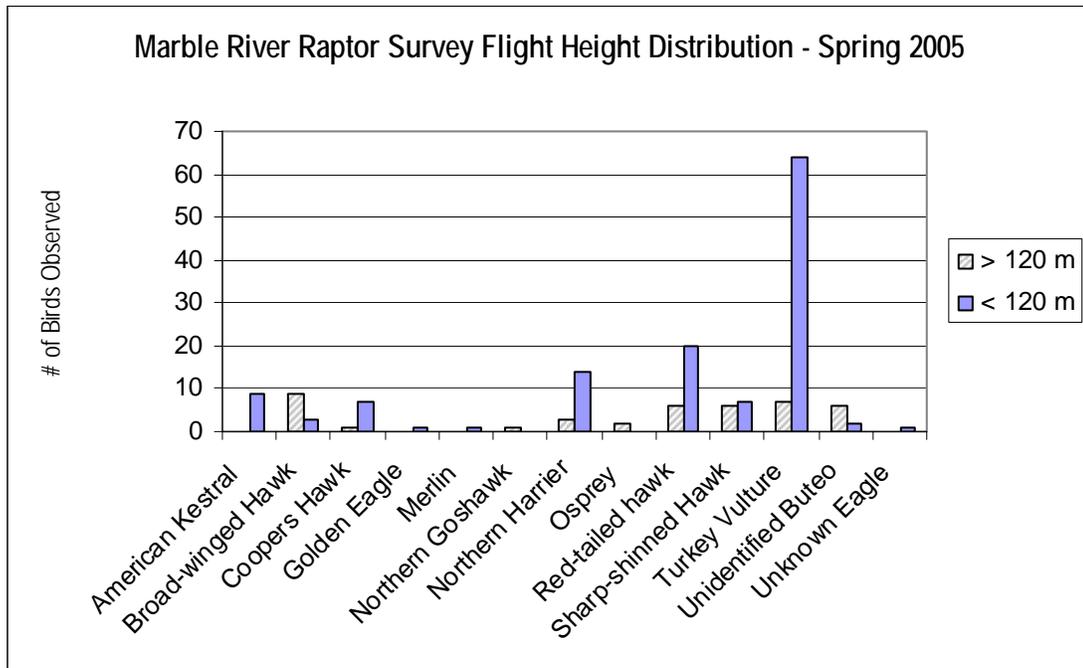
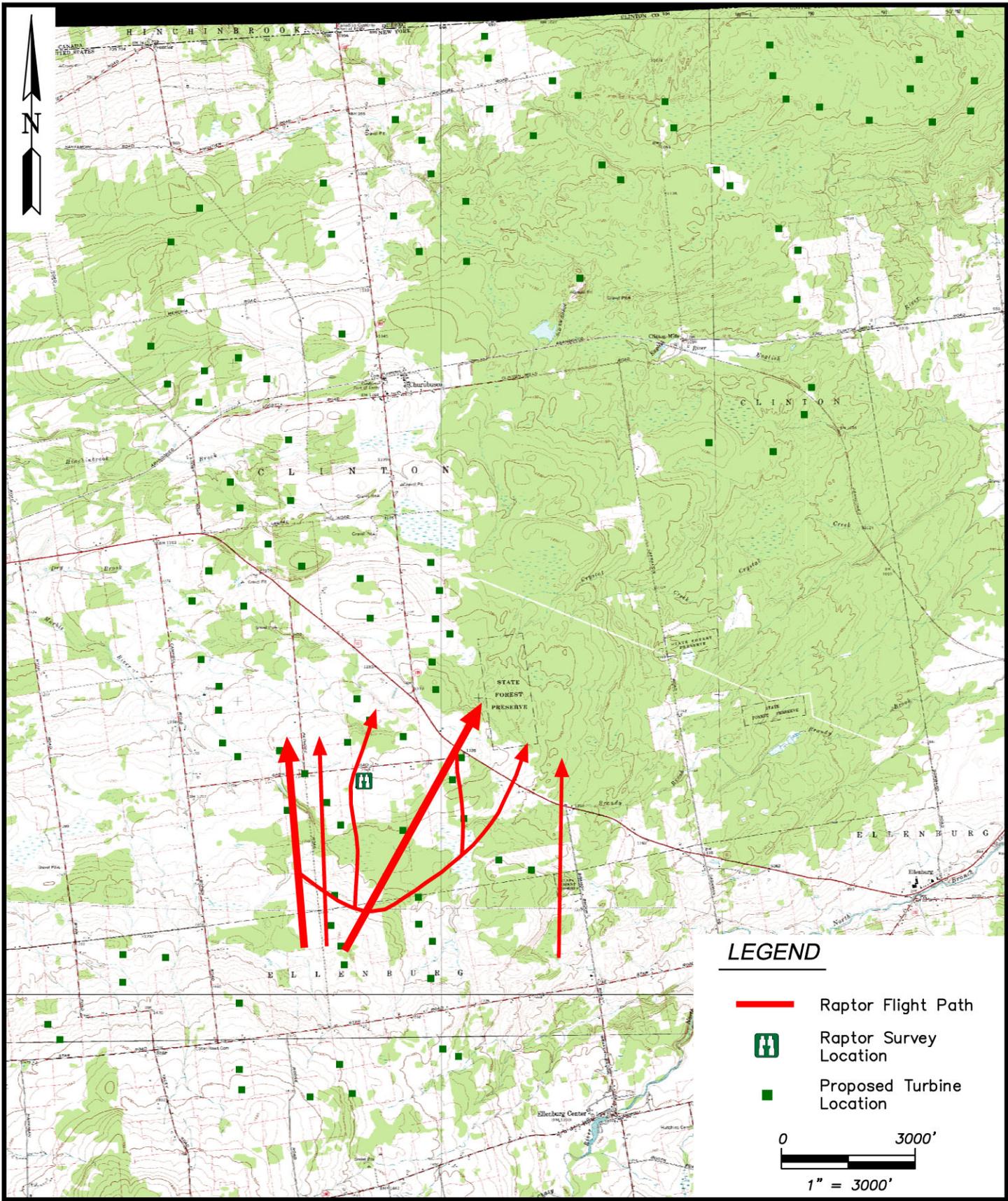


Figure 2-4. Raptor flight height distribution.

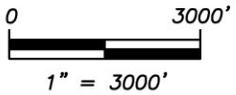
The flight habits of raptors in the project area were variable, though the locations of those observations often occurred in similar locations. Most migrants passing through the project area were flying on a south to north orientation. Many of the birds, particularly red-tailed hawks, northern harriers, and American kestrels, flew in different directions over the observation site and were sometimes 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). Northern harriers were occasionally observed flying low over fields and in various directions suggesting a resident bird. The general locations of migrating raptors observed are depicted in Figure 2-5.

Raptor migration at Marble River occurred over a broad front; hence, migration pathways were not easily identifiable. Raptors flew distributed across the study area but two major and five minor flyways have been generalized. Most flyways were on an S-N orientation and most flights were over forested areas. However, some of the minor flyways occurred over farm fields. There were no differences in flight heights between the major and minor flyways.



**LEGEND**

- Raptor Flight Path
- Raptor Survey Location
- Proposed Turbine Location



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**Figure 2-5**  
*Raptor Migration Flight Paths*  
*Marble River Wind Project*  
*Clinton and Ellenburg, New York*

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## 2.4 Discussion

A total of 170 migrating raptors were observed during 10 days of field surveys from April to May 2005 at Marble River site. Eleven different species were recorded with an observation rate of 2.83 birds/hour. Turkey vultures were the most abundant species observed and comprised approximately 42 percent of all observations. Red-tailed hawks comprised 15 percent of observations. One state-listed endangered species (golden eagle), 1 state-listed threatened species (northern harrier), and 4 species of concern (northern goshawk, Cooper's hawk, osprey, and sharp-shinned hawk) were observed migrating through the project area. Broad-winged hawks were usually observed in pairs and no large kettles of broad-winged hawks were reported during the study. Most birds observed were considered migrants, although several may have been residential birds based on their activity and behavior. Golden eagles, red-tailed hawks, northern harriers, Cooper's hawks, sharp-shinned hawks, and turkey vultures were the first raptors observed in early April. Ospreys were the last species to migrate through the study site. Two species of raptors (northern harrier and red-tailed hawk) were believed to be paired and local residential birds.

For this site, passage rates are relatively low compared to other sites in the region, where raptor migration surveys were conducted during the same timeframe (spring 2005). Observation rates at other NY sites ranged from 33 to 69 (birds/hour). There could be several reasons for the greater passage rates, including survey effort, geographical location, and visibility. The most active site was Derby Hill in Mexico, NY, with a total of 23,623 raptors counted (61.1 birds/hour). At Braddock Bay in Hilton, NY, 30,793 birds (68.8 birds/hour) were observed. In Hamburg, NY, 13,141 raptors (33.2 birds/hour) were observed. These areas may have very different landscape features (proximity to large bodies of water) than this project, but offer comparative regional information on raptor migration.

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 during their 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.

Geographical location can affect the magnitude of raptor migration at a particular site. Two well-known examples include Cape May, NJ, and Hawk Mountain, PA. 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 (Appendix A, Table 4) are demonstrative of this situation.

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, merlins, 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 migrated within the blade-swept area of the proposed turbines. Approximately 76 percent of raptors were observed flying below 120 m (394'). There were differences between species, generally with accipiters, falcons, and most buteos flying at lower altitudes. Generally, smaller species were observed at lower flight altitudes. Broad-winged hawks and osprey were most frequently observed migrating above the height zone of proposed wind turbines at the site. Overall, it may be easier to detect large species flying at low and high altitudes; therefore, smaller species may sometimes be underrepresented (Kerlinger 1989).

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 that 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). There were no detectable differences in flight heights between major and minor flight pathways.

Broad movements of raptors in the project area were observed. On some days, raptors were observed flying both north and south. This could be attributed to migrants overshooting their breeding grounds or presence of residential birds moving across the study area.

## **2.5 Conclusions**

The results of the field surveys indicate that fall raptor migration in the Marble River 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 hillsides, valleys, and individual peaks that migrating raptors use as stepping stones as they pass through the area.

There is potential that some of the birds observed may have not demonstrated characteristics of resident species. Resident birds fly at lower heights than migrants, as they are typically undertaking small-scale movements while foraging. There is potential that many of the turkey vultures observed are resident birds. There are a consistent number of turkey vultures observed in the mornings on each of the survey days. It cannot be determined what percentage of these birds are migrants as opposed to local birds engaging in daily dispersal patterns.

Migrants observed passing through the project area flew higher than resident birds. These birds were taking advantage of thermals and crosswinds flowing up hillsides and out of valleys. Consequently, they were consistently observed gaining altitude in these areas before following straight flight paths north. Based on the flight paths of migrants observed, it is likely that the central paths of the fields, where most wind turbines are being proposed, receive low use by migrating raptors. The majority of birds follow valleys, ridgelines, and side slopes that develop stronger thermals and crosswinds for migration; however, this site lacks those landscape features and migrants move across the landscape in inconsistent patterns. This observation site had low to moderate numbers and diversity of migrating hawks. Raptors observed during the study were seen flying low when crossing fields. This behavior may be a potential concern for the project site due to the non-continuous ridges of the northern-NY landscape and the behavior of migrating raptors.

## 3.0 Nocturnal Radar Survey

### 3.1 Introduction

The vast majority of North American landbirds 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. Additionally, night migration may 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 nocturnally 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 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 Marble River project area to characterize spring nocturnal migration patterns in the area.

The goal of the surveys was to characterize the overall passage rates for nocturnal migration in the vicinity of the project area, including the number of migrants, their flight direction, and their flight altitude. 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 Furuno FR1510-MKIII® radar was mounted atop a platform approximately 4 m (13') above the ground. The radar display and all other equipment were stored and used in a mobile radar station.

The radar has a peak power output of 12 kW and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen 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.

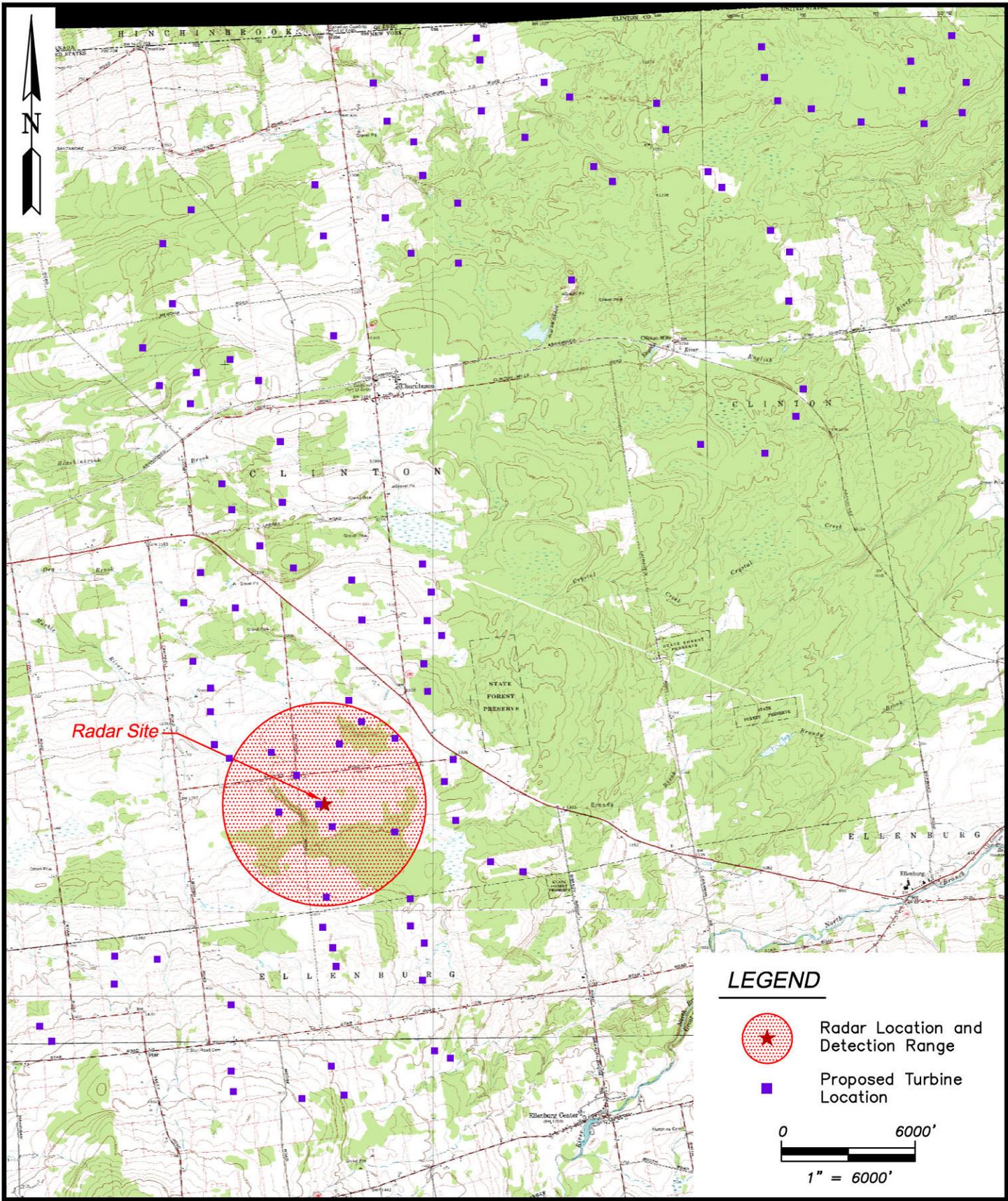
The radar was equipped with a 2-m (6.5') waveguide antenna. The antenna has a vertical beam height of 20° (10° above and below horizontal) and the front end of it was inclined approximately 5° to increase the proportion of the beam directed into the sky.

The radar unit was located centrally on the site in an area that both maximized site characterization and objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas. The radar unit was positioned on the edge of a field and atop a 4 m (13') tall platform to minimize the amount of ground clutter and maximize ability to detect targets.

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 90° to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but instead provide information on the altitude of targets passing through the vertical, 20° 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, thereby 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.

Radar surveys were conducted from sunset to sunrise. Thirty-nine nights of surveys were conducted between April 15 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 including occasional showers were sampled. The operation of the radar for each survey night is presented in Table 3-1.



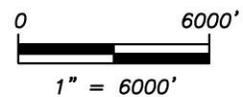
**LEGEND**



Radar Location and Detection Range



Proposed Turbine Location



PREPARED BY:



**WOODLOT**  
ALTERNATIVES, INC.  
ENVIRONMENTAL CONSULTANTS

DATE: January 2006

SCALE: 1" = 6000'

JOB NO. 105038

FILE: 105038-00-Location.dwg

*Figure 3-1*  
**Radar Location Map**  
*Marble River Wind Project*  
*Clinton and Ellenburg, New York*

REV.

**Table 3-1. Survey dates, level of effort, and weather – Marble River, Spring 2005**

<b>Night of</b>	<b>Sunset</b>	<b>Sunrise</b>	<b>Hours of Survey</b>	<b>Weather</b>	<b>Wind Direction (coming from)</b>
April 15	7:42 PM	6:15 AM	9	calm and clear	SE
April 16	7:44 PM	6:13 AM	4	calm and clear	S
April 17	7:45 PM	6:12 AM	9	breezy then calm, partly cloudy	SW
April 18	7:46 PM	6:10 AM	11	calm and clear	SW
April 19	7:47 PM	6:09 AM	9	breezy with some rain	SW
April 21	7:49 PM	6:06 AM	11	calm and clear	SW
April 22	7:50 PM	6:04 AM	2	light wind, cloudy	SE
April 24	7:53 PM	6:01 AM	6	cloudy, light wind, some rain and light snow	W
April 29	7:58 PM	5:54 AM	10	calm, clear then cloudy	SW
April 30	8:00 PM	5:53 AM	7	light wind, cloudy and foggy	W to SW
May 1	8:01 PM	5:51 AM	10	breezy and partly cloudy	SW
May 2	8:02 PM	5:50 AM	10	breezy then calm, mostly clear	SW
May 3	8:03 PM	5:49 AM	10	calm and clear then cloudy, passing showers late	SW
May 4	8:04 PM	5:47 AM	10	calm and clear	SW
May 5	8:05 PM	5:46 AM	10	calm and clear	SE
May 6	8:06 PM	5:45 AM	9	calm and clear	SE
May 7	8:07 PM	5:44 AM	10	breezy and partly cloudy	NE
May 8	8:09 PM	5:42 AM	9	calm and cloudy	NE
May 9	8:10 PM	5:41 AM	10	light wind and clear	SE
May 10	8:11 PM	5:40 AM	10	calm then breezy, clear then cloudy	SE to SSW
May 11	8:12 PM	5:39 AM	8	cloudy with heavy gusts and rain showers	NW
May 12	8:13 PM	5:38 AM	8	calm and clear	NW to S to N
May 13	8:14 PM	5:37 AM	8	calm, cloudy with passing showers late	SE to S
May 14	8:15 PM	5:36 AM	4	light wind, cloudy	SE
May 15	8:16 PM	5:35 AM	5	light wind, cloudy, some rain	W
May 16	8:17 PM	5:34 AM	10	calm, cloudy, passing rain showers	SW to W
May 17	8:18 PM	5:33 AM	10	calm, cloudy	W to SW
May 18	8:19 PM	5:32 AM	10	calm, partly cloudy	N
May 19	8:20 PM	5:31 AM	8	calm and cloudy	SE
May 20	8:21 PM	5:30 AM	7	Not available	n/a
May 21	8:22 PM	5:29 AM	5	Not available	n/a
May 22	8:23 PM	5:28 AM	2	breezy, cloudy with light rain	NE
May 23	8:24 PM	5:27 AM	7	strong winds, cloudy with gusts	E to NE
May 24	8:25 PM	5:27 AM	9	light wind, partly cloudy	E
May 25	8:26 PM	5:26 AM	9	light wind, clear	SE
May 26	8:27 PM	5:25 AM	7	breezy then calm, cloudy, some rain	NE
May 27	8:28 PM	5:25 AM	3	light wind, cloudy, misty and raining	NW
May 28	8:29 PM	5:24 AM	6	light wind and partly cloudy	SW
May 29	8:30 PM	5:23 AM	8	light wind, mostly cloudy, light rain early	S

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

### *Data Collection*

The radar display was connected to video recording software of a computer. 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 samples during the first 15 minutes after sunset;
- One 10-minute vertical sample during the next 30 minutes; and
- Eight 1-minute 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. Weather data recorded 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 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 diffuse 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, bats, and insects observed. This information was used during data analysis to help distinguish between 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 6 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)  $\pm$  1 SE. The hourly rates were used to calculate passage rates for each night and the entire season.

Mean target flight directions ( $\pm$  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 in this program are based on Batschelet (1965), which take into account the circular nature of the data. Nightly wind direction was also calculated using similar methods from 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 ( $\pm 1$  SE) were calculated by hour, night, and overall season. The percent of targets flying below 120 m (394') (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 310 hours on 39 nights between April and May 2005 (Table 3-1). The radar site provided generally good visibility of the surrounding airspace and targets were observed in most areas of the radar display unit. The radar site had good views to the south and east. The western view was slightly obstructed by a low-lying forested wetland.

#### Passage Rates

A total of 780 one-minute radar video samples were analyzed during the passage rate and flight direction analysis and included a total of 8,221 targets. Nightly passage rates varied from  $3 \pm 3$  t/km/hr (May 22) to  $728 \pm 136$  t/km/hr (April 22), and the overall passage rate for the entire survey period was  $254 \pm 45$  t/km/hr (Figure 3-2; Appendix B Table 1). On nights with highest observed passage rates, the wind was typically from the southwest to southeast. During rainy nights, only certain hours could be sampled. However, most survey nights had a least 10 hours of survey time. During inclement weather, researchers were able to record at least 2 hours of data per night.

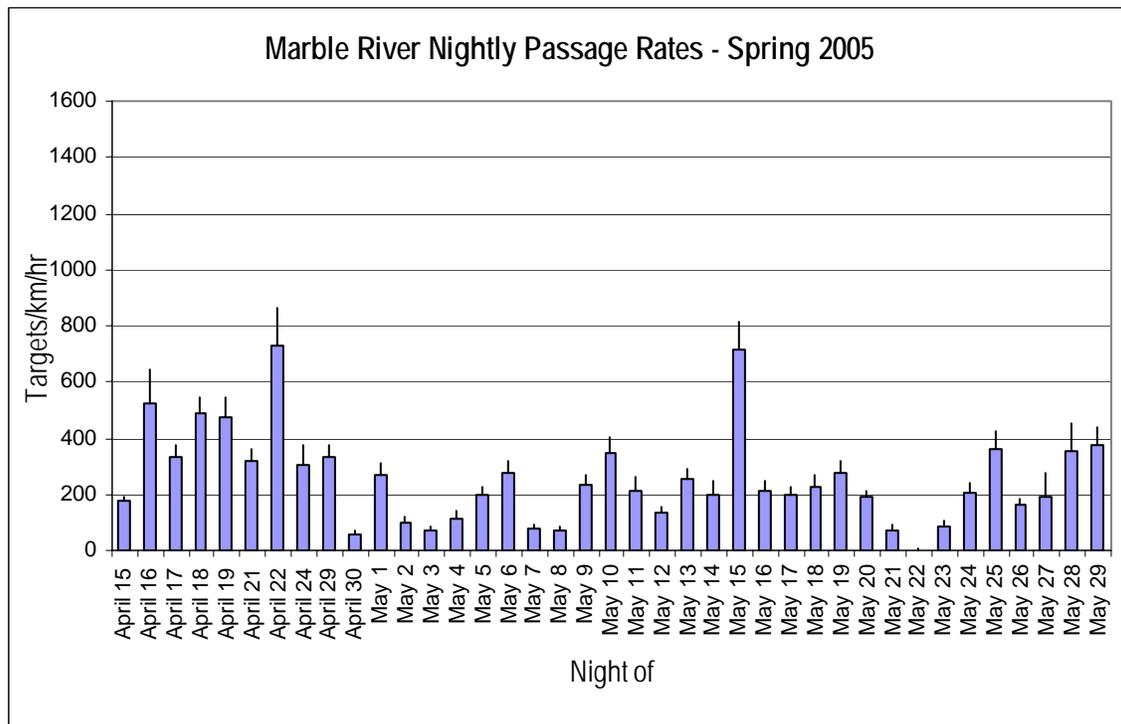


Figure 3-2. Nightly passage rates (error bars = 1 SE) observed.

Individual hourly passage rates throughout the entire season varied from 3 to 728 t/km/hr (Appendix B Table 1). Hourly passage rates varied throughout each night and for the season overall.

For the entire season, passage rates were highest during the fourth and fifth hour after sunset, followed by a relatively steady decline for the remainder of the night (Figure 3-3).

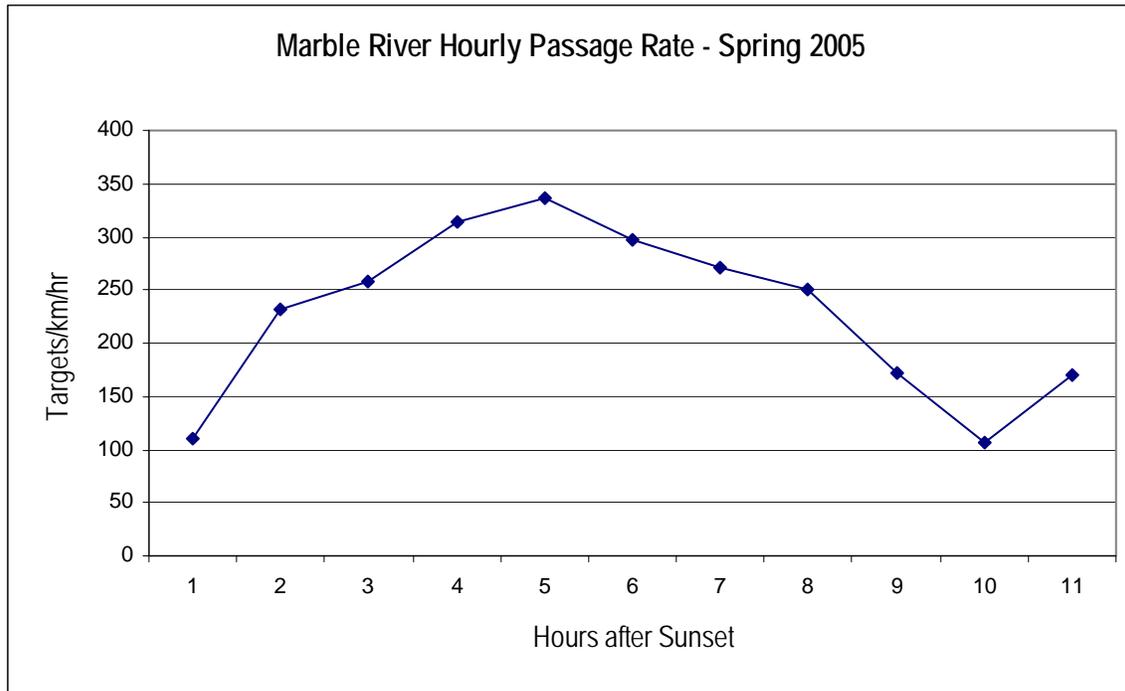
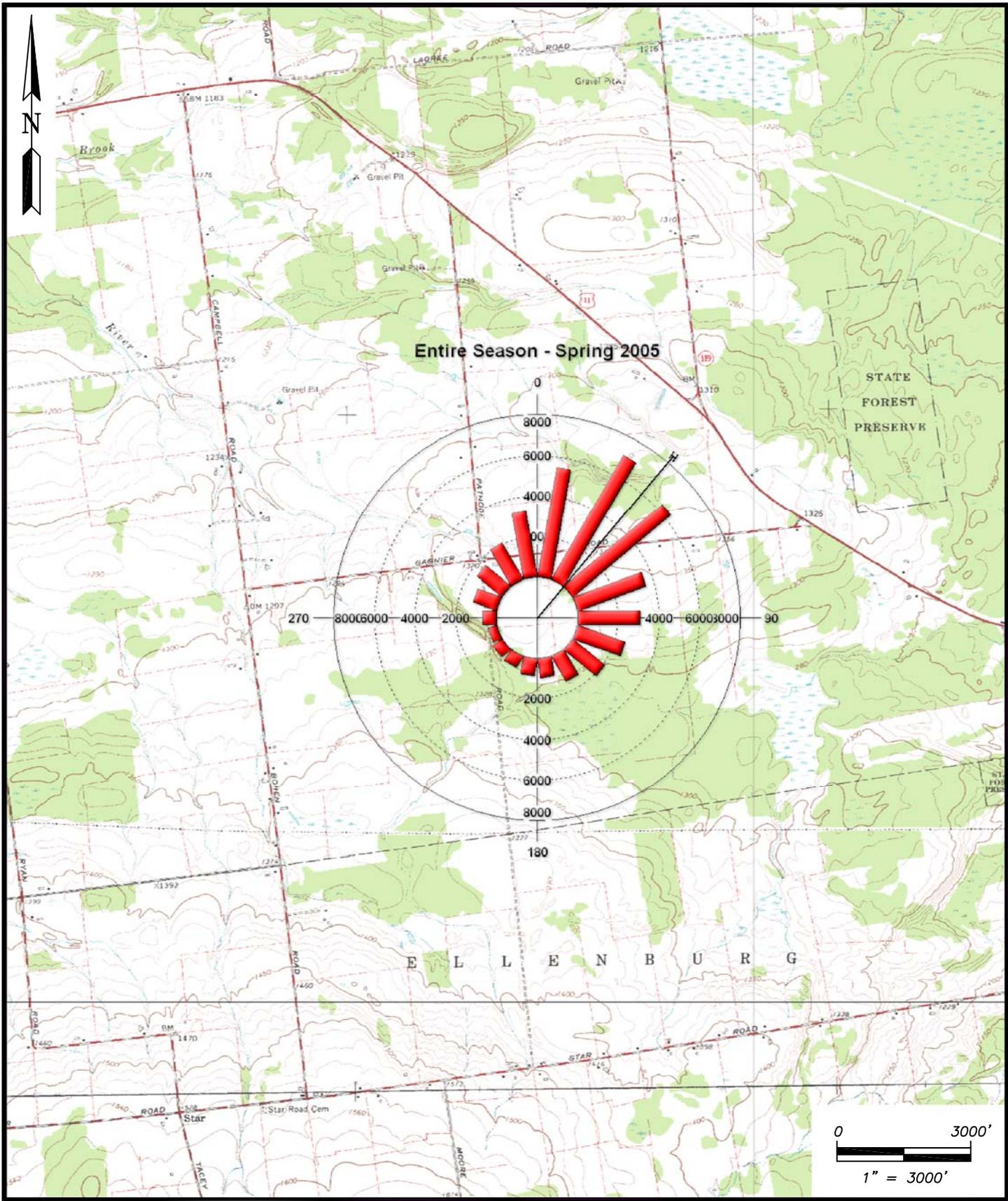


Figure 3-3. Hourly passage rates for entire season.

#### *Flight Direction*

Mean flight direction through the project area was  $40^{\circ} \pm 66^{\circ}$  (Figure 3-4; Appendix B Table 2). There was considerable night to night variation in mean direction, although within each night there was less variation (Figure 3-5). The average nightly flight direction was typically northeast on more than half of the nights sampled.



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DATE: September 2005
SCALE: 1" = 3000'
JOB NO. 105038
FILE: 105038-00-Location.dwg

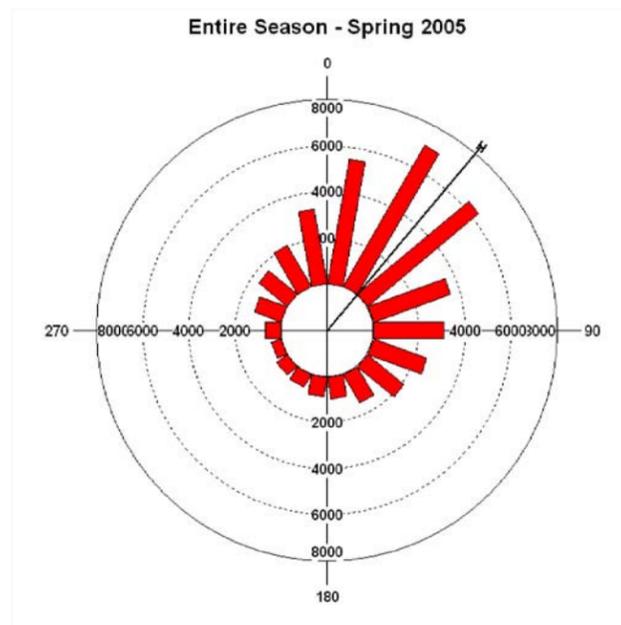
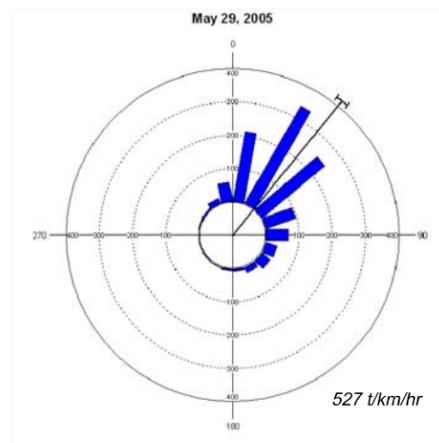
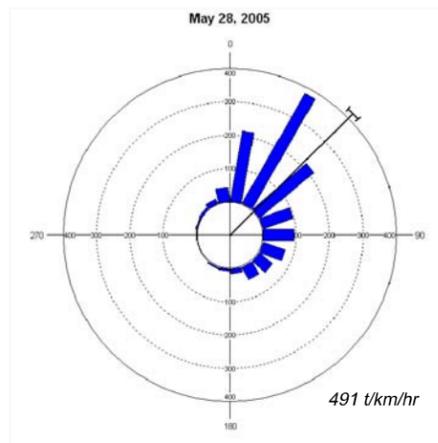
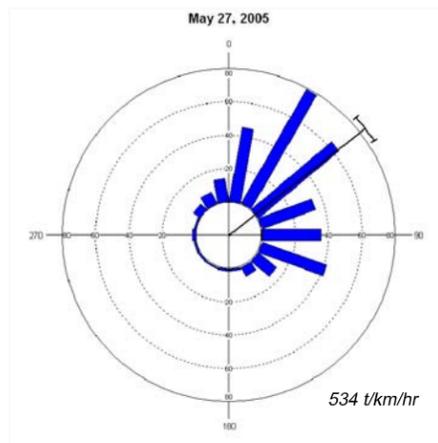
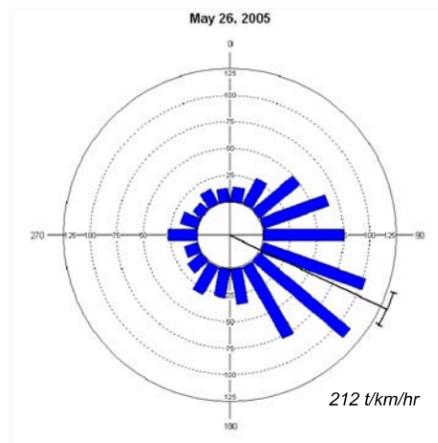
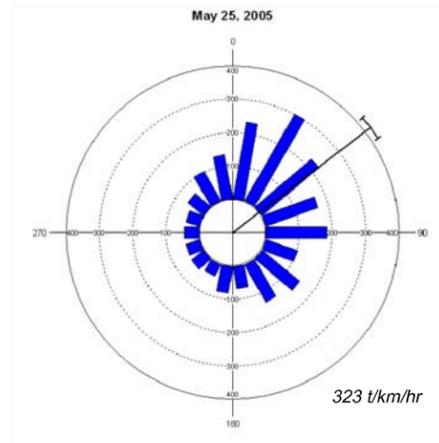
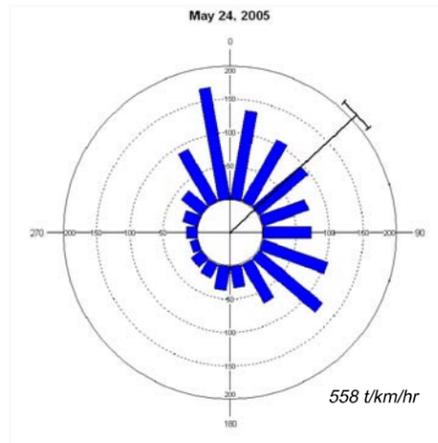
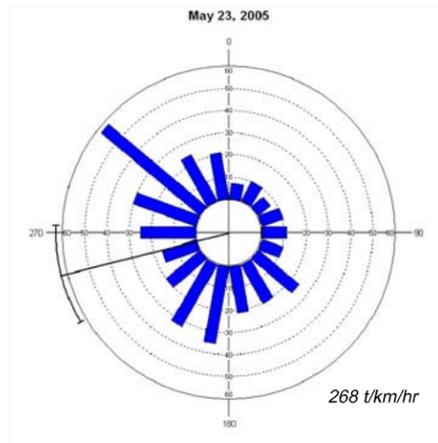
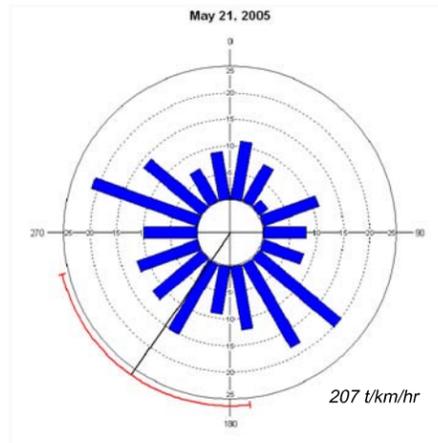
*Figure 3-4*  
 Spring 2005 Target Flight Direction  
 Marble River Wind Project  
 Clinton and Ellenburg, New York

REV.









### RADAR DATA ROSE LEGEND

Observation Period → April 19, 2005

Number of Targets  
Histogram scale varies from night to night.

95% Confidence Interval

Mean Flight Direction

Mean Hourly Traffic Rate (Targets per Kilometer per Hour)  
376 t/km/hr

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

PROJECT: Marble River Wind Project		SHEET TITLE: Nightly Mean Flight Direction		NO.		REVISIONS		DATE	
ADDRESS: Clinton and Ellenburg, New York		SCALE: n/a		DATE: September 2005					
<b>WOODLOT</b> ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS <small>105038-00-Traffic.dwg</small>		PROJ. NO. 105038		FIGURE NO. 3-5					

*Flight Altitude*

The mean flight height of all targets was  $422 \text{ m} \pm 54 \text{ m}$  ( $1,384' \pm 177'$ ) above the radar site. The average nightly flight height ranged from  $172 \text{ m} \pm 37 \text{ m}$  ( $564' \pm 121'$ ) to  $831 \text{ m} \pm 23 \text{ m}$  ( $2,726' \pm 75'$ ) (Figure 3-6, Appendix B Table 3). The percent of targets observed flying below 120 m (394') also varied by night, from 0 percent to 47 percent (Figure 3-7). The seasonal average percentage of targets flying below 120 m (394') was 11 percent.

Hourly flight height peaked from about 2 hours after sunset (Figure 3-8). Within 100 m (328') height zones, the greatest percentage of targets (16%) was documented from 200 m to 300 m (656' to 984'), 54 percent were observed from 200 m to 700 m (656' to 2,297'), and 75 percent were observed from 100 m to 800 m (328' to 2,625') above the radar site (Figure 3-9).

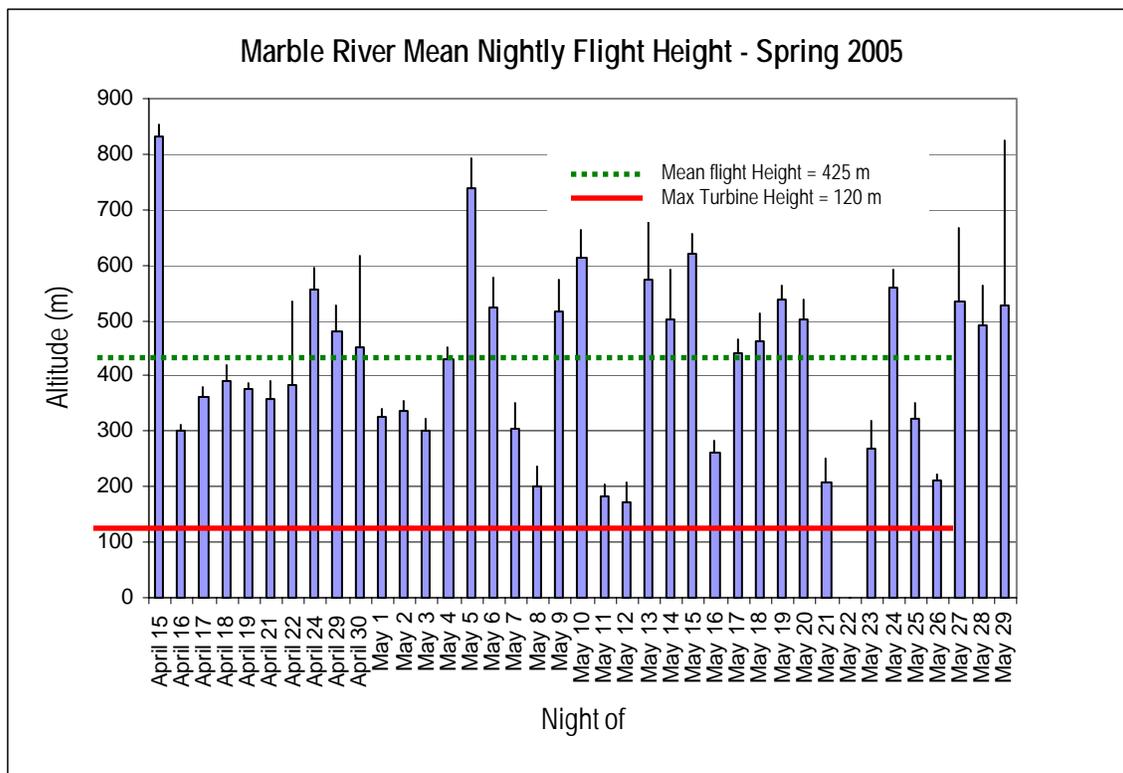


Figure 3-6. Mean nightly flight height of targets.

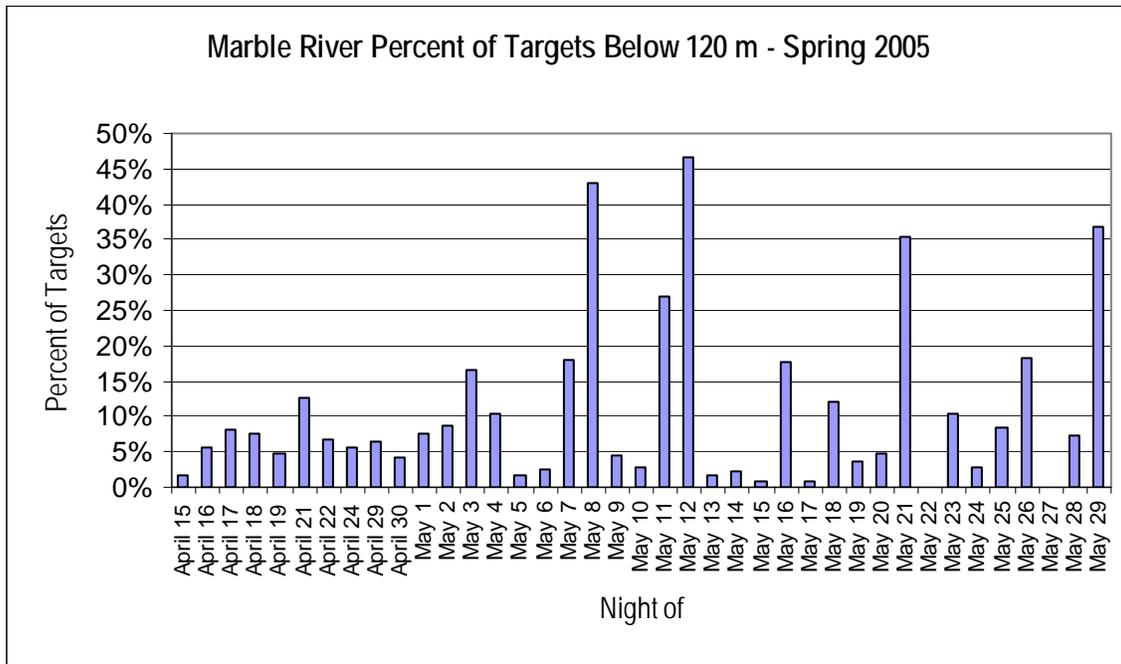


Figure 3-7. Percent of targets observed flying below a height of 120 m (394').

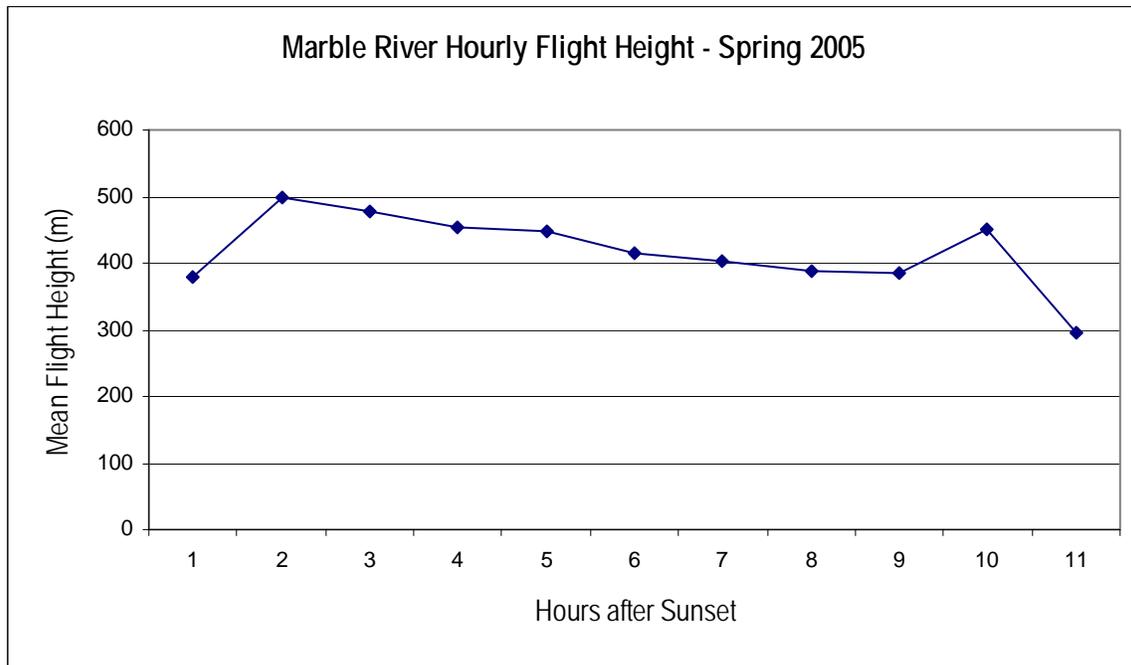


Figure 3-8. Hourly target flight height distribution.

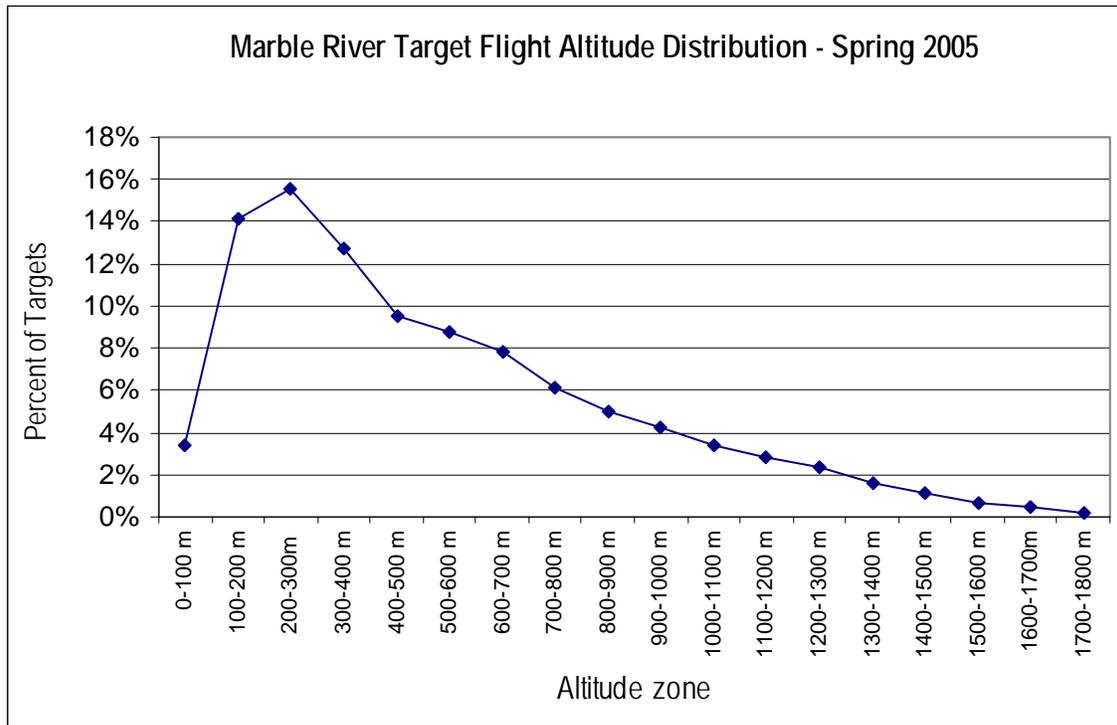


Figure 3-9. Target flight height distribution within 100 m height zones.

#### *Ceilometer Observations*

Ceilometer data collected during the radar survey yielded a total of 254 observations. Those observations, as is typical, resulted in relatively few bird observations. Only five birds were observed flying through the ceilometer beam.

### **3.4 Discussion**

Spring 2005 radar surveys documented migration activity and patterns in the vicinity of the proposed Marble River 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 (Richardson 1972). Consequently, nightly migration traffic rates can be expected to be variable and to peak when the best migration weather occurs. The variable nightly passage rates documented at Marble River 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.

Nightly passage rates varied from  $3 \pm 3$  t/km/h to  $728 \pm 136$  t/km/hr, with an overall mean of  $254 \pm 45$  t/km/hr. Passage rates often peaked 5 hours after sunset, which is later than typical time of nighttime migration activity of 3 to 4 hours after sunset (Able 1970; Gauthreaux 1971; Richardson 1971, 1972).

Few surveys using the same methods and equipment and conducted during the same time period are available for comparison (Table 3-2). In a similar study overlooking Lake Erie in western NY, Cooper *et al.* (2004a) documented spring 2003 passage rates between 15 and 1,702 t/km/hr with an overall passage rate of 395 t/km/hr. There are limitations in comparing that study with data from 2005, as year-to-year variation in continental bird populations invariably affects how many birds migrate through an area. However, nightly mean passage rates observed at Marble River were 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 sizes of continental bird populations are likely change from year-to-year. Second, the location of the Marble River project is more easterly than that survey. Consequently, the size of the continental bird population east of Lake Erie could be considerably smaller than other sites.

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

Location	Passage Rate
Chautauqua, NY	395
Copenhagen, NY	170
Wethersfield, NY	62

Finally, the visibility of the radar also affects passage rates documented during surveillance mode operation. Whenever energy is reflected from the ground, surrounding vegetation, and other objects that surround the radar unit, a ground-clutter echo appears on the display screen of the radar unit. Ground clutter can obscure part of the display screen thus obscuring bird targets. This occurrence was minimized by elevating the forward edge of the antenna by approximately 5°.

#### *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 varied topography, such as the most rugged areas of the northern Appalachians and the Alps. The landscape around the Marble River project area consists of plains and peaks with elevation differentials of 90 m to 260 m (300' to 850'). This is considerably less than in those other areas where potential topographic effects on flight direction have been observed. The mean flight direction of  $40^\circ \pm 66^\circ$  generally comes from the direction of the high peaks of the Adirondack Park.

### *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 (492') and 450 m (1,476') above the ground level, but on some nights the majority of birds observed were from 450 m (1,476') to 762 m (2,500') 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 (1,640') to 700 m (2,296') 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.* (2004a) documented a mean overall flight altitude of  $528 \pm 3$  m during a spring migration survey in Chautauqua, NY. The highest percentage (36 %) of migrants was documented 300 m (984') to 600 m (1,968') above the ground and the smallest percentage (0.1%) above 1,401 m. In the fall at Chautauqua, Cooper *et al.* (2004b) documented a mean flight altitude of 532 m (1,745') with a small percentage (4%) of targets flying less than 125 m (410') above the ground. Results from Marble River are similar to those of Cooper *et al.* (2004a), with nightly flight altitudes varying from  $172 \text{ m} \pm 37$  m ( $564' \pm 121'$ ) to  $831 \text{ m} \pm 23$  m ( $2,726' \pm 75'$ ) and a mean of  $422 \text{ m} \pm 54$  m ( $1,384' \pm 177'$ ). The percentage of targets flying less than 120 m (394') above the ground was low, 11 percent, similar to that found by Cooper *et al.* (2004b).

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. Because mean flight altitude is above the radar, it is likely that most birds are flying at a height that is unimpeded by topographic features, such as hillsides or mountaintops, as they pass over valleys, ridges, and mountaintops.

## **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 Marble River project area. The results of the surveys indicate that bird migration patterns are generally similar to patterns observed at other proposed wind power sites being assessed in the region.

Migration activity varied throughout the season, which is probably largely attributable to weather patterns. The mean passage rate ( $254 \pm 45$  t/km/hr) is lower than that observed at similar studies. Migration activity throughout each night typically peaked 5 hours after sunset. Nightly passage rates varied from  $3 \pm 3$  t/km/hr to  $728 \pm 136$  t/km/hr.

Mean flight direction for the entire season was  $40^\circ \pm 60^\circ$ . Flight direction data indicate that nocturnal migrants are not avoiding the project area for any topographic-related reasons and that migrants appeared to be coming from the direction of the high peaks of the Adirondack Mountains.

The average flight altitude above the ground was  $422 \text{ m} \pm 54$  m ( $1,384' \pm 177'$ ). There were 11 percent of the targets observed during vertical radar operation that flew below an altitude of 120 m (394'), the maximum height of the proposed turbines, indicating that risk of collision to night-migrating birds is limited to a subset of those birds.

Risk to nocturnally-migrating birds is known to occur, particularly during periods of inclement weather that can force birds to fly at lower heights and decrease night-time visibility. Lower flight altitudes were observed during cloudy, foggy, and rainy nights in the project area. Those nights, however, were typically associated with low to very low nightly passage rates.

## 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, WV, 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 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 NY, based upon their normal geographic range. These are the little brown myotis (*Myotis lucifugus*), northern myotis, (*M. septentrionalis*), Indiana myotis (*Myotis 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). Of these, the Indiana myotis is listed as federally endangered, and the small-footed bat is listed as a special concern species by the state of NY. According to the NYDEC, eight Indiana myotis hibernacula are present in NY, located in Albany, Essex, Jefferson, Onondaga, Ulster, and Warren counties (NYDEC website, accessed 8/4/05). Marble River is located in northern Clinton County, which borders Essex County to the south. Depending upon the precise location of the hibernacula within Essex County, Marble River is roughly 30 to 60 miles removed to the north.

To document bat activity in the area of the proposed wind facility, Woodlot conducted bat surveys in spring 2005, between April 14 to May 13. Acoustic surveys using Anabat II detectors (Titley Electronics Pty Ltd) were the primary survey type used in this study and were designed to document bat passage rates near the rotor zone of the proposed turbines. Visual ceilometer surveys were also conducted in spring 2005, concurrent with nocturnal radar surveys.

## 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<sup>3</sup>) 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 logged onto compact flash media using a CF ZCAIM (Tittle 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 low end of the blade-swept area of the proposed turbines. To do this, an Anabat II detector was suspended from the guy wires of a meteorological tower (met tower) at the Marble River site, near the location where radar surveys occurred (Figure 4-1). The detector was suspended in a weatherproof box at heights of approximately 15 m (49') and 30 m (100') on the met tower guy wires (Figure 4-2). The detector was programmed to activate from sunset to sunrise resulting in approximately 10 hours of sampling per detector per night.

### *Data Analysis*

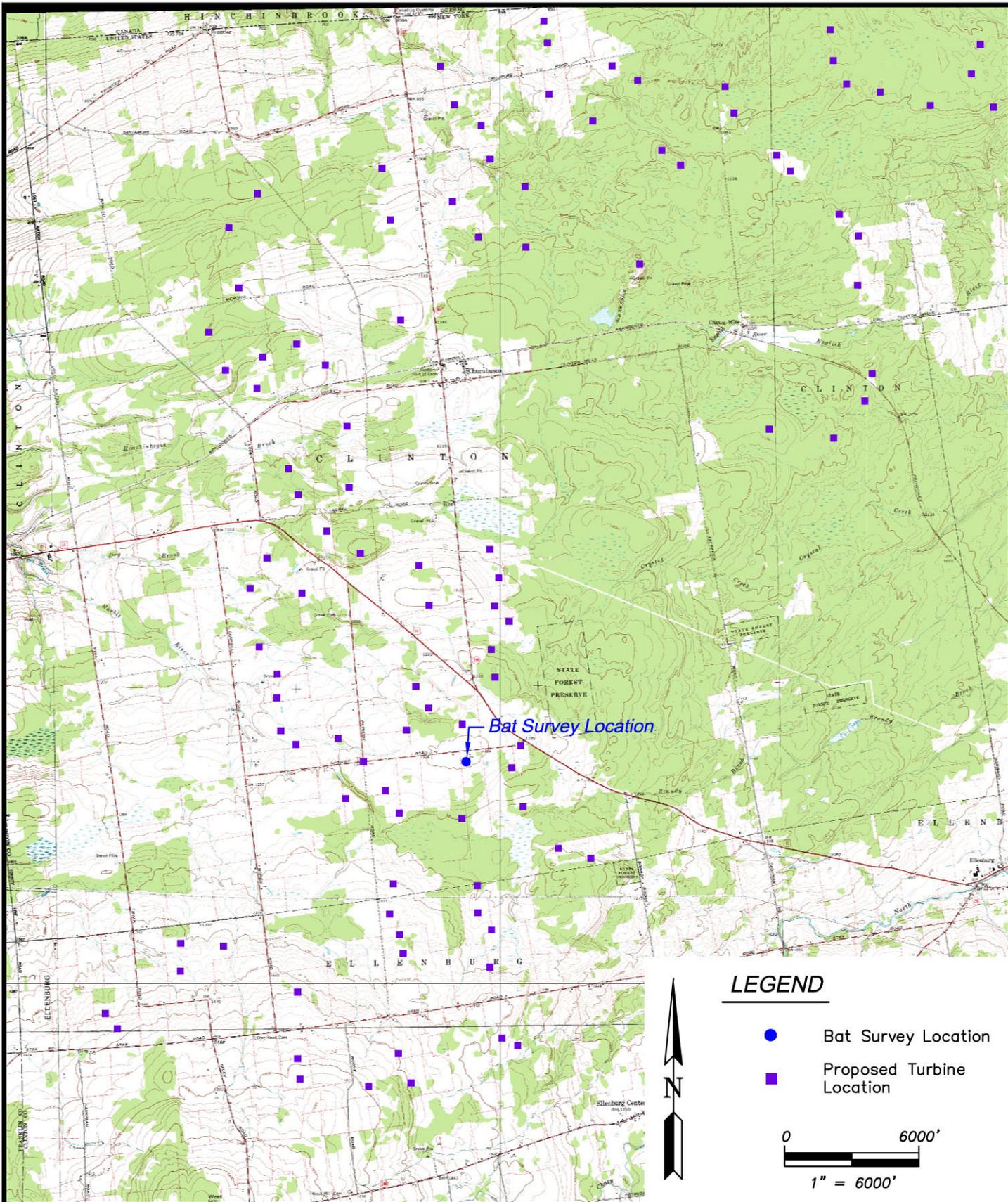
Call files were extracted from data files using CFCread<sup>®</sup> software, with default settings in place. Nightly tallies of detected calls were compiled for each detector. Mean detection rates (calls/hour and calls/night) were calculated for each night. These were summarized by time period within the migration season and detector location (15 m or 30 m high in the met tower). Detection rates indicate only the number of calls detected, and do not necessarily reflect the number of individual bats in an area.

Ultrasonic calls of bats are attenuated quickly by the atmosphere, and are only able to travel limited distances, depending upon their frequency (Griffin 1970, 1971). Also, Anabat detectors have a limited range of roughly 10 m to 15 m (30' to 50'). This was confirmed at the beginning of the survey period using an artificial "bat chirp" (Tony Messina) device and field tests with flying bats. Consequently, the height of bat calls recorded by the detectors deployed in the met tower was assumed to be roughly that of the detector that recorded the bat.

In addition to documenting passage rates, acoustic surveys with Anabat II detectors allow for limited species identification (O'Farrell and Gannon 1999). Because bat calls vary widely within species, and are influenced by habitat and region, definitive species identification based upon acoustic monitoring alone is not always possible. However, several of the species that are present in this area have calls that appear distinct when recorded with the Anabat system.

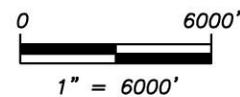
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<sup>3</sup> The frequency division setting literally divides ultrasonic calls detected by the detector by the division setting in order to produce signals at frequencies audible to the human ear.



**LEGEND**

- Bat Survey Location
- Proposed Turbine Location



PREPARED BY:



DATE: January 2005

SCALE: 1" = 6000'

JOB NO. 105038

FILE: 105038-00-Location.dwg

**Figure 4-1**  
**Bat Survey Location Map**  
**Marble River Wind Project**  
**Clinton and Ellenburg, New York**

REV.

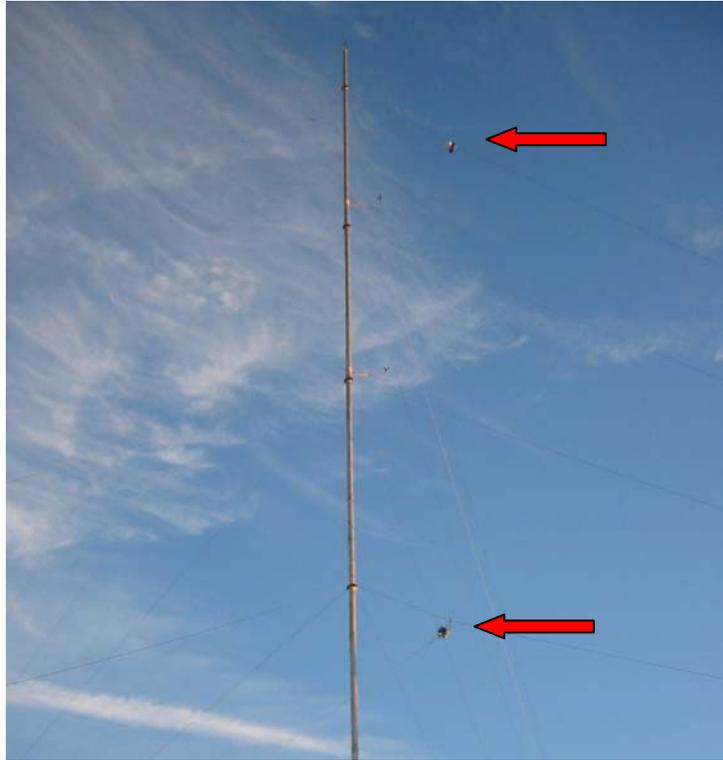


Figure 4-2. Photo of bat detectors set at 15 and 30 meters in met tower.

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). Calls recorded during the survey were compared to reference calls compiled by Chris Corben, the designer of the Anabat II software used in this study, and data from the University of Maine Mammalogy Department. These reference calls were of western and northeastern origin and served as a basis for differentiating the calls that were recorded. Recorded calls were classified based upon the shape of the call sequence, the slope, and the maximum and minimum frequencies. Calls with insufficient material upon which to determine the species were classified as unknown. Because some calls within the *Myotis* genus are so similar, many were identified to the genus level.

#### *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.

### **4.3 Results**

#### *Acoustic Monitoring*

One to two bat detectors were operated on 46 separate nights from April 14 to May 30. A single bat detector was operated at a height of 30 m (100 ft) from April 14 through May 30, and a second detector was added at 15 m (50 ft) on May 1 and operated until May 30. However, this lower detector

malfunctioned and did not record data for the duration of its deployment. Therefore, acoustic monitoring occurred on a total of 46 detector-nights. During this time, 12 bat call sequences were detected and recorded (Table 4-1). Calls were detected throughout the sampling period, with the greatest number of calls per night (three calls) occurring on May 18. All but three of the call sequences were detected between sunset and midnight (Table 4-1).

**Table 4-1. Bat calls detected – Marble River, Spring 2005**

<b>Night of</b>	<b>Time</b>	<b>Detector</b>	<b>Species</b>
16-Apr	21:03	30 m	MYSP
16-Apr	3:50	30 m	MYSP
29-Apr	22:37	30 m	MYSP
4-May	20:39	30 m	MYSP
6-May	23:00	30 m	MYSP
10-May	21:57	30 m	MYSP
10-May	0:29	30 m	MYSP
10-May	2:26	30 m	MYSP
13-May	20:05	30 m	MYSP
13-May	20:59	30 m	MYSP
25-May	22:49	30 m	MYSP
28-May	21:14	30 m	MYSP

Of the 12 recorded calls, all 12 were identified as *Myotis* sp. Because calls within the genus *Myotis* are so similar, we did not attempt to differentiate between species. Calls were detected throughout the sampling period, although 5 of the 12 calls were detected between May 10 and May 13. Due to the low numbers of calls detected, hourly passage rates were not calculated. In general, most bat call sequences were detected between sunset and midnight. Sample visual displays of the recorded calls are shown in Figure 4-3.

*Ceilometer Data*

Ceilometer data collected during the radar survey yielded a total of 254 observations. Those observations, as is typical, resulted in relatively few bat observations. Only five bats were observed flying through the ceilometer beam.

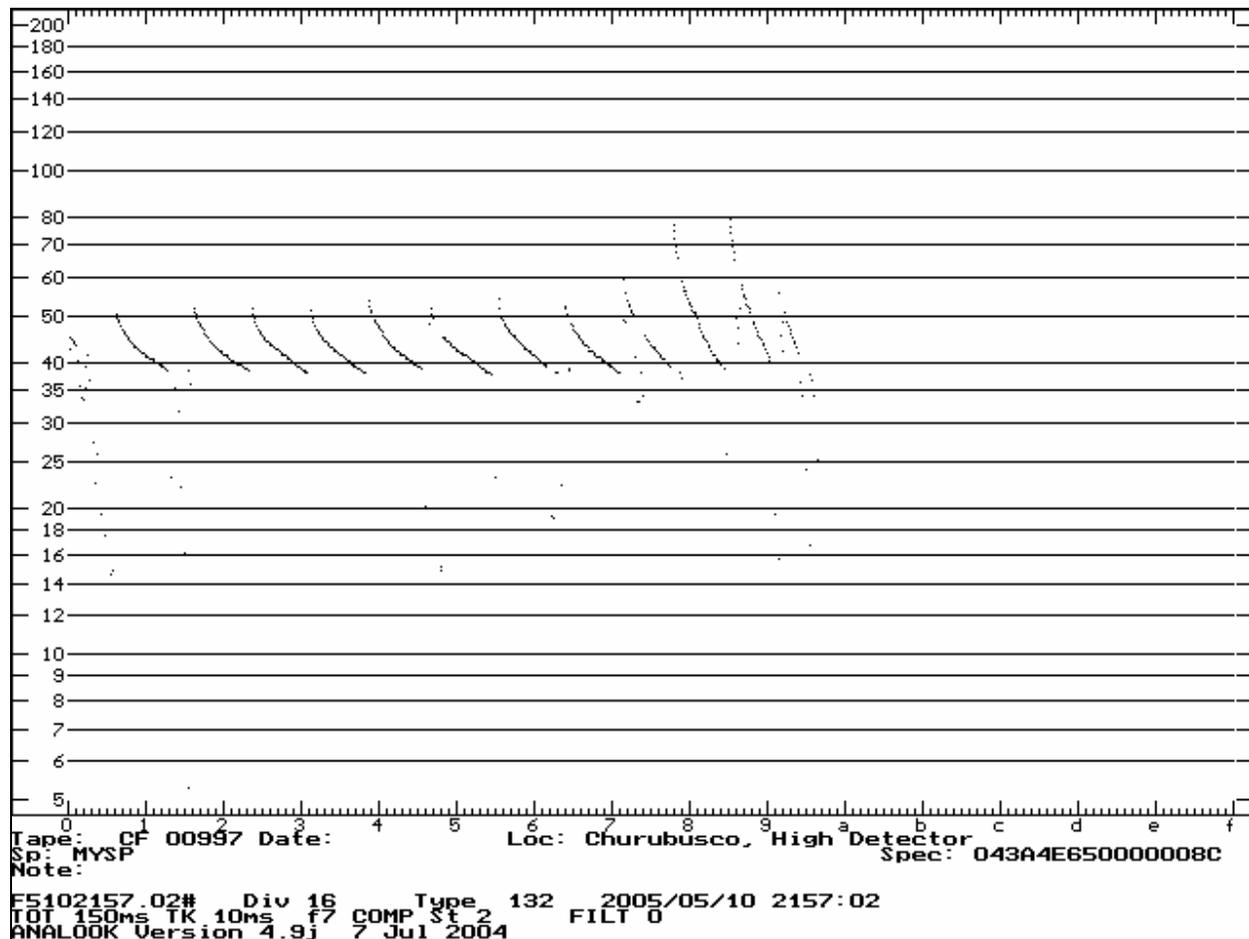


Figure 4-3. Example of the Visual Display of *Myotis* sp.

#### 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. There is insufficient scientific understanding of bat migration patterns and navigation systems, inadequate data on interactions between bats and turbines at existing wind farms in forested landscapes, 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.

Spring sampling at the proposed facility in Marble River revealed very low levels of bat activity between April 14 and May 30. Bats were recorded on 8 of the 46 nights sampled, with 12 call sequences being detected during the entire survey period. Nine out of 12 call sequences were detected during the first 5 hours of the night (between 7 pm and midnight). Although calls were detected throughout the survey period, the majority of call sequences were detected during the second week of May, with 5 out of 12 calls detected on the nights of May 10 and May 13. However, due to the low overall number of calls detected, no clear pattern could be drawn from the data.

Twelve recorded calls were identified to the genus *Myotis*, which includes the federally endangered Indiana myotis. Due to the similarity of calls within this genus, we did not attempt to differentiate between species within the genus *Myotis*, and therefore did not determine whether Indiana myotis were present in the study area. The State of NY supports eight known Indiana myotis hibernacula, located in Albany, Essex, Jefferson, Onondaga, Ulster, and Warren counties. The Marble River site is located in the northern portion of Clinton County, roughly 30 miles north of the border with Essex County, which contains at least one Indiana myotis hibernacula. Because so little is known about the distribution of Indiana myotis' summer habitat and migration routes, significant uncertainty exists regarding the likelihood of their presence in the study area.

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, especially hoary and eastern red bats, have been found to comprise most fatalities at several operating wind farms, although fatalities of eastern pipistrelles and silver-haired bats were also common in some locations (Johnson 2004). During spring surveys at Marble River, no individuals of these species were detected.

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. Additionally, data on passage rates measured in the met towers represent only a very small sample area relative to the blade-swept area of the proposed wind turbines. Ultrasonic calls of bats are attenuated quickly by the atmosphere and are only able to travel limited distances, depending upon their frequency (Griffin 1970, 1971). Also, Anabat detectors have a limited range, roughly 10 m to 15 m (30' to 50'), based upon trials with an artificial "bat chirp" and field tests with flying bats. Due to these factors, a single Anabat II detector samples a cone of airspace approximately 45° wide and 9 m to 15 m (30' to 50') deep. Therefore, the detection distance of the upper detector, at 30 m (100'), would extend only 3 m to 5 m (10' to 16') into the bottom of a wind turbine's blade-swept area, representing only roughly 1 percent to 3 percent of that area. Detectors were unable to sample bat passage rates in the central and upper regions of the rotor zone, which are at heights of approximately 80 m (260') and 110 m (360'). Based on the lower numbers of flying insects at higher elevations, and more extreme wind/weather conditions at higher elevations, it is likely that bat passage rates would be lower at these greater heights, but our study does not confirm this.

## **4.5 Conclusions**

Acoustic bat surveys revealed low numbers of bats in the Marble River site during April and May 2005. Bats were detected between April 16 and May 28, although the greatest number of bats detected in one night was three bats on the night of May 10. The low number of detected bats could indicate a small bat population in the region, avoidance of the area by bats, or poor conditions for bats.

No definitive determination of the presence or absence of any rare bats from the project area can be made. Although all 12 bats detected at Marble River belonged to the genus *Myotis*, the only genus that contains rare bats in NY, we did not attempt to identify the calls to species.

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## **Appendix A**

<b>Appendix A Table 1: Summary of Observations during Raptor Surveys – Spring 2005</b>											
<b>Species</b>	<b>4/5/2005</b>	<b>4/6/2005</b>	<b>4/9/2005</b>	<b>4/10/2005</b>	<b>4/18/2005</b>	<b>4/19/2005</b>	<b>5/3/2005</b>	<b>5/4/2005</b>	<b>5/5/2005</b>	<b>5/6/2005</b>	<b>Entire Season</b>
American Kestrel		1	1	5		1				1	<b>9</b>
Broad-winged Hawk							7	1	4		<b>12</b>
Cooper's Hawk	2		2	3	1						<b>8</b>
Golden Eagle	1										<b>1</b>
Merlin		1									<b>1</b>
Northern Goshawk				1							<b>1</b>
Northern Harrier	2	2	1			3	1	1	4	3	<b>17</b>
Osprey									2		<b>2</b>
Red-tailed hawk	5	2	5	6	1	2	3	1		1	<b>26</b>
Sharp-shinned Hawk	1	1	3	2		3	2		1		<b>13</b>
Turkey Vulture	5	8	7	13	1	20	4	3	4	6	<b>71</b>
Unidentified Buteo	1						4		2	1	<b>8</b>
Unknown Eagle		1									<b>1</b>
<b>Entire Season</b>	<b>17</b>	<b>16</b>	<b>19</b>	<b>30</b>	<b>3</b>	<b>29</b>	<b>21</b>	<b>6</b>	<b>17</b>	<b>12</b>	<b>170</b>

**Appendix A Table 2. Summary of Hourly Raptor Observations**

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	Entire Season
American Kestral	2	2	2	1	1	1	9
Broad-winged Hawk	4	7				1	12
Cooper's Hawk	1	2	1	1	1	2	8
Golden Eagle				1			1
Merlin	1						1
Northern Harrier	2	8	3	1	1	2	17
Osprey						2	2
Red-tailed hawk	7	4	4	6	2	3	26
Sharp-shinned Hawk	2	5	2		2	2	13
Turkey Vulture	14	18	17	4	6	12	71
Unidentified Buteo	3	2	1		1	1	8
Unknown Eagle		1					1
Northern Goshawk		1					1
<b>Entire Season</b>	<b>36</b>	<b>50</b>	<b>30</b>	<b>14</b>	<b>14</b>	<b>26</b>	<b>170</b>

Species	> 120 m	< 120 m	Entire Season
American Kestrel		9	9
Broad-winged Hawk	9	3	12
Cooper's Hawk	1	7	8
Golden Eagle		1	1
Merlin		1	1
Northern Goshawk	1		1
Northern Harrier	3	14	17
Osprey	2		2
Red-tailed hawk	6	20	26
Sharp-shinned Hawk	6	7	13
Turkey Vulture	7	64	71
Unidentified Buteo	6	2	8
Unknown Eagle		1	1
Entire Season	41	129	170

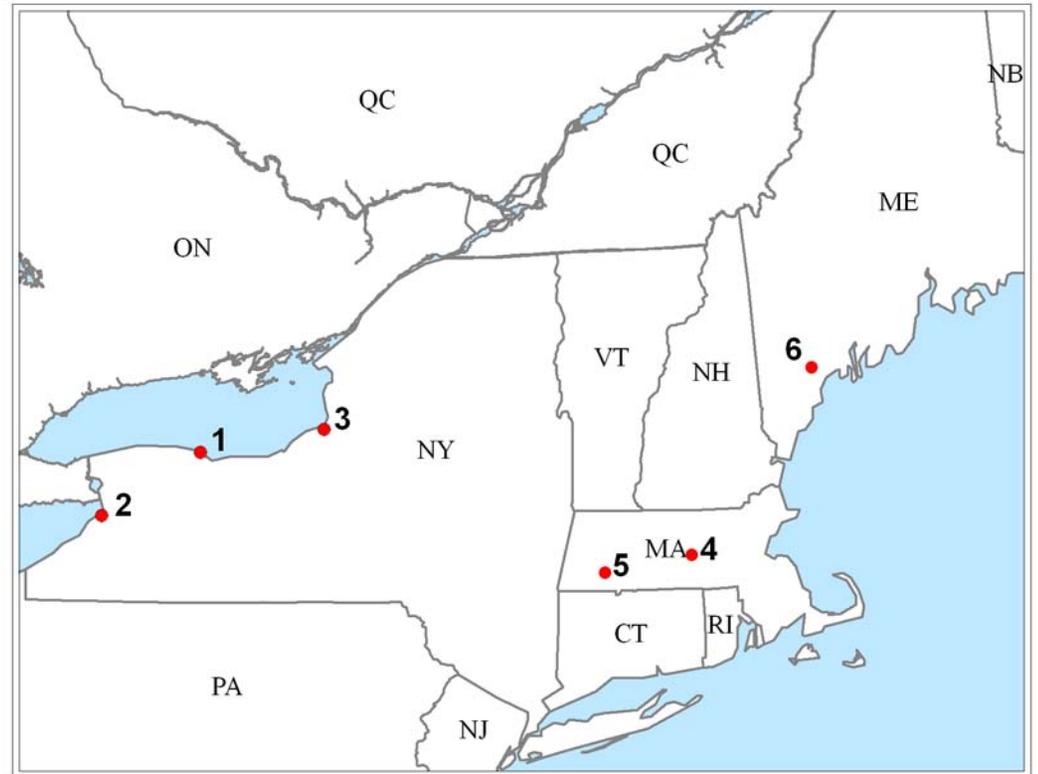
Appendix A Table 4. Summary of Regional Spring (March - May) Migration Surveys\*

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:**

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



## **Appendix B**

<b>Appendix B Table 1. Summary of passage rates by hour, night, and for entire season.</b>														
<b>Night of</b>	<b>Passage Rate (targets/km/hr) by hour after sunset</b>											<b>Entire Night</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>Mean</b>	<b>Stdev</b>	<b>SE</b>
April 15	--	136	187	223	147	106	217	186	239	145		176	45	15
April 16	--	--	--	645	787	--	--	--	--	580	80	523	345	122
April 17	313	379	414	469	424	435	259	180	124	--	--	333	122	41
April 18	234	329	486	555	756	771	614	615	531	284	159	485	208	63
April 19	167	273	460	687	754	753	450	340	362	--	--	472	214	71
April 21	134	148	254	419	538	508	383	356	259	223	274	318	135	41
April 22	592	864	--	--	--	--	--	--	--	--	--	728	192	136
April 24	121	180	161	324	553	468	--	--	--	--	--	301	178	73
April 29	67	281	426	478	437	386	291	444	386	99	--	330	145	46
April 30	20	55	98	86	105	21	25	--	--	--	--	59	37	14
May 1	73	194	302	356	321	383	381	285	345	61	--	270	120	38
May 2	21	78	162	212	176	148	94	36	54	19	--	100	70	22
May 3	9	54	99	126	150	114	60	64	36	13	--	73	48	15
May 4	17	37	114	165	133	154	206	232	75	14	--	115	77	24
May 5	137	169	171	186	176	170	206	323	373	70	--	198	88	28
May 6	75	159	193	253	362	334	420	388	321	--	--	278	116	39
May 7	31	70	96	136	107	127	133	54	30	3	--	79	48	15
May 8	36	105	127	114	99	101	54	60	40	--	--	74	41	13
May 9	126	214	143	177	269	339	379	409	231	43	--	233	117	37
May 10	48	141	473	474	441	471	493	481	359	57	--	344	186	59

(continued)

<b>Appendix B Table 1. Summary of passage rates by hour, night, and for entire season (continued).</b>														
<b>Night of</b>	<b>Passage Rate (targets/km/hr) by hour after sunset</b>											<b>Entire Night</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>Mean</b>	<b>Stdev</b>	<b>SE</b>
May 11	178	350	346	389	213	113	61	61	--	--	--	214	133	47
May 12	--	193	210	193	155	101	77	57	73	--	--	132	62	22
May 13	51	181	279	343	359	326	321	161	--	--	--	252	110	39
May 14	40	216	254	269	--	--	--	--	--	--	--	195	106	53
May 15	315	804	860	827	761	--	--	--	--	--	--	713	226	101
May 16	61	261	409	370	297	261	199	139	59	36	--	209	133	42
May 17	75	180	253	234	259	244	306	273	142	11	--	198	95	30
May 18	37	169	241	270	340	373	410	287	81	21	--	223	140	44
May 19	93	206	277	221	257	314	395	450	--	--	--	277	112	40
May 20	--	--	--	206	264	277	189	169	112	129	--	192	63	24
May 21	--	31	98	113	91	21	--	--	--	--	--	71	42	19
May 22	--	2	11	--	--	--	--	--	--	--	--	3	5	3
May 23	--	--	86	167	135	87	53	34	16	--	--	82	54	20
May 24	43	264	293	242	301	256	248	142	47	--	--	204	101	34
May 25	140	483	663	503	420	409	329	279	54	--	--	364	188	63
May 26	--	--	64	148	207	211	196	203	90	--	--	160	61	23
May 27	--	--	49	349	179	--	--	--	--	--	--	192	150	87
May 28	8	--	--	--	680	544	513	344	46	--	--	356	282	94
May 29	62	471	--	407	459	507	465	468	161	--	--	375	200	67
<b>Entire Season</b>	111	233	258	315	336	298	272	251	172	106	171	<b>254</b>	<b>123</b>	<b>45</b>
-- indicates no data for that hour														

<b>Appendix B Table 3. Summary of mean flight heights by hour, night, and for entire season</b>															<b>% of targets below 120 meters</b>
<b>Night of</b>	<b>Mean Flight Height (altitude in meters) by hour after sunset</b>										<b>Entire Night</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>Mean</b>	<b>Stdev</b>	<b>SE</b>	
April 15	--	789	783	866	819	938	892	896	744	748	--	831	70	23	2%
April 16	--	--	--	--	--	--	--	--	--	311	295	303	12	8	5%
April 17	377	--	408	379	321	320	310	348	438	--	--	363	46	16	8%
April 18	262	493	475	--	424	416	351	335	--	384	--	392	76	27	8%
April 19	318	417	442	385	374	344	366	358	380	--	--	376	37	12	5%
April 21	--	335	315	288	418	244	480	277	491	393	--	360	89	30	13%
April 22	234	534	--	--	--	--	--	--	--	--	--	384	212	150	7%
April 24	408	642	625	--	537	562	--	--	--	--	--	555	93	42	6%
April 29	130	437	510	545	599	519	656	618	423	356	--	479	154	49	6%
April 30	130	916	382	383	380	--	180	--	--	--	--	453	331	166	4%
May 1	--	336	384	372	--	295	287	334	272	332	--	327	40	14	7%
May 2	398	405	416	329	274	287	328	259	323	--	--	336	58	19	9%
May 3	--	371	251	271	319	178	243	341	382	356	--	301	69	23	16%
May 4	--	316	449	505	455	457	426	397	443	--	--	431	55	20	10%
May 5	289	752	749	800	741	883	858	867	790	662	--	739	172	54	2%
May 6	234	728	719	696	617	570	463	409	292	507	--	523	175	55	3%
May 7	190	267	171	--	336	405	583	212	265	--	--	304	137	48	18%
May 8	--	380	331	129	97	175	153	201	135	--	--	200	102	36	43%
May 9	251	520	665	627	649	529	--	--	366	--	--	515	156	59	4%
May 10	438	634	807	828	666	598	620	575	364		--	615	151	50	3%

(continued)

Appendix B Table 3. Summary of mean flight heights by hour, night, and for entire season (continued)															% of targets below 120 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	11	Mean	Stdev	SE	
May 11	--	217	237	165	175	--	114	--	--	--	--	182	48	21	27%
May 12	--	--	--	141	353	108	169	127	134	--	--	172	91	37	47%
May 13	84	650	667	738	770	--	536	--	--	--	--	574	254	103	2%
May 14	239	610	566	599	--	--	--	--	--	--	--	503	177	89	2%
May 15	--	552	666	--	642	--	--	--	--	--	--	620	60	35	1%
May 16	206	316	308	294	--	246	227	168	339	--	--	263	60	21	18%
May 17	--	493	470	430	410	430	497	505	302	--	--	442	67	24	1%
May 18	--	471	516	448	748	375	327	316	511	--	--	464	139	49	12%
May 19	--	593	534	602	446	521	468	598	--	--	--	537	64	24	4%
May 20	--	--	--	--	573	567	389	486	504	--	--	504	75	33	5%
May 21	--	--	173	155	293	--	--	--	--	--	--	207	75	43	35%
May 22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
May 23	--	--	337	399	408	141	146	178	--	--	--	268	127	52	10%
May 24	--	586	643	486	438	--	647	551	--	--	--	558	84	34	3%
May 25	276	481	360	376	286	268	245	292	--	--	--	323	78	28	8%
May 26	--	--	--	--	185	--	241	213	211	--	--	212	23	11	18%
May 27	787	343	474	--	--	--	--	--	--	--	--	534	228	132	0%
May 28	334	--	--	--	--	579	640	412	--	--	--	491	142	71	7%
May 29	2011	359	--	--	154	223	222	193	--	--	--	527	730	298	37%
<b>Entire Season</b>	<b>380</b>	<b>498</b>	<b>478</b>	<b>453</b>	<b>449</b>	<b>414</b>	<b>402</b>	<b>388</b>	<b>386</b>	<b>450</b>	<b>295</b>	<b>425</b>	<b>125</b>	<b>53</b>	<b>11%</b>