A Fall 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

During summer and fall 2005, Woodlot Alternatives, Inc. (Woodlot) conducted field surveys of bird and bat migration activity at the Marble River project area in Clinton and Ellenburg, New York. 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 to be located on open agricultural lands. These surveys represented the second season of investigation undertaken at this site. Surveys included daytime surveys of migrating raptors and breeding birds 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. These findings are especially relevant when considered along with the spring 2005 studies conducted in the same location. The survey data collected is a valuable tool for the assessment of risk to birds and bats during migration through the area.

Raptor Migration

The fall field surveys included 10 days of visual observation between September 6 and November 2, 2005. A total of 217 raptors, representing 15 species, were observed during the surveys. Approximately 69 percent of the raptors observed were flying less than 120 meters (m) (394') above the ground. The overall passage rate of raptors was 3.62 birds/hour (SD ± 3.67, range 1.00 to 12.67). Daily count totals ranged from 6 to 76 birds. For this site, passage rates are low compared to other sites in the region where raptor migration surveys were conducted during the same timeframe (fall 2005)

Nocturnal Radar Survey

The fall field survey targeted 45 nights of sampling from September 1 to October 15, 2005. Of these 45 nights, a total of 38 were sampled due to inclement weather on seven nights that created conditions in which the radar could not adequately document bird movements.

Nightly passage rates varied from 9 ± 4 t/km/hr to 429 ± 39 targets per kilometer per hour (t/km/hr), with the overall passage rate for the entire survey period at 152 ± 16 t/km/hr. Mean flight direction through the project area was 193° ± 89°.

The mean flight height of targets was 438 m ± 15 m (1,437' ± 49') above the radar site. The average nightly flight height ranged from 259 m ± 14 m (850' ± 46') to 704 m ± 92 m (2,310' ± 302'). The percent of targets observed flying below 120 m (394') also varied by night, from 0 percent to 32 percent. The seasonal average percentage of targets flying below 120 m was 5 percent.

Fall and spring surveys resulted in similar characteristics of bird migration through the project area. The mean fall passage rates at Marble River were slightly lower than the mean spring survey rate and within the range of fall migration rates reported from other radar migrations studies in the Northeast.

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 flight heights, demonstrates a limited avian mortality risk during fall 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.

Breeding Bird Survey

The summer field survey included two 2-day point count surveys to count the number of individuals of each species located at a series of 30 survey points. All birds seen or heard at each survey point during 5-minute periods during peak songbird activity between approximately 4:30 and 9:30 am were documented. During the survey, 53 species were observed at the 30 points: 14 points in field and 16 in forested habitats. An additional eight species were observed either passing by the project area or were seen while traveling between survey points. Species richness at survey points ranged from 5 to 12 species per survey point (mean = 8.4).

Summer Bat Survey

Summer surveys included both passive and active sampling on nine nights from July 5 to July 31 for a total of 126.25 hours. Passive surveys occurred from July 5 to 7, July 19 to 21, and July 29 to 31 for total of 108 hours. Active surveys took place on July 5 to 6, July 19 to 21, and July 29 to 01 for a total of 18.25 hours. Out of 341 total bat call sequences recorded during this time, 22 were from the passively deployed bat detectors and 319 were collected during active sampling.

Hoary bats (*Lasiurus cinereus*) were the most frequently recorded species, comprising 55 percent of the bat calls recorded. *Myotids* comprised 29 percent of the total recorded bat calls, followed by big brown bat (*Eptesicus fuscus*) call sequences (8%). Eastern red bats (*Lasiurus borealis*) and silver-haired bats (*Lasionycteris noctivagans*) were also detected during summer surveys, with two call sequences detected for each species.

Fall Bat Survey

Fall surveys included the deployment 3 passive detectors resulting in 91 detector nights collected from August 1 to October 11. Two detectors were deployed in the meteorological measurement tower one detector was placed in a tree along a field edge. Of the 506 calls recorded during the fall sampling period, 51 percent were *myotids*, followed by 20 percent unknown species, and 17 percent big brown bat. Also present in lesser numbers were hoary bats and silver-haired bats.

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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 2,500 feet 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 2005 and an agreement was reached on ecological studies to be performed.

1.2 Project Area Description

The 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.

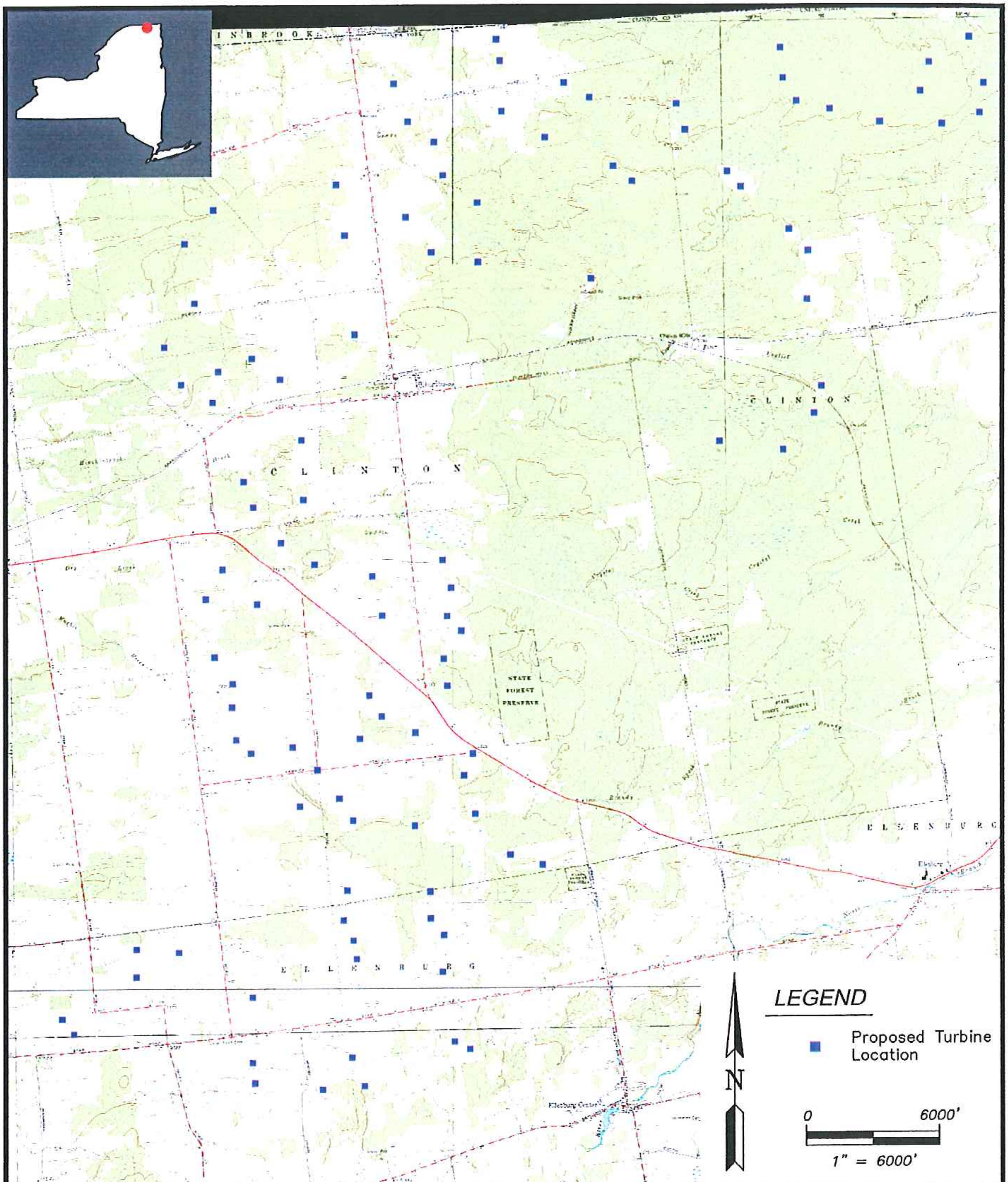

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Figure 1-1
Study Area Location Map
Marble River Wind Project
Clinton and Ellenburg, New York

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1.3 Survey Overview

Woodlot Alternatives, Inc. (Woodlot) conducted field investigations for bird and bat migration during the fall 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 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 present during the summer and the fall migration period.

The field surveys included daytime raptor migration surveys, a radar study of bird and bat migration activity, and recordings of bat echolocation calls in several landscape settings and heights. Surveys were conducted from August to November 2, 2005, although effort for the different aspects of the work varied within this time period. A total of 10 days of raptor surveys, 38 nights of radar surveys, 4 days of breeding bird surveys, 136 hours and 13 minutes of summer bat surveys, and 66 nights of bat detector recordings in the fall were completed.

Raptor surveys were conducted off Gagnier Road south of the meteorological measurement tower (met tower). Methods employed were the same as those used by the Hawk Migration Association of North America (HMANA) (HMANA 2005a).

Radar surveys were conducted from the vicinity of a met tower, which provided wind data for the time period of sampling. Radar data provide information 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. During the summer, active sampling was achieved by hand carrying a detector and recording device along habitat features that typically receive high use by bats, such as field edges, roadsides, stream corridors, pond shores, edges of wetlands, and buildings. These habitats were sampled during the first four to six hours after sunset. Sampling took place during groups of three nights during the month of July.

During the summer, passive surveys consisted of deploying bat detectors approximately 20 m (66') and 10 m (33') above the ground attached to an on-site met tower. Active sampling included hand carrying a detector during the first four hours of the night along various landscape features in the project area, such as field edges, field hedgerows, roadsides, streams, and wet areas.

Fall surveys included the deployment of three passive systems; two in the met tower at heights of 20 m (66') and 10 m (33') and one in the treeline at 2 m (6'). Deployment in this fashion provided information on the bat community in the project area and, to some extent, their flight characteristics.

Calls of the genus *Myotis* were examined to determine if those of the Indiana bat (*Myotis sodalis*), a federally listed Endangered species, had been recorded. These calls were reviewed by Eric Britzke, a national expert researching the ability to identify this species from recorded call sequences. The review by Mr. Britzke indicated that no calls of Indiana bats were recorded during the summer sampling.

For each survey period, weather conditions were recorded for the survey location to provide information about temperature, cloud cover, wind direction, and wind speed.

This report is divided into primary sections that discuss the methods and results for each field survey. Each section includes summary graphs of the survey results. In addition, supporting data tables are provided in a separate appendix for each chapter.

2.0 Diurnal Raptor Surveys

2.1 Introduction

The Marble River Wind project site is located in the southeast central portion of the Central 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 and northeastward to breeding grounds in the spring (Kerlinger 1989, Kellogg 2004).

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 or southern 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 fall migration, raptors fly south over the Adirondack Mountains and encounter a different landscape. The topography of the project area is much different from the Adirondack Mountains. North of the Adirondack Mountains, the area changes from mountainous features to a relatively flat and uniform landscape mosaic of farm fields, forests, and low density housing. Due to this lack of mountainous topography, migrating hawks are more dispersed throughout the landscape of the project area.

Because northern New York lies at the northern range of many species breeding grounds, there are fewer birds passing through this region than other more southern locations in the North American hawk flyways. Raptors migrating through northern New York 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 2005).

Woodlot conducted a raptor survey to determine if significant raptor migration occurred in the vicinity of the proposed project location. The survey was conducted on 10 days during the months of September and October. The goal of the survey was to document the occurrence of raptors in the vicinity of the project area, including the number and 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 from the middle of a corn field along Gagnier Road in Ellenburg, New York (Figure 2-1). This site, at an elevation of 396 m (1,300'), provides a view to the north, east, west, and to the south. Raptor surveys were conducted from atop a 7 m tall platform in an active corn field surrounded immediately by relatively flat terrain. The Adirondack Mountains are located due south of the project area. Lyon Mountain 1,159 m (3,803'), one of the northernmost peaks of the Adirondack Mountains, provides the backdrop for the observation site and is the limit of observation to the south. To the north, a forested field border slightly obstructs the view. Eastern and western views consisted of farm fields, forest fragments, and distant ridges.

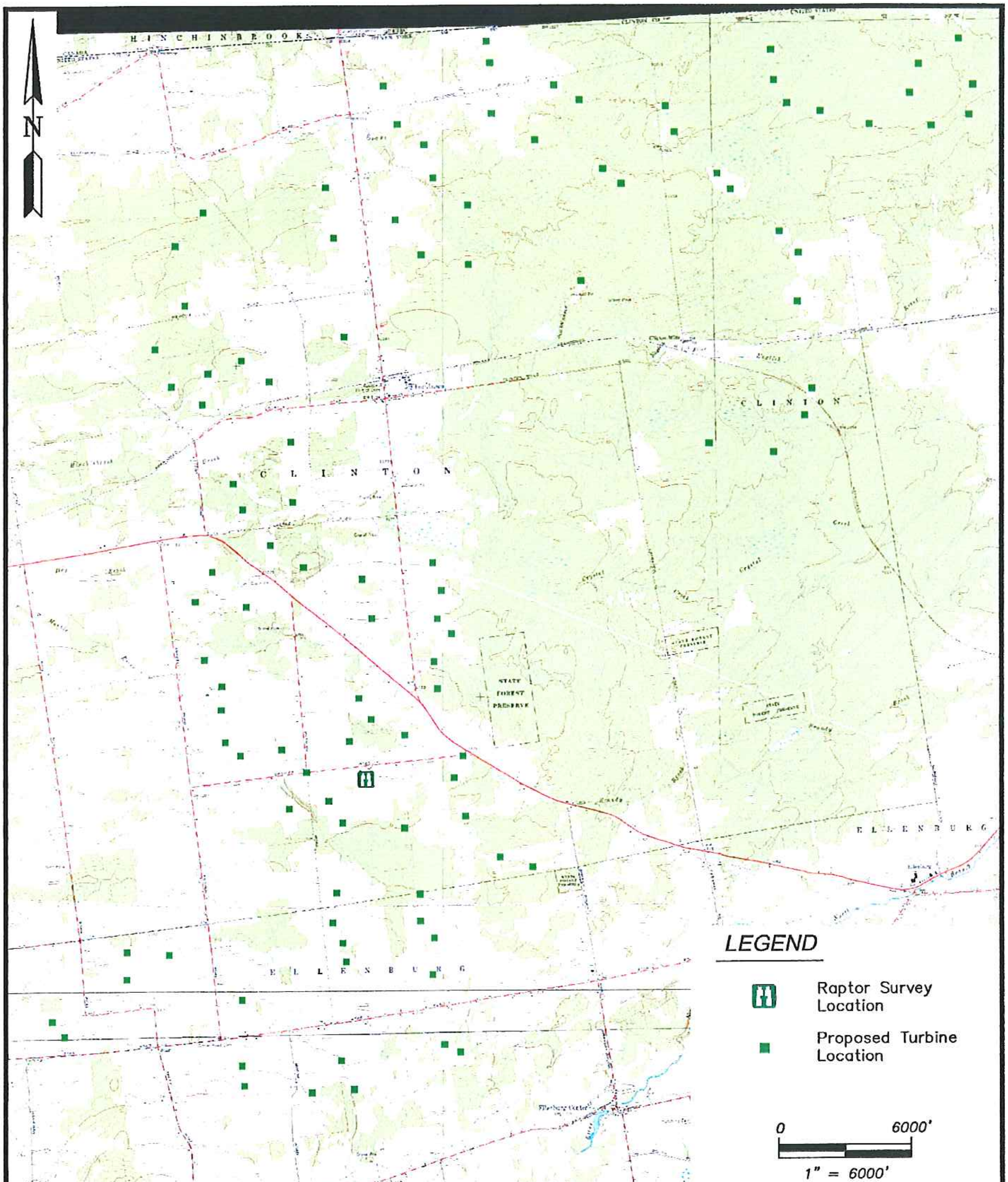

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Figure 2-1
Raptor Survey Location Map
Marble River Wind Project
Clinton and Ellenburg, New York

Raptor surveys occurred on 10 days between September 6 and November 2, 2005, and 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 northerly winds, and days following the passage of a cold front. However, weather conditions during the survey period made this difficult. Consequently northerly winds occurred during surveys on five of the ten survey days. Also, the survey period was limited to three hours on one day due to inclement weather. Temperatures ranged from 0 to 27°s C (32 to 80° F).

Surveys were based on methods defined by the HMANA (HMANA 2005a). 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 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 raptor behavior and repetitive sightings of individuals 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, wind 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, 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), standard deviation of observation rates, daily range, 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. The species composition of birds observed flying below and above the approximate height of the proposed turbines was determined. 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 other site totals from data from local or regional HMANA hawk watch sites available on the HMANA web site (HMANA 2005b). The HMANA watch sites used for direct comparisons with the project site included; Franklin Mountain in Oneonta, NY; and Cranberry Marsh, Ontario, Canada. The Marble River project area is closest to the Franklin Mountain site which is approximately 200 miles to the south. Cranberry Marsh is located on the north side of Lake Ontario approximately 300 miles southwest.

2.3 Results

Most surveys were conducted on days with good visibility when the winds were light to moderate. During the September surveys, the temperature ranged from 3° C to 27° C (35° F to 80° F); temperatures during the October surveys ranged from 0° C to 7° C (32° F to 45° F).

Some survey effort did occur on days when the weather and wind were suboptimal for raptor migration, due to inaccurate weather forecasting, relatively weak cold fronts, and weeks of rain. Six surveys were conducted with optimal winds from the north, northwest, northeast, or west northwest. Winds on four surveys were from the south, southwest, southeast, or east southeast. On one survey day, visibility was limited by intermittent rain that cleared by early afternoon as the system passed.

Surveys were conducted for a total of 60 hours during the 10 survey days. A total of 217 raptors, representing 15[1] species, were observed during that time, yielding an overall observation rate of 3.62 birds/hour (SD ± 3.67, range 1.00 to 12.67) (Appendix A Table 1; Figure 2-2). Daily count totals ranged from 6 to 76 birds. The highest count of raptors (76) was observed on September 19, a day of moderate (6 to 28 km/hr) west to northwest winds with temperatures of 21° C to 24° C. The mean number of raptors migrating on days when the winds had a northerly component (4.5 birds/day) exceeded the mean for days when winds were not from the north (2.3 birds/day).

Red-tailed hawks (*Buteo jamaicensis*) (N = 67) were, by far, the most commonly observed species. Turkey vultures (*Cathartes aura*)[2] (N= 43) were the next most abundant species, followed by broad-winged hawks (*Buteo platypterus)* (N = 34), northern harriers (*Circus cyaneus)* (N = 14), and sharp-shinned hawks (*Accipiter striatus*) (N = 14).

The remainder of observed species comprised less than 20 percent of the total (each with 7 or less individuals). These species include the red-shouldered hawk *(Buteo lineatus*), rough-legged hawk *(Buteo lagopus),* osprey (*Pandion haliaetus*), golden eagle (*Aquila chrysaetos*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), American kestrel (*Falco sparverius*), merlin (*Falco columbarius)*, northern goshawk (*Accipiter gentiles)*, and Cooper's hawk (*Accipiter cooperii*). Five individuals were not identifiable due either to distance from the observation site or very brief occurrence within the view of the surveyors. These were identified as species within the genus *Buteo*. One individual could not be identified to genus and was recorded as an unidentified raptor.

Nine of the aforementioned species are listed as endangered, threatened, or of special concern in New York. The peregrine falcon and golden eagle are listed as endangered; the bald eagle and northern harrier are listed as threatened; the osprey, sharp-shinned hawk, northern goshawk, Cooper's hawk, and red-shouldered hawk are listed as species of special concern. The bald eagle was the only federally threatened species observed.

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[1] Additional birds 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.

[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.

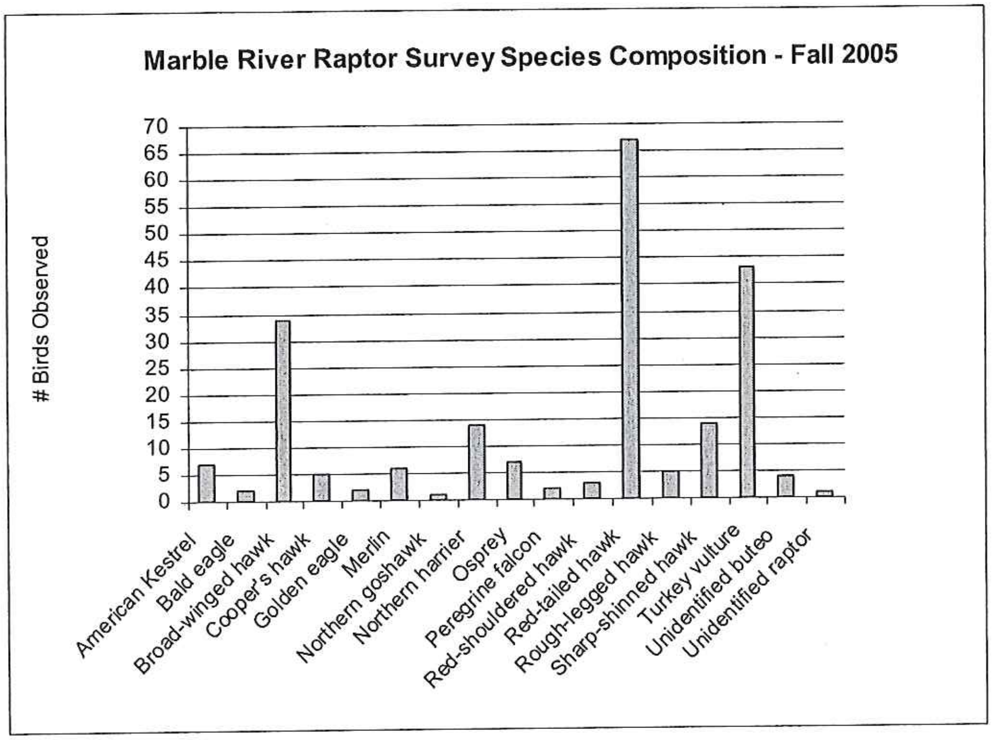

Figure 2-2. Species composition of raptors observed during raptor surveys

Several observations of northern harriers, red-tailed hawks, and turkey vultures were noted as possible repeated sightings of the same individuals. In these cases, an individual raptor may have been observed flying back and forth across a section of field or perching in an area repeatedly. However, most raptors were believed to be actively migrating and these observations are included in the count data reported. There were six observations of resident northern harriers, including two pairs that were observed actively hunting, vocalizing, and interacting with juvenile birds. There were observations of resident turkey vultures and red-tailed hawks perched in the area for extended periods during the surveys. However, for the most part, raptors observed were believed to be actively migrating.

In addition to some seasonal variation, the timing of raptor observations varied during each day. The overall distribution of hourly observations for the entire survey period shows peak flight at 10:00 am to 11:00 am. Typically, observations began slowly with fewer observations occurring during the first hour of the survey period, increasing rapidly during the second hour of observation, and decreasing again after 11:00 am (Figure 2-3). Also, early in the season, when total numbers were low, most raptors were observed during the morning hours (Appendix A Table 2).

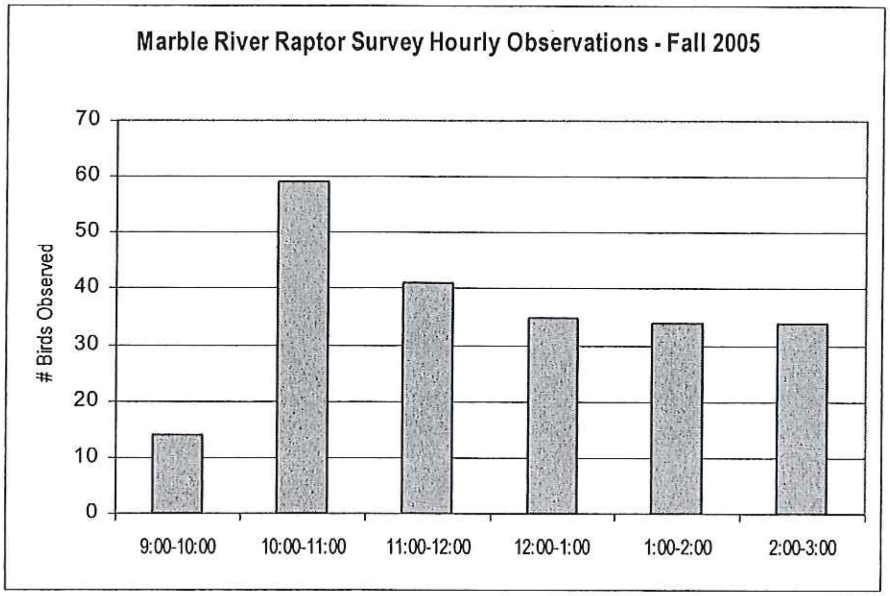

Figure 2-3. Hourly observation rates

Flight heights were categorized as below or above 120 m (394'), the approximate height of the turbines. Overall, approximately 69 percent (150 out of 217) 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). The majority of red-tailed hawks and turkey vultures were observed within the blade swept area. Small species, such as the accipiters and falcons, were also consistently observed flying low. The majority of falcons observed were flying below the proposed turbine height. Exceptions to this included broad-winged hawks and osprey, of which 79 and 57 percent, respectively, were flying greater than 120 m above the ground. Both bald eagles observed flew above 120 m while one golden eagle flew below and one golden eagle flew above 120 m.

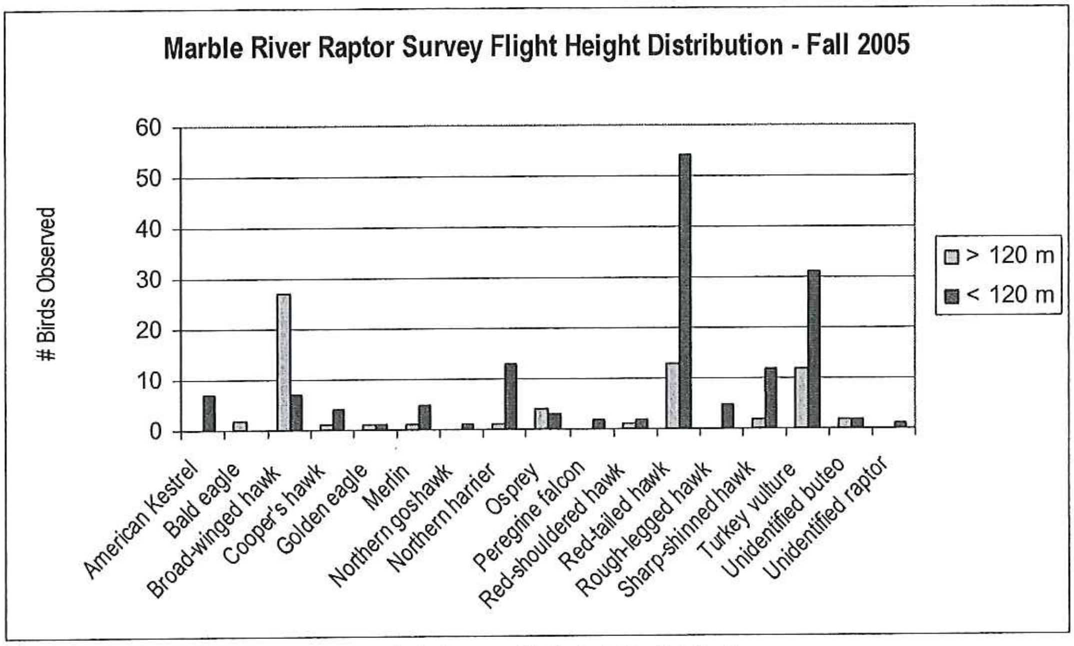

Figure 2-4. Raptor flight height distribution

The flight habits of raptors in the project area were variable, though the locations of those observations often occurred in similar locations. Many of the birds, particularly northern harriers and red-tailed hawks flew in different directions over the observation site and were typically observed hunting, hovering, and kiting over the project area. Individuals believed to be undertaking long-distance migratory movements (broad-winged hawks) had much more direct flight paths. Migrating raptors flew across the project area in a broad front (Figure 2-5). Therefore, there were no distinguishable flight pathways. The flight direction during the fall was predominately southward; however, on days with strong winds, raptors' flight was altered and birds flew either southwest or southeast.

2.4 Discussion

A total of 217 migrating raptors were observed during 10 days of field surveys in September and October 2005. Fifteen different species were recorded with an observation rate of 3.62 birds/hour. Red-tailed hawks were the most abundant species observed and comprised approximately 31 percent of all observations. Turkey vultures comprised 20 percent of observations.

Fifty observations were of species listed as endangered, threatened, or of special concern in New York, including the peregrine falcon, bald eagle, golden eagle, northern harrier, osprey, sharp-shinned hawk, northern goshawk, Cooper's hawk, and red-shouldered hawk. The federally threatened bald eagle was also observed. There were at least two pairs of northern harrier that were regularly observed hunting, hovering, and kiting over the project area. Most of their flights were well below the height of the proposed turbine tips.

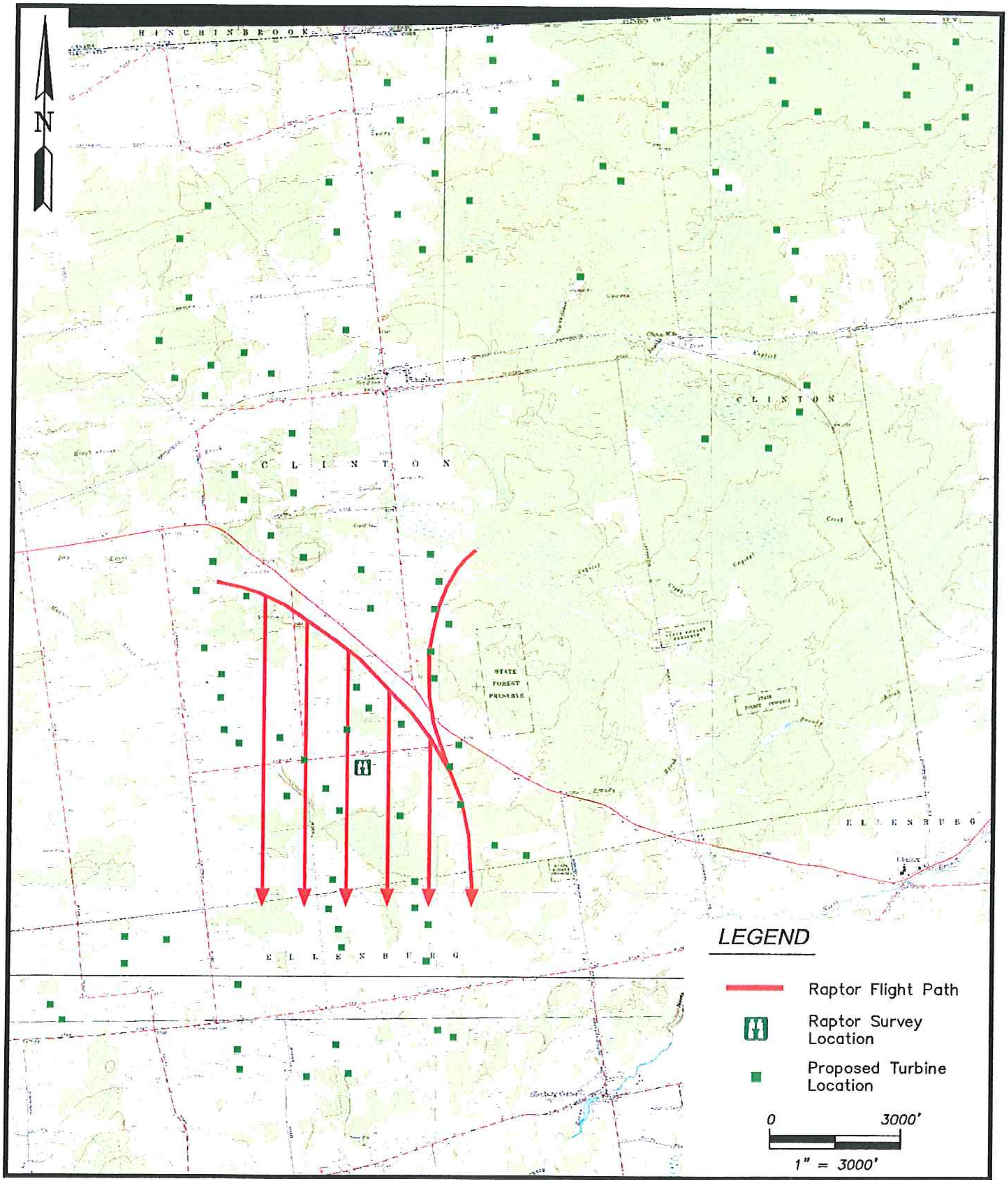

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Figure 2-5
Raptor Migration Flight Paths
Marble River Wind Project
Clinton and Ellenburg, New York

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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 (Fall 2005). Observation rates at other sites in the region ranged from 1.4 to 26.2 (birds/hour) (HMANA 2005b). There could be several reasons for the greater passage rates, including survey effort, geographical location, and visibility. The most active site was Cranberry Marsh, Ontario, with a total of 6,505 raptors counted (26.2 birds/hour). The two hawkwatch sites closest to the Marble River project site are Summitville Hawkwatch in Summitville, New York, and Franklin Mountain in Oneonta, New York. There were a total of 1,518 raptors observed (19.7 birds/hour) at Summitville and 4,297 (8.1 birds/hour) at Franklin Mountain through the end of October 2005. These areas may have very different landscape features (i.e., proximity to large bodies of water, mountainous) than this project, but offer comparable 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 (September through October). Alternatively, sampling only during sub-optimal migration weather would decrease observation rates.

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 (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 proposed wind project area lacks large landscape features that concentrate raptors.

The flight heights of raptors observed in the project area indicate that birds migrated within the blade-swept area of the proposed turbines. Approximately 69 percent of raptors were observed flying below 120 m (394'). The majority of the 15 species observed consistently flew below 120 m. Bald eagles and broad-winged hawks were the only two species whose flight heights were recorded frequently above 120 m. Overall, it may be easier to detect large species in flight; therefore, smaller species may sometimes be underrepresented (Kerlinger 1989).

Birds flying below this height should be considered more at risk of possible collision with the turbines, than those flying above the turbine blade height. Generally, it's still largely unknown what avoidance behavior migrating raptors possess when flying near wind turbines. Unpublished observations of hawk migration activity at an existing facility in New England (Woodlot, unpublished data) often included the passage of small raptors (such as sharp-shinned hawks) below the blade-swept area of turbines and the passage of larger raptors well above the turbines. Some observations have also included birds rising above one turbine and then decreasing altitude between turbines. It is unclear, however, if this type of presumed avoidance behavior would be observed at other wind turbine facilities in the East.

Migration of raptors is a dynamic process due to various internal and external factors. Migrating raptors are known to follow "leading lines" such as rivers, shorelines, and ridges that are orientated in the direction they are heading. 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 is 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 flight pathways.

2.5 Conclusions

The results of the field surveys indicate that fall raptor migration in the Marble River project area is generally lower than other sites in the region. The hourly passage rate of 3.62 birds is low, but expected given the site's location. This site had a relatively low number of migrants, but a high species diversity (N =15).

The lack of prominent topographical features in the region that could concentrate migration activity is likely part of the reason for this decreased passage rate. Also, Marble River occurs at the northern range of most migrating raptor species.

Resident birds dispersing from the project area comprise the minority of raptor observations during the migration period. Resident birds that are initiating their migration likely fly at lower heights than migrants, as they are typically undertaking small-scale movements while foraging and moving into the broad migratory pathways.

Most (69%) migrants were observed flying below the height of the proposed turbines. Differences between species were observed and could be due to typical flight height preferences or to limitations in the distance that different species are visible. Despite this, the low abundance of migrants reduces the potential for migrating raptors to come into close contact with the proposed development.

3.0 Nocturnal Radar Survey

3.1 *Introduction*

The 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 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.

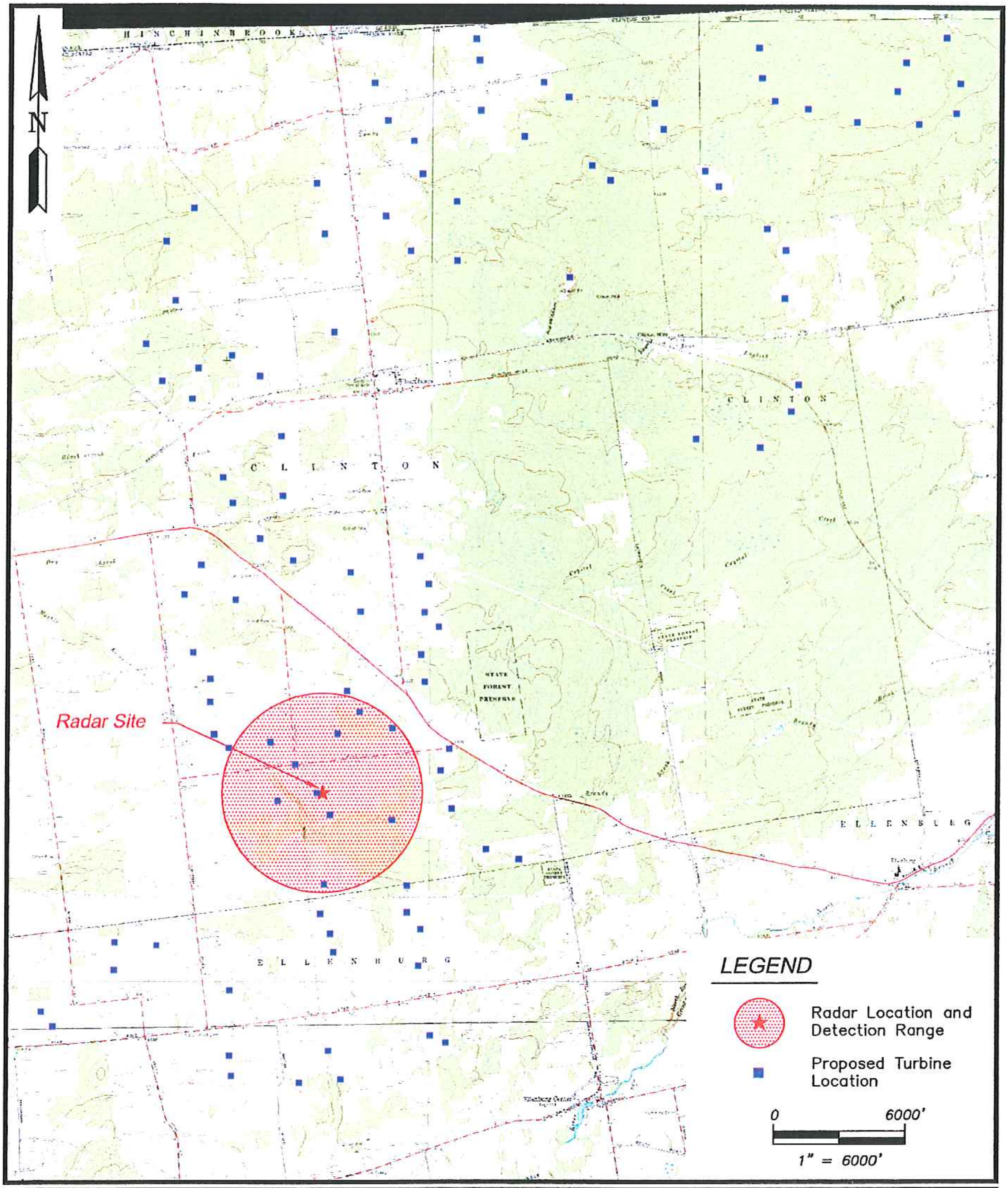
Factors that could affect potential collision risk of nocturnally-migrating birds by wind turbines can include weather, magnitude of migration, height of flight, and movement patterns in the vicinity of a wind project, along with the height of turbines and other site-specific characteristics of a wind project. Radar surveys were conducted at the Marble River project site to characterize fall nocturnal migration patterns in the area. The goal of the surveys was to document 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.

3.2 *Methods*

Field Methods

The radar study was conducted in a farm field along Patnode Road in Clinton, New York (Figure 3-1). This site (Figure 3-1), at an elevation of 396 m (1,300'), provided a view in all directions. The treeline surrounding the farm field helped mask the sounding ground clutter, giving a clear image of the surrounding survey area. A marine surveillance radar similar to that described by Cooper *et al.* (1991) was used during field data collection. The radar has a peak power output of 12 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. The radar has an echo trail function that maintains past echoes of target trails. 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.



PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS	DATE: January 2006	*Figure 3-1*
	SCALE: 1" = 6000'	*Radar Location Map*
	JOB NO. 105038	*Marble River Wind Project*
	FILE: 105038-00-Location.dwg	*Clinton and Ellenburg, New York* REV.

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. However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by 'hiding' clutter-causing objects from the radar. These nearby features also cause ground clutter but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen (Figure 3-2). The presence of ground clutter and other objects that could reduce clutter were important factors considered during the site selection process.

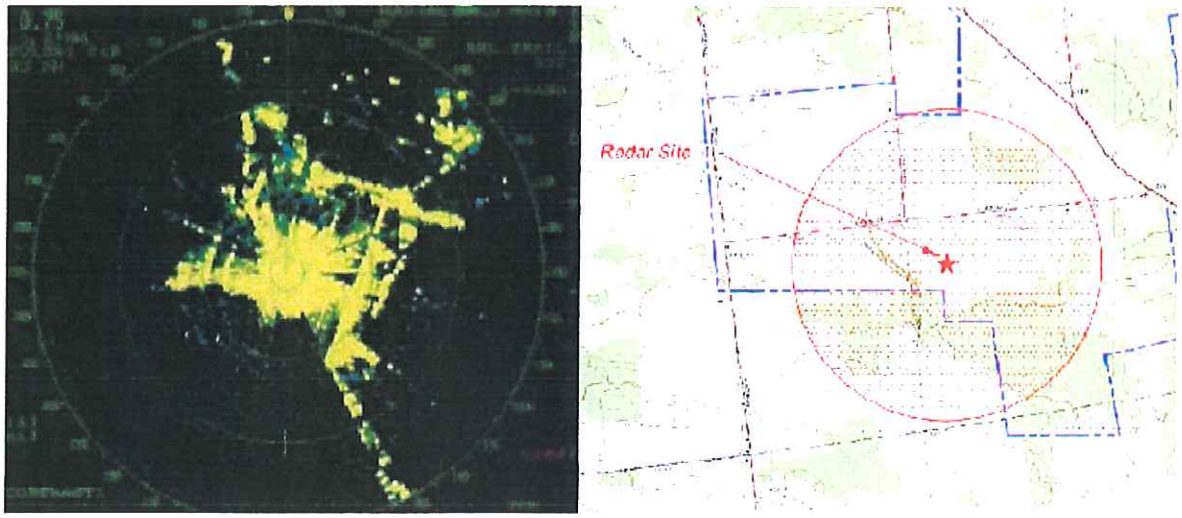


Figure 3-2. Ground clutter in project area

Radar surveys were conducted from sunset to sunrise. Forty-five nights of surveys were targeted for sampling between September 1 and October 15, 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, in order 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.

The radar was operated in two modes throughout the night. In the first mode, surveillance, the antenna spins horizontally to survey the airspace around the radar and detects targets moving through the area. By analyzing the echo trail, the flight direction of targets can be determined. In the second mode of operation, vertical, 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 do provide information on the altitude of targets passing through the vertical, 20° radar beam. Both modes of operation were used during each hour of sampling.

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.

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

Night of	Sunset	Sunrise	Hours of Survey	Weather	Wind Direction (from)
Night of Sept 01	7:10 pm	5:52 am	11	clear, gusty wind	W-SW
Night of Sept 02	7:08 pm	5:54 am	11	showers early, then clearing and cool	W
Night of Sept 03	7:06 pm	5:55 am	11	calm and cool, misty	W-NW
Night of Sept 04	7:04 pm	5:56 am	11	calm, cool, clear	W-NW
Night of Sept 05	7:02 pm	5:57 am	11	calm, clear	W-SW
Night of Sept 06	7:00 pm	5:59 am	12	wind calm, mild temperature	W-SW
Night of Sept 07	6:58 pm	6:00 am	11	clear, mild	W-SW
Night of Sept 08	6:56 pm	6:01 am	10	clear with periods of fog	W-SW
Night of Sept 09	6:54 pm	6:02 am	9	cool and calm	N-NE
Night of Sept 10	6:52 pm	6:04 am	11	cool and calm	W-SW
Night of Sept 14	6:44 pm	6:09 am	12	cloudy with rain showers	W-SW
Night of Sept 15	6:42 pm	6:10 am	3	cloudy, calm	E-NE
Night of Sept 17	6:38 pm	6:12 am	11	calm and misty	N-NW
Night of Sept 18	6:36 pm	6:14 am	12	clear with light wind	W-SW
Night of Sept 19	6:34 pm	6:15 am	5	calm, increasing clouds	S-SW
Night of Sept 20	6:32 pm	6:16 am	12	gusty winds	W-NW
Night of Sept 21	6:30 pm	6:18 am	12	gusty winds	W-NW
Night of Sept 22	6:28 pm	6:19 am	9	rain showers	W-SW
Night of Sept 23	6:26 pm	6:20 am	12	cool with light winds	N-NW
Night of Sept 24	6:24 pm	6:21 am	12	light winds	S-SE
Night of Sept 25	6:22 pm	6:23 am	8	wind increasing, rain	SW
Night of Sept 27	6:18 pm	6:25 am	11	cool with slight breeze	W-SW
Night of Sept 28	6:16 pm	6:27 am	12	calm and partly cloudy	S
Night of Sept 29	6:14 pm	6:28 am	12	cool with slight breeze	W
Night of Sept 30	6:12 pm	6:29 am	13	cool and calm	W-SW
Night of Oct 01	6:10 pm	6:31 am	13	cool and calm	W-SW
Night of Oct 02	6:08 pm	6:32 am	12	cool and calm	S-SE
Night of Oct 03	6:06 pm	6:33 am	13	clear and calm	S-SW
Night of Oct 04	6:04 pm	6:35 am	12	clear and calm	W-SW
Night of Oct 05	6:02 pm	6:36 am	12	clear and calm	W-SW
Night of Oct 06	6:01 pm	6:37 am	13	warm with slight breeze	SW
Night of Oct 08	5:57 pm	6:40 am	11	cool, slight breeze	E-NE
Night of Oct 09	5:55 pm	6:41 am	13	cool, breezy, hazy	E-NE
Night of Oct 10	5:53 pm	6:43 am	13	cool, slight breeze, drizzle	E-NE
Night of Oct 11	5:51 pm	6:44 am	11	cool, calm and cloudy	E-NE
Night of Oct 12	5:49 pm	6:46 am	3	cool, breezy, rain	E-SE
Night of Oct 14	5:46 pm	6:48 am	12	calm and foggy	S-SW
Night of Oct 15	5:44 pm	6:50 am	12	cool, breezy and cloudy	W-NW
		Total Hours =	414		

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

Data Collection

The radar display was recorded using video recording software of a computer. Based on a random sequence for each night, approximately 25 minutes of video samples were recorded during each hour of operation. These included 15 one-minute horizontal samples and 10 one-minute vertical samples.

During each hour, 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 (below 100 m [328']) 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 these nights with fuller moon and clear skies, moonwatching (Lowery 1951) was used. This technique 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 characterize activity of insects, birds, and bats.

Data Analysis

The video samples were analyzed using a digital video analysis software tool developed by Woodlot. Targets observed during horizontal samples were differentiated, based on their speed, between birds, bats, and insects. The speed of targets was corrected for wind speed and direction; targets traveling faster than approximately 6 miles per second were identified as a bird or bat, while targets traveling slower than this were considered insects (Larkin 1991, Bruderer and Boldt 2001), and thus were not counted.

The software tool recorded the time, location, and flight vector for each target likely to be a bird or bat. The results for each sample were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location. The results for each sample were output to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour [t/km/hr]), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular SD) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this are based on Batschelet (1965), which take into account the circular nature of the data. Nightly wind direction was also summarized using similar methods using data collected from the nearest met tower to the radar. 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 120 m (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 414 hours on 38 nights between September 1 and October 15, 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. At the radar location, local topography provided good views to the south and east; the western view was slightly obstructed by a low-lying forested wetland.

Passage Rates

Nightly passage rates varied from 9 ± 4 t/km/hr (October 14) to 429 ± 39 t/km/hr (September 23), and the overall passage rate for the entire survey period was 152 ± 16 t/km/hr (Figure 3-3; Appendix B Table 1). On nights with highest observed passage rates, the wind was typically from the northwest to northeast. An exception to this was October 3, on which moderate winds were coming from the south.

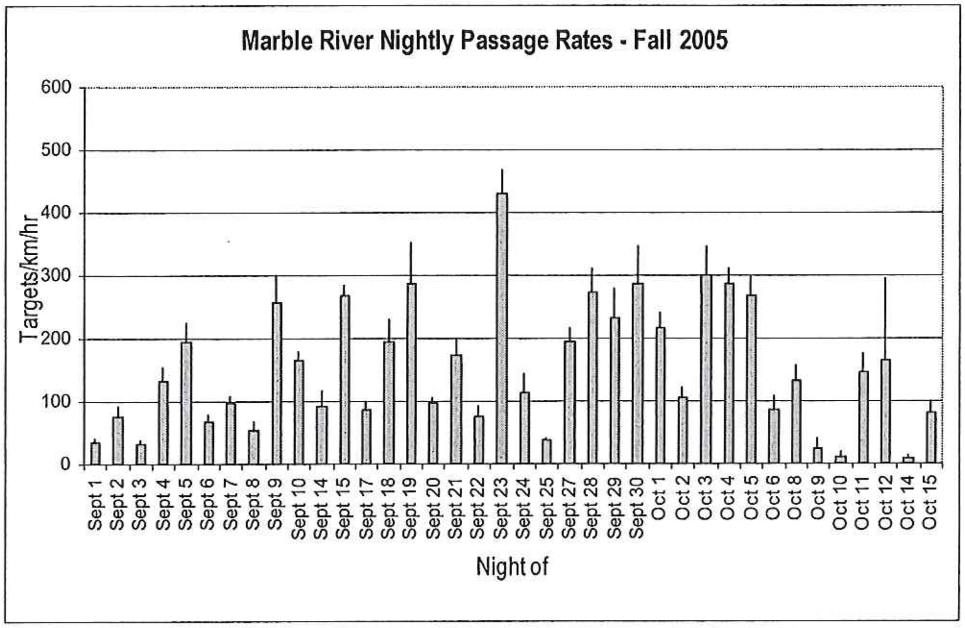


Figure 3-3. Nightly passage rates (error bars = 1 SE) observed

Individual hourly passage rates varied throughout the entire season from 0 to 693 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 third and fourth hour after sunset, followed by a period of relatively steady decline, then remaining steady for five hours until sunrise (Figure 3-4).

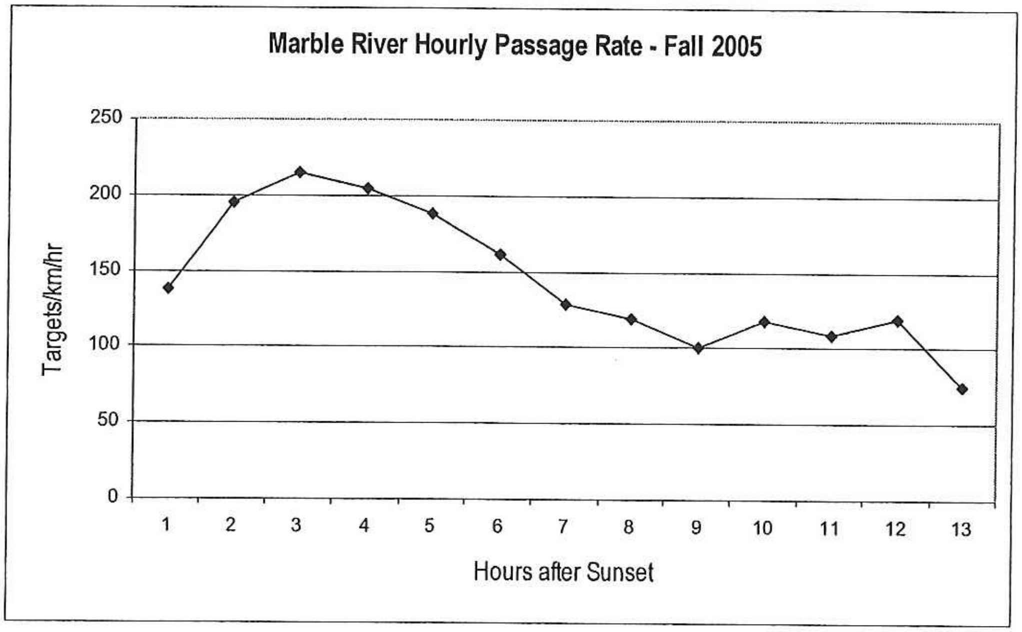


Figure 3-4. Hourly passage rates for entire season

Flight Direction

Mean flight direction through the project area was 193° ± 89° (Figure 3-5; Appendix B Table 2). There was considerable night-to-night variation in mean direction, although within each night there was less variation (Figure 3-6). The average nightly flight direction was typically southeast to southwest on more than half of the nights sampled.

Flight Altitude

The mean flight height of all targets was 438 m ± 15 m (1,437' ± 49') above the radar site. The average nightly flight height ranged from 259 m ± 14 m (805' ± 46') to 704 m ± 92 m (2,310' ± 302') (Figure 3-7, Appendix B Table 3). The percent of targets observed flying below 120 m (394') also varied by night, from 0 percent to 32 percent (Figure 3-8). The seasonal average percentage of targets flying below 120 m (394') was 5%.

Hourly flight height peaked from about third to seventh hours after sunset, but was highest in the fourth hour (Figure 3-9). Within 100 m (328') height zones, the greatest percentage of targets (19%) was documented from 200 m to 300 m (656' to 984'), 69 percent of targets were observed from 200m to 700 m (656' to 2,297'), and 85 percent were observed from 100 m to 800 m (328' to 2,625') above the radar site (Figure 3-10).

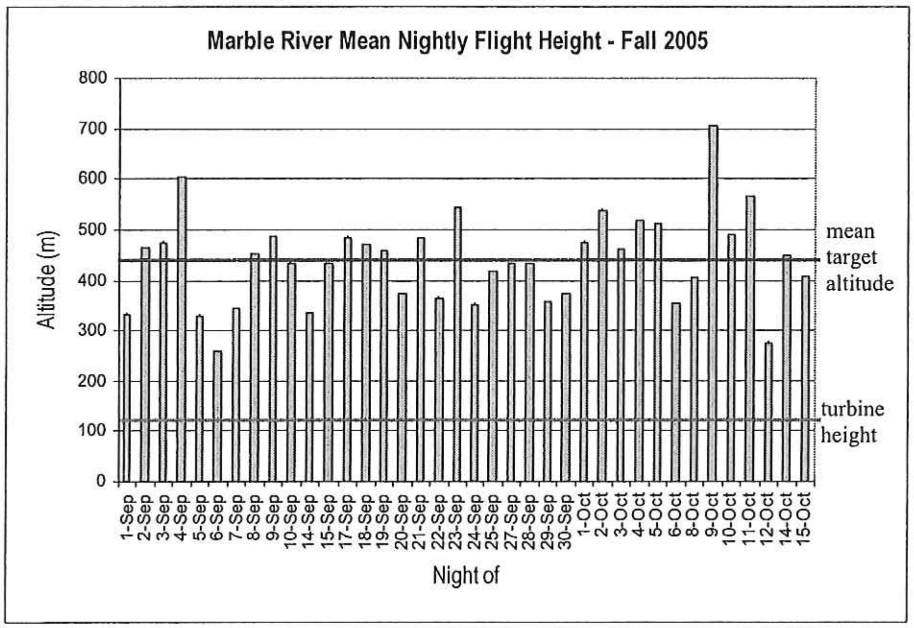
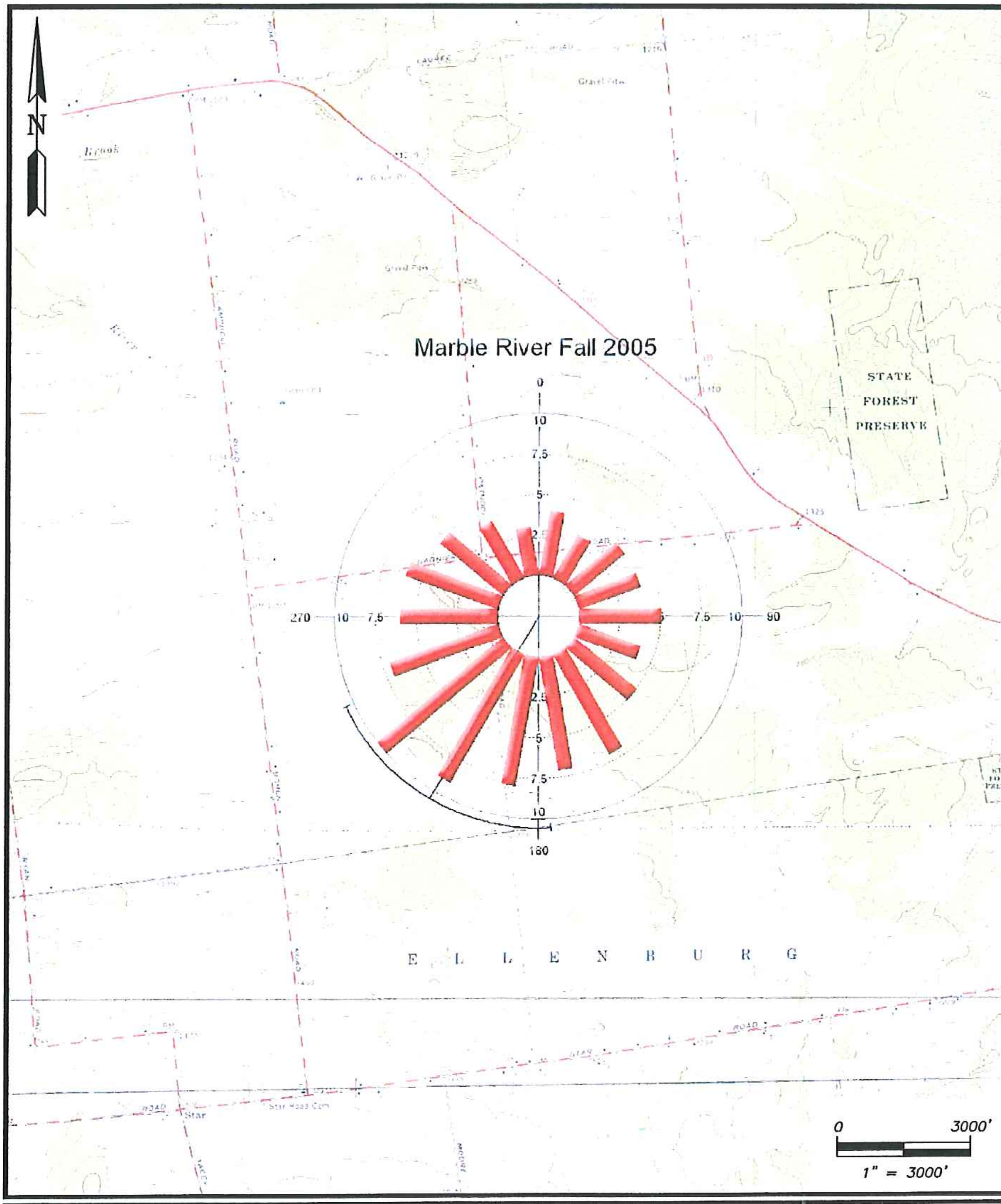


Figure 3-7. Mean nightly flight height of targets



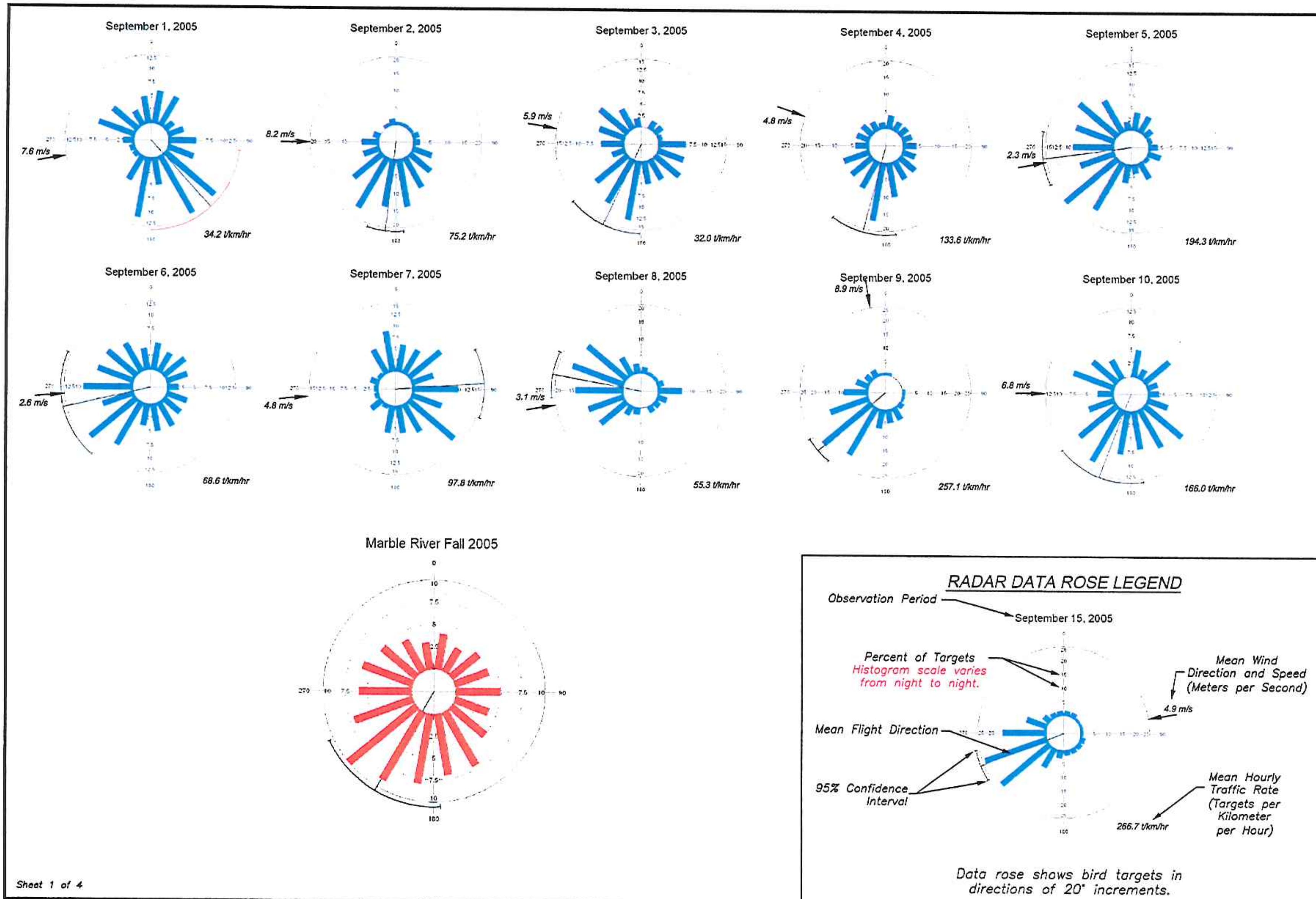
PREPARED BY:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

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

Figure 3-5
Fall 2005 Target Flight Direction
Marble River Wind Project
Clinton and Ellenburg, New York

REV.



SHEET TITLE: Nightly Mean Flight Direction

SCALE: n/a

DATE: December 2005

NO.	REVISIONS	DATE

PROJECT: Marble River Wind Project

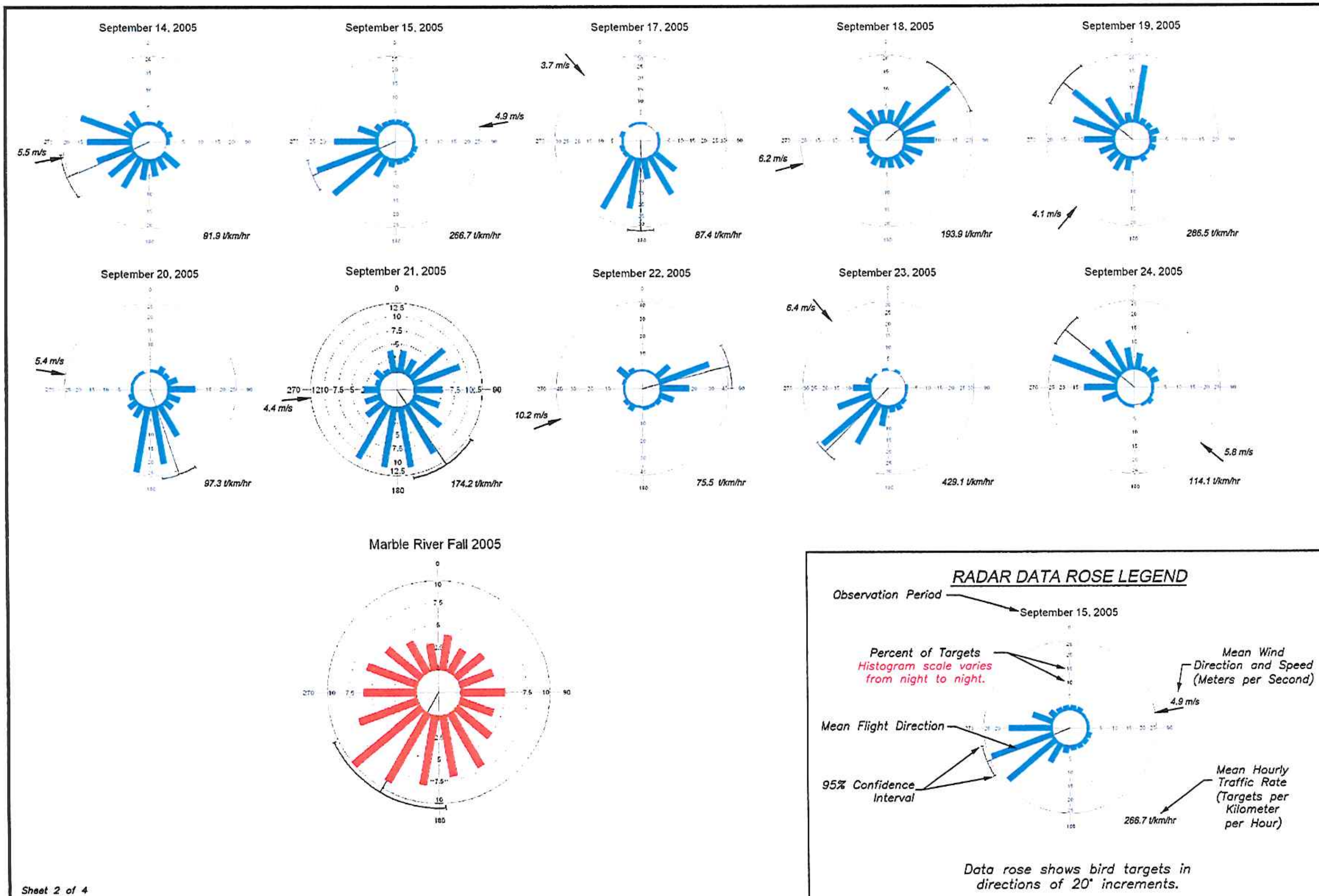
ADDRESS: Clinton and Ellenburg, New York

PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

105038-00-Traffic.dwg

PROJ. NO. 105038

FIGURE NO. 3-6



SHEET TITLE: Nightly Mean Flight Direction

SCALE: n/a

DATE: December 2005

PROJECT: Marble River Wind Project

ADDRESS: Clinton and Ellenburg, New York

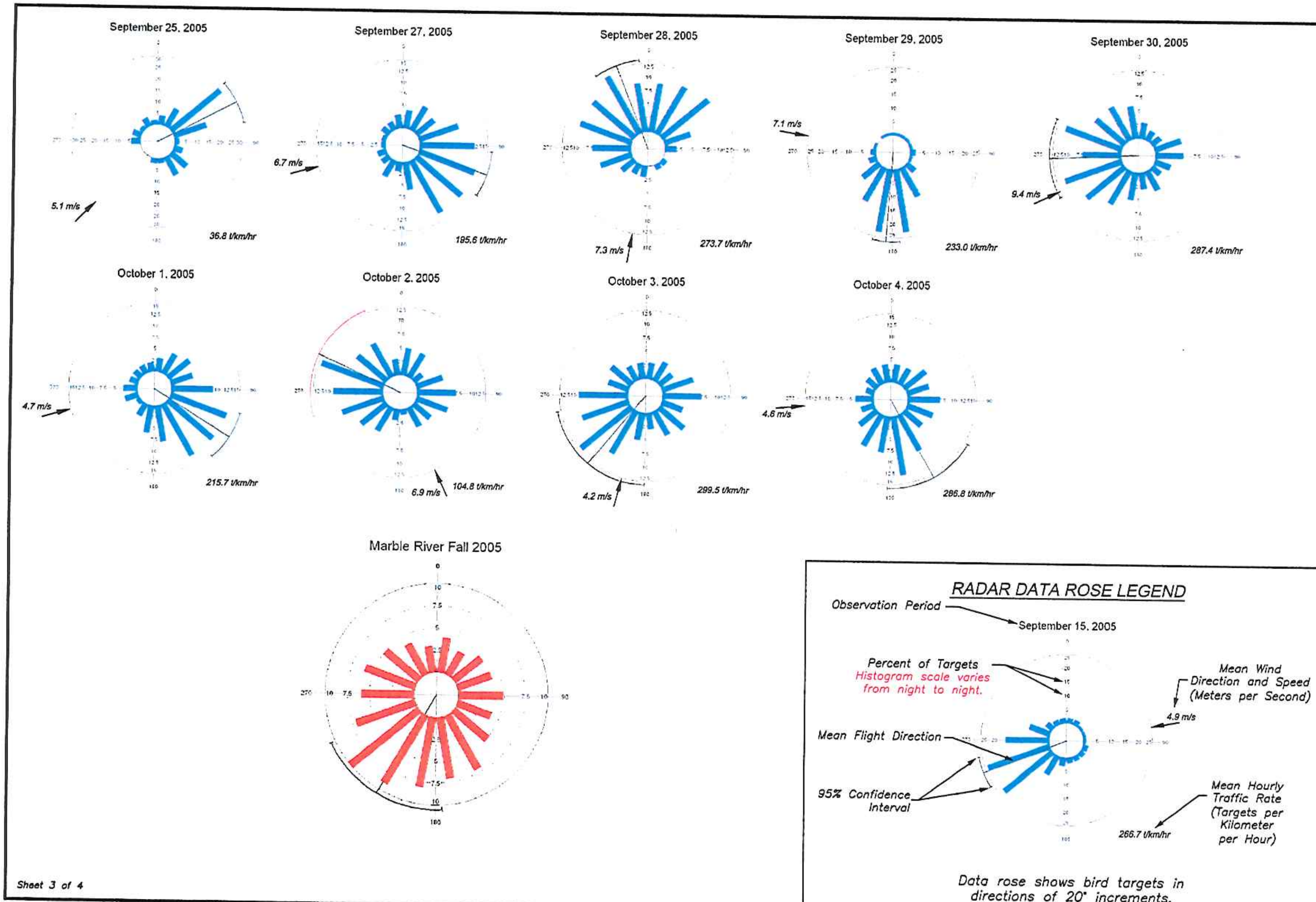
PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

105038-00-Traffic.dwg

PROJ. NO. 105038

FIGURE NO. 3-6

NO.	REVISIONS	DATE

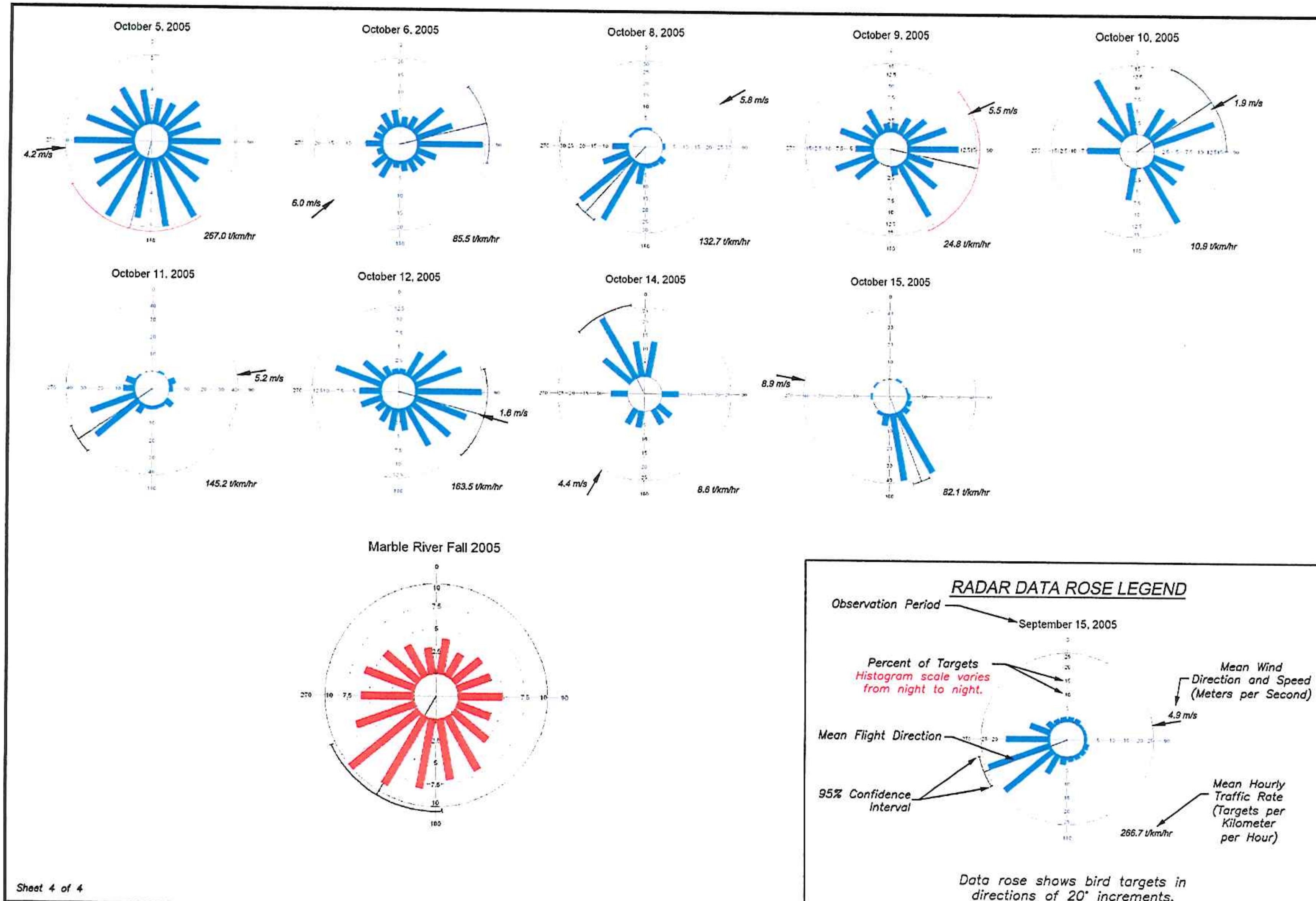


Sheet 3 of 4

PROJECT:	Marble River Wind Project
ADDRESS:	Clinton and Ellenburg, New York
SHEET TITLE:	Nightly Mean Flight Direction
SCALE:	n/a
DATE:	December 2005
PREPARED BY:	WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS
PROJ. NO.	105038
FIGURE NO.	3-6

105038-00-Traffic.dwg

NO.	REVISIONS	DATE



Sheet 4 of 4

PROJECT:	Marble River Wind Project
ADDRESS:	Clinton and Ellenburg, New York
SHEET TITLE:	Nightly Mean Flight Direction
SCALE:	n/a
DATE:	December 2005
PREPARED BY:	WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS
PROJ. NO.	105038
FIGURE NO.	3-6

105038-C0-Traffic.dwg

NO.	REVISIONS	DATE

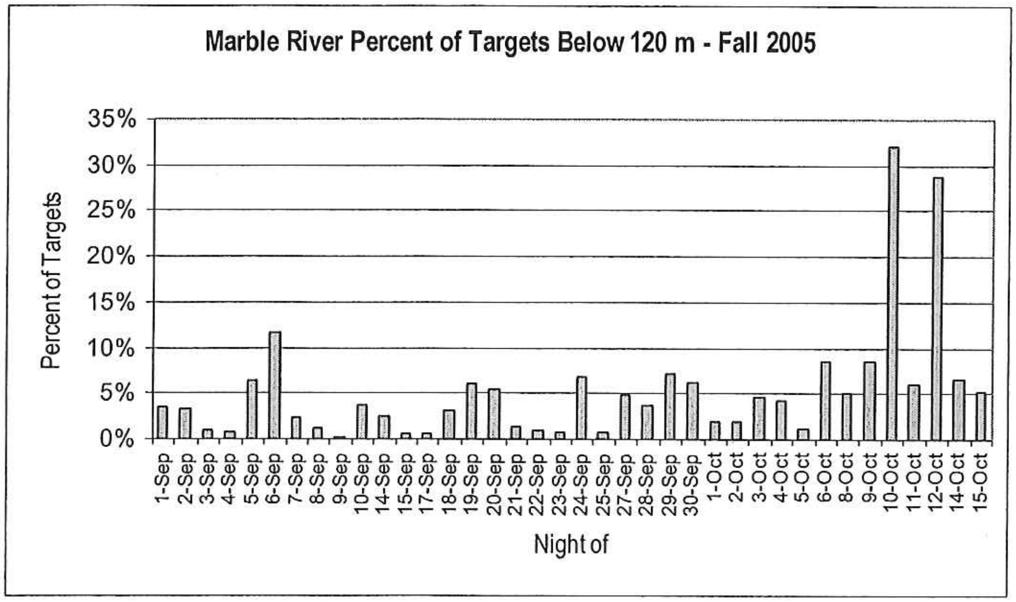


Figure 3-8. Percent of targets observed flying below a height of 120 m (394')

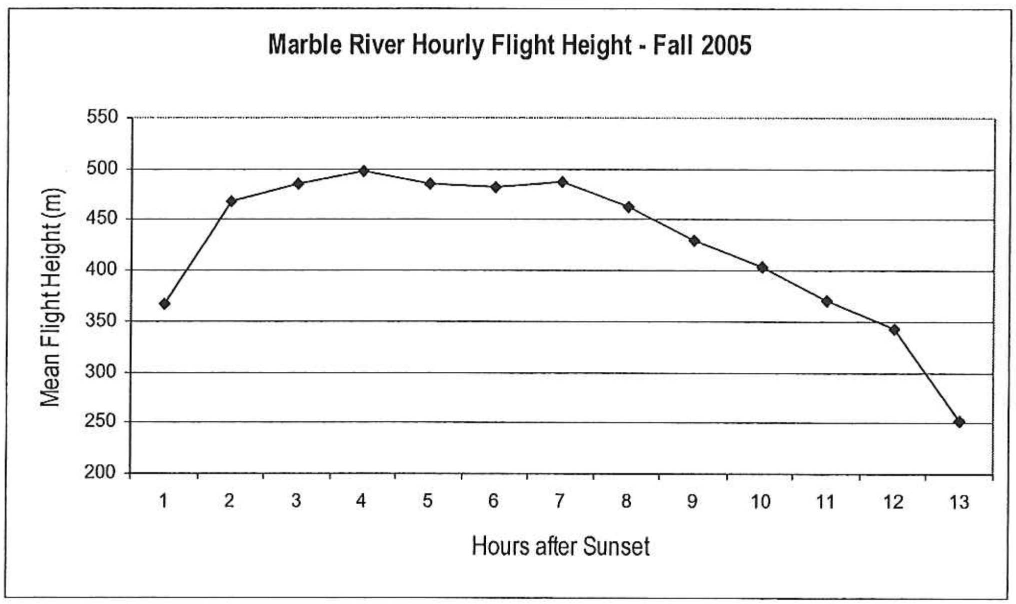


Figure 3-9. Hourly target flight height distribution

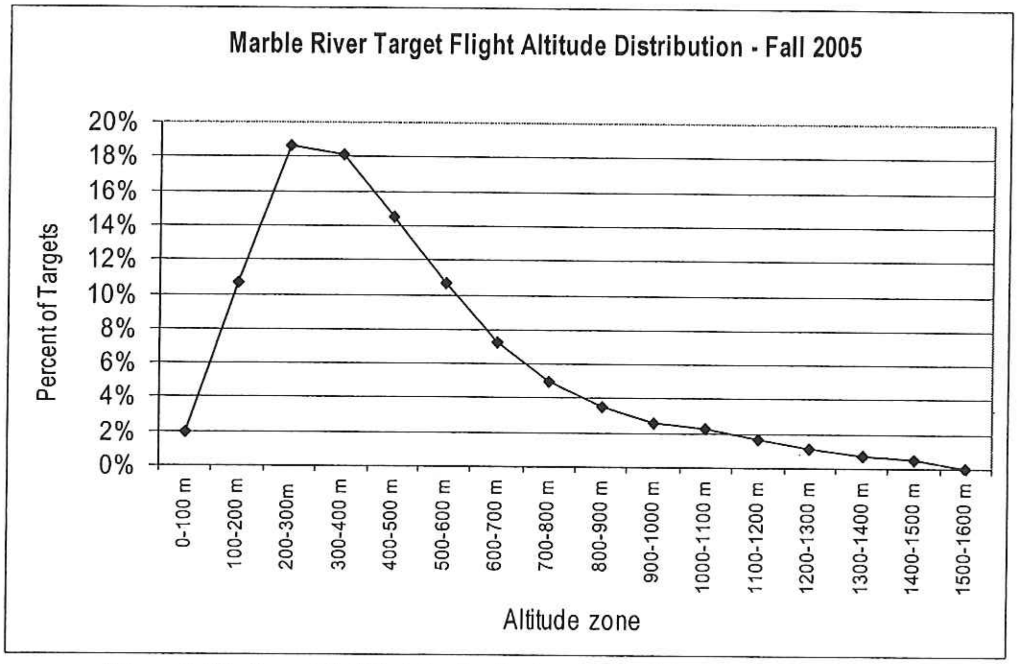


Figure 3-10. Target flight height distribution within 100 m (328') height zones

Ceilometer and Moonwatching Observations

Ceilometer data collected during the radar survey yielded a total of 400 5-minute observations, including both the ceilometer beam and moonwatching data collection. Those observations, however, resulted in only 21 bird and four bat sightings in the ceilometer beam.

3.4 Discussion

Fall 2005 radar surveys documented migration activity and patterns in the vicinity of the proposed Marble River 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, Richardson 1972, Able 1973, Bingman *et al.* 1982, and 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 fall, the passage of low pressure systems and cold fronts are typically followed by periods of southerly flowing winds that can last from one to three days. Bird migration is often more abundant during these periods, as birds are capitalizing on the generally suitable wind direction for fall 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 9 ± 4 to 429 ± 39 t/km/hr, with an overall mean of 152 ± 16 t/km/hr. Passage rates often peaked 3 to 4 hours after sunset, which is typical of nighttime migration activity (Able 1970; Richardson 1972).

Few surveys using the same methods and equipment and conducted during the same time period are available for comparison (Table 3-2). 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. However, nightly mean passage rates observed at the Marble River project area were within the range of those studies.

Table 3-2. Summary of passage rates from other fall radar studies

Year	Location	Passage Rate (t/km/hr)	Reference
1994	Western Maine	551	ND&T 1995
1994	Copenhagen, NY	121	Cooper *et al.* 1995
1994	Martinsburg, NY	225	Cooper *et al.* 1995
1998	Harrisburg, NY	122	Cooper and Mabee 1999
1998	Wethersfield, NY	168	Cooper and Mabee 1999
2003	Chautauqua, NY	238	Cooper *et al.* 2004a
2003	Mt. Storm, WV	241	Cooper *et al.* 2004b
2004	Prattsburgh, NY	200	Mabee *et al.* 2005

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 changes year-to-year. Second, the location of the Marble River project site is more northerly than those surveys. Consequently, the size of the continental bird population north of the Marble River project area may be considerably smaller than those other sites.

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 Alternatives, Inc. 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 rolling hills with elevation differentials of 372 m (1,220') to 411 m (1,350'). This is considerably less than in those other areas where potential topographic effects on flight direction have been observed. The mean flight direction of 193° ± 89° takes migrants over the project area towards the northern foothills of the Adirondack State Park.

Flight Altitude

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.* (2004b) documented mean nightly flight altitudes at Mount Storm, West Virginia, between 214 m (702') and 769 m (2,522'), with a seasonal mean of 410 m and an average of 16% of targets flying below 125 m (410'). In western New York, Cooper *et al.* (2004a) documented a mean flight altitude of 532 m (1,745') with a small percentage (4%) of targets flying less 125 m (410') above the ground.

Results from the Marble River project area are generally similar to those of Cooper *et al.* (2004a, 2004b), with nightly flight altitudes varying from 259 m ± 14 m (850' ± 46') to 704 m ± 92 m (2,310' ± 302') and a mean of 438 m ± 15 m (1,437' ± 49'). The percentage of targets flying less than 120 m (394') above the ground was low, 5%, similar to that found by Cooper *et al.* (2004a).

The 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.

3.5 Conclusions

Radar surveys during the fall 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 sites in the region.

Migration activity varied throughout the season, which is probably largely attributable to weather patterns. The mean passage rate (152 ± 16 t/km/hr) is within, but at the low end of, the range in passage rates observed at similar studies. Flight direction for the entire season was 193° ± 89°. Flight direction data indicate that nocturnal migrants are not avoiding the project area for any topographic-related reasons.

The average flight altitude above the ground was 438 m ± 15 m (1,437' ± 49'). Only 5 percent of the targets observed during vertical radar operation were flying below an altitude of 120 m (394'), the height of the proposed turbines, indicating that risk of collision to night-migrating birds is limited to a very small subset of those birds. On nights when wind was from the southwest, flight altitudes were typically lower. Alternately, flight heights were higher when winds were generally from the north.

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. At the Marble River project area the five nights with the lowest passage rates experienced weather conditions ranging from rain showers to drizzle and fog. Those nights, however, were typically associated with low to very low nightly passage rates. Despite this fact, while increased risk potential could develop due to inclement weather, the prediction of those events cannot be reliably made because night-to-night variation in flight characteristics occur, even on nights with similarly unsuitable migration weather.

4.0 Bat Survey

Wind projects have emerged as a potentially significant source of mortality for migrating bats following results of post-construction mortality surveys conducted at several operational wind farms in the southeastern United States (Arnett *et al.* 2005). While concerns about the risk of bat collision mortality were initially focused on forested ridgelines in the eastern United States, recent evidence from one facility on the prairies of Alberta indicate that bat mortality in those open habitats can be comparable to that observed along the forested ridgelines of the central Appalachian mountains (Robert Barclay, unpublished data). Two consistent patterns have emerged from mortality studies of bats at operational wind farms: the timing of mortality and the species most commonly found. The majority of bat collisions appears to occur consistently during the month of August and is thought to be linked to fall migration patterns. The species most commonly found during mortality searches are the migratory tree bats: red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), eastern pipistrelle (*Pipistrellus subflavus*), and silver-haired bat (*Lasionycteris noctivagans*) (Arnett *et al.* 2005). Bat collision mortality during the breeding season has been virtually non-existent, despite the fact that relatively large populations of some bat species have been documented in close proximity to some wind facilities that have been investigated. These data suggest that wind plants have minimal impact to resident breeding bat populations in the United States.

Bat researchers have presented a number of plausible hypotheses explaining the high rates of bat mortality, as well as these patterns in timing and species vulnerability, but none have been adequately tested. The most likely mechanisms explaining bat collision center on the possibility that bats are unable to detect rotating turbine blades by echolocation, that bats are visually or acoustically attracted to wind turbines as potential roost habitat or due to curiosity, or that ridgelines act as corridors for migrating bats (Arnett *et al.* 2005). Additionally, bats may rely on navigational cues other than echolocation while migrating, making them less able to detect the rotating blades of a wind turbine. Although evidence is highly preliminary, the rotation of turbines appears to be linked to mortality estimates, as no dead bats were found beneath the single non-operational turbine at the West Virginia site (Arnett *et al.* 2005).

The Marble River site is located in a flat, agricultural landscape in the Towns of Clinton and Ellenburg, New York, in Clinton County. This site is within the potential range of nine bat species: the little brown myotis (*Myotis lucifugus*), northern long-eared myotis (*M. septentrionalis*), eastern small-footed myotis (*M. leibii*), Indiana myotis (*M. sodalis*), big brown bat (*Eptesicus fuscus*), eastern red bat, hoary bat, eastern pipistrelle, and silver-haired bat. Within the surrounding region, agricultural fields, road corridors, and wetlands likely serve as important feeding habitats, and man-made structures and mature trees within isolated forest fragments likely comprise the majority of roost habitats. Clinton County is the northernmost county in New York, and is above the normal mapped range of the Indiana myotis, although there is a known Indiana myotis hibernaculum in Essex County, which borders Clinton County to the south.

To document bat activity in the area of the proposed Marble River wind facility, Woodlot conducted acoustic monitoring surveys during spring, summer, and fall 2005. These surveys consisted of a combination of active and passive acoustic monitoring. Anabat II detectors were used for the duration of the surveys and were designed to document bat passages near the rotor zone of the proposed turbines, at an intermediate height, and near the ground. Visual ceilometer surveys, which have the potential to document bats in the area, were also conducted during concurrent nocturnal radar surveys.

4.1 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 so that they are audible to humans. A factor of 16 was used in this study[3]. Frequency division detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad range of frequency, which allows detection of all species of bats that could occur in the region. Data from the Anabat detectors were logged onto compact flash media using a CF ZCAIM (Titley Electronics Pty Ltd.) and downloaded to a computer for analysis.

The summer field survey included documentation of summer bat activity through active and passive surveys with detectors during several three-night sampling periods. Passive summer bat surveys consisted of deploying bat detectors approximately 20 m (66') and 10 m (33') above the ground in the guy wires of the on-site met tower. Active sampling included hand carrying a detector during the first four hours of the night along various landscape features in the project area, such as field edges, field hedgerows, roadsides, streams, and wet areas (Figure 4-1).

Fall surveys consisted of deployment of three detectors on site during the fall breeding and migration season, which likely occurs during August and early September. Two of the detectors were positioned at heights of approximately 20 m (66') and 10 m (33') in a met tower on site, and the third detector was suspended from a tree near the edge of the met tower field at a height of 2 m (6') (Figure 4-1). Detectors were programmed to record nightly from 6:00 pm to 8:00 am.

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 reference calls used were obtained by other researchers, most of which were of western origin, identifications were conservative. Poor quality recordings or brief fragments were labeled 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. Appendix C contains representative examples of call files included in this report.

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

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.

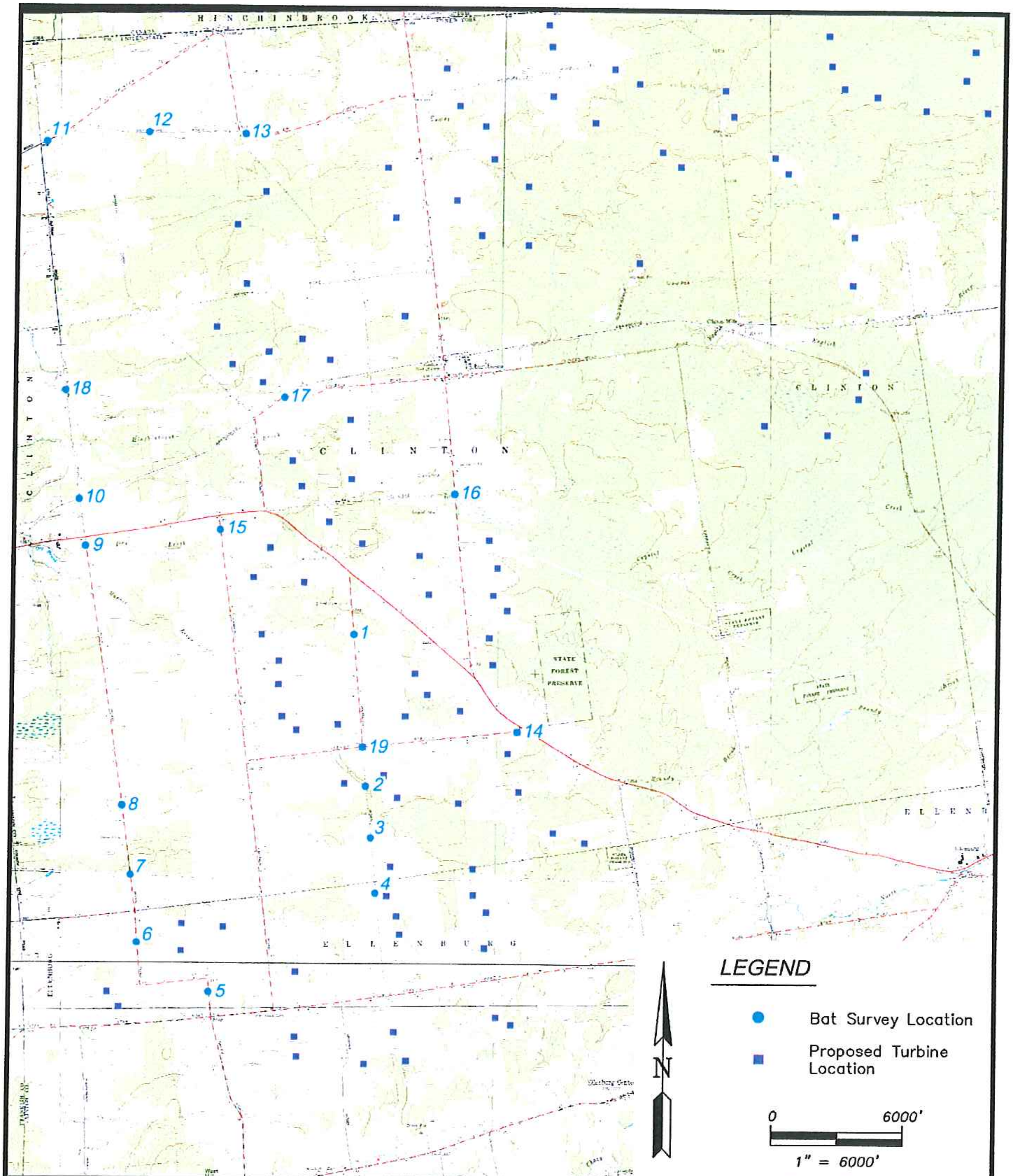
Weather Data

Wind speed and temperature data recorded at 10-minute intervals were obtained from the on-site met tower between August 1 and October 11. The mean, maximum, and minimum wind speeds and temperatures between 7:00 pm and 7:00 am were calculated for each night.

4.2 Results

Summer Surveys

Summer surveys took place on nine nights between July 5 and 31, totaling 126 hours, 13 minutes of sample time. Passive surveys took place on the nights of July 5 to July 7, July 19 to July 21, and July 29 to July 31, totaling 108 hours of sampling. Active surveys took place on the nights of July 5 to July 6, July 19 to 21, and July 29 to July 31, totaling 18 hours, 13 minutes. Active surveys consisted of driving, walking, or surveying fixed points in the greater study area (Figure 4-1). Active surveys did not take place on July 7 due to thunderstorms (Table 4-1). During these surveys, a total of 341 bat call sequences were detected and recorded, 22 during passive surveying and 319 during active surveying. Hourly call rates ranged from 0 to 137.6, with an overall value of 0.2 call sequences/hour during passive surveys and 17.5 call sequences/hr during active surveys. Bats were detected on 5 out of 9 passive survey nights and during 20 out of 30 active survey sampling periods.



PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS	DATE: January 2005	*Figure 4-1*
	SCALE: 1" = 6000'	*Bat Survey Location Map*
	JOB NO. 105038	*Marble River Wind Project*
	FILE: 105038-00-Location.dwg	*Clinton and Ellenburg, New York*
		REV.

Table 4-1. Summary table for the results of summer bat surveys at Marble River

Date (night of)	Time	Survey Length	Site #	Site Description	# Call Sequences	# Call Sequences/Hour	EPFU	MYSP	LABO	LACI	LANO	UNKN	Notes
7/5/05	1900-0700	12:00	MET		5	0.4	1	3				1	
7/6/05	1900-0700	12:00	MET		0	0.0							
7/7/05	1900-0700	12:00	MET		0	0.0							Thunderstorms
7/19/05	1900-0700	12:00	MET		4	0.3	3					1	
7/20/05	1900-0700	12:00	MET		5	0.4	2			2		1	
7/21/05	1900-0700	12:00	MET		3	0.3		2				1	
7/29/05	1900-0700	12:00	MET		0	0.0							
7/30/05	1900-0700	12:00	MET		0	0.0							
7/31/05	1900-0700	12:00	MET		5	0.4	4			1			
7/5/02	2100-2300	2:00		Woods along Patnode Rd., near radar site	8	4.0	2	6					Bats detected in open patch, and under overhanging trees
7/5/05	2300-0000	1:00		Open agricultural fields between Patnode and Gagnier roads.	0	0.0							
7/6/05	2145-2230	0:45		Barn on Gagnier Rd.	5	6.7		3				2	
7/6/05	2230-2252	0:22		Woods along Patnode Rd., near radar site	1	2.7		1					
7/6/05	2252-0000	1:08		Open field, .25 mi from Patnode Rd.	0	0.0							
7/19/05	2100-2200	1:00		Field edges near radar site	3	3.0		1				2	
7/19/05	2200-0000	2:00		Driving along road near site	8	4.0	1	6				1	Overhanging trees
7/20/05	2045-2245	2:00		Driving along fields off Patnode and Gagnier roads.	2	1.0		1				1	Thunderstorms began at 22:45
7/21/05	2054-2130	0:43		Field edges near radar site	5	7.0	3		1			1	
7/21/05	2130-2300	1:30		Driving along road near site	4	2.7		4					Overhanging trees
7/21/05	2300-0000	1:00		Field edges near radar site	2	2.0		2					
7/29/05	2057-2122	0:05	1	Both sides forested wetland. Mature deciduous trees, white cedar interspersed.	8	96.0	7	1					55 degrees f. 60%CC wet.
7/29/05	2131-2141	0:10	2	On east side, a vernal pool. Some deciduous trees and then a hay field. On W side of hay field	2	12.0		1	1				
7/29/05	2145-2148	0:03	3	Thick mature deciduous forest on both sides of road.	0	0.0							
7/29/05	2150-2208	0:18	4	Thick mature deciduous forest on both sides of Rd.	8	26.7		8					
7/29/05	2208-2218	0:10	5	Early successional forest; saplings, shrubs. On W side, agricultural field.	0	0.0							45-50 degrees f. @2200
7/29/05	2221-2233	0:12	6	Both sides of road. mature deciduous forest with thick understory.	0	0.0							
7/29/05	2237-2245	0:08	7	Both sides marsh and some forested wetland. Deciduous.	0	0.0							
7/29/05	2252-2305	0:13	8	Both sides a fen (insistent emergent) with some saplings. Flooded.	0	0.0							
7/29/05	2309-2312	0:03	9	Too many crickets. Stream crossing some deciduous trees. Mature.	2	40.0		2					
7/29/05	2316-2324	0:08	10	On both sides mature deciduous. Possibly forested swamp?	0	0.0							

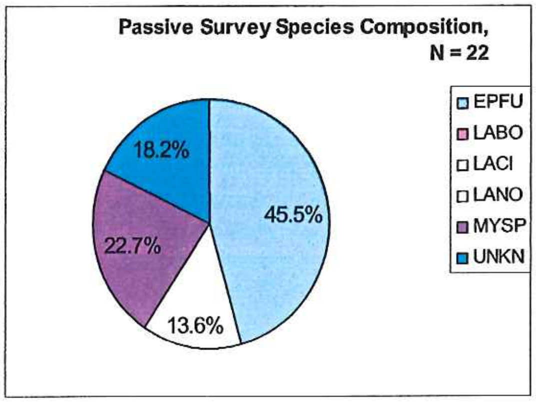
(continued)

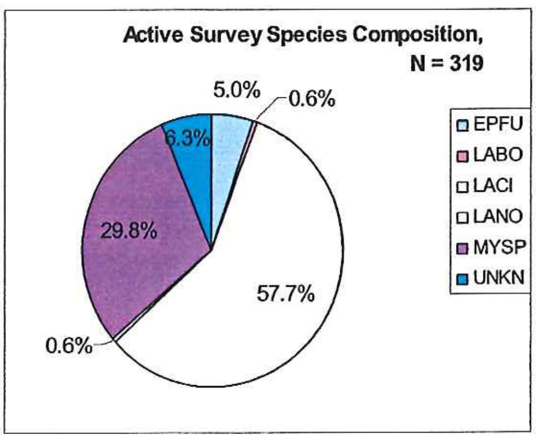
Table 4-1. Summary table for the results of summer bat surveys at Marble River (continued)

Date (night of)	Time	Survey Length	Site #	Site Description	# Call Sequences	# Call Sequences/Hour	EPFU	MYSP	LABO	LACI	LANO	UNKN	Notes
7/30/05	2120-2139	0:19	10	Permanently flooded, some mature deciduous trees surrounding. Agricultural fields nearby.	3	9.5	1	2					50 degrees f. 60% CC No Breeze
7/30/05	2142-2156	0:14	11	On N side line of trees sapling deciduous on S side hayfield	1	4.3						1	
7/30/05	2201-2212	0:11	12	On N side mature deciduous forest. On S side early successional field.	0	0.0							
7/30/05	2217-2254	0:37	13	On left side mature deciduous forest. On right either early successional field or scrub shrub wetland.	77	124.9		11		64		2	
7/31/05	2142-2229	0:47	14	On S side deciduous forest. On N side maintenance building	136	173.6		6		119	2	9	60 degrees f. scattered showers. 100% CC
7/31/05	2232-2247	0:15	15	Deciduous forest on both sides of road. Stream crossing nearby.	3	12.0		3					
7/31/05	2254-2316	0:22	16	Both sides forested swamp with persistent emergents.	30	81.8	2	28					
7/31/05	2319-2332	0:13	17	On south side, grassy field. On N side mature deciduous trees.	0	0.0							
7/31/05	2343-0000	0:17	18	Both sides of road, mature deciduous forest. Nature trail crosses Rd.	11	38.8		9		1		1	
Total Passive	N/A	108:00	N/A	N/A	22	0.2	10	5	0	3	0	4	
Total Active	N/A	18:13	N/A	N/A	319	17.5	16	95	2	184	2	20	
Total	N/A	126:13	N/A	N/A	341	2.7	26	100	2	187	2	24	0

Notes: Site # refers to locations on Figure 4-1.
EPFU = big brown bat, LABO = red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* sp., PISU = eastern pipistrelle, UNKN = unknown.

Hoary bats accounted for 187 of the 341 (55%) of the call sequences detected during summer surveys, *myotids* accounted for 100 call sequences (29%), and 26 (8%) big brown bat call sequences were detected. Eastern red and silver-haired bats were also detected during summer surveys, with two call sequences detected for each species. Twenty-four calls were classified as "unknown" (Figure 4-2). Eastern red and silver-haired bats were not detected during passive summer surveys. Although hoary bats accounted for the largest number of call sequences recorded during active surveying, they are not likely to be the most common species in the area. Appendix C contains representative examples of call sequences recorded at the Marble River site.





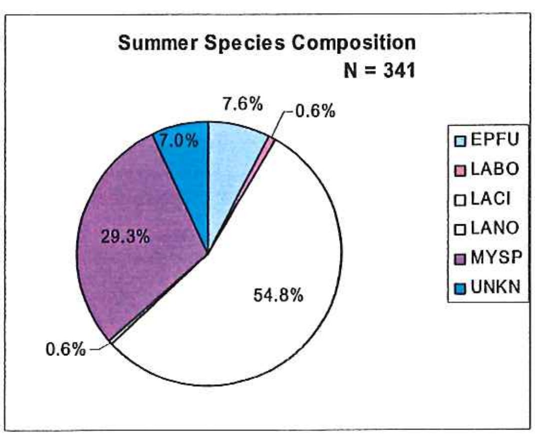


Figure 4-2. Species detected at Marble River during summer bat surveys.

EPFU = big brown bat, LABO = red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* sp., PISU = eastern pipistrelle, UNKN = unknown.

Bats were detected in a variety of habitats during active summer surveys, although activity seemed to be highest along forest edges, and in association with wetlands. The highest rate of call sequences (174 call sequences per hour) was detected on the night of July 31, when surveying along a road with deciduous forest on one side and a maintenance building on the other side. A total of 136 call sequences of 4 species were recorded during 47 minutes of sampling. However, as can often be the case with acoustic sampling, many of these sequences were likely those of a few individual bats flying past the detector repeatedly. The majority of call sequences recorded at this site were hoary bats. The timing of call sequences also suggests that they were produced by a single bat flying repeatedly past the detector. The same pattern is true for the large number of calls recorded at a nearby site on the night of July 30.

Fall Surveys

Fall surveys took place on 66 nights between August 1 and October 11, totaling 91 detector-nights of sampling (Table 4-2). Although three detectors were deployed continuously during the survey period, equipment malfunctions prevented data from being collected by each detector at some point during the survey period. A total of 506 bat call sequences were detected and recorded during fall surveys. Bats were detected on 57 out of the 66 nights sampled. The highest nightly passage rates were recorded by the high detector during the middle of September, with the maximum value of 33 call sequences per night occurring on the night of September 15. Although the detectors were not operating simultaneously, combined data from the low and high detectors for August and September suggests that activity levels increased during August and peaked in mid-September (Figure 4-3).

Table 4-2. Summary table for the results of fall bat surveys at Marble River

Date (night of)	# Detectors	Detector Location	Survey Time	# Call Sequences, High Detector	# Call Sequences, Low Detector	# Call Sequences, Field Detector	Total # Call Sequences
8/1/05	1	High	19:00-07:00	7	--	--	7
8/2/05	1	High	19:00-07:00	10	--	--	10
8/3/05	1	High	19:00-07:00	7	--	--	7
8/4/05	1	High	19:00-07:00	1	--	--	1
8/5/05	1	High	19:00-07:00	11	--	--	11
8/6/05	1	High	19:00-07:00	3	--	--	3
8/7/05	1	High	19:00-07:00	1	--	--	1
8/8/05	1	High	19:00-07:00	5	--	--	5
8/9/05	1	High	19:00-07:00	2	--	--	2
8/10/05	1	High	19:00-07:00	7	--	--	7
8/11/05	1	High	19:00-07:00	6	--	--	6
8/12/05	1	High	19:00-07:00	4	--	--	4
8/13/05	1	High	19:00-07:00	13	--	--	13
8/14/05	1	High	19:00-07:00	9	--	--	9
8/15/05	1	High	19:00-07:00	4	--	--	4
8/16/05	1	High	19:00-07:00	4	--	--	4
8/17/05	1	High	19:00-07:00	1	--	--	1
8/18/05	1	High	19:00-07:00	4	--	--	4
8/19/05	2	Middle, Ground	19:00-07:00	--	6	0	6

(continued)

Table 4-2. Summary table for the results of fall bat surveys at Marble River (continued)

Date (night of)	# Detectors	Detector Location	Survey Time	# Call Sequences, High Detector	# Call Sequences, Low Detector	# Call Sequences, Field Detector	Total # Call Sequences
8/20/05	2	Middle, Ground	19:00-07:00	--	6	0	6
8/21/05	2	Middle, Ground	19:00-07:00	--	11	8	19
8/22/05	2	Middle, Ground	19:00-07:00	--	5	2	7
8/23/05	2	Middle, Ground	19:00-07:00	--	4	5	9
8/24/05	2	Middle, Ground	19:00-07:00	--	2	15	17
8/25/05	2	Middle, Ground	19:00-07:00	--	5	13	18
8/26/05	1	Middle	19:00-07:00	--	5	9	14
8/27/05	1	Middle	19:00-07:00	--	8	13	21
8/28/05	1	Middle	19:00-07:00	--	7	0	7
8/29/05	1	Middle	19:00-07:00	--	4	0	4
8/30/05	1	Middle	19:00-07:00	--	8	0	8
8/31/05	1	Middle	19:00-07:00	--	7	0	7
9/1/05	1	Middle	19:00-07:00	--	14	0	14
9/8/05	1	Middle	19:00-07:00	--	0	--	0
9/9/05	1	Middle	19:00-07:00	--	0	--	0
9/10/05	1	Middle	19:00-07:00	--	0	--	0
9/11/05	1	Middle	19:00-07:00	--	3	--	3
9/12/05	1	Middle	19:00-07:00	1	4	--	5
9/13/05	2	High, Middle	19:00-07:00	23	5	--	28
9/14/05	2	High, Middle	19:00-07:00	28	5	--	33
9/15/05	2	High, Middle	19:00-07:00	33	9	--	42
9/16/05	2	High, Middle	19:00-07:00	7	5	--	12
9/17/05	2	High, Middle	19:00-07:00		2	--	2
9/18/05	2	High, Middle	19:00-07:00	13	4	--	17
9/19/05	2	High, Middle	19:00-07:00	7	3	--	10
9/20/05	1	Middle	19:00-07:00	--	0	--	0
9/21/05	1	Middle	19:00-07:00	--	8	--	8
9/22/05	1	Middle	19:00-07:00	--	4	--	4
9/23/05	1	Middle	19:00-07:00	--	2	--	2
9/24/05	1	Middle	19:00-07:00	--	0	--	0

(continued)

Table 4-2. Summary table for the results of fall bat surveys at Marble River (continued)

Date (night of)	# Detectors	Detector Location	Survey Time	# Call Sequences, High Detector	# Call Sequences, Low Detector	# Call Sequences, Field Detector	Total # Call Sequences
9/25/05	1	Middle	19:00-07:00	--	3	--	3
9/26/05	1	Middle	19:00-07:00	--	1	--	1
9/27/05	2	Middle, Ground	19:00-07:00	--	0	0	0
9/28/05	2	High, Ground	19:00-07:00	1	--	3	4
9/29/05	2	High, Ground	19:00-07:00	3	--	2	5
9/30/05	2	High, Ground	19:00-07:00	0	--	0	0
10/1/05	2	High, Ground	19:00-07:00	1	--	1	2
10/2/05	2	High, Ground	19:00-07:00	4	--	7	11
10/3/05	2	High, Ground	19:00-07:00	3	--	6	9
10/4/05	2	High, Ground	19:00-07:00	6	--	17	23
10/5/05	2	High, Ground	19:00-07:00	6	--	3	9
10/6/05	2	High, Ground	19:00-07:00	1	--	8	9
10/7/05	2	High, Ground	19:00-07:00	2	--	1	3
10/8/05	1	High	19:00-07:00	1	--	--	1
10/9/05	1	High	19:00-07:00	0	--	--	0
10/10/05	1	High	19:00-07:00	4	--	--	4
10/11/05	1	High	19:00-07:00	0	--	--	0
Total	91	N/A	N/A	243	150	113	506

Notes: Dashes indicate non-functioning detectors.
EPFU = big brown bat, LABO = red bat, LACI = hoary bat, LANO = silver-haired bat,
MYSP = *Myotis* sp., PISU = eastern pipistrelle, UNKN = unknown.

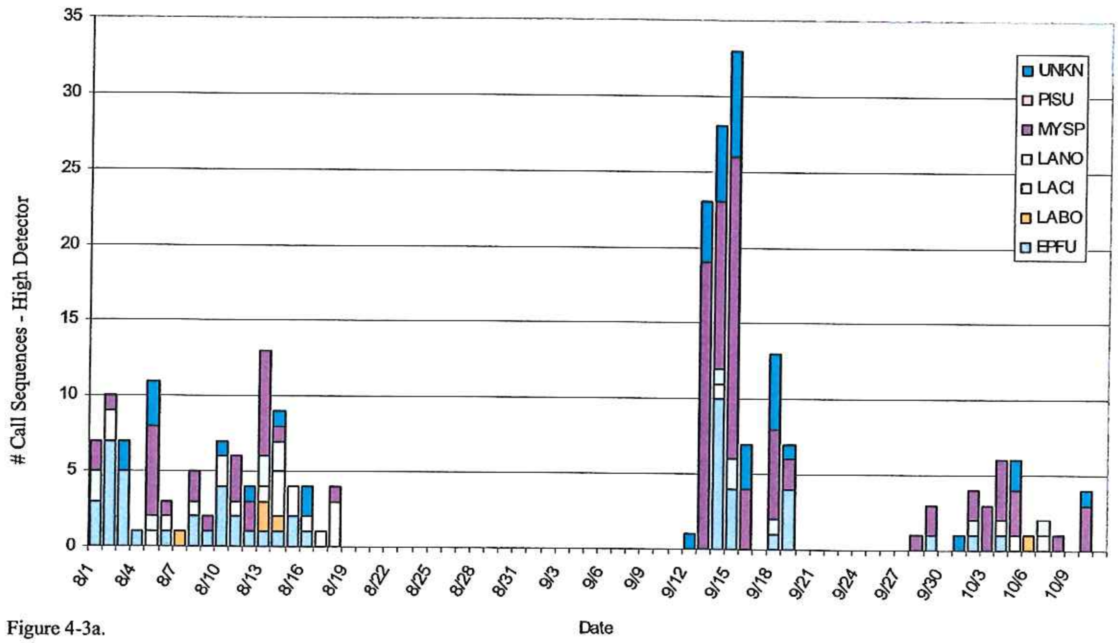


Figure 4-3a.

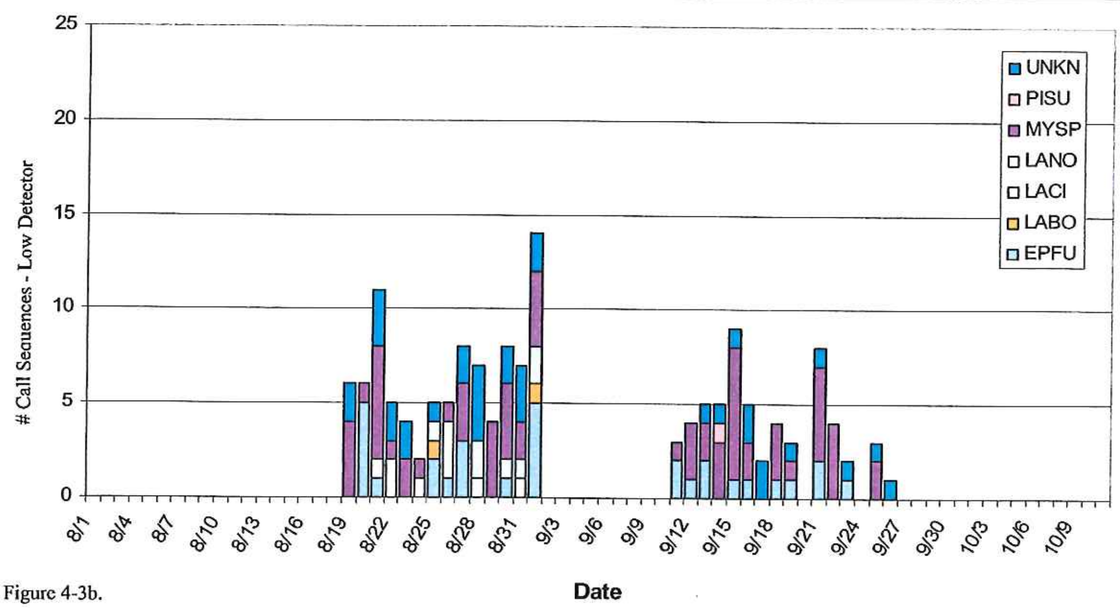


Figure 4-3b.

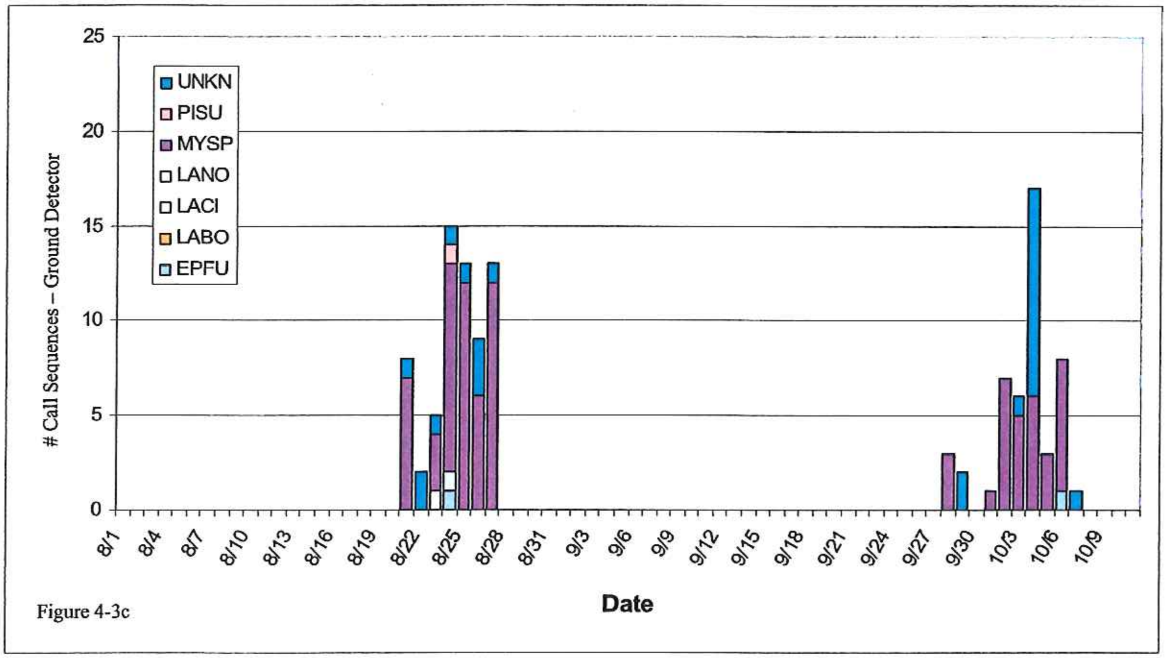


Figure 4-3. Nightly passage rates by species, detected by the high (a), low (b), and ground (c) detectors at Marble River during fall surveys. EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* sp., PISU = eastern pipistrelle, UNKN = unknown.

Myotids and big brown bats were the most commonly detected species during fall surveys (Figure 4-4). Although we did not attempt to identify individual *myotid* call sequences to species, the majority of *myotid* call sequences detected most closely resembled calls of the little brown myotis, a species expected to be common in the area. A relatively large number of call sequences that were classified as unknown during fall surveys were calls of either big brown bats or silver-haired bats, based on their frequency and shape. Calls of these species can be very similar, and conservative measures were used to identify these call sequences to species. Representative examples of call sequences detected at the Marble River site during active and passive sampling are found in Appendix C.

Ceilometer Surveys

Ceilometer surveys took place on 400 five-minute intervals during radar sampling, and 4 bats and numerous insects were observed.

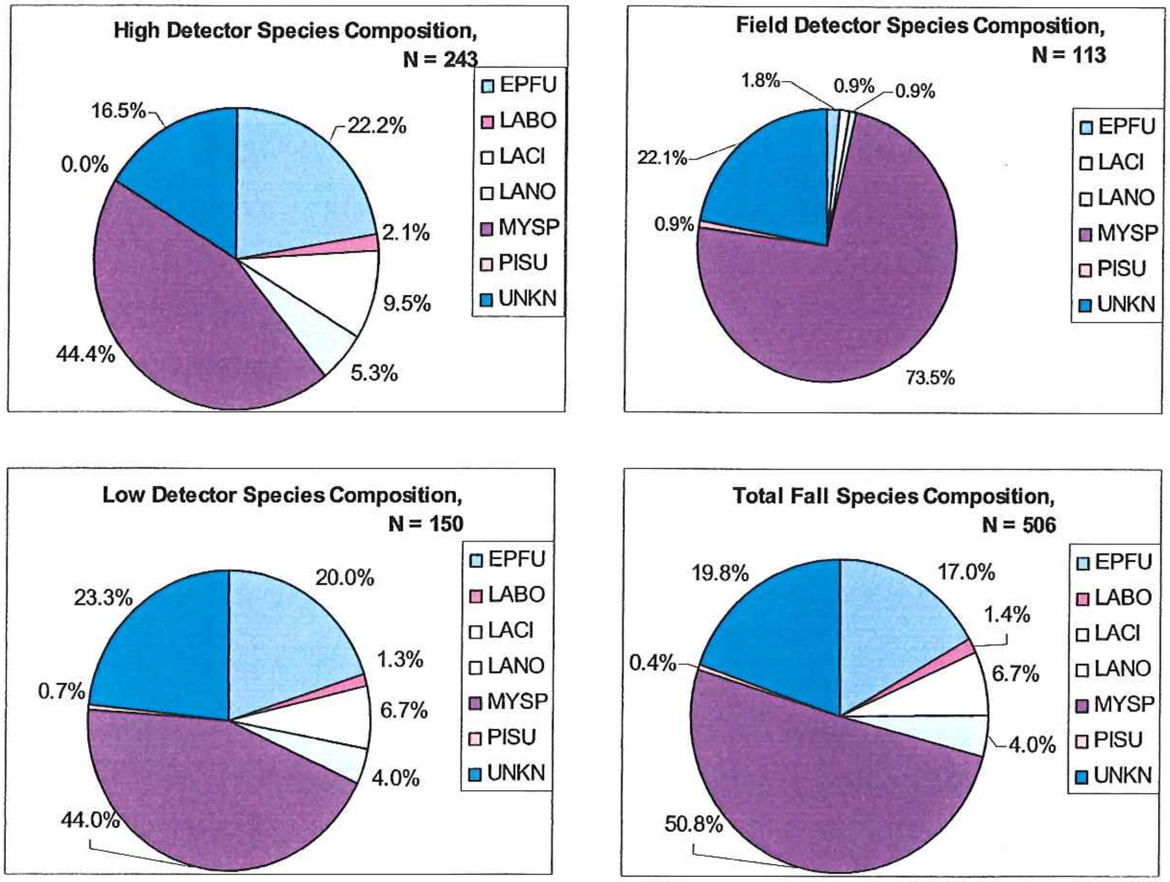


Figure 4-4. Species detected at Marble River during fall bat surveys.
EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* sp., PISU = eastern pipistrelle, UNKN = unknown.

Weather Data

Mean nightly temperature fluctuated considerably throughout the fall survey period, but began to decline after mid August, with the exception of warm periods in the last week of August, the second week of September, and the first week of October (Figure 4-5). The maximum nightly mean temperature of 25.8° C (78.6° F) was measured on the night of August 4, and the minimum nightly mean temperature of 5.34° C (41.6° F) was measured on the night of October 8. Mean nightly wind speed varied between approximately 2 m/s and 10 m/s, with an average nightly wind speed of 5.4 m/s between August 1 and October 11 (Figure 4-6). The maximum wind speed of approximately 18 m/s was measured on the night of September 29.

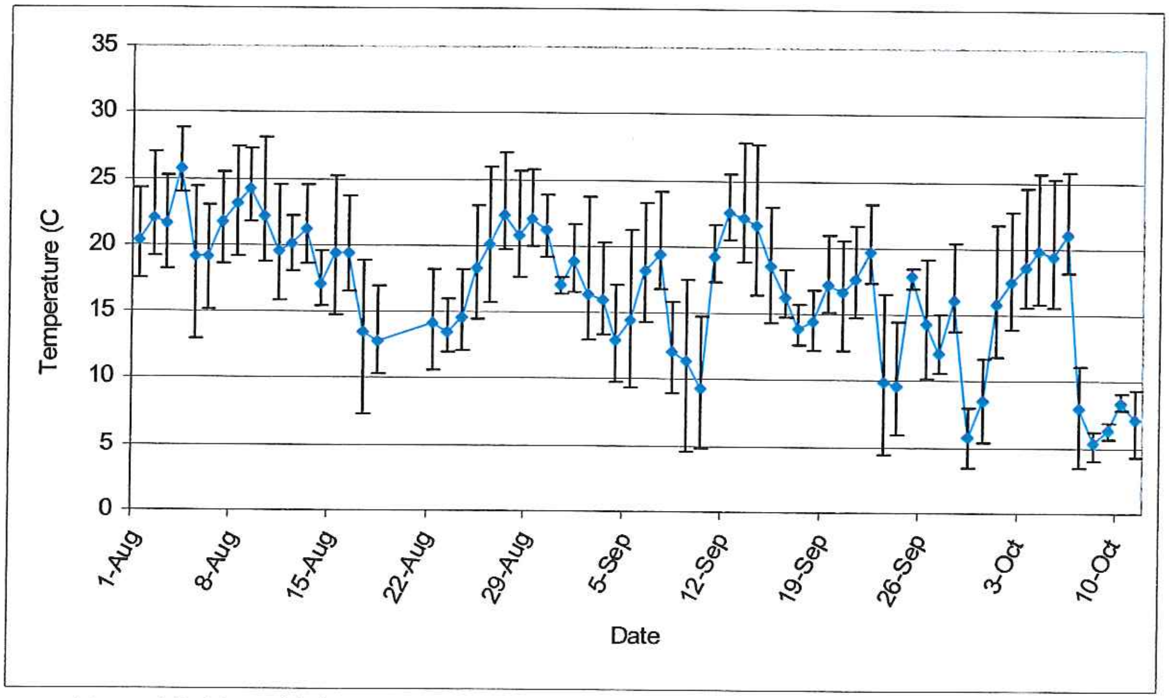


Figure 4-5. Mean nightly temperature recorded at Marble River during summer and fall bat surveys. Bars represent nightly minima and maxima.

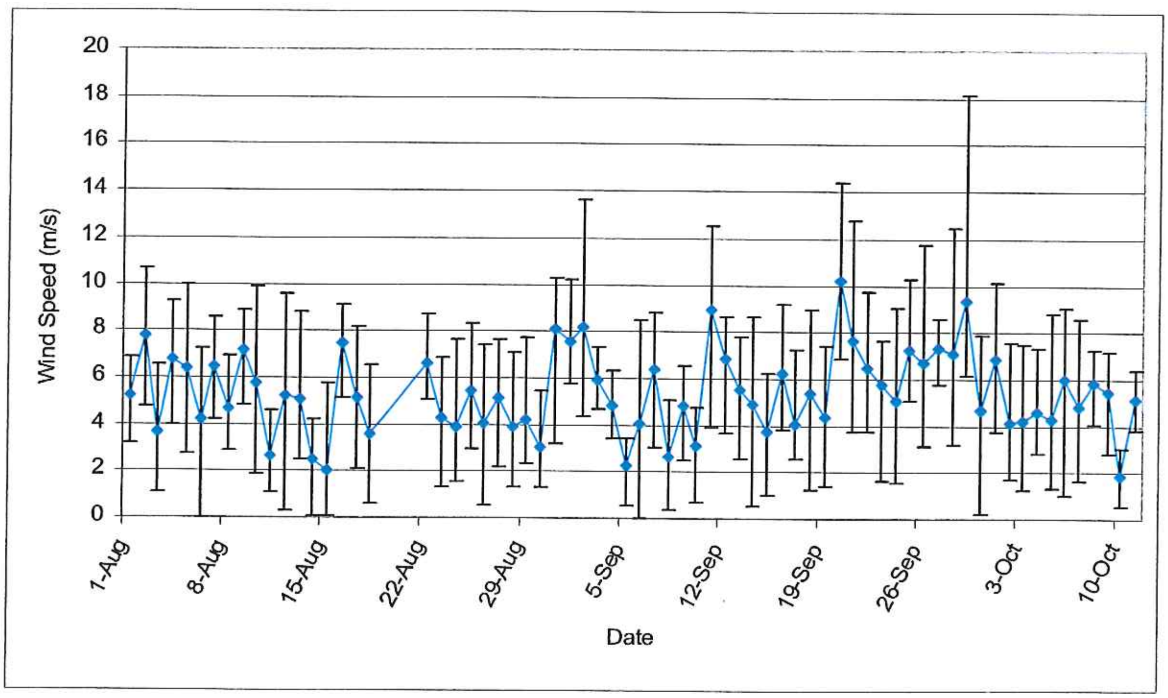


Figure 4-6. Mean nightly wind speed recorded at Marble River during summer and fall bat surveys. Bars represent nightly minima and maxima.

4.3 Discussion

Bat surveys conducted at Marble River during summer and fall 2005 suggest that bat activity levels are highest in this area during the fall, especially between mid August and mid September. This pattern may be linked to movement of migrating bats, seasonal changes in behavior of resident bats, and/or behavior of bats during the breeding season, which also occurs in late summer and early fall for most species. Although high passage rates were documented at certain locations during summer surveys, these data are more likely to reflect the results of recording a single bat multiple times, than data from passive surveys. Passage rates recorded in the met tower were highest during mid September.

Bat surveys did not focus on habitat characterization, but no characteristics of the Marble River site that would make it especially well suited for bats were documented. The highest passage rates documented during summer surveys were along forest edges, wetland edges, and road corridors, all of which are common throughout the greater landscape, which is generally flat, and dominated by agricultural land use. Due to its location near the northern border of New York, the likelihood that Indiana bats are present at the site is also quite low.

Identification of recorded call sequences suggests that *myotids* and big brown bats are the most common species in the area during the summer months. Hoary bats were also locally common. Although *myotid* calls were not individually identified, they most closely resembled calls of the little brown bat. Eastern red bats, silver-haired bats, and eastern pipistrelles were also detected at the site, but in considerably smaller numbers.

Results of bat echolocation surveys must be interpreted with the understanding that bat detectors are able to sample only a relatively small air space, extending approximately 12 m to 15 m (40' to 50') in front of the detector. Therefore, a detector mounted on a met tower samples only a small percentage of the area that would be occupied by a wind turbine and is not able to sample the upper portion of the rotor zone of a wind turbine. No data currently exists on flight height of migrating bats, and it is possible that they fly at higher altitudes, where they could not be detected using current acoustic sampling methods. Until more data are available from operational wind farms, the factors causing bat collision mortality will be difficult to understand.

5.0 Breeding Birds Surveys

5.1 *Introduction*

The topography of the proposed project area is relatively flat, with an elevation of approximately 396 m (1,300'). The area is rural, dominated by a mosaic of agricultural fields with fragments of woodlands and scattered low-density housing. The site is located near the intersection of three ecozones, specifically the Western Adirondack Foothills, Western Adirondack Transition, and Champlain Transition ecozones. The forest fragments in the area consist of three potential forest types: white pine-northern hardwood, spruce-fir northern hardwood, and aspen-gray birch-paper birch.

The area was originally a forest-wetland complex, and although little of the forest remains today (American Bird Conservancy 2000) some of the wooded fragments are intermixed with wetlands and creeks. In some areas, the transition between cultivated fields and woodlands is buffered by early successional or scrub habitat. Avian species tolerant of disturbed areas, croplands, pastures, sharp transitional edges, and fragmented woodlands would be expected to occur in this environment. Species known to prefer or require expansive tracts of intact forest would be unlikely to breed within the project area. Species listed as endangered, threatened, or of special concern by the NYDEC that might be expected in the proposed project area include the northern harrier, upland sandpiper (*Bartramia longicauda),* horned lark (*Eremophila alpestris,*), grasshopper sparrow (*Ammodramus savannarum*), and vesper sparrow (*Pooecetes gramineus*).

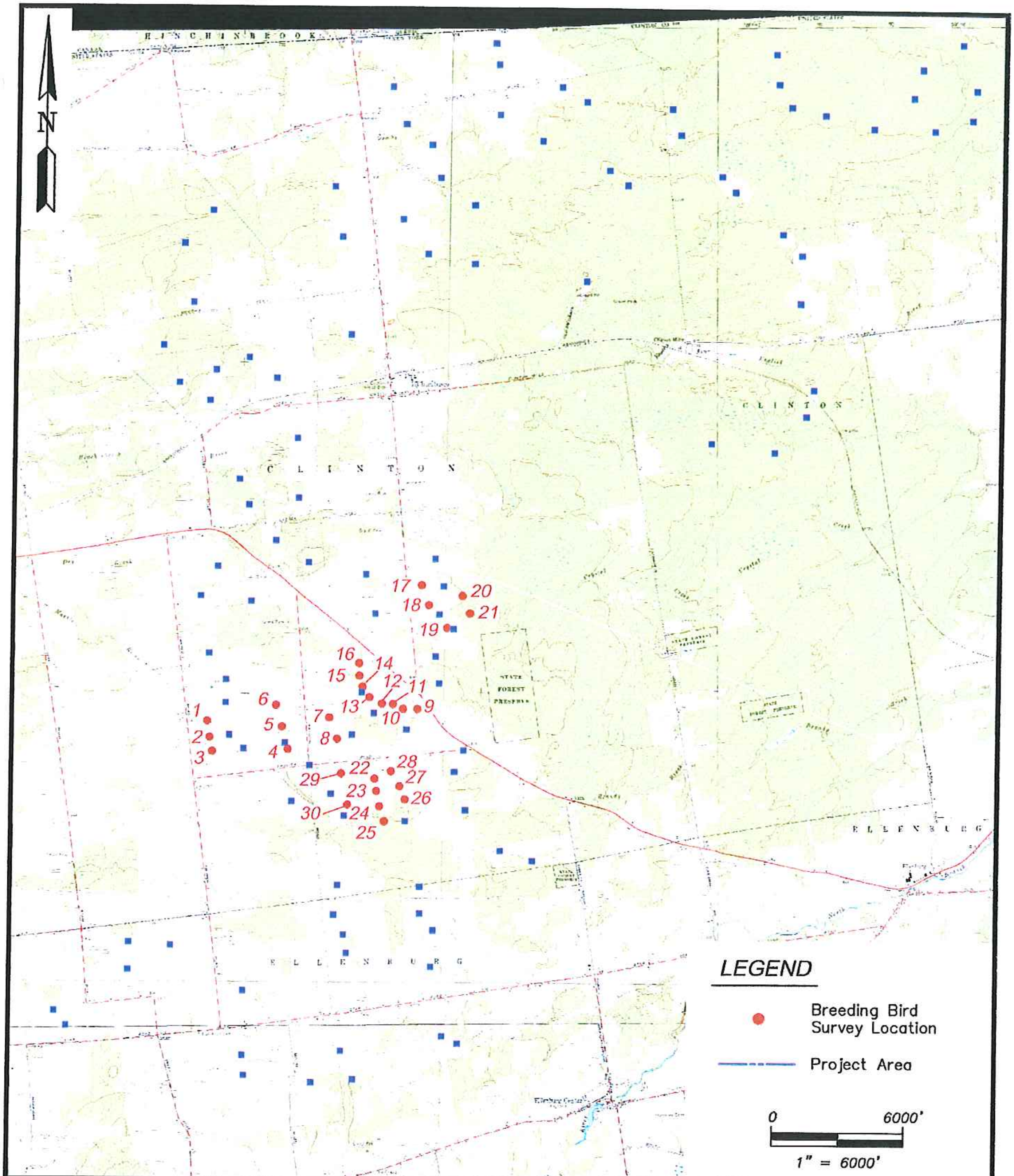
Woodlot conducted systematic point counts to characterize the species diversity and abundance of birds breeding in the vicinity of the proposed project location. These efforts were intended to provide a baseline preconstruction record of the area's breeding birds. Observers gathered information on species identification, abundance, nest building, courtship displays, and any other notable behaviors.

5.2 *Methods*

Field Surveys

Breeding bird surveys were conducted at the proposed Marble River Wind Power Project, in the towns of Clinton and Ellenburg, New York, during the month of June 2005 (Figure 5-1). The point count method, modeled on U.S. Fish and Wildlife Service Breeding Bird Survey (BBS) methodology (Sauer *et al.* 1997), was used to count individuals of each species located at a series of survey points. Thirty survey points were sampled, 14 points in fields and 16 in forested habitats. Fifteen points were surveyed per day on two consecutive days, and the survey was repeated again in one week to identify breeding birds during peak nesting season, when the males are calling. Survey locations were chosen to provide coverage of the proposed locations of the wind turbines and transmission lines as well as proportional coverage of the project area habitat types. The survey points were spaced to ensure that double-counting of individuals did not occur. Point locations were recorded using a handheld Geographic Position System (GPS).

All points were surveyed twice during the nesting season on days with suitable weather conditions, which included generally mild conditions or, at worst, light rain showers and light to moderate winds. Surveys were not conducted during periods of moderate to heavy rain or high winds. Surveys were timed to coincide with the hours of peak bird singing activity, approximately 4:30 to 9:30 am. Each point was surveyed for three minutes during which all visual or audible observations of birds were recorded onto a data sheet for that point. Each bird was identified as to species and distance from survey site (0 – 50 m,



PREPARED BY:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

DATE:	January 2006
SCALE:	1" = 6000'
JOB NO. 105038	
FILE: 105038-00-Location.dwg	

Figure 5-1
Breeding Bird Survey Location Map
Marble River Wind Project
Clinton and Ellenburg, New York

REV.

50 – 100 m, or >100 m). This method is similar to the methodology of the BBS and provides the opportunity for comparison with BBS data in the future. The approximate location of each bird was also plotted on a point count data sheet to ensure that individual birds were not double-counted.

When possible, species identifications of birds flying overhead (flyovers) were documented, as were observations of notable activities (i.e., singing, courtship flights, territorial displays, nest flushes, food exchanges, or foraging). In addition, bird observations made incidental to the survey were noted.

Data Analysis

Data collected from the field surveys were used to calculate the species richness, relative abundance, and frequency of breeding avian species over the entire survey area and by habitat type. Although all birds observed were recorded on the data sheets, only birds recorded within 100 m (328') of the survey site were used in the data analysis to avoid double-counting birds that occurred at adjacent points. Birds observed beyond 100 m, flyovers, and incidental observations were not included in the numerical analyses.

5.3 Results

During the two survey periods 429 bird observations were made of 61 bird species. Ninety-three observations were of flyover birds or birds beyond 100 m (328') from the survey point and were excluded from the analyses, leaving 336 bird observations of 53 species for numerical analyses. A summary of the number of observations, relative number of birds, and frequency of occurrence is provided in Appendix D Table 1.

The number of bird observations at each survey point over the course of both surveys ranged from 8 to 16, with an overall relative abundance of 5.60 (Figure 5-2). Species richness (number of observed species at survey points) ranged from 5 to 12 species per survey point (mean = 8.4).

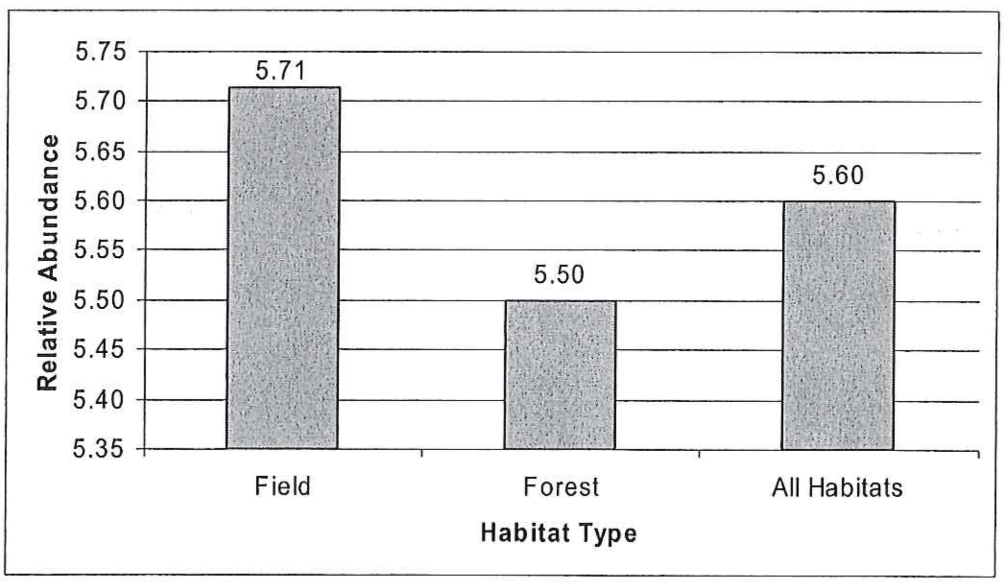


Figure 5-2. Relative Breeding Bird Abundance by Habitat Type

The most frequently observed species were the white-throated sparrow (*Zonotrichia albicollis*), black-and-white warbler (*Mniotilta varia*), yellow warbler (*Dendroica petechia*), and American robin (*Turdus migratorius*). Species with the highest relative abundance were the song sparrow (*Melospiza melodia*), white-throated sparrow, black-capped chickadee (*Poecile atricapillus*), and black-and-white warbler.

No species listed by New York as threatened or endangered were observed. New York species of special concern observed included the cerulean warbler (*Dendroica cerulea)*, grasshopper sparrow, and horned lark.

The most commonly observed flyover species were the red-winged blackbird, (*Agelaius phoeniceus*), American crow (*Corvus brachyrhynchos*), and barn swallow (*Hirundo rustica).* Species that were observed exclusively as flyovers or beyond 100 m (328') were the barn swallow, Canada goose (*Branta canadensis*), eastern kingbird (*Tyrannus tyrannus*), mourning dove (*Zenaida macroura*), rock pigeon (*Columba livia*), sharp-shinned hawk (New York state threatened), tree swallow (*Tachycineta bicolor*), and warbling vireo (*Vireo gilvus*).

Field

Forty-seven percent of the survey points were in field habitat. Forty-eight percent of the bird observations (160 observations) and 62 percent of the species (33 species) occurred at these points. Thirty-two percent of total species observed (17 species) (Table 5-1) were unique to field habitats. Song sparrow, red-winged blackbird, American robin, and white-throated sparrow were the most frequently observed birds at field points. Song sparrow, red-winged blackbird, American robin, and bobolink (*Dolichonyx oryzivorus*) were the most abundant. The relative abundance of all bird species per field point was 5.71.

Forest

Fifty-three percent of the survey points were in forest habitat. Fifty-two percent of the bird observations (176 observations) and 66 percent of the species (35 species) occurred at these points. Thirty-eight percent of the species observed (20 species) (Table 5-1) were unique to forest habitats. White-throated sparrow, yellow warbler, black-capped chickadee, and black-and-white warbler were the most frequently observed species at forest points. White-throated sparrows, black-capped chickadees, black-and-white warbler, and veery (*Catharus fuscescens*) were the most abundant. The relative abundance of all bird species per forest point was 5.50.

Table 5-1. Breeding bird species unique to a single habitat type

Field	Forest
American goldfinch (*Carduelis tristis*)	American redstart (*Setophaga ruticilla*)
American woodcock (*Scolopax minor*)	black-throated green warbler (*Dendroica virens*)
Baltimore oriole (*Icterus galbula*)	chestnut-sided warbler (*Dendroica pensylvanica*)
bobolink (*Dolichonyx oryzivorus*)	eastern wood-pewee (*Contopus virens*)
brown thrasher (*Toxostoma rufum*)	indigo bunting (*Passerina cyanea*)
chipping sparrow (*Spizella passerina*)	hairy woodpecker (*Picoides villosus*)
eastern meadowlark (*Sturnella magna*)	least flycatcher (*Empidonax minimus*)
European starling (*Sturnus vulgaris*)	magnolia warbler (*Dendroica magnolia*)
field sparrow (*Spizella pusilla*)	northern cardinal (*Cardinalis cardinalis*)
grasshopper sparrow (*Ammodramus savannarum*)	northern flicker (*Colaptes auratus*)
(continued)	

Table 5-1. Breeding bird species unique to a single habitat type (continued)

Field	Forest
gray catbird (*Dumetella carolinensis*)	northern parula (*Parula americana*)
horned lark (*Eremophila alpestris*)	olive-sided flycatcher (*Contopus cooperi*)
house sparrow (*Passer domesticus*)	pine siskin (*Carduelis pinus*)
killdeer (*Charadrius vociferus*)	rose-breasted grosbeak (*Pheucticus ludovicianus*)
northern mockingbird (*Mimus polyglottos*)	red-breasted nuthatch (*Sitta canadensis*)
ring-necked pheasant (*Phasianus colchicus*)	ruby-crowned kinglet (*Regulus calendula*)
red-winged blackbird (*Agelaius phoeniceus*)	ruby-throated hummingbird (*Archilochus colubris*)
northern harrier (*Circus cyaneus*)	ruffed grouse (*Bonasa umbellus*)
	scarlet tanager (*Piranga olivacea*)
	Tennessee warbler (*Vermivora peregrina*)
	yellow-rumped warbler (*Dendroica coronata*)

5.4 Discussion

The species encountered during the breeding bird surveys at the Marble River project area are consistent with those expected in the habitats present. The most abundant birds across all habitat types are well documented as breeding species in the Marble River project area: song sparrow, white-throated sparrow, black-capped chickadee, and black-and-white warbler (Andrle and Carroll 1988).

The most abundant birds within each habitat type were also consistent with historical records for the project area. Song sparrow, red-winged blackbird, American robin, and bobolink were the most abundant at field points. These 4 species accounted for 42 percent of the total observations in field habitat.

White-throated sparrow, black-capped chickadee, black-and-white warbler, and veery were the most abundant birds at forest points. These 4 species accounted for 39 percent of the total observations in forest habitat. Chestnut-sided warblers (*Dendroica pensylvanica*) were also observed in early successional forest patches.

The survey produces an index of relative abundance rather than a complete count of breeding bird populations (Sauer *et al.* 1997). Relative abundance for field and forest habitats was similar, 5.71 and 5.50, respectively (Figure 5-1).

The number of unique species found in each habitat type was consistent with the number of survey points in that point, i.e., field habitat with 14 survey points had 17 unique species; forest habitat with 16 survey points had 20 unique species. The number of survey points in each habitat type is proportional to the amount of habitat in the proposed project area. Thus, the relationship between number of survey sites and number of unique species may reflect the positive relationship between the amount of habitat and its suitability for species dependent upon that habitat (Table 5-1).

Observations of New York listed species occurred in both field and forest habitat types. Horned lark and grasshopper sparrow, both species of special concern and typical grassland species, were each observed at four field points. Northern harriers (state threatened) were observed flying over grasslands and croplands. Cerulean warbler was observed at one field point and at two forest points. Sharp-shinned hawks (special concern species) were observed as a flyover at one forest survey point and their breeding status could not be determined.

The Atlas of Breeding Birds in New York State (Andrle and Carroll 1988) does not report the cerulean warbler as occurring in the proposed project area. However, the Partners in Flight Physiographic Area Plan for the St. Lawrence Plain (American Bird Conservancy 2000) (which includes the proposed project area) states that the population of cerulean warblers is expanding in the remaining forest fragments. The Plan also suggests that the species is underrepresented in BBS counts of the St. Lawrence Plain.

Upland sandpipers (threatened) and vesper sparrows (species of special concern) were not observed during the surveys. Historic occurrences of these species have been recorded in the vicinity of the proposed project area (Andrle and Carroll 1988). Habitat for these species has been observed in the region.

5.5 Conclusions

The proposed project area is in the St. Lawrence Plain Physiographic Area, considered by Partners in Flight to be the largest and most important area of grassland in the Northeast (American Bird Conservancy 2000). Grassland birds are more abundant in the St. Lawrence Plain than anywhere else in the region (American Bird Conservancy 2000). The fact that upland sandpiper and vesper sparrow were not observed in the surveys suggests that grassland habitats in the proposed project area are less suitable for these grassland species than elsewhere in the St. Lawrence Plain. However, northern harriers were observed flying and hunting over the study area, so habitat is of an acceptable quality for this species.

The observation of cerulean warblers at the forested survey points suggests that the fragments of forested habitat in the survey area provide important habitat for woodland species. Considered together these observations suggest that grassland habitat quality may be declining and woodland improving due to the removal of land from agricultural production and its subsequent succession to woodland habitats.

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Appendix A

Raptor Survey Data Tables

Appendix A Table 1. Species composition of raptors observed during surveys

Species	9/6/2005	9/19/2005	9/21/2005	9/30/2005	10/9/2005	10/12/2005	10/20/2005	10/21/2005	10/22/2005	11/2/2005	Entire Season
American kestrel	1	3	2			1					**7**
Bald eagle		2									**2**
Broad-winged hawk		33	1								**34**
Cooper's hawk			1	1			2		1		**5**
Golden eagle							1			1	**2**
Merlin		5					1				**6**
Northern goshawk				1							**1**
Northern harrier		3	1			3	1	1	3	2	**14**
Osprey		5	1		1						**7**
Peregrine falcon						1			1		**2**
Red-shouldered hawk		1			1				1		**3**
Red-tailed hawk		6		5	2	13	33	3	2	3	**67**
Rough-legged hawk									2	3	**5**
Sharp-shinned hawk	3	3	1	1		1	3	2			**14**
Turkey vulture	10	15	6	6	2	1	2		1		**43**
Unidentified buteo	4										**4**
Unidentified raptor							1				**1**
Grand Total	**18**	**76**	**13**	**14**	**6**	**20**	**44**	**6**	**11**	**9**	**217**

Appendix A. Table 2. Hourly observation totals for raptors

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	Grand Total
American Kestrel	0	1	1	2	1	2	**7**
Bald eagle	0	0	0	0	1	1	**2**
Broad-winged hawk	0	23	5	0	2	4	**34**
Cooper's hawk	1	0	1	2	0	1	**5**
Golden eagle	0	0	0	0	1	1	**2**
Merlin	0	1	0	3	0	2	**6**
Northern goshawk	0	1	0	0	0	0	**1**
Northern harrier	3	6	3	1	0	1	**14**
Osprey	1	3	1	1	1	0	**7**
Peregrine falcon	1	0	1	0	0	0	**2**
Red-shouldered hawk	1	0	1	1	0	0	**3**
Red-tailed hawk	3	5	18	13	17	11	**67**
Rough-legged hawk	2	2	0	1	0	0	**5**
Sharp-shinned hawk	0	6	4	0	3	1	**14**
Turkey vulture	2	9	6	11	6	9	**43**
Unidentified buteo	0	2	0	0	2	0	**4**
Unidentified raptor	0	0	0	0	0	1	**1**
Hourly Totals	**14**	**59**	**41**	**35**	**34**	**34**	**217**

Appendix A Table 3. Differences in flight altitudes between species

Species	> 120 m	< 120 m	Grand total
American Kestrel	0	7	**7**
Bald eagle	2	0	**2**
Broad-winged hawk	27	7	**34**
Cooper's hawk	1	4	**5**
Golden eagle	1	1	**2**
Merlin	1	5	**6**
Northern goshawk	0	1	**1**
Northern harrier	1	13	**14**
Osprey	4	3	**7**
Peregrine falcon	0	2	**2**
Red-shouldered hawk	1	2	**3**
Red-tailed hawk	13	54	**67**
Rough-legged hawk	0	5	**5**
Sharp-shinned hawk	2	12	**14**
Turkey vulture	12	31	**43**
Unidentified buteo	2	2	**4**
Unidentified raptor	0	1	**1**
Grand Total	**67**	**150**	**217**

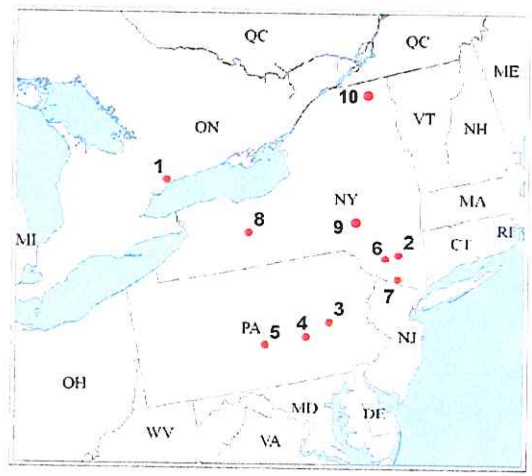
Appendix A Table 4. Summary of Fall 2005 Hawk Count Surveys at Marble River, NY and Other Regional Hawk Watch Sites*

Site Number**	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	**Cranberry Marsh, Ontario**	248.5	0	2920	122	40	89	1216	153	10	43	220	996	19	19	482	27	15	0	134	0	0	0	0	6505	26.2
2	**Mohonk Preserve, NY**	19.5	0	0	6	1	1	28	4	0	0	15	4	0	0	7	1	4	0	5	0	0	0	0	76	3.9
3	**Hawk Mountain, PA**	742.4	61	300	480	154	114	4324	1017	11	192	5273	2581	1	50	465	189	52	0	130	0	0	0	0	15394	20.7
4	**Second Mountain, PA**	669	76	172	189	69	82	1813	266	45	73	3082	773	0	34	105	39	25	0	56	0	0	0	0	6899	10.3
5	**Stone Mountain, PA**	187	0	43	65	22	36	765	262	6	55	425	934	1	31	92	33	9	1	29	0	0	0	0	2809	15.0
6	**Summitville, NY**	77.25	5	120	53	16	10	205	58	8	13	660	306	1	6	24	4	8	0	21	0	0	0	0	1518	19.7
7	**Mount Peter, NY**	314.67	65	102	129	28	51	1199	152	4	21	3826	418	0	5	149	40	18	0	65	0	0	0	0	6272	19.9
8	**Kestrel Haven, NY**	629.5	0	427	3	3	9	75	21	45	5	5	148	11	3	86	3	2	0	9	0	0	0	0	855	1.4
9	**Franklin Mountain, NY**	532.92	0	465	132	65	40	500	105	19	39	867	1769	5	46	149	35	10	0	51	0	0	0	0	4297	8.1
10	**Marble River, NY**	60	0	43	7	2	14	14	5	1	3	34	67	5	0	7	6	2	0	1	4	0	0	0	217	3.6

* Data current from HMANA website as of 11-1-05.
** See map to right for site location.

Abreviation Key:

BV - Black Vulture
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
RT - Red-tailed Hawk
RL - Rough-legged Hawk
GE - Golden Eagle
AK - American Kestrel
ML - Merlin
PG - Peregrine Falcon
SW - Swainson's Hawk
UR - unidentified Raptor
UB - unidentified Buteo
UA - unidentified Accipiter
UF - unidentified Falcon
UE - unidentified Eagle



Appendix B

Radar Survey Data Tables

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	12	13	Mean	Stdev	SE
Sept 1	21	46	24	36	20	77	70	25	21	14	21	--	--	34	21	6
Sept 2	28	82	183	135	81	114	64	67	21	31	21	--	--	75	52	16
Sept 3	19	23	59	59	55	38	13	27	25	20	13	--	--	32	18	5
Sept 4	23	43	64	153	232	198	140	107	164	170	176	--	--	134	67	20
Sept 5	150	439	171	241	214	200	86	107	107	143	279	--	--	194	101	30
Sept 6	121	150	92	61	79	54	37	43	46	82	38	21	--	69	38	11
Sept 7	75	64	86	143	136	56	71	150	118	107	70	--	--	98	34	10
Sept 8	11	59	89	121	64	116	--	--	29	21	43	0	--	55	43	13
Sept 9	93	311	400	279	321	314	--	--	--	317	229	50	--	257	152	44
Sept 10	154	150	204	129	201	121	204	210	129	219	107	--	--	166	42	13
Sept 14	0	64	64	107	54	121	64	123	70	60	32	343	--	92	87	25
Sept 15	236	293	271	--	--	--	--	--	--	--	--	--	--	267	29	17
Sept 17	29	81	54	64	94	182	129	71	64	86	107	--	--	87	41	12
Sept 18	252	295	418	364	254	204	107	91	54	96	150	43	--	194	124	36
Sept 19	134	244	--	413	460	182	--	--	--	--	--	--	--	287	143	64
Sept 20	64	91	107	119	114	129	118	75	129	79	111	32	--	97	30	9
Sept 21	182	284	268	204	257	150	219	107	93	193	86	48	--	174	78	22
Sept 22	161	110	43	118	107	64	38	29	11				--	76	50	17
Sept 23	214	414	407	579	650	592	504	386	443	375	357	229	--	429	135	39
Sept 24	54	107	364	214	118	209	118	68	21	29	11	57	--	114	103	30
Sept 25	36	43	50	50	38	25	43	11	--	--	--	--	--	37	13	5
Sept 27	11	166	214	214	219	204	295	208	--	204	257	161	--	196	72	22
Sept 28	171	506	479	407	332	257	207	164	193	214	193	161	--	274	126	36
Sept 29	246	357	507	563	214	198	164	113	107	107	134	86	--	233	160	46
Sept 30	86	557	557	454	693	338	279	129	124	146	150	204	21	287	214	59
Oct 1	271	439	266	273	214	161	171	139	171	193	214	193	96	216	85	24
Oct 2	188	--	150	64	64	150	154	96	96	64	70	161	0	105	55	16
Oct 3	257	600	600	471	326	252	150	307	161	220	129	314	107	300	166	46
Oct 4	214	321	313	364	305	350	--	364	321	261	289	295	43	287	88	25
Oct 5	271	286	493	330	236	300	264	261	221	204	--	295	43	267	102	29
Oct 6	261	182	193	64	71	75	46	59	16	11	32	79	21	85	78	22
Oct 8	91	107	357	182	167	145	86	107	73	80	64	--	--	133	84	25
Oct 9	186	0	0	5	0	0	17	17	0	7	4	0	86	25	54	15
Oct 10	107	0	0	21	0	0	13	0	0	0	0	0	0	11	30	8
Oct 11	129	177	--	188	--	121	129	166	139	121	86	59	429	145	107	30
Oct 12	426	17	48	--	--	--	--	--	--	--	--	--	--	164	227	131
Oct 14	--	5	16	7	11	0	0	0	0	0	7	7	50	9	14	4
Oct 15	--	107	136	161	163	129	96	102	32	39	0	21	0	82	61	18
Entire Season	**138**	**195**	**215**	**204**	**188**	**162**	**128**	**119**	**100**	**119**	**109**	**119**	**75**	**152**	**101**	**16**

-- indicates no data for that hour

Appendix B Table 2. Mean Nightly Flight Direction

Night of	Mean Flight Direction	Circular Stdev
Sept 1	136.011°	104.077°
Sept 2	185.761°	57.281°
Sept 3	201.932°	88.581°
Sept 4	194.34°	82.673°
Sept 5	261.81°	74.644°
Sept 6	255.533°	98.522°
Sept 7	88.096°	84.548°
Sept 8	279.789°	70.28°
Sept 9	227.766°	48.687°
Sept 10	201.015°	94.581°
Sept 14	247.38°	70.264°
Sept 15	248.472°	50.292°
Sept 17	180.963°	42.052°
Sept 18	49.536°	82.233°
Sept 19	308.856°	71.053°
Sept 20	159.972°	54.108°
Sept 21	148.022°	84.025°
Sept 22	76.527°	65.094°
Sept 23	224.669°	40.391°
Sept 24	310.82°	52.63°
Sept 25	60.243°	67.341°
Sept 27	105.944°	66.304°
Sept 28	340.042°	66.299°
Sept 29	182.972°	46.805°
Sept 30	269.525°	90.616°
Oct 1	123.815°	73.823°
Oct 2	294.088°	102.549°
Oct 3	220.286°	104.066°
Oct 4	151.801°	93.014°
Oct 5	194.424°	103.038°
Oct 6	73.993°	89.696°
Oct 8	221.903°	37.261°
Oct 9	103.514°	109.292°
Oct 10	60.074°	99.361°
Oct 11	234.904°	50.263°
Oct 12	100.986°	93.456°
Oct 14	327.393°	78.372°
Oct 15	158.969°	28.314°
Entire Season	192.75°	88.74°

Appendix B Table 3. Summary of mean flight heights by hour, night, and for entire season

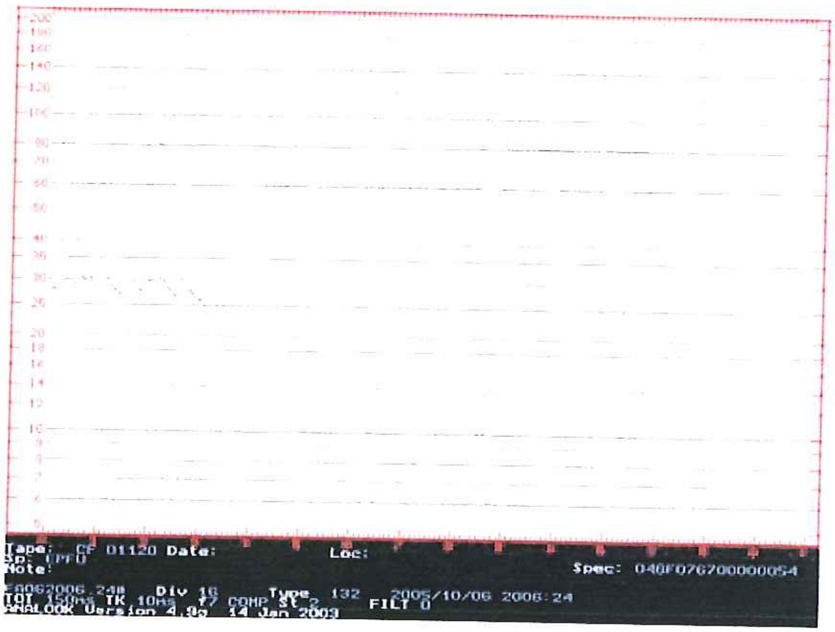
Night of	Mean Flight Height (altitude in meters) by hour after sunset													Entire Night			% targets < 120 m
	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean	SD	SE	
Night of Sept 1	325	357	343	375	385	344	347	336	301	308	237	--	--	333	41	12	3%
Night of Sept 2	301	606	595	698	504	441	484	427	487	427	126	--	--	463	154	47	3%
Night of Sept 3	384	616	465	449	402	499	575	567	451	425	401	--	--	476	79	24	1%
Night of Sept 4	582	719	843	748	710	642	566	533	479	404	404	--	--	603	144	43	1%
Night of Sept 5	366	353	354	352	333	309	300	277	276	333	380	--	--	330	35	11	6%
Night of Sept 6	--	346	327	277	225	248	225	235	235	254	220	--	--	259	44	14	12%
Night of Sept 7	289	317	301	309	321	365	390	382	338	399	375	--	--	344	39	12	2%
Night of Sept 8	400	463	485	--	--	--	--	478	427	487	420	--	--	451	35	13	1%
Night of Sept 9	499	515	482	449	--	--	--	--	--	--	--	--	--	486	28	14	0%
Night of Sept 10	411	540	507	441	403	506	431	415	386	383	355	--	--	434	59	18	4%
Night of Sept 14	309	348	318	355	354	333	317	329	354	--	--	--	--	335	18	6	2%
Night of Sept 15	410	442	447	--	--	--	--	--	--	--	--	--	--	433	20	12	1%
Night of Sept 17	510	544	471	512	475	466	549	480	394	438	491	--	--	485	45	14	1%
Night of Sept 18	377	633	621	580	547	570	435	444	354	444	409	234	--	470	121	35	3%
Night of Sept 19	306	396	594	533	489	430	--	--	--	--	--	--	--	458	103	42	6%
Night of Sept 20	372	352	430	415	432	383	404	441	403	408	345	75	--	372	98	28	6%
Night of Sept 21	593	697	681	494	508	513	460	394	355	387	368	336	--	482	123	36	1%
Night of Sept 22	412	334	304	356	408	337	411	357	--	--	--	--	--	365	41	15	1%
Night of Sept 23	466	633	722	634	660	548	478	510	478	489	436	468	--	544	94	27	1%
Night of Sept 24	330	342	346	360	--	347	367	362	396	327	350	342	--	352	19	6	7%
Night of Sept 25	341	393	387	402	448	447	450	470	--	--	--	--	--	417	43	15	1%
Night of Sept 27	313	410	455	455	492	490	536	507	453	388	345	357	--	433	71	20	5%
Night of Sept 28	362	376	399	360	429	435	497	501	502	434	454	440	--	432	51	15	4%
Night of Sept 29	309	543	319	285	331	--	413	429	411	394	321	177	--	357	95	29	7%
Night of Sept 30	230	351	356	494	474	410	414	434	405	373	357	321	238	374	79	22	6%
Night of Oct 01	337	445	432	391	508	466	489	492	513	521	514	540	533	475	60	17	2%
Night of Oct 02	391	501	552	532	623	597	587	615	701	481	525	603	292	538	107	30	2%
Night of Oct 03	305	512	453	514	553	583	463	497	466	369	443	371	--	461	81	23	5%
Night of Oct 04	312	460	488	593	565	662	653	604	579	453	456	394	--	518	108	31	4%
Night of Oct 05	485	530	629	585	634	718	543	514	453	422	431	457	263	513	116	32	1%
Night of Oct 06	532	445	521	564	477	--	304	471	228	211	240	201	37	353	170	49	9%
Night of Oct 08	401	417	410	386	387	411	434	392	407	--	--	--	--	405	15	5	5%
Night of Oct 09	212	821	1036	983	908	1030	700	779	663	383	--	224	--	704	305	92	9%
Night of Oct 10	178	255	702	1006	214	276	1060	520	538	--	--	--	146	489	339	107	32%
Night of Oct 11	448	462	544	626	679	636	715	720	613	594	461	649	206	565	142	39	6%
Night of Oct 12	154	390	284	--	--	--	--	--	--	--	--	--	--	276	118	68	29%
Night of Oct 14	214	309	660	515	516	442	606	588	--	571	--	214	302	449	163	49	7%
Night of Oct 15	452	639	611	623	621	541	--	252	260	198	168	123	--	408	208	63	5%
Entire Season	**368**	**469**	**486**	**497**	**485**	**482**	**488**	**463**	**429**	**404**	**371**	**344**	**252**	**438**	**90**	**15**	**5%**

Appendix C

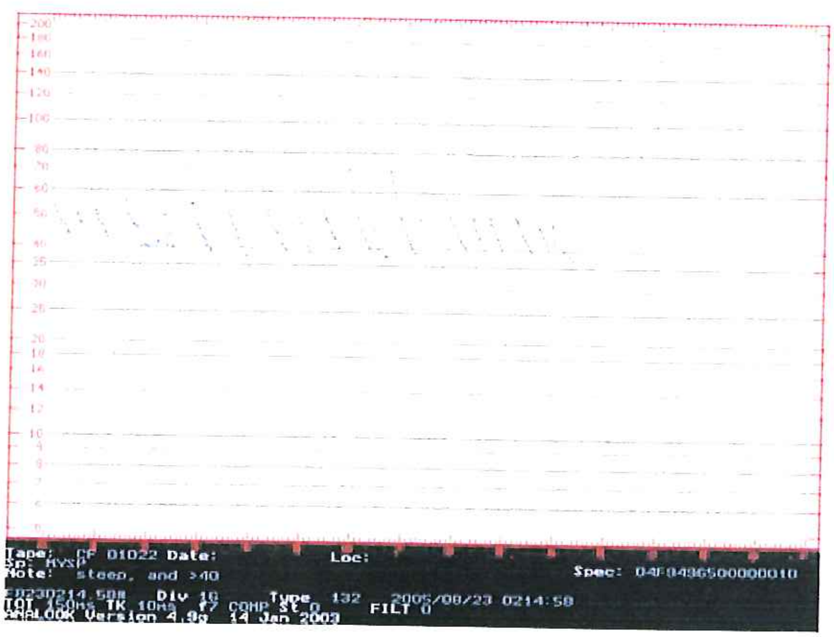
Bat Survey Figures

Appendix C Figure 1. Representative samples of calls detected during Fall 2005. Figure 1a is identified as *Myotis* spp and Figure 1b is identified as big brown bat (*Eptesicus fuscus*).

1a



1b



Appendix D

Breeding Bird Survey Data Tables

Appendix D Table 1. Total number of observations, relative number of birds, and frequency of occurrence

Species[a]	Field (Points)			Forest (Points)			Forest/field edge (Points)			All Habitats (Points)		
	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]
AMCR	3	0.11	21.4%	2	0.07	13.3%	0	0.00	0.0%	5	0.08	16.7%
AMGO	2	0.07	14.3%	0	0.00	0.0%	0	0.00	0.0%	2	0.03	6.7%
AMRE	0	0.00	0.0%	3	0.10	20.0%	0	0.00	0.0%	3	0.05	10.0%
AMRO	12	0.43	64.3%	5	0.17	26.7%	1	0.50	100.0%	18	0.30	46.7%
AMWO	4	0.14	28.6%	0	0.00	0.0%	0	0.00	0.0%	4	0.07	13.3%
BAOR	3	0.11	21.4%	0	0.00	0.0%	0	0.00	0.0%	3	0.05	10.0%
BAWW	4	0.14	28.6%	14	0.47	66.7%	1	0.50	100.0%	19	0.32	50.0%
BCCH	1	0.04	7.1%	18	0.60	73.3%	1	0.50	100.0%	20	0.33	43.3%
BHVI	1	0.04	7.1%	3	0.10	20.0%	0	0.00	0.0%	4	0.07	13.3%
BLJA	2	0.07	7.1%	2	0.07	13.3%	0	0.00	0.0%	4	0.07	10.0%
BOBO	10	0.36	28.6%	0	0.00	0.0%	0	0.00	0.0%	10	0.17	13.3%
BRTH	1	0.04	7.1%	0	0.00	0.0%	0	0.00	0.0%	1	0.02	3.3%
BTNW	0	0.00	0.0%	10	0.33	60.0%	1	0.50	100.0%	11	0.18	33.3%
CERW	1	0.04	7.1%	3	0.10	13.3%	0	0.00	0.0%	4	0.07	10.0%
CHSP	8	0.29	35.7%	0	0.00	0.0%	0	0.00	0.0%	8	0.13	16.7%
COGR	1	0.04	7.1%	1	0.03	6.7%	0	0.00	0.0%	2	0.03	6.7%
COYE	5	0.18	28.6%	6	0.20	40.0%	0	0.00	0.0%	11	0.18	33.3%
CSWA	0	0.00	0.0%	6	0.20	33.3%	0	0.00	0.0%	6	0.10	16.7%
EAME	5	0.18	35.7%	0	0.00	0.0%	0	0.00	0.0%	5	0.08	16.7%
EAPH	6	0.21	28.6%	5	0.17	26.7%	0	0.00	0.0%	11	0.18	26.7%
EAWP	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
EUST	3	0.11	21.4%	0	0.00	0.0%	0	0.00	0.0%	3	0.05	10.0%
FISP	2	0.07	7.1%	0	0.00	0.0%	0	0.00	0.0%	2	0.03	3.3%
GRCA	1	0.04	7.1%	0	0.00	0.0%	0	0.00	0.0%	1	0.02	3.3%
GRSP	5	0.18	28.6%	0	0.00	0.0%	0	0.00	0.0%	5	0.08	13.3%
HAWO	0	0.00	0.0%	2	0.07	13.3%	0	0.00	0.0%	2	0.03	6.7%
HOLA	6	0.21	28.6%	0	0.00	0.0%	0	0.00	0.0%	6	0.10	13.3%
HOSP	1	0.04	7.1%	0	0.00	0.0%	0	0.00	0.0%	1	0.02	3.3%
KILL	4	0.14	21.4%	0	0.00	0.0%	0	0.00	0.0%	4	0.07	10.0%
LEFL	0	0.00	0.0%	2	0.07	13.3%	0	0.00	0.0%	2	0.03	6.7%
MAWA	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
NOCA	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
NOFL	0	0.00	0.0%	2	0.07	13.3%	0	0.00	0.0%	2	0.03	6.7%
NOMO	1	0.04	7.1%	0	0.00	0.0%	0	0.00	0.0%	1	0.02	3.3%
NOPA	0	0.00	0.0%	2	0.07	13.3%	0	0.00	0.0%	2	0.03	6.7%
OSFL	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
PISI	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
RBGR	0	0.00	0.0%	10	0.33	53.3%	0	0.00	0.0%	10	0.17	26.7%
RBNU	0	0.00	0.0%	5	0.17	33.3%	0	0.00	0.0%	5	0.08	16.7%
RCKI	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
REVI	1	0.04	7.1%	4	0.13	26.7%	2	1.00	100.0%	7	0.12	20.0%
RNEP	1	0.04	7.1%	0	0.00	0.0%	0	0.00	0.0%	1	0.02	3.3%
RTHU	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
RUGR	0	0.00	0.0%	3	0.10	20.0%	0	0.00	0.0%	3	0.05	10.0%
RWBL	16	0.57	64.3%	0	0.00	0.0%	0	0.00	0.0%	16	0.27	30.0%

(continued)

Appendix D Table 1. Total number of observations, relative number of birds, and frequency of occurrence (continued)

	Field (Points)			Forest (Points)			Forest/field edge (Points)			All Habitats (Points)		
Species[a]	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]	Total #[b]	Relative Abundance[c]	Frequency[d]
SAVS	9	0.32	35.7%	1	0.03	6.7%	0	0.00	0.0%	10	0.17	20.0%
SCTA	0	0.00	0.0%	1	0.03	6.7%	0	0.00	0.0%	1	0.02	3.3%
SOSP	29	1.04	78.6%	1	0.03	6.7%	1	0.50	100.0%	31	0.52	43.3%
TEWA	0	0.00	0.0%	0	0.00	0.0%	1	0.50	100.0%	1	0.02	3.3%
VEER	1	0.04	7.1%	13	0.43	53.3%	1	0.50	100.0%	15	0.25	33.3%
WTSP	8	0.29	50.0%	20	0.67	86.7%	1	0.50	100.0%	29	0.48	70.0%
YRWA	0	0.00	0.0%	2	0.07	13.3%	0	0.00	0.0%	2	0.03	6.7%
YWAR	3	0.11	21.4%	13	0.43	80.0%	0	0.00	0.0%	16	0.27	50.0%
Total	160	5.71		166	5.53		10	5.00		336	5.60	
# Species	33			35			9			53		

[a] Four-letter bird species codes consistent with Pyle and DeSante 2005.
[b] Total number of observations.
[c] Mean number of birds observed.
[d] Percent of survey points where species occurred.