A Fall 2005 Radar, Visual, and Acoustic Survey of Bird and Bat Migration at the Proposed Clayton Wind Project

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November 2005

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Executive Summary

During the fall of 2005, Woodlot Alternatives, Inc. (Woodlot) conducted field surveys of bird and bat migration activity at the Clayton wind project area in Clayton, Orleans, and Brownville, New York. The surveys are part of the planning process by PPM Atlantic Renewable (PPM) for a proposed wind project, which will include the erection of up to 54 wind turbines within the surrounding landscape of predominately dairy and pasture land. Surveys included daytime surveys migrating raptors and nighttime surveys of birds and bats using radar and bat echolocation detectors. These studies represent the second of two seasons of migration surveys undertaken by PPM at this site.

The results of the field surveys provide useful information about site-specific migration activity and patterns in the vicinity of the Clayton wind project area. The findings of this study provide valuable information about migration patterns within the proposed project area, especially when compared to results from the spring survey. This analysis 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 11 days of visual observation between September 9 and October 16, 2005. A total of 575 raptors, representing 13 species, were observed during the surveys. Approximately 89 percent of the raptors observed were flying less than 150 meters (m) (492') above the ground. Two pairs of northern harriers (*Circus cyaneus*) in the vicinity of the project area were believed to have bred or at least spent the nesting season within the project area. The overall passage of raptors observed in the study area was considerably lower than that observed at other hawk watch locations in the eastern United States.

Radar Survey

The fall field survey included 37 nights of radar surveys to collect and record video samples of the radar during horizontal and vertical operation. Horizontal operation documents the abundance, flight path and speed of targets moving through the project area, and vertical operation documents the altitude of targets, operation. While 45 nights of sampling were targeted, a total of 37 were sampled due to inclement weather creating conditions in which the radar could not adequately document bird movements.

Nightly passage rates varied from 83 (September 10 and 11) to 877 (September 24) targets per kilometer per hour (t/km/hr), with the overall passage rate for the entire survey period at 418 ± 40 t/km/hr. Mean flight direction through the project area was 168º ± 111º. The mean flight height of targets was 475 m ± 14 m (1,558' ± 46') above the radar site. The average nightly flight height ranged from 305 m ± 15 m (1,001' ± 49') to 663 m ± 40 m (2,175' ± 131'). The percent of targets observed flying below 150 m (492') also varied by night, from 1 percent to 20 percent. The seasonal average percentage of targets flying below 150 m was 10 percent. Throughout the fall migration survey flight direction generally seemed to be influenced by wind direction.

The overall fall passage rate from the Clayton Wind Project area is similar to results from other migration studies in New York. The fall passage rate was slightly less than that found during the spring season and the flight height was slightly higher than that found in the spring study.

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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 and flat topography of the site, demonstrates a lack of topographic influences on bird migration in the area and probably a limited avian mortality risk during fall migration.

Bat Migration

The fall field survey included deployment of bat detectors on 33 separate nights. Detectors were deployed in the guy wire array of a meteorological measurement tower (met tower) at heights of 2 m (6.6') and 30 m (100').

A total of 154 bat call sequences were recorded. The overall bat detection rate over the course of the entire study was only 4.7 bat calls/detector-night. Bat calls were recorded on all but two of the nights surveyed.

When possible, recorded bat calls were identified to species, genus (in the case of *Myotis*), or as "unknown," based upon the shape of the call sequence, the slope, and the maximum and minimum frequencies. Of the 154 calls recorded, 124 were identified to species or genus group. The *myotids* were the most abundant calls recorded, accounting for 97 (63%) of the calls. Following these were calls of the big brown bat (*Eptesicus fuscus*, 19 calls), eastern red bat (*Lasiurus cinereus*, 4 calls), silver-haired bats (*Lasionycteris noctivagans*, 3 calls), and eastern pipistrelle (*Pipistrellus subflavus*, 1 call). Thirty calls were too poor of quality or too short to identify.

The *myotid* calls were examined for the possibility of the Indiana bat (*Myotis sodalis*) being included within the call set. Considerable variation within this set of calls was observed but no definitive determination has yet been made. Considering the known occurrence of Indiana bats within the project area during summer 2005, it is possible that some of the *myotid* calls recorded during the fall survey were of this species.

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1.0 Introduction

1.1 Project Context

PPM Atlantic Renewable has proposed the construction of a wind project to be located in Clayton, Orleans, and Brownville, New York (Figure 1-1). The project would include up to approximately 54 2.75-megawatt (MW) wind turbines that could generate up to 150 MW of power annually. Turbines would have a maximum height of approximately 150 meters (m) (492') and would be located predominantly in active agricultural fields being used for hay and crop production, as well as for pasturing.

Birds are known to collide with tall lighted structures, such as buildings and communication towers, particularly when weather conditions reduce visibility (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 mortality of migrating and resident birds and bats has been documented at wind farms as a result of collisions with turbines, meteorological measurement towers (met towers), and guy wires (Anderson *et al.* 2004; Erickson *et al.* 2000, 2003; Johnson *et al.* 2003; Thelander and Rugge 2000).

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 some standard methods that are developing within the wind power industry and consultation with the NY Department of Environmental Conservation (NYDEC).

1.2 Project Area Description

The project area is located within the Eastern Ontario Plain ecozone of New York (Andrle and Carroll 1988). This is a relatively flat region, with elevation ranging from approximately 76 m to 152 m (250' to 500'). Forest communities in the area are dominated by American elm (*Ulmus americana*), red maple (*Acer rubrum*), and northern hardwoods on soils of lake sediments that overlie limestone bedrock. The proximity of Lake Ontario helps moderate the local climate, which has resulted in the widespread development of agricultural land uses, predominantly dairying.

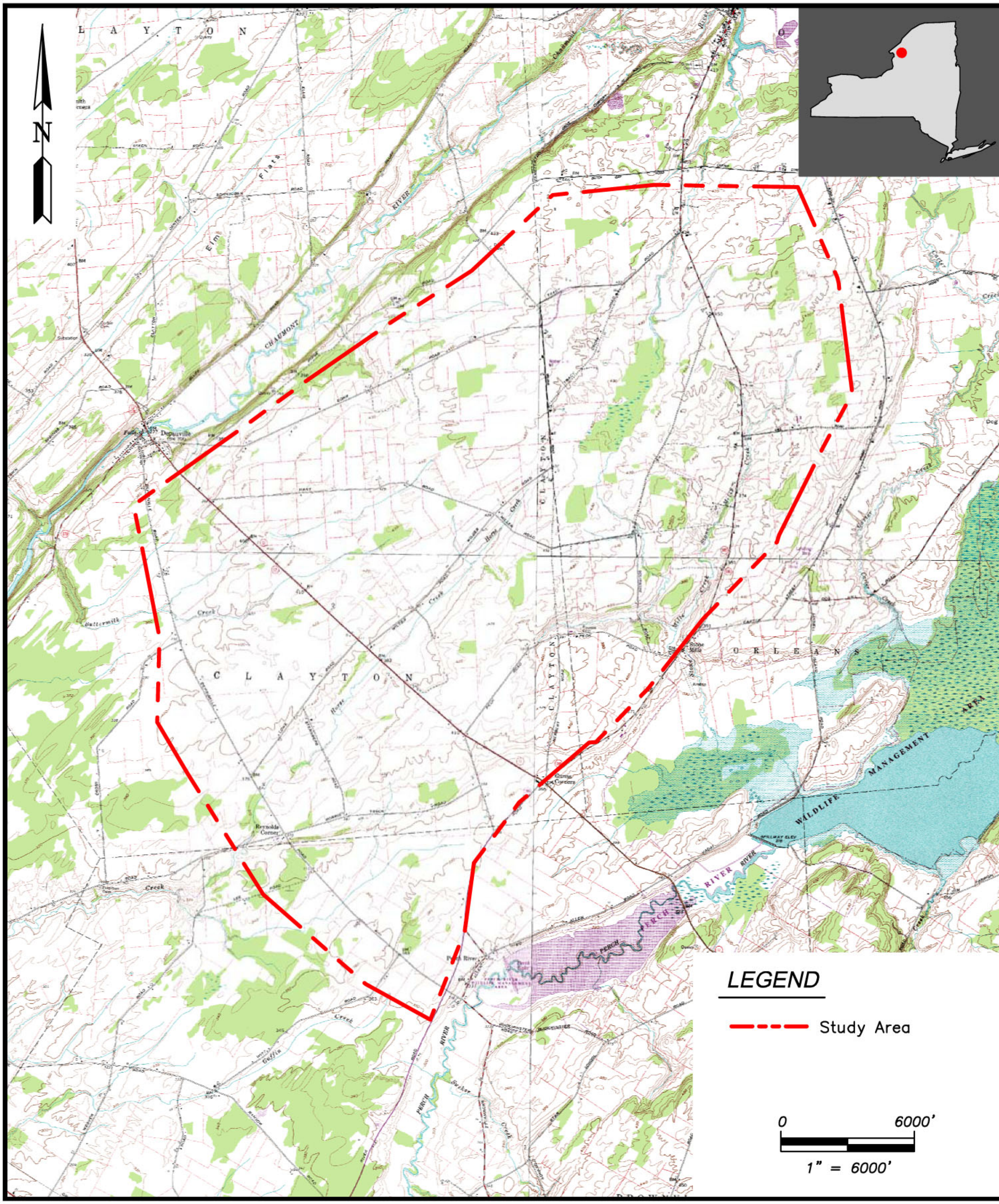

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Figure 1-1
Study Area Location Map
Clayton Wind Project
Clayton, New York

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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 day-time 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 19 to October 16, 2005, although effort for the different aspects of the work varied within this time period. A total of 11 days of raptor surveys, 37 nights of radar surveys, and 33 nights of bat detector recordings were completed.

Raptor surveys were conducted near the met tower in a hay field on Lowe Road in Clayton. Methods employed were the same as those used by the Hawk Migration Association of North America (HMANA).

Radar surveys were conducted in the same vicinity as the fall raptor surveys. Radar data provide insight on the flight patterns of birds (and bats) migrating over the project area, including abundance, flight direction, and flight altitude. The nearby met tower provided a reliable source for wind data during the sampling period. Weather conditions for the survey location were also recorded by the radar technician to be used in conjunction with met tower data. The field observations of weather conditions provided information about temperature, cloud cover, wind direction and wind speed.

Bat surveys included the use of Anabat II (Titley Electronics Pty Ltd) bat detectors to record the location and timing of bat activity. Detectors were deployed in the guy wire array of the met tower off Lowe Road in Clayton at heights of approximately 20 m (66'), 10 (33'), and 2 m (6.6') above the ground.

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 using criteria developed by Eric Britzke, a national expert researching the ability to identify this species from recorded call sequences.

2.0 Diurnal Raptor Surveys

2.1 Introduction

The project area 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 in the spring (Kerlinger 1989, Kellogg 2004).

The Great Lakes, within the Central Continental Flyway, heavily influence the migration of raptors throughout the region. Migrating raptors typically avoid crossing large expanses of water by following shorelines until they resume their original migration direction. During fall migration, raptors of eastern-central Canada often travel west along the northern shores of Lakes Ontario and Erie to avoid those large water bodies. Once at the western ends of these lakes these birds then continue southward to their wintering areas. The reverse is true in the Given these observed trends, the eastern portion of the Central Flyway and specifically, the southern and eastern shores of Lake Ontario, could then be expected to concentrate large numbers of raptors during migration.

The project area is located within the Eastern Ontario Plain ecozone of New York (Andrle and Carroll 1988). This is a relatively flat region, with elevations ranging from approximately 76 m to 152 m (250' to 500'). Forest communities in the area are dominated by American elm, red maple, and northern hardwoods on soils of lake sediments that overlie limestone bedrock. Lake Ontario moderates the local climate, which has resulted in the widespread development of agricultural land uses, predominantly dairying.

The project area lies just south of the St. Lawrence River and east of Lake Ontario. Perch River Wildlife Management Area, an 8,000-acre complex of wetlands including flooded valleys, wooded swamps, wet meadows, mixed woods, shrub swamp, and grassland lies just south of the project area. Because of the lack of large landscape features in the project area, migrating raptors move across the area in broad fronts, unlike migrating raptors in mountainous environments.

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 11 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 a flat hayfield approximately 8 miles southeast of Clayton, New York; or 0.5 miles southwest of the intersection of State Route 12 and Lowe Road (Figure 2-1). This site, at an elevation of 120 m (400'), is surrounded by flat agricultural fields interspersed with small woodland fragments and marshland. It afforded unobstructed views in all directions, except for very low-flying birds beyond the tree line bordering the hayfield's western edge.

Raptor surveys occurred on 11 days from September 9 to October 16, 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 conducted throughout the entire raptor migration season to coincide with peak migration of all species. Surveys were targeted for days with favorable flight conditions produced by the passage of low-pressure systems bringing winds from the north, and days following the passage of a cold front were targeted as survey days. However, weather conditions during the survey period made this difficult and some days included less than optimal hawk migration weather.

Surveys were based on methods defined by the HMANA. Observers scanned the sky and surrounding landscape for raptors flying into the survey areas. Observations were recorded onto HMANA data sheets, which summarize the data by hour. Notes on each observation, including location and flight path, flight height, and activity of the animal, were recorded. Height of flight of each observation was estimated. Nearby objects with known heights, such as the met towers and surrounding trees, were used to gauge flight height. Information regarding the raptors' behavior and whether a raptor was observed in the same locations throughout the study period was noted to differentiate between migrant and resident birds. When possible, general flight paths of individuals observed were plotted on topographic maps of the project area.

Hourly weather observations, including wind speed, direction from which the wind was coming, temperature, percent cloud cover, and precipitation, were recorded on HMANA data sheets. 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, 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 as was the species composition of birds observed flying below and above 150 m (492'), the approximate height of the proposed turbines. Finally, the mapped flight locations of individuals were reviewed to identify if any concentrated migration corridors occurred in the project area.

Observations from the project area were compared to data obtained from local or regional HMANA hawk watch sites available from www.hmana.org. The HMANA watch sites with available data determined to be the most suitable for comparison with the project area counts were from New York, Pennsylvania, and Ontario.

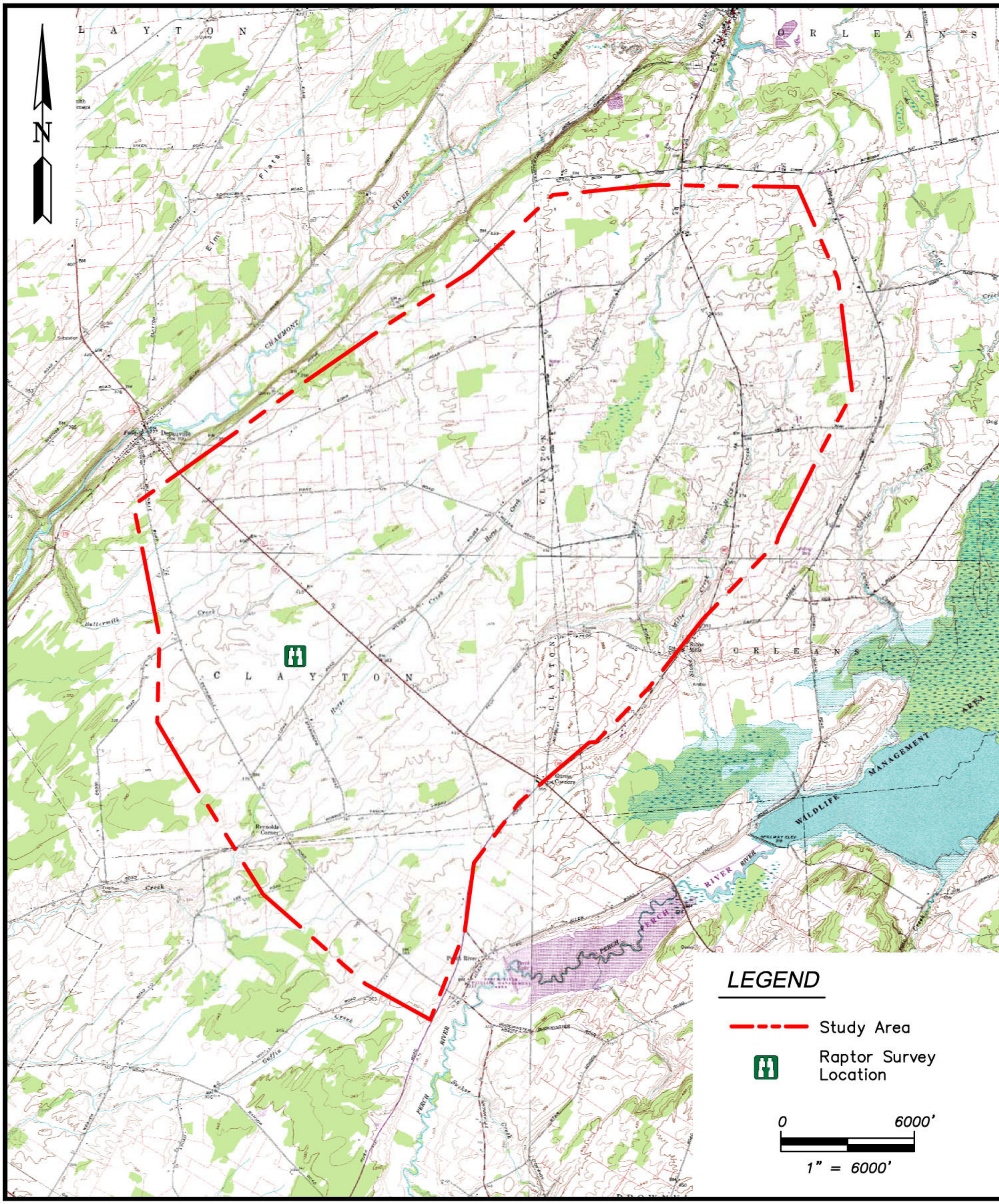

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Figure 2-1
Raptor Survey Location Map
Clayton Wind Project
Clayton, New York

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2.3 Results

Most surveys were conducted on clear days when the wind was light to moderate. During the earlier September surveys, the temperature ranged from 55 – 85º F while temperatures during the October surveys ranged from 40 – 65º F. Surveys on most days occurred after the passage of cold fronts. The development of thermals on these days was evident as temperatures increased and cumulus clouds were formed. On some of the survey days, visibility was inhibited by morning fog (accompanied by drizzle) that cleared as temperatures and wind speed increased. However, visibility was excellent for most surveys.

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 extended periods of rain. Four surveys were conducted with N, ENE, or WNW winds. Six surveys were with SW or SSW winds, and one survey had variable wind direction.

Surveys were conducted for a total of 63.5 hours during the 11 survey days. A total of 575 raptors, representing 13[1] species, were observed during that time, yielding an overall observation rate of 9.1 birds/hour. The range in daily observation rates varied from 3.25 to 18.67 birds/hour (Figure 2-2; Appendix A Table 1). Daily count totals ranged from 13 to 115 birds. The largest count of 115 raptors was observed on October 15, a day of moderate (6–28km/hr) SW to WSW winds with temperatures of 52 – 60º F.

Turkey vultures (*Cathartes aura*)[2] (N = 391) were, by far, the most commonly observed species and accounted for 68 percent of the season's total birds. After turkey vultures the most common species observed, in decreasing order of abundance, were red-tailed hawks (*Buteo jamaicensis*) (N = 81), northern harriers (*Circus cyaneus)* (N = 31), sharp-shinned hawks (*Accipiter striatus)* (N = 17), and American kestrels (*Falco sparverius*) (N = 14).

The remainder of observed species comprised less than 1.5 percent of the total (each with ≤ 10 individuals). These species include broad-winged hawks (*Buteo platypterus),* osprey (*Pandion haliaetus*), merlin (*Falco columbarius*), peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), 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 views of the individual. The unidentified birds were mostly from the genus *Accipiter*, although several individuals could not even be identified to genus (and hence noted as "unidentified raptor") due to the brevity of their occurrence.

Of the aforementioned species, the golden eagle and peregrine falcon are listed as Endangered in New York, while the northern harrier and bald eagle are listed as Threatened. Species listed by the State as Species of Special Concern include osprey, sharp-shinned hawk, and Cooper's hawk. Only one federally listed species was observed: the bald eagle, which is listed as Threatened.

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

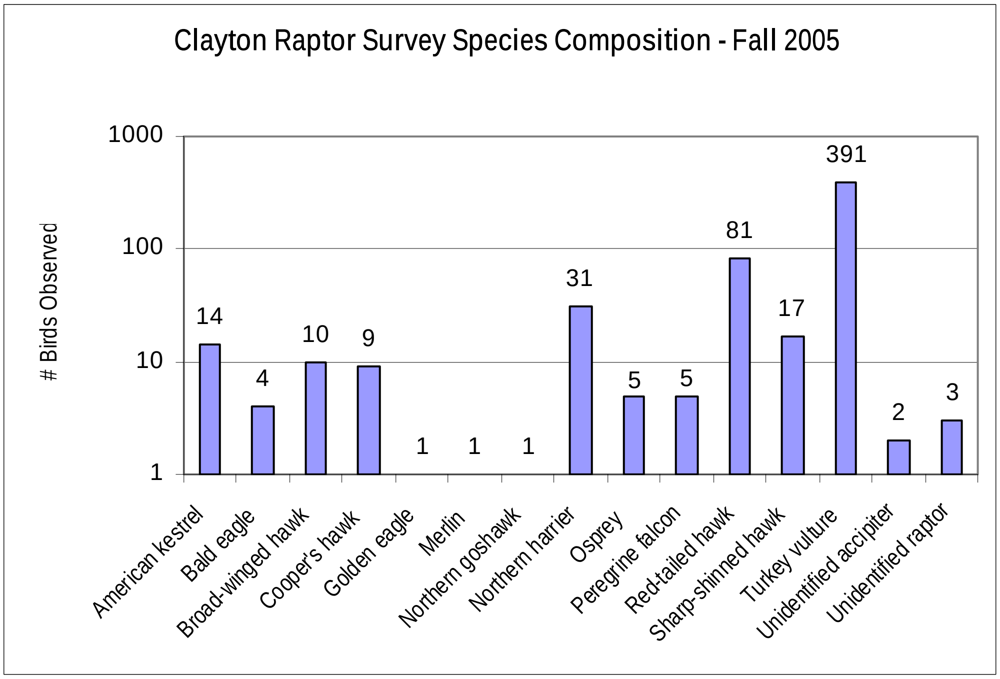


Figure 2-2. Species composition and number of individuals observed during raptor surveys.

Observations of some northern harriers, red-tailed hawks, American kestrels, sharp-shinned hawks, and osprey were noted to possibly be repeated sightings of the same individuals. In these cases, a particular individual may have been observed flying back and forth across a section of field or perching in an area repeated during the same day or on more than one survey day. However, for the most part, raptors that were observed were believed to be actively migrating and all observations are included in the count data reported. At least two pairs of northern harrier and red-tailed hawks observed were believed to be resident to the project area either year-round or at least during the summer 2005 nesting season. Both species were observed actively hunting, vocalizing, and interacting with juvenile birds. During surveys, ospreys were frequently seen to the southeast of observation area, over portions of the Perch River Wildlife Management Area.

In addition to some seasonal variation, the timing of raptor observations varied during each day. Typically, observations began slowly and reached a peak during the fourth hour of observation, after which observed decreased fairly quickly (Figure 2-3). This pattern was consistent for most of the species observed although on some days a later peak during the last 1 to 2 hours of the day was observed (Appendix A Table 2). It should be noted when winds shifted to more favorable migration direction (i.e., a north wind), raptors were more abundant.

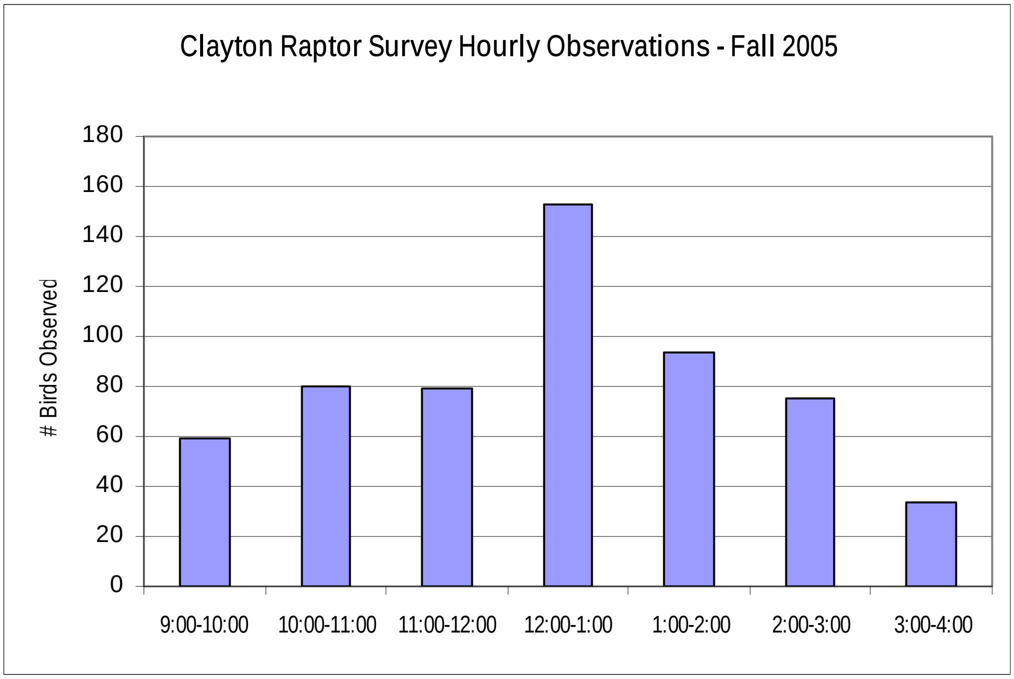


Figure 2-3. Hourly observation rates

Flight heights were categorized as below or above 150 m (492'), the approximate height of the proposed turbines. Overall, approximately 89 percent of the raptors observed were flying less than 150 m (492') above the ground. Differences in flight altitudes between species were observed (Figure 2-4; Appendix A Table 3). Small species, such as the accipiters and falcons were consistently observed flying low. In fact, all of the falcons observed were flying below this height. Sharp-shinned hawks and northern harriers were also consistently flying low. Exceptions to this included broad-winged hawks, of which 100 percent were flying greater than 150 m above the ground. Most *Buteo* flights were below 150 m.

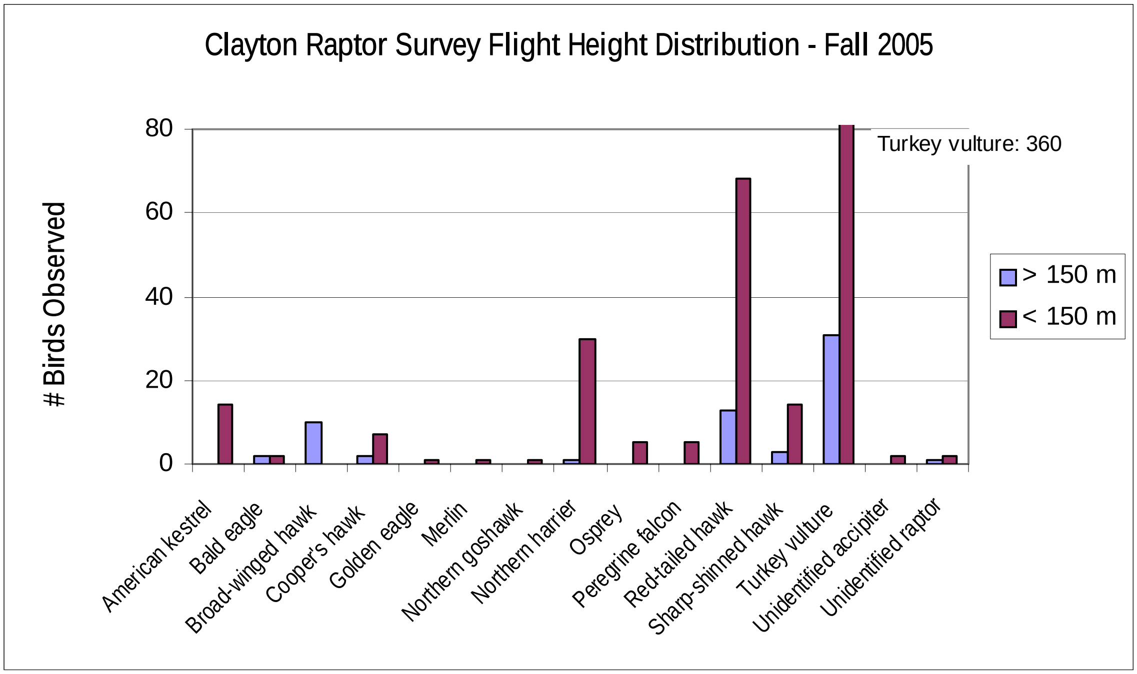


Figure 2-4. Raptor flight height distribution

The flight habits of raptors in the project area were variable, though their flight locations often occurred in similar locations. Many of the birds, particularly northern harriers, sharp-shinned hawks, red-tailed hawk, and American kestrels flew in different directions over the observation site and were typically observed kiting and hunting over the fields surrounding the observation site. Individuals believed to be undertaking long-distance migratory movements (particularly turkey vultures) had much more direct flight paths. On one occasion, a peregrine falcon was observed hunting after a flock of European starlings. Another peregrine falcon was observed following prey in the vicinity of the guy wires of the nearby met tower.

2.4 Discussion

A total of 575 migrating raptors were observed during 11 days (63.5 hrs) of field surveys during September and October 2005. Thirteen different species were recorded with an observation rate of 9.1 birds/hour. Turkey vultures were the most abundant species observed and comprised approximately 68 percent of all observations. Red-tailed hawks comprised 14 percent of observations.

At the Clayton project site, the absence of proximate landscape-scale features such as river corridors or mountain ridges played a significant role in the migratory patterns through the project area. This lack of major topography or other landscape features served to distribute migrants fairly evenly across the project area, rather than in a concentrated flight corridor. Also, because of the lack of features to concentrate migrating raptors, relatively few were observed at Clayton than at other sites surveyed during the fall 2005 migration season that have these landscape features. Observation rates at other regional sites ranged from 1.4 to 26.2 birds/hour (Appendix A Table 4).

There could be several reasons for the greater passage rates, including survey effort, geographical location, and visibility. The most active site was Hawk Mountain Sanctuary in Kempton, Pennsylvania, with a total of 15,394 raptors counted (20.7 birds/hour). At Cranberry Marsh in Whitby, Ontario, Canada, 6,505 birds (26.2 birds/hour) were observed. In Kestrel Haven, in Burdett, NY, 855 raptors (1.4 birds/hour) were observed. In comparison, the Clayton project area had a passage rate of 9.1 birds/hour a rate lower than the most active fall migration site but greater than other sites. The selected HMANA sites have a range of landscapes and elevations whose results offer comparative regional information on raptor migration in the northeast.

Survey effort varies from site to site and this could be a significant factor in comparing data from different sites. 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. The rational for sampling across an extended sampling period, such as during this study, 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. During the surveys completed at the project site, several days with sub-optimal migration weather (south winds) were sampled and fewer hawks were typically observed on those days.

Geographical location can affect the magnitude of raptor migration at a particular site. Two well-known examples include Cape May, 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. The project area provided no survey locations with similar views of the surrounding landscape and forest canopies.

The flight heights of raptors observed in the project area indicate that birds migrated within the blade-swept area of the proposed turbines. Approximately 89 percent of raptors were observed flying below 150 m (492’). Most falcons and accipiters flew within the blade-swept area. The only golden eagle observed and 50% of bald eagles flew within the blade-swept area. While all broad-winged hawks passed over the site at > 150m. Overall, it may be easier to detect large species flying at low and high altitudes; therefore, smaller species may sometimes be underrepresented or represented disproportionately at lower flight heights (Kerlinger 1989). 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. The paucity of raptor fatalities documented during mortality surveys outside the state of Californian (scarcely more than 10 fatalities have been reported in the literature) indicates that avoidance at wind facilities that are more modern than some California wind farm (which have had high mortality rates).

Migration of raptors is a dynamic process due to various internal and external factors. Migrating raptors are well 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. In general, raptors tend to converge toward a small number of pathways as they migrate. Raptors may shift and use different ridge lines and cross different valleys from year to year or season to season. Because the project area lies in an area without significant ridges and slopes, raptors were observed moving across the area in a broad front and not in any concentrated pathways.

The project area has a mosaic of edge and grassland habitat which provide good nesting habitat (nesting structure and prey) for northern harriers, American kestrels, red-tailed hawks, short-eared owls, Cooper’s hawks, and sharp-shinned hawks. In close proximity is the Perch River Wildlife Management area, considered by New York Audubon as an Important Bird Area (IBA) due to a diverse wetland bird community with both wetland-associated and grassland birds (www.ny.audubon.org).

2.5 Conclusions

The results of the field surveys indicate that fall raptor migration in the Clayton project area is moderate relative to other sites in the region. This is likely due to a lack of large landscape features that could concentrate migration activity at the project area.

Most (89%) 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 on limitations in the distance that different species are visible.

Migrants observed passing near or through the project area flew higher than birds believed to be resident to the project area. This is expected, as resident birds would be undertaking daily movements and activities, such as foraging, which would be concentrated at lower altitudes. Alternatively, birds focusing solely on migrating would be expected to utilize thermals and cross-current winds to gain altitudes more suitable for long distance migration.

One of these more commonly observed species believed to be resident to the project area was the northern harrier, which is currently listed as Threatened in New York. Repeated observations of hunting and brood-rearing activities indicate that this species is nesting in the project area. Another species listed by the State as a Species of Special Concern, the sharp-shinned hawk, is suspected to be nesting within the project area. Observations of this species included one to two individuals undertaking low flights and juvenile birds in project area. Other species listed as rare in the State or regionally were also observed. However, the individuals of those species were suspected to only be migrating through the project area and not nesting within it.

3.0 Nocturnal Radar Survey

3.1 Introduction

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

Collision with unseen obstacles is a potential hazard to 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.

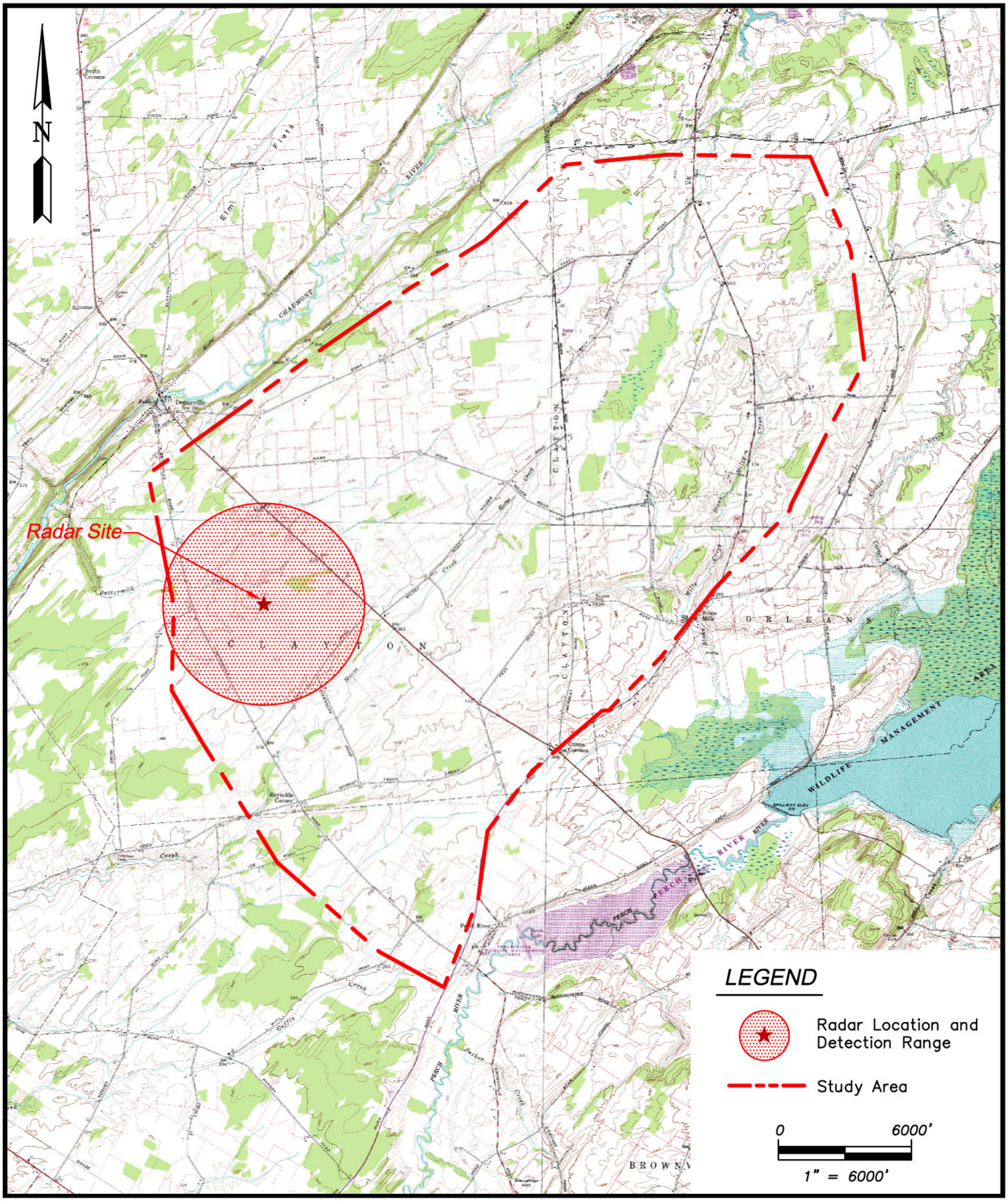
Factors that could affect potential collision risk of nocturnally-migrating birds by wind turbines can include weather, magnitude of migration, height of flight, and movement patterns in the vicinity of a wind project, along with the height of turbines and other site-specific characteristics of a wind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

A marine surveillance radar similar to that described by Cooper *et al.* (1991) was used to document the night-time movement of migrating birds and bats over the study area. The radar was located in a small field largely surrounded by low trees near the met tower off of Lowe Road in Clayton (Figure 3-1). The radar had a peak power output of 25 kW and the ability to track small animals, including birds, bats, and even insects out to distances of up to 1,200 m (3,937'). The radar cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen are called targets.

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



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FILE: 105030-00-Location.dwg	

Figure 3-1
Radar Location Map
Clayton Wind Project
Clayton, 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 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. The presence of ground clutter (Figure 3-2) and other objects that could reduce clutter were important factors considered during the site selection process. The Clayton site was chosen for the low tree line bordering the radar which effectively masked a significant amount of surrounding ground clutter to the north. More extended views of fields by the radar to the west and east did occur but these were minimized by the presence of some nearby hedgerows.

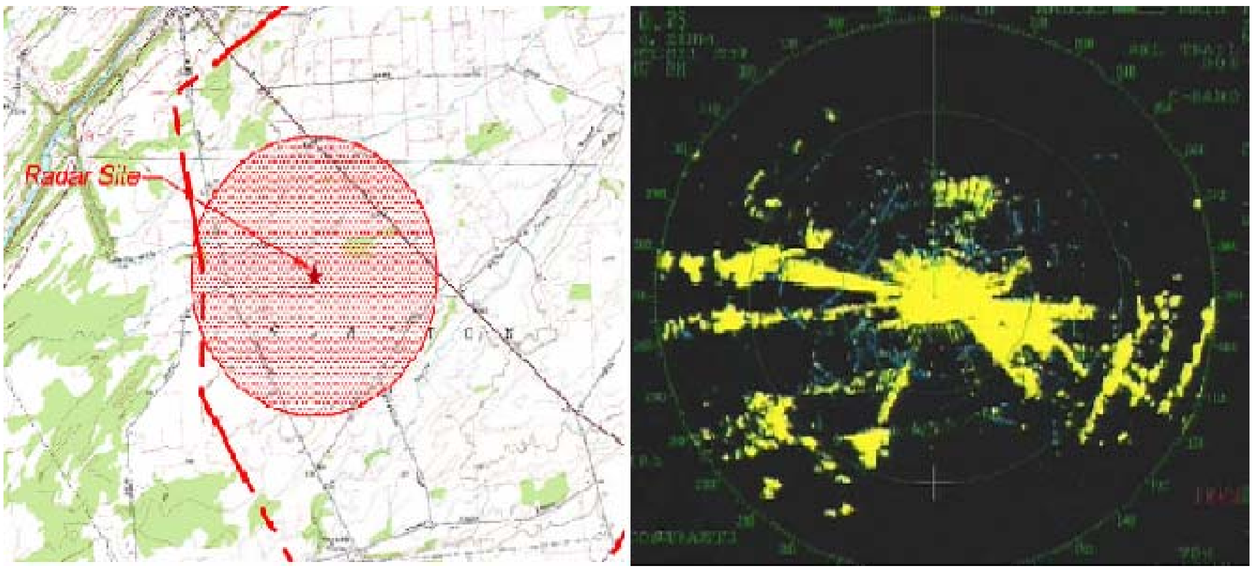

Figure 3-2. Ground clutter in project area

Radar surveys were conducted from sunset to sunrise. Forty-five nights of surveys were targeted from 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, vertical, the antenna is rotated 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data but do provide information on the altitude of targets passing through the vertical, 20º 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 Figures 3-1 and 3-2.

Table 3-1. Radar Survey dates, level of effort, and weather – Clayton, Fall 2005

Night of	Sunset	Sunrise	Hours of Survey	Weather	Wind Direction (from)
Sept 2	19:38	6:29	8	clear, moderate winds	W
Sept 3	19:36	6:30	9	mostly cloudy, rain, calm	N
Sept 4	19:34	6:31	11	clear and calm	NE
Sept 6	19:31	6:34	5	clear and calm	S
Sept 7	19:29	6:35	3	clear and calm	SSW
Sept 8	19:27	6:36	10	mostly cloudy, light winds late	SE
Sept 9	19:25	6:37	4	clear and calm	NE
Sept 10	19:23	6:38	7	clear and calm	SE
Sept 11	19:21	6:39	7	partly cloudy, light winds	SW
Sept 12	19:20	6:41	11	mostly cloudy, light winds	SW
Sept 13	19:18	6:42	11	partly cloudy, showers, calm	S
Sept 14	19:16	6:43	9	overcast, rain, light winds	NNW
Sept 15	19:14	6:44	10	mostly cloudy, light winds	SE
Sept 17	19:10	6:46	10	mostly cloudy, calm	N
Sept 18	19:08	6:47	12	partly cloudy, foggy, calm	SE
Sept 19	19:06	6:49	11	warm, mostly cloudy	S
Sept 20	19:05	6:50	11	clear and calm	W
Sept 21	19:03	6:51	12	clear and calm	SW
Sept 22	19:01	6:52	11	overcast, rain, moderate winds	W
Sept 23	18:59	6:53	10	clear and calm	NE
Sept 24	18:57	6:55	12	clear to overcast, light winds	S
Sept 27	18:51	6:58	12	clear and calm	SSW
Sept 28	18:50	6:59	12	overcast, strong winds	S
Sept 29	18:48	7:00	12	partly cloudy, light winds	WNW
Sept 30	18:46	7:02	11	partly cloudy, calm	S
Oct 1	18:44	7:03	13	clear and calm	SSE
Oct 2	18:42	7:04	13	clear and calm	SE
Oct 3	18:40	7:05	13	partly cloudy, light winds	S
Oct 4	18:39	7:06	13	clear and calm	S
Oct 5	18:37	7:08	12	clear and calm	S
Oct 6	18:35	7:09	11	partly cloudy, gusty winds, rain in AM	SSW
Oct 8	18:31	7:11	13	partly cloudy, strong winds	NE
Oct 9	18:30	7:13	9	overcast, showers, moderate gusty winds	NE
Oct 10	18:28	7:14	9	overcast, light winds	NE
Oct 11	18:26	7:15	11	overcast, light winds	NE
Oct 14	18:21	7:19	13	overcast, calm	SE
Oct 15	18:19	7:20	13	mostly cloudy, light gusty winds	W

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

Data Collection

The radar display was connected to video recording software of a computer. 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.

Data Analysis

The video samples were analyzed using a digital video analysis software tool developed by Woodlot. For horizontal samples, targets were identified as birds and bats rather than insects based on their speed. The speed of targets was corrected for wind speed and direction; targets traveling faster than approximately 6 m per second were identified as a bird or bat target. The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat. The results for each sample were output to a spreadsheet. For vertical samples, the software 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 or 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 and data collected from the nearest met tower to the radar.

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 150 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 384 hours on 37 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 throughout the radar display unit. A summary of nightly radar and weather data from the survey efforts is provided in Table 3-2. Appendix B contains data tables that provide nightly and hourly survey results.

Passage Rates

Nightly passage rates varied from 83 t/km/hr (September 10 and 11) to 877 t/km/hr (September 24), and the overall passage rate for the entire survey period was 418 ± 40 t/km/hr (Figure 3-3; Appendix B Table 1). A weak relationship between passage rate and wind direction was observed. On nights with the highest observed passage rates, the wind was typically from the northwest to northeast. An exception to this was September 24, on which winds were coming from the south but the highest passage rate was documented.

Table 3-2. Summary of radar and weather data, Clayton Wind Project - Fall 2005

Night of	Passage Rate (t/km/hr)	Flight Height (m)	Flight Direction (to)	Wind Speed (m/s)	Mean Temp (C)	Wind Direction (from)
Sep 2	578	498	125	5.75	17	294
Sep 3	260	574	205	4.90	17	8
Sep 4	216	547	171	2.73	12	40
Sep 6	305	382	318	3.23	15	202
Sep 7	447	417	39	6.17	16	209
Sep 8	186	595	195	2.77	12	115
Sep 9	243	663	190	6.20	12	51
Sep 10	83	523	271	3.23	9	155
Sep 11	83	584	22	7.82	17	218
Sep 12	95	569	30	6.91	20	215
Sep 13	780	464	324	5.95	19	189
Sep 14	613	483	131	3.91	20	341
Sep 15	857	490	161	2.66	16	128
Sep 17	560	633	100	3.00	16	355
Sep 18	726	476	31	5.88	15	221
Sep 19	412	441	322	7.69	20	181
Sep 20	415	458	114	5.82	15	274
Sep 21	446	429	31	7.40	18	217
Sep 22	359	413	70	7.41	20	272
Sep 23	769	539	198	7.01	9	45
Sep 24	877	390	267	6.02	15	167
Sep 27	262	523	40	5.98	11	210
Sep 28	249	387	339	13.10	19	181
Sep 29	292	451	152	4.47	6	297
Sep 30	634	348	299	6.58	10	186
Oct 1	404	506	334	4.29	11	202
Oct 2	625	465	222	4.21	15	145
Oct 3	146	384	304	5.38	17	195
Oct 4	415	506	258	4.84	17	181
Oct 5	411	444	249	5.71	17	191
Oct 6	163	406	36	7.43	21	207
Oct 8	778	506	175	9.14	9	42
Oct 9	93	321	221	6.40	10	49
Oct 10	200	305	189	4.44	11	40
Oct 11	816	428	184	6.85	11	49
Oct 14	300	444	127	2.08	14	239
Oct 15	361	580	124	7.10	11	288

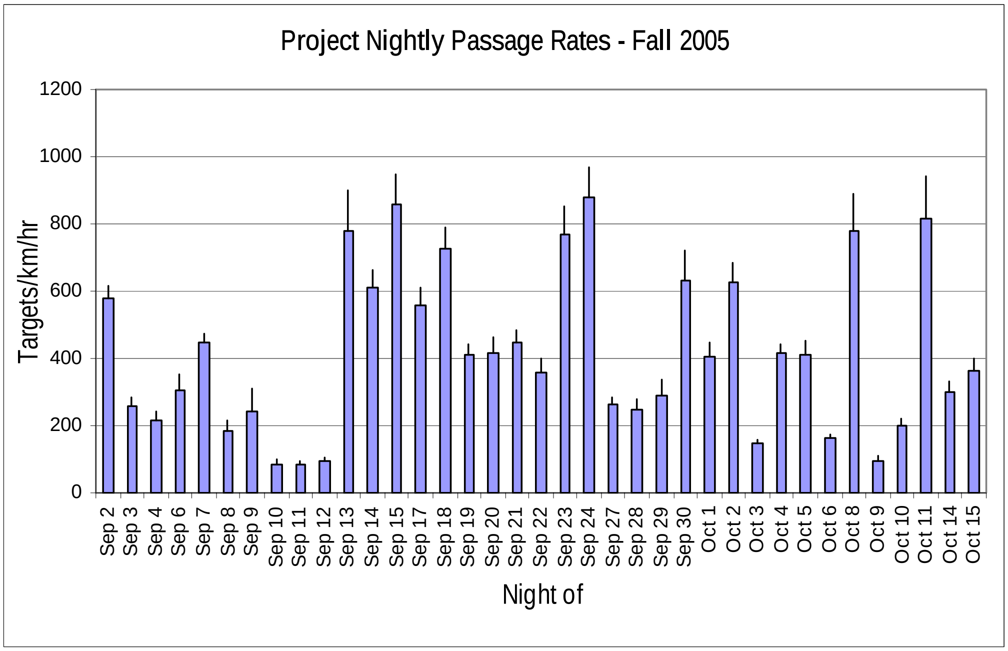

Figure 3-3. Nightly passage rates (error bars = 1 SE) observed

Individual hourly passage rates throughout the entire season varied from 21 to 1,425 t/km/hr. Hourly passage rates varied throughout each night and for the season overall. For the entire season, passage rates were highest during the second to fourth hour after sunset, followed by a relatively steady decline through the remainder of the nighttime period (Figure 3-4).

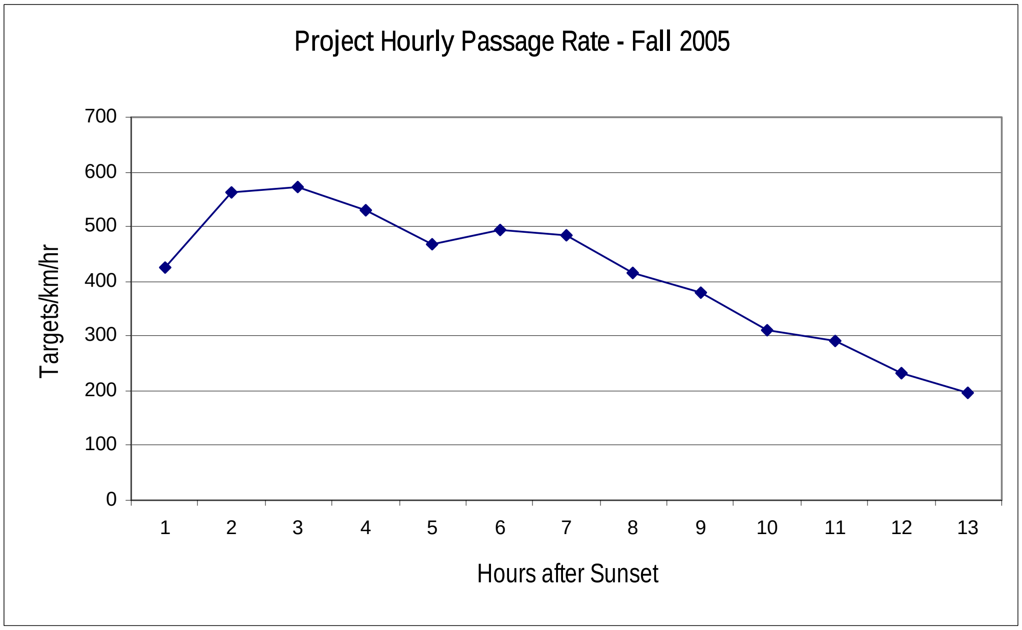

Figure 3-4. Hourly passage rates for entire season

Flight Direction

Mean flight direction through the project area was 168º ± 111º (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). Flights were generally southward on most nights although nights with flights in more westerly or easterly directions were often associated with winds from the south (i.e., birds flew perpendicular to the wind and not downwind on nights with winds opposite the preferred migratory direction).

Flight Altitude

The mean flight height of all targets was 475 m ± 14 m (1,558' ± 46') above the radar site. The average nightly flight height ranged from 305 m ± 15 m (1,001' ± 49') to 663 m ± 40 m (2,175' ± 131') (Figure 3-7, Appendix B Table 3). The percent of targets observed flying below 150 m (492') also varied by night, from 1 percent to 20 percent (Figure 3-8). The seasonal average percentage of targets flying below 150 m was 10%. A weak relationship between flight height and wind speed was observed, migrants flying at lower heights when the wind speeds were greatest.

Hourly flight height was greatest from about five to seven hours after sunset although in general it flight height stayed relatively constant through the nighttime period (Figure 3-9). Within 100 m (328') height zones, the greatest percentage (14%) of targets occurred in both the 200 m to 300 m (656' to 984') and the 300 m to 400 m (984' to 1,312'). Sixty-one percent of all targets were observed from 200 m to 700 m (656' to 2,297'), and 80 percent were observed from 100 m to 800 m (328' to 2,625') above the radar site (Figure 3-10).

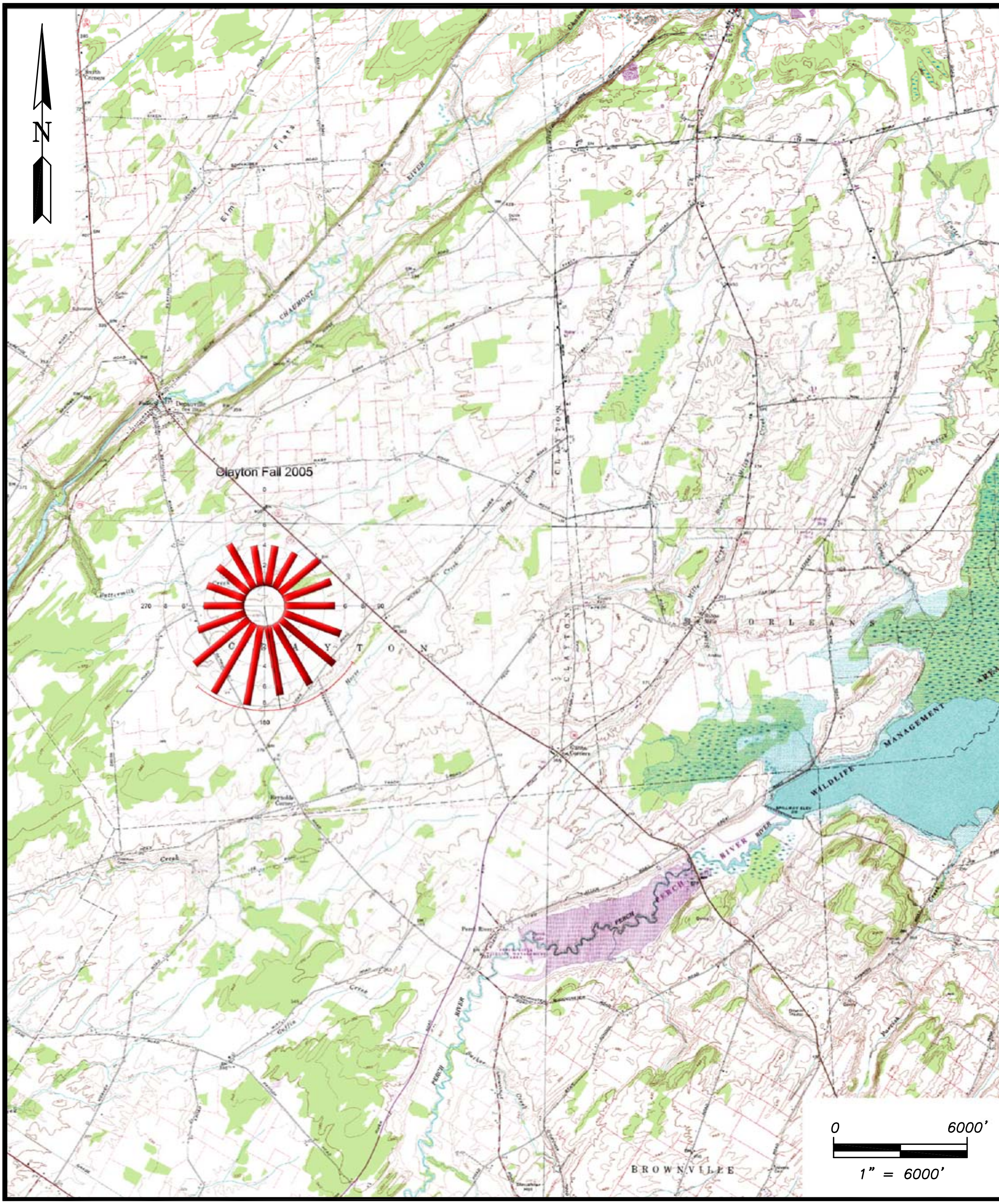

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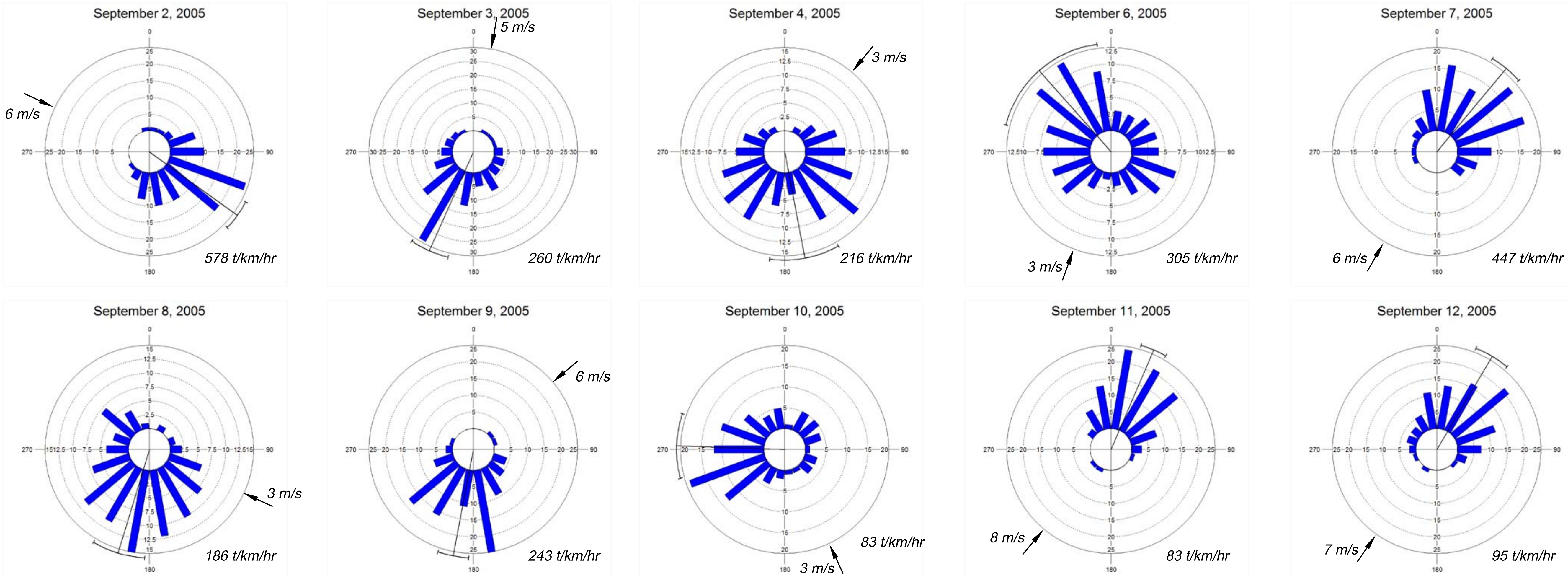
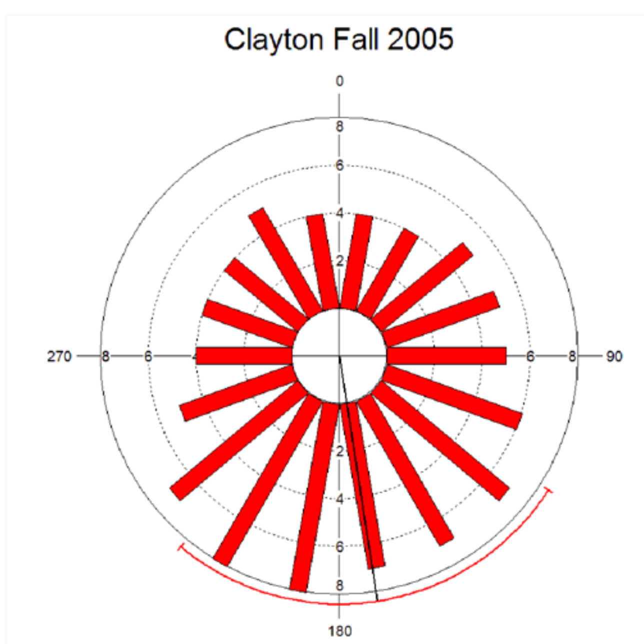
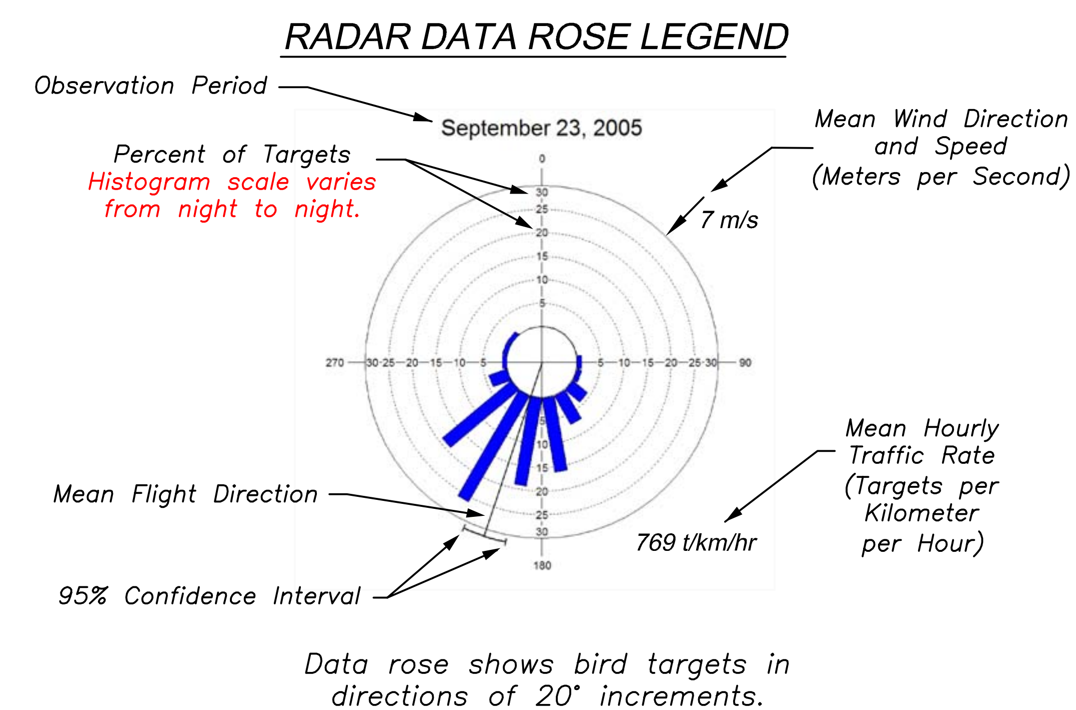
Figure 3-5
Fall 2005 Target Flight Direction
Clayton Wind Project
Clayton, New York

REV.







Sheet 1 of 4

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DATE:	November 2005
PROJECT:	Clayton Wind Project
ADDRESS:	Clayton, New York
PREPARED BY:	WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS
PROJ. NO.	105030
FIGURE NO.	3-6

NO. REVISIONS DATE

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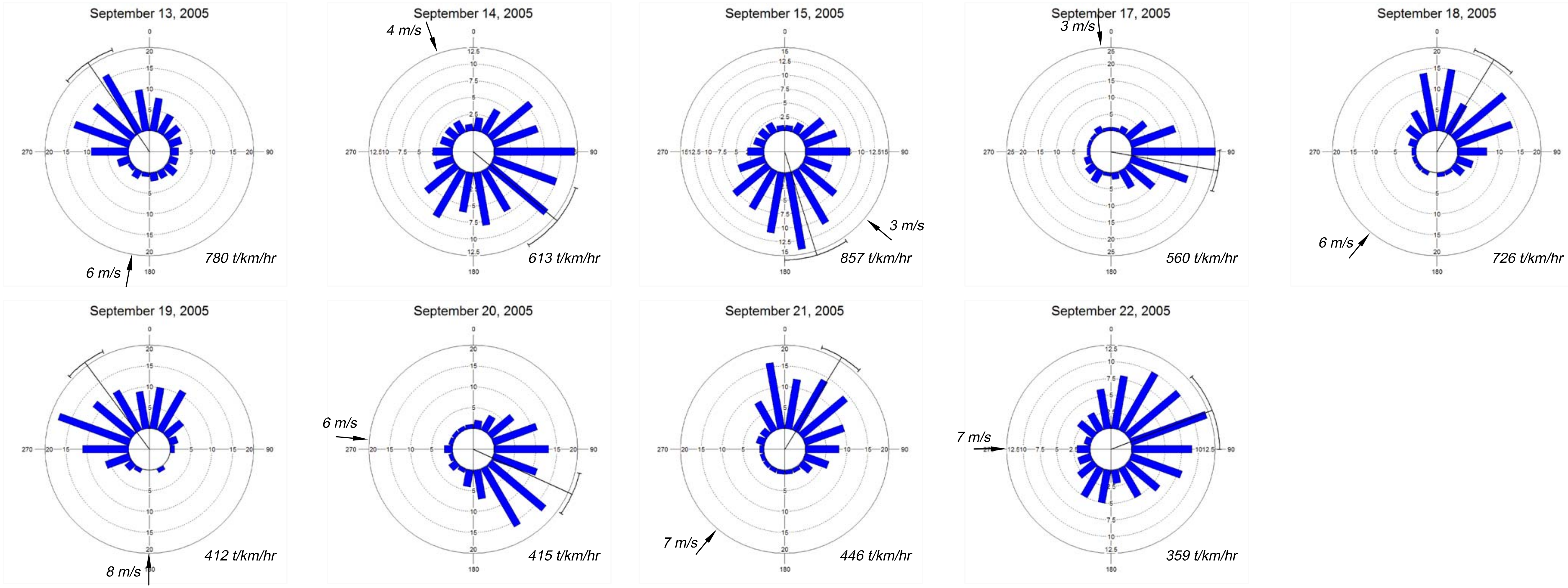

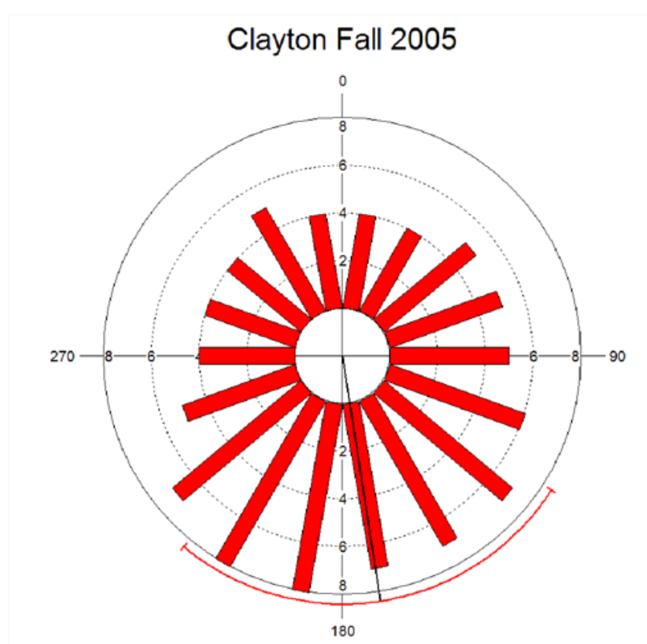

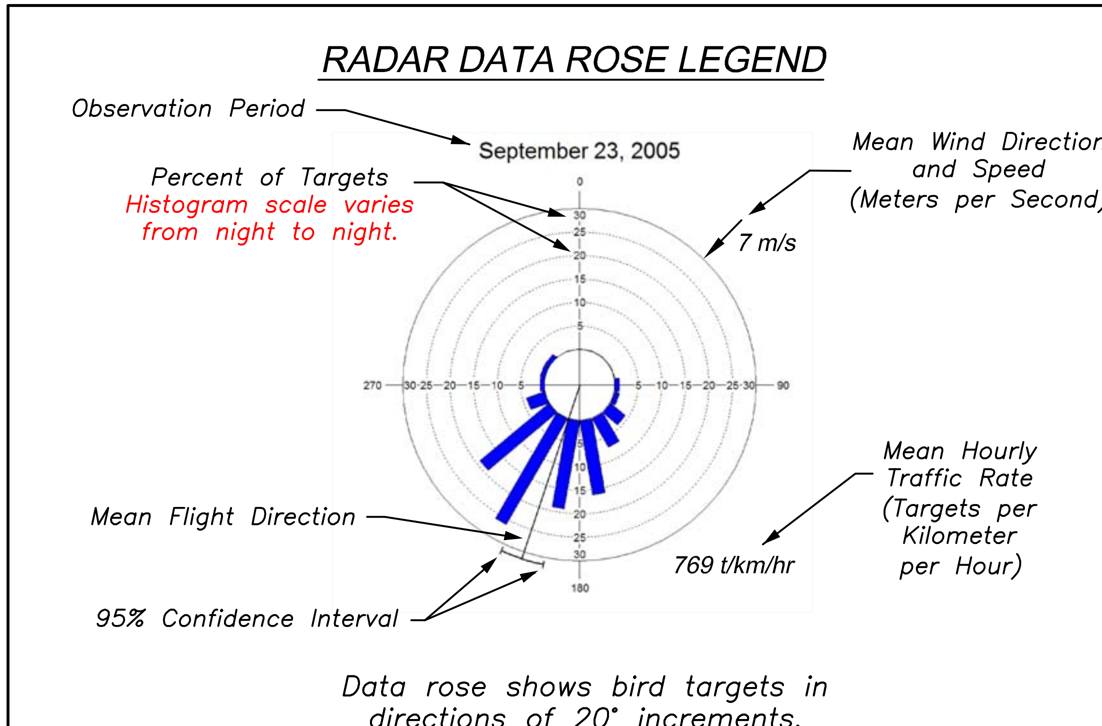

Sheet 2 of 4

NO. | REVISIONS | DATE

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SCALE: n/a

DATE: November 2005

PROJECT: Clayton Wind Project

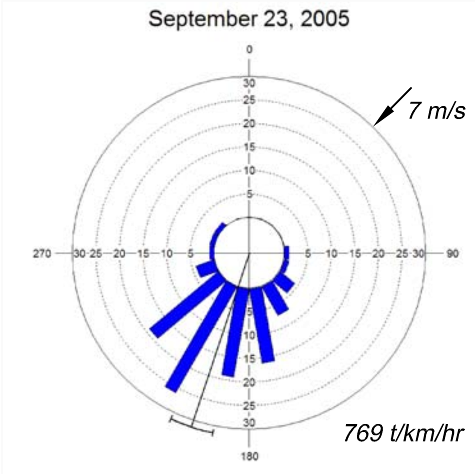
ADDRESS: Clayton, New York

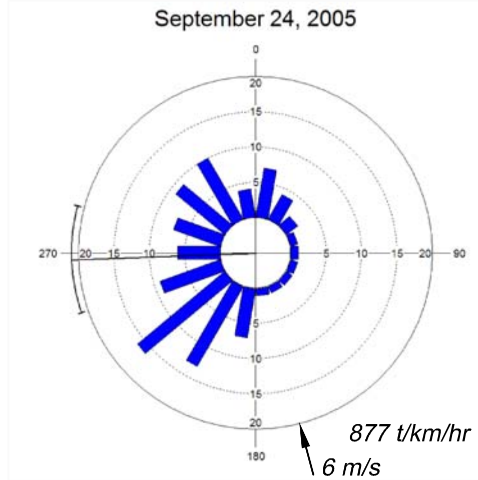
PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

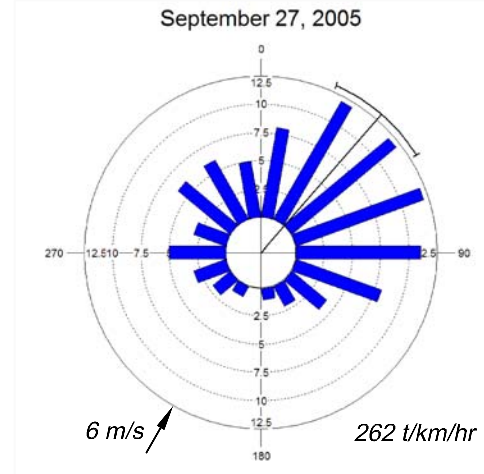
105030-00-traffic.dwg

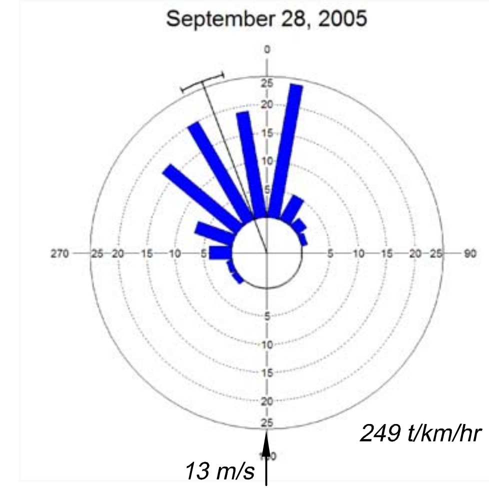
PROJ. NO. 105030

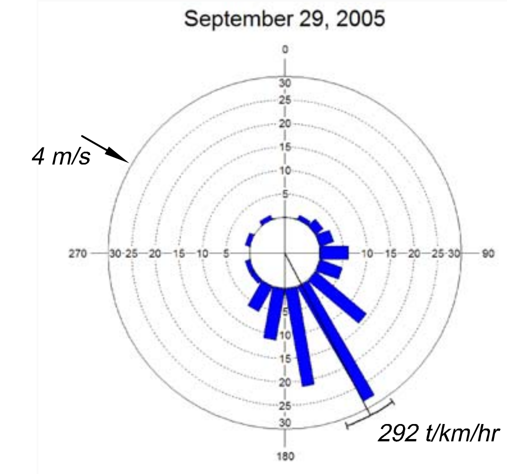
FIGURE NO. 3-6

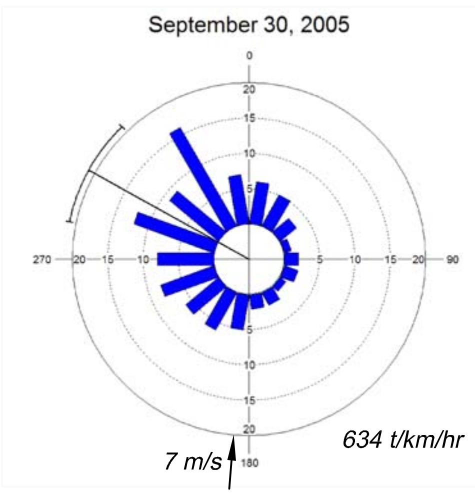


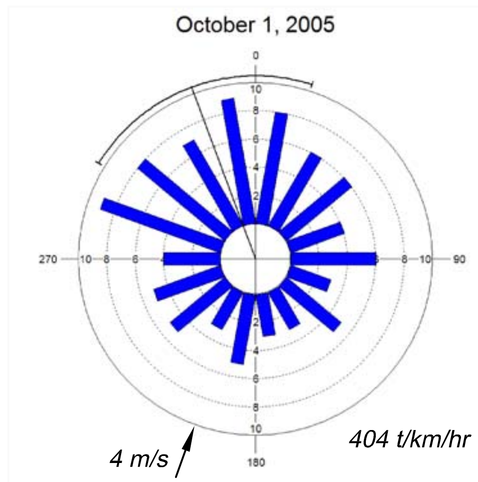


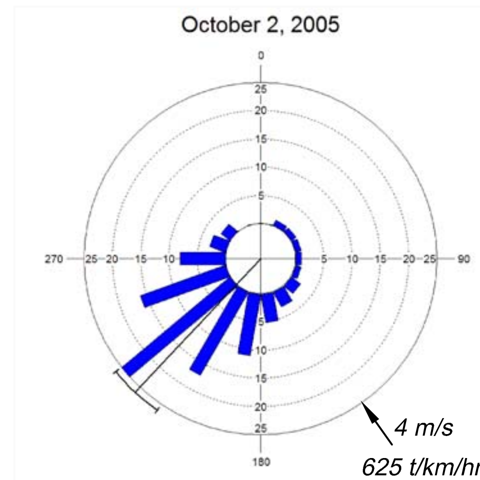


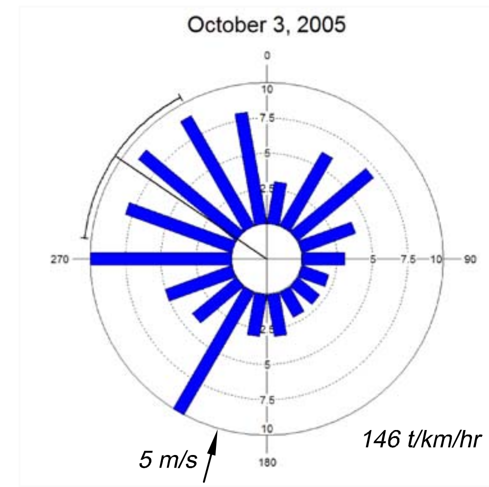


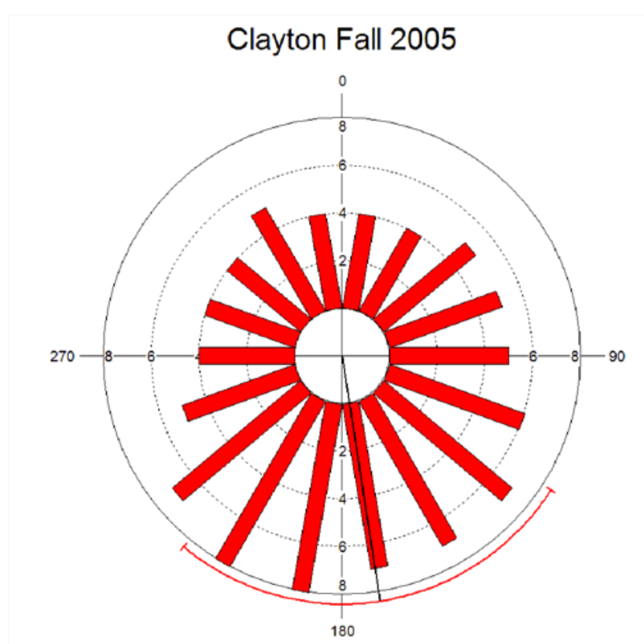












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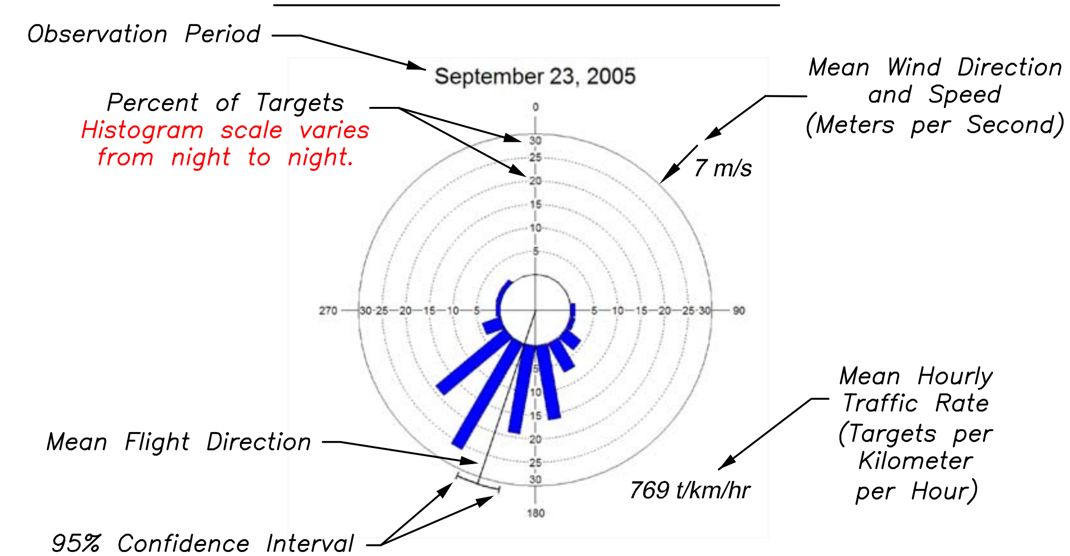


Data rose shows bird targets in directions of 20° increments.

Sheet 3 of 4

NO.	REVISIONS	DATE

SHEET TITLE: Nightly Mean Flight Direction

SCALE: n/a

DATE: November 2005

PROJECT: Clayton Wind Project

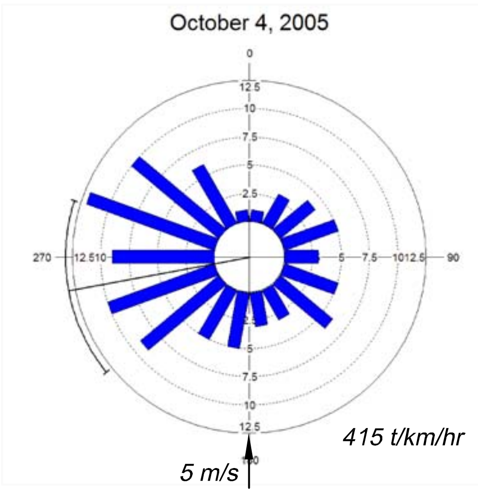
ADDRESS: Clayton, New York

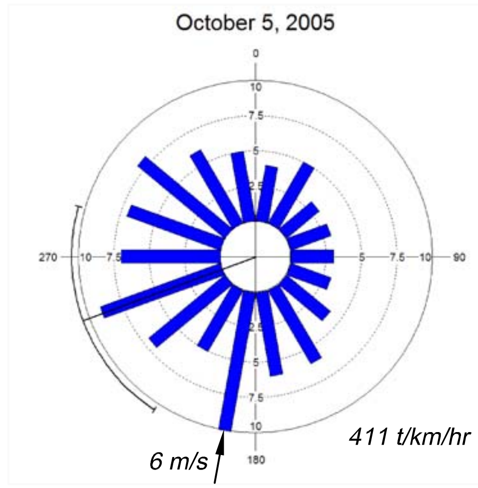
PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

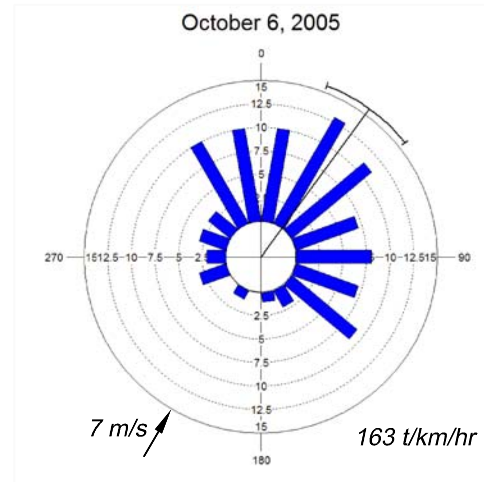
105030-00-traffic.dwg

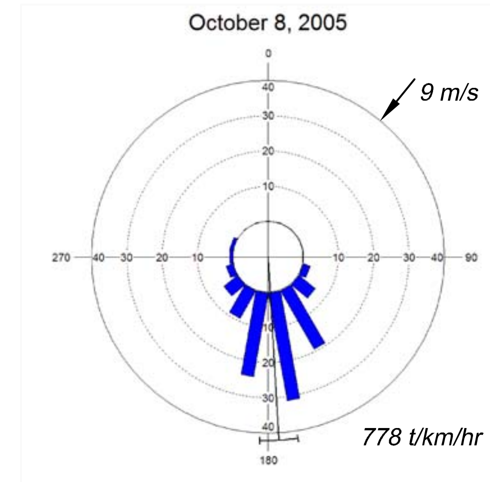
PROJ. NO. 105030

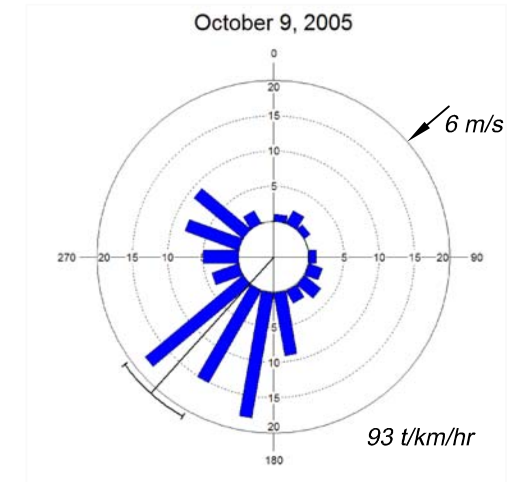
FIGURE NO. 3-6

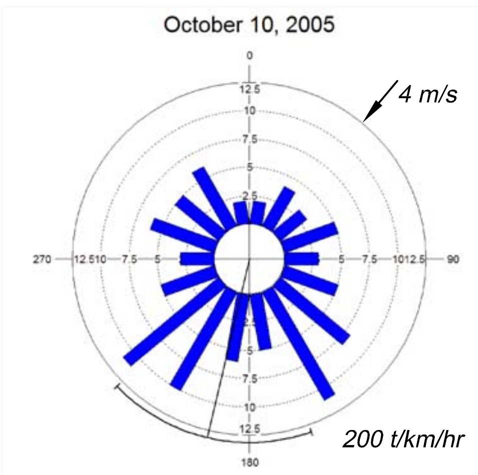


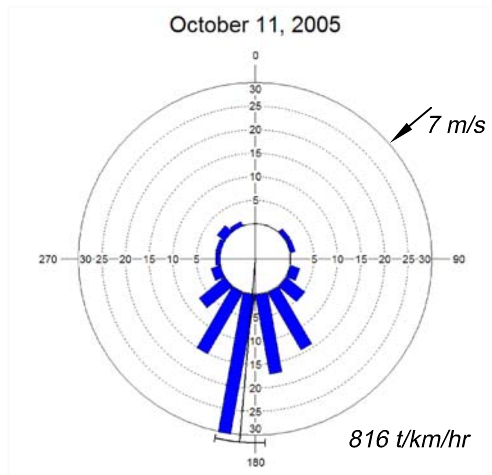


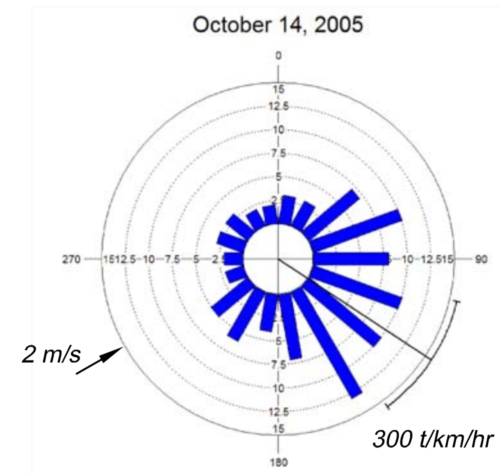


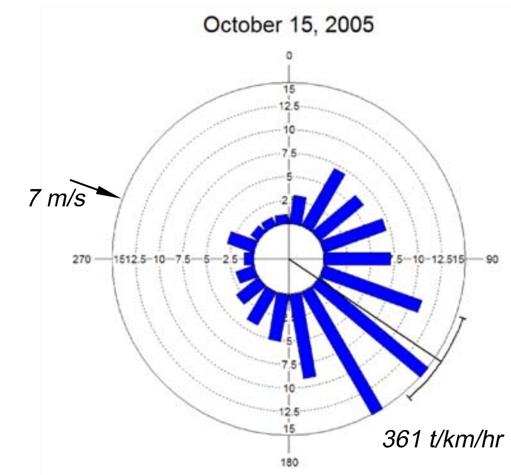


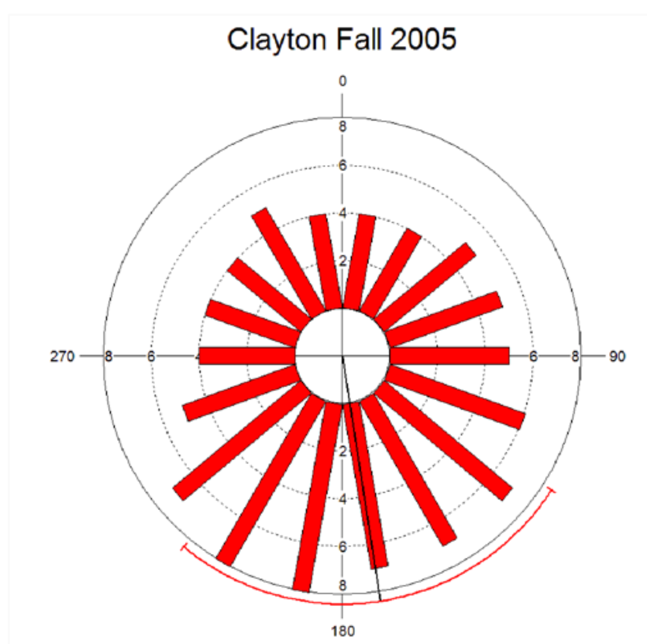












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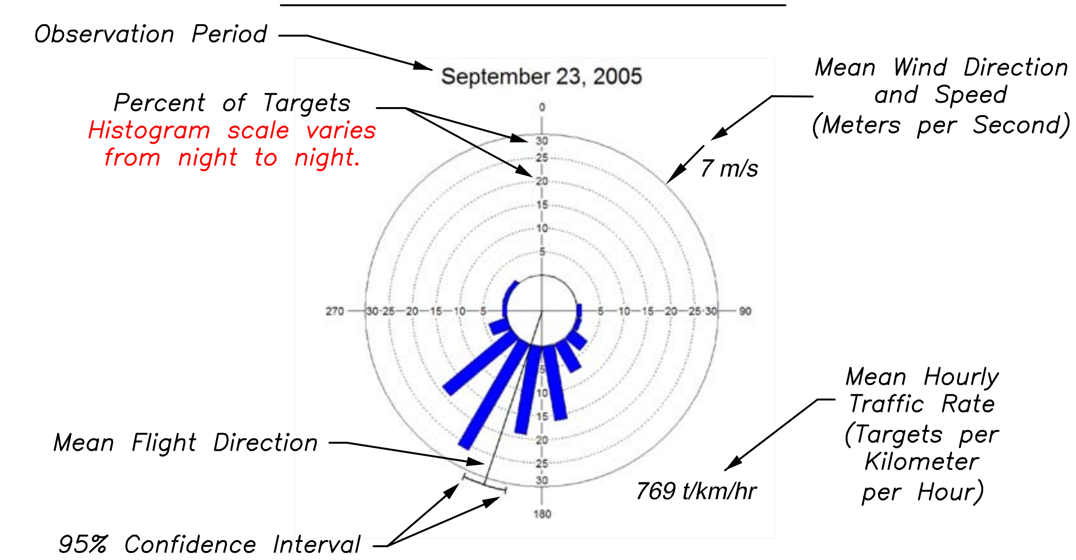

Data rose shows bird targets in directions of 20° increments.

NO.	REVISIONS	DATE

SHEET TITLE: Nightly Mean Flight Direction

SCALE: n/a

DATE: November 2005

PROJECT: Clayton Wind Project

ADDRESS: Clayton, New York

PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

105030-00-traffic.dwg

PROJ. NO. 105030

FIGURE NO. 3-6

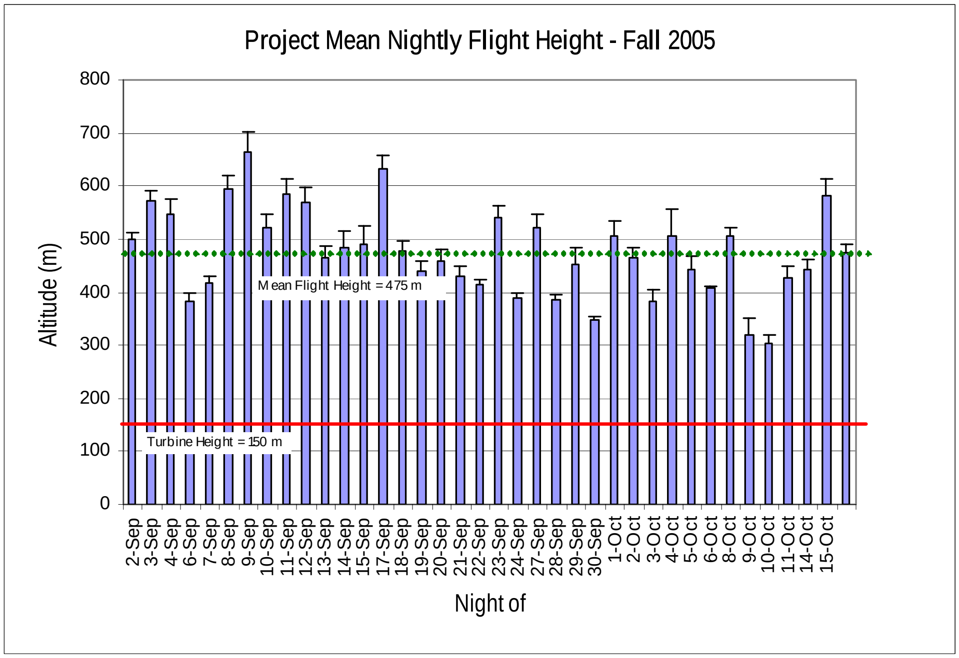

Figure 3-7. Mean nightly flight height of targets

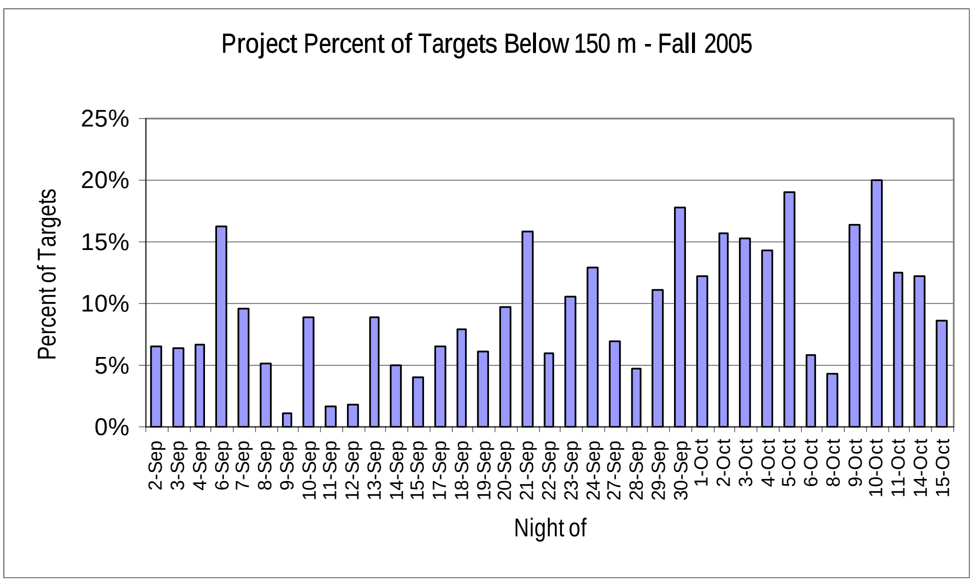

Figure 3-8. Percent of targets observed flying below a height of 150 m (492')

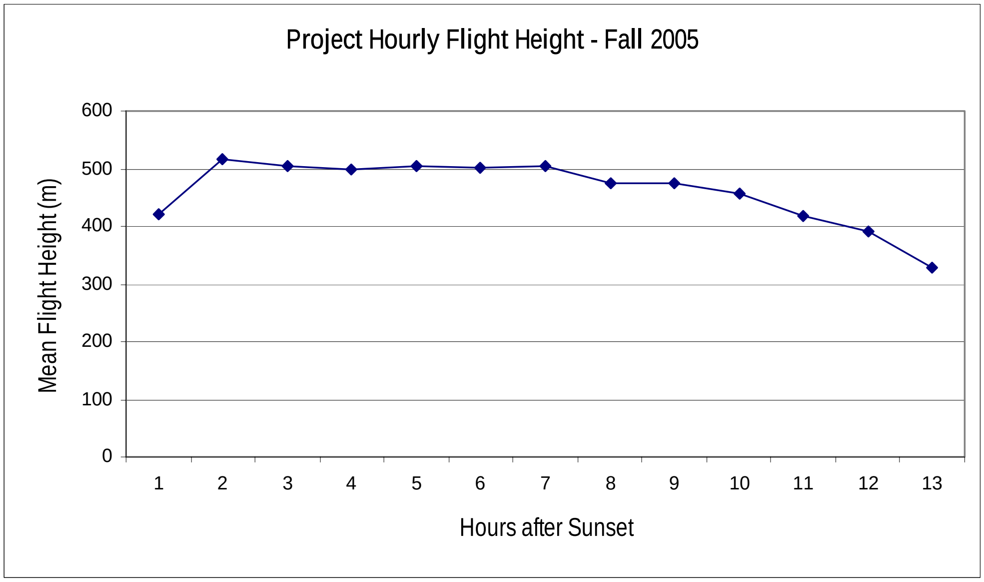

Figure 3-9. Hourly target flight height distribution

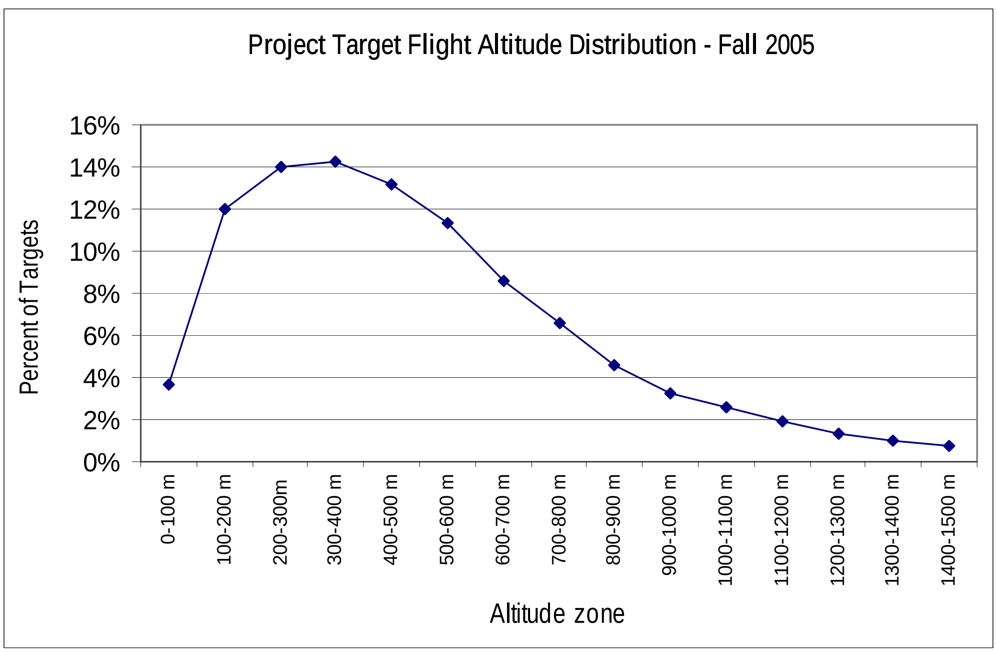

Figure 3-10. Target flight height distribution within 100 m (328') height zones

3.4 Discussion

Fall 2005 radar surveys documented migration activity and patterns in the vicinity of the proposed Clayton 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. 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 the Clayton wind project are consistent with this.

Nightly passage rates varied from 83 ± 17 to 877 ± 93 t/km/hr, with an overall mean of 418 ± 40 t/km/hr. Passage rates often peaked 2 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 3-3). 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 Clayton wind project were within the range of those studies, particularly those studies in relatively close proximity to Clayton (Copenhagen, Martinsburg, and Harrisburg, NY).

Table 3-3. 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	341	Cooper *et al.* 1995
1994	Martinsburg, NY	661	Cooper *et al.* 1995
1998	Harrisburg, NY	336	Cooper and Mabee 1999
1998	Wethersfield, NY	466	Cooper and Mabee 1999
2003	Chautauqua, NY	235	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 change year-to-year. Second, the timing of the surveys occurred during the second half of the migration season. Several nights of high migration activity could have occurred prior to the initiation of the surveys. Finally, year-to-year differences in regional weather patterns probably also affects where birds concentrate during the migration period.

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 Clayton wind project consists of relatively flat terrain with low hills and an elevation differential of only 76 m to 152 m (250' to 500'), which is considerably less than in those other areas where potential topographic effects on flight direction have been observed. Consequently, topographic features are not believed to be affecting bird movements in this area.

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 and 450 m above the ground level but on some nights the majority of birds observed were from 450 m to 762 m above the ground. Radar studies have largely confirmed those visual observations, with the majority of nocturnal bird migration appearing to occur less than 500 m to 700 m above the ground (Able 1970, Alerstam 1990, Gauthreaux 1991, Cooper and Ritchie 1995).

Recent radar studies 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 and 769 m, with a seasonal mean of 410 m and an average of 16% of targets flying below 125 m. In western New York, Cooper *et al.* (2004a) documented a mean flight altitude of 532 m with a small percentage (4%) of targets flying less 125 m above the ground.

Results from the Clayton wind project are similar to those of Cooper *et al*. (2004a, 2004b) with nightly flight altitudes varying from 305 m ±15 m (1,001' ± 49') to 663 m ± 40 m (2,175' ± 131') and a mean of 475 m ± 14 m (1,558' ± 46'). The percentage of targets flying less than 150 m above the ground was low, 10%, similar to that found by Cooper *et al*. (2004a).

The high mean flight altitude of targets documented during this study likely further supports the presumption that topographic features are not affecting migration patterns over the project area. 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.

Comparison with the Spring 2005 Survey

The fall 2005 surveys represent the second season of radar surveys at the Clayton wind project area. The fall 2005 survey (Woodlot 2005) documented a slightly lower passage rate than the spring survey (Table 3-4). This is generally consistent with what would be expected, as bird populations in fall would typically be higher than in spring due to the recruitment of juvenile birds into the post-nesting season population. Flight direction in the fall was generally opposite that documented in the spring.

Flight altitude was approximately 32 m (105') higher in the fall than in the spring. There was slightly more variation in flight height observed in the spring and, consequently, the percentage of targets flying less than 150 m (492') above the radar was higher in the spring (14%) than in the fall (10%).

Table 3-4. Comparison of results from radar surveys in Spring and Fall 2005

	Spring 2005	**Fall 2005**
Overall Passage Rate	450 ± 62 t/km/hr	418 ± 40 t/km/hr
Flight Direction	30° ± 53°	168° ± 111°
Flight Height	443 ± 38	475 ± 14
Seasonal Average below 150 m	14%	10%

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 Clayton wind project area. The results of the surveys indicate that bird migration patterns are generally similar to patterns observed at other sites in the region.

Migration activity varied throughout the season, which is probably largely attributable to weather patterns. The mean passage rate (418 ± 40 t/km/hr) is comparable to those observed at similar studies and generally similar to the spring study. Migration activity throughout each night typically peaked 2 to 4 hours after sunset and continued a steady decline fro the remainder of the night.

Flight direction for the entire season was 168º ± 111º. The average flight altitude above the ground was 475 m ± 14 m (1,558' ± 46'). Only 10 percent of the targets observed during vertical radar operation were flying below an altitude of 150 m (492'). Flight direction and height data indicate that nocturnal migrants are not avoiding the project area for any topographic-related reasons. Additionally, the flight height of targets so far above the height of the proposed turbines indicates that the risk of collision to night-migrating birds is limited to a very small subset of those birds

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 initially focused on forested ridgelines in the eastern United States, recent evidence from one facility on the prairies of Alberta indicates that bat mortality in those open habitats can be comparable to that observed along 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 appear to occur consistently during the month of August, which is thought to be linked to fall migration patterns, and the species most commonly found during mortality searches are the migratory tree bats: eastern red bat (*Lasiurus cinereus*), hoary bat (*Lasiurus 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 do not currently impact resident breeding bat populations in the United States. All available evidence indicates that most of the bat mortality at wind plants in the United States involves migrant or dispersing bats in the late summer and fall.

A number of plausible hypotheses explaining the high rates of bat mortality, as well as these patterns in timing and species vulnerability, have been presented by bat researchers, 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 surveyed for fatalities (Arnett *et al.* 2005).

Particular concern at this project has been expressed for the Indiana bat, a federally listed Endangered species that is known to occur in the vicinity of the project. Radio-tagging of Indiana bats from the nearest known hibernacula (approximately 14 km (8.7 mi) from the project area) during the pre-exodus period of 2005 documented several Indiana bats that traveled to the project area (pers. comm. Al Hicks, NYDEC).

To document bat activity in the area of the proposed Clayton Wind Project, Woodlot conducted acoustic monitoring surveys during fall 2005. Anabat II detectors were used to document bat passages near the rotor zone of the proposed turbines, at an intermediate height, and near the ground.

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 frequency range, which allows detection of all species of bats that could occur in New York.

The survey included the deployment of 2 detectors on 33 nights from August 19 to September 20, 2005. Two detectors were deployed at heights of approximately 30 m (100') and 2 m (6.6') above the ground at an on-site met tower. This location was the same as that used for the raptor and radar surveys. The detectors were programmed to record data from 7:00 pm to 7:00 am every night. 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.

Data Analysis

Call files were extracted from data files using CFCread© software, with default settings in place. Call files were visually screened to remove files caused by wind, insect noise, and other static so that only bat calls remained. Nightly tallies of detected calls were then compiled 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.

Call files were examined visually and assigned to species categories, based on comparison to libraries of known bat reference calls. Due to the similarity of calls between species in the genus *Myotis*, these calls were identified only to genus. However, calls of the genus *Myotis* were examined to determine if those of the Indiana bat, a federally listed Endangered species, may have been recorded. These calls were reviewed using characteristics identified by Eric Britzke, a national expert researching the ability to identify this species from recorded call sequences, as useful for separating this species from other *Myotis*. Calls lacking sufficient material upon which to base identification, or that could not be distinguished between species with similar call attributes, such as some silver-haired and big brown bat (*Eptesicus fuscus*) or eastern red bat and eastern pipistrelle calls, were labeled as "unknown." Nightly passage rates were calculated for each detector to document changes in species composition during the survey period.

4.2 Results

Of the 154 calls recorded, 124 were identified to species or genus group. The *myotids* were the most abundant calls recorded, accounting for 97 (63%) of the calls. Following these were calls of the big brown bat (19 calls), eastern red bat (4 calls), silver-haired bats (3 calls), and eastern pipistrelle (1 call). Thirty calls were of too poor of quality or too short to identify.

The *myotid* calls were examined for the possibility of the Indiana bat being included within the call set. Considerable variation within this set of calls was observed but no definitive determination has yet been

[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.

made. Considering the known occurrence of Indiana bats within the project area during summer 2005 it is possible that some of the *myotid* calls recorded during the fall survey are of this species.

The detectors were deployed continuously from August 19 to September 20, 2005. A malfunction in the high bat detector resulted in corrupt data files. Consequently, a total of 33 detector-nights of data were recorded. At total of 154 bat call sequences were recorded during the sampling, all from the lower detector. The total number of calls detected on any given night ranged from 0 (September 11 and 17) to 14 (August 28), with corresponding detection rates of 0 to 14 calls/detector-night. The overall average number of calls recorded per detector-night was 4.7. No overall trend in detection rate was observed.

Of the total number of recorded call sequences (154), 124 were identified to 5 different species categories and 30 were categorized as unknown (Figure 4-1). *Myotid* calls were the most abundant calls recorded (97), followed by big brown bat (19), eastern red bat (4), silver-haired bat (3), and eastern pipistrelle (1). No strong trends in the seasonal occurrence of any species were observed. However, several species (red bat, silver-haired bat, and eastern pipistrelle) were not observed after the August 28. Big brown bats and the myotids were generally documented throughout the survey period.

Table 4-1. Summary table for the results of fall bat surveys at Clayton.

Date (night of)	Big brown bat	Eastern red bat	Silver-haired bat	Myotis spp.	Eastern pipistrelle	Unknown	Total # Call Sequences
8/19/05		1		3		6	10
8/20/05				3			3
8/21/05		2		5		2	9
8/22/05			1	4			5
8/23/05		1		5		1	7
8/24/05	2		2	3			7
8/25/05	3			1			4
8/26/05				5		2	7
8/27/05	1			4		9	14
8/28/05				4	1	2	7
8/29/05	1			8			9
8/30/05	1			2		4	7
8/31/05	1			5			6
9/1/05	2			5			7
9/2/05	3			2			5
9/3/05				2		2	4
9/4/05				1			1
9/5/05				1			1
9/6/05				1		1	2
9/7/05				4			4
9/8/05				1			1
9/9/05	1			4			5
9/10/05				1			1
9/11/05							0
9/12/05				6			6
9/13/05	1			4		1	6
9/14/05				4			4
9/15/05	3						3
9/16/05				2			2
9/17/05							0
9/18/05				1			1
9/19/05				4			4
9/20/05				2			2
Total Calls	***19***	***4***	***3***	***97***	***1***	***30***	***154***
Detection Rate*	***0.6***	***0.1***	***0.1***	***2.9***	***0.03***	***0.9***	***4.7***

* Calls per detector-night

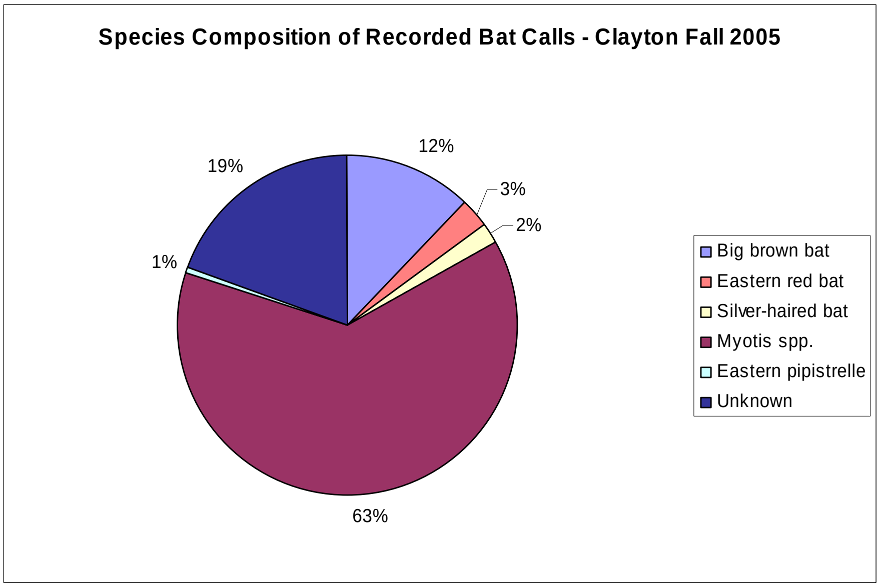

Figure 4-1. Species composition of bat calls recorded at the proposed Clayton Wind Project – Fall 2005

4.3 Discussion

The fall bat echolocation surveys provide some insight into activity patterns, species composition, and timing of movements of bats in the project area. Evaluation of the data collected does not document any obvious trend in the timing of activity during the time sampled.

Identification of recorded bat call sequences revealed that big brown bats and members of the genus *Myotis* were the most common species in the project area during fall. The detection rates documented during the fall survey were low. Very few of the tree-roosting species–species for which the greatest risk of collision has been demonstrated at some existing wind facilities–were documented during the fall survey.

Care must be taken in interpreting the results of echolocation surveys and using these data to predict the potential risk of a wind farm to bats. Although the relationship between bat activity levels, as measured by acoustic echolocation surveys, and bat collision mortality at wind farms has not been established and likely depends upon numerous factors, high bat passage rates could indicate increased likelihood of bat collision mortality while low detection rates could indicate lower risk of collisions.

Because so little is understood about the behavior of migrating bats, identifying the causes of collision mortality has been very difficult and any predictions based on pre-construction surveys should be conservative. The current understanding of bat mortality at wind farms is based on a small number of surveys, which may not be representative of more widespread patterns. Multiple survey types (acoustic echolocation surveys, mortality searches, thermal imaging, and radar) conducted concurrently at more wind farms once they become operational may be the only method of understanding this complicated issue.

4.4 Conclusions

Detector surveys during the fall 2005 migration period provided important information on bat activity in the vicinity of the Clayton project area. The survey documented the species that would be expected in the area based on the species' range and abundance, as well as the habitats in the project area. The generally low level of activity could be caused by many biological factors or simply by chance.

Of the bat calls recorded, 63 percent were classified as *Myotis* but were not further classified to species. Based on the relative abundance of these species, most of the *myotid* calls were likely from little brown bats (*Myotis lucifugus*) and northern long-eared bats (*Myotis septentrionalis*). However, considering the known occurrence of Indiana bats within the project area during summer 2005, it is possible that some of the *myotid* calls recorded during the fall survey were of this species.

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Appendix A

Appendix A Table 1. Summary of Daily Raptor Migration Surveys

Species	**Sep 09**	**Sep 16**	**Sep 18**	**Sep 19**	**Sep 27**	**Sep 28**	**Oct 04**	**Oct 05**	**Oct 06**	**Oct 15**	**Oct 16**	**Total**
American kestrel		3	1	2	1		2	2	1	1	1	14
Merlin					1							1
Northern harrier	2	3	2	3	2	2	2	3	2	7	3	31
Peregrine falcon	2				2			1				5
Red-tailed hawk	1		6	4	4	2	5	1	1	43	14	81
Sharp-shinned hawk		1	3	1	2		2		1	6	1	17
Turkey vulture	39	6	41	34	56	42	25	30	47	49	22	391
Cooper's hawk				1			2	1	1	2	2	9
Unidentified accipiter									1	1		2
Unidentified raptor			1							2		3
Broad-winged hawk			10									10
Bald eagle			1	1					2			4
Osprey	1			1		1		1			1	5
Golden eagle										1		1
Northern goshawk											1	1
Daily total	45	13	65	47	68	47	38	39	56	112	45	575

Appendix A Table 2. Summary of Hourly Raptor Observations

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	Grand Total
American kestrel	3	2	2		4	2	1	**14**
Bald eagle					2	2		**4**
Broad-winged hawk			9			1		**10**
Cooper's hawk	3			2	3	1		**9**
Golden eagle						1		**1**
Merlin		1						**1**
Northern goshawk					1			**1**
Northern harrier	8	6	5	6	5	1		**31**
Osprey		1	1	1	1	1		**5**
Peregrine falcon	1	2	1	1				**5**
Red-tailed hawk	8	5	4	16	18	7	23	**81**
Sharp-shinned hawk		1	2	4	5	2	2	**16**
Turkey vulture	36	62	54	123	53	55	8	**391**
Unidentified accipiter					1	1		**2**
Unidentified raptor			1		1	1		**3**
Grand Total	**59**	**80**	**79**	**153**	**94**	**75**	**34**	**574**

Appendix A Table 3. Raptor species distribution below turbine height

Species	> 150 m	< 150 m	Total
American kestrel	0	14	14
Bald eagle	2	2	4
Broad-winged hawk	10	0	10
Cooper's hawk	2	7	9
Golden eagle	0	1	1
Merlin	0	1	1
Northern goshawk	0	1	1
Northern harrier	1	30	31
Osprey	0	5	5
Peregrine falcon	0	5	5
Red-tailed hawk	13	68	81
Sharp-shinned hawk	3	14	17
Turkey vulture	31	360	391
Unidentified accipiter	0	2	2
Unidentified raptor	1	2	3
Total	**63**	**512**	**575**

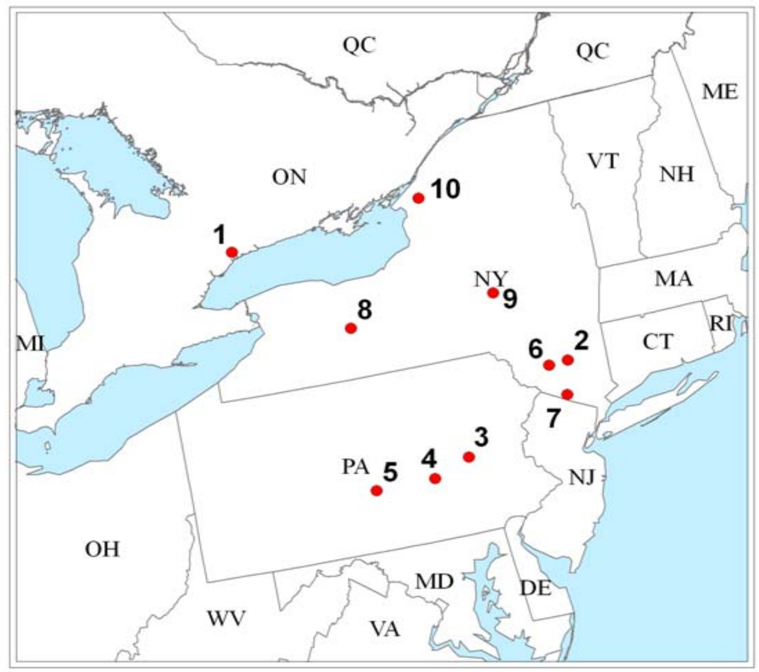
Appendix A Table 4. Summary of Fall 2005 Hawk Count Surveys at Clayton Wind Project and Other Regional Hawk Watch Sites*

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	**Clayton Wind Project NY**	63.5	0	391	5	4	31	17	9	1	0	10	81	0	1	14	1	5	0	3	0	2	0	0	575	9.1

* 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

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	SE
Sep 2	660	705	672	580	520	561	529	399	--	--	--	--	--	578	35
Sep 3	430	327	230	289	260	220	183	196	207	--	--	--	--	260	26
Sep 4	56	247	318	289	294	262	213	236	201	168	91	--	--	216	25
Sep 6	--	--	--	136	280	374	392	343	--	--	--	--	--	305	46
Sep 7	--	407	496	438	--	--	--	--	--	--	--	--	--	447	26
Sep 8	--	401	285	222	179	163	178	171	144	63	55	--	--	186	32
Sep 9	66	200	364	343	--	--	--	--	--	--	--	--	--	243	69
Sep 10	75	176	--	--	101	78	73	37	43	--	--	--	--	83	17
Sep 11	--	--	109	121	80	94	55	--	75	48	--	--	--	83	10
Sep 12	--	77	53	67	81	70	86	93	129	132	147	107	--	95	9
Sep 13	336	1397	1357	1093	1050	--	836	654	589	504	564	204	--	780	120
Sep 14	843	845	698	607	579	579	--	464	439	461	--	--	--	613	52
Sep 15	1179	1277	971	819	--	918	986	600	807	713	300	--	--	857	89
Sep 17	--	--	618	686	690	707	647	605	632	339	420	257	--	560	51
Sep 18	793	893	954	868	786	648	724	889	771	680	552	157	--	726	61
Sep 19	257	589	441	568	418	393	375	354	378	413	343	--	--	412	29
Sep 20	514	611	546	--	514	471	461	468	361	300	227	86	--	415	47
Sep 21	557	525	643	493	541	493	407	416	380	339	457	100	--	446	40
Sep 22	686	391	364	364	396	--	471	171	198	284	346	279	--	359	42
Sep 23	879	948	913	964	1007	994	664	600	525	193	--	--	--	769	84
Sep 24	429	1209	1357	1187	868	1256	943	900	707	664	557	446	--	877	93
Sep 27	321	307	364	289	246	336	289	321	200	207	--	104	161	262	23
Sep 28	241	382	411	300	364	329	236	139	137	157	143	150	--	249	30
Sep 29	--	286	514	500	391	386	311	257	359	236	163	75	21	292	44
Sep 30	--	1350	893	734	582	475	586	536	356	407	386	671	--	634	86
Oct 1	246	546	729	493	339	519	530	436	279	279	193	197	471	404	45
Oct 2	364	707	657	750	1033	875	804	686	600	546	454	402	246	625	61
Oct 3	161	159	225	150	193	180	161	107	118	107	150	43	150	146	13
Oct 4	332	263	350	343	500	540	450	579	468	429	343	536	263	415	30
Oct 5	--	429	450	557	413	414	750	396	476	304	236	327	179	411	43
Oct 6	193	139	171	121	146	171	--	86	214	139	214	193	--	163	12
Oct 8	150	841	1079	1286	1286	1232	921	957	814	605	464	279	204	778	112
Oct 9	--	--	--	--	147	134	139	157	54	36	32	39	100	93	18
Oct 10	--	--	--	250	246	261	--	143	159	129	157	171	286	200	20
Oct 11	514	557	777	1200	--	1425	1404	870	1071	--	480	421	252	816	124
Oct 14	450	414	514	332	332	321	343	332	236	171	188	155	113	300	34
Oct 15	364	354	396	600	568	423	386	501	343	307	161	171	116	361	41
Entire Season	**427**	**561**	**573**	**531**	**468**	**494**	**485**	**415**	**378**	**312**	**290**	**232**	**197**	**418**	**40**

Appendix B Table 2. Mean Nightly Flight Direction

Night of	Mean Flight Direction	Circular Stdev
Sep 2	125	45
Sep 3	205	52
Sep 4	171	75
Sep 6	318	97
Sep 7	39	48
Sep 8	195	65
Sep 9	190	41
Sep 10	271	73
Sep 11	22	36
Sep 12	30	48
Sep 13	324	65
Sep 14	131	80
Sep 15	161	72
Sep 17	100	54
Sep 18	31	56
Sep 19	322	54
Sep 20	114	55
Sep 21	31	55
Sep 22	70	81
Sep 23	198	36
Sep 24	267	73
Sep 27	40	73
Sep 28	339	34
Sep 29	152	41
Sep 30	299	72
Oct 1	334	100
Oct 2	222	45
Oct 3	304	91
Oct 4	258	92
Oct 5	249	101
Oct 6	36	69
Oct 8	175	30
Oct 9	221	58
Oct 10	189	97
Oct 11	184	43
Oct 14	127	80
Oct 15	124	69
Entire Season	**168**	**111**

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		% of targets < 150 m
	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean	SE	
2-Sep	473	566	519	515	485	496	484	449	--	--	--	--	--	498	12	7%
3-Sep	--	--	570	576	617	653	603	599	526	520	500	--	--	574	17	6%
4-Sep	610	658	640	676	621	556	510	485	494	473	365	473	--	547	27	7%
6-Sep	--	--	--	360	443	363	361	384	--	--	--	--	--	382	16	16%
7-Sep	--	406	404	442	--	--	--	--	--	--	--	--	--	417	12	10%
8-Sep	--	695	649	659	643	628	608	543	569	501	453	--	--	595	24	5%
9-Sep	697	708	583	--	--	--	--	--	--	--	--	--	--	663	40	1%
10-Sep	496	625	--	--	534	564	535	447	459	--	--	--	--	523	23	9%
11-Sep	--	--	423	612	555	597	630	--	594	674	--	--	--	584	30	2%
12-Sep	--	572	665	615	703	620	601	579	501	566	458	383	--	569	28	2%
13-Sep	511	554	548	386	387	454	449	491	--	431	343	549	--	464	22	9%
14-Sep	413	418	424	473	424	426	--	494	566	708	--	--	--	483	33	5%
15-Sep	--	664	626	596	507	453	472	458	416	411	--	301	--	490	35	4%
17-Sep	--	649	674	722	740	673	670	660	603	557	553	457	--	633	25	7%
18-Sep	435	566	490	544	534	573	522	462	378	393	388	429	--	476	21	8%
19-Sep	286	538	510	455	455	443	435	450	427	410	442	--	--	441	19	6%
20-Sep	420	518	491	507	528	584	476	429	419	407	438	283	--	458	22	10%
21-Sep	--	482	548	525	483	401	422	383	368	383	364	363	--	429	21	16%
22-Sep	--	410	349	409	405	416	411	385	423	452	475	--	--	413	11	6%
23-Sep	--	648	623	614	578	541	559	545	488	451	437	450	--	539	22	11%
24-Sep	355	378	375	379	411	442	431	395	396	389	--	343	--	390	9	13%
27-Sep	369	573	549	538	604	573	600	602	542	452	433	440	--	523	23	7%
28-Sep	335	373	357	412	407	381	394	394	396	390	405	402	--	387	6	5%
29-Sep	--	489	469	--	530	547	549	566	436	369	450	376	185	451	33	11%
30-Sep	329	354	338	348	324	337	353	346	389	306	377	381	337	348	7	18%
1-Oct	345	383	386	427	499	546	573	595	621	592	--	566	534	506	28	12%
2-Oct	427	534	441	410	396	385	482	498	549	547	576	436	366	465	19	16%
3-Oct	--	366	388	324	418	339	332	390	513	496	363	294	--	384	21	15%
4-Oct	333	650	566	622	680	702	729	596	510	371	355	335	127	506	51	14%
5-Oct	319	428	438	558	496	447	505	519	547	486	396	370	261	444	25	19%
6-Oct	--	391	420	408	393	422	411	416	416	--	391	396	--	406	4	6%
8-Oct	439	531	584	595	568	538	519	478	470	461	467	426	--	506	17	4%
9-Oct	--	--	--	282	415	449	357	314	373	347	323	216	131	321	30	16%
10-Oct	--	--	--	335	307	297	--	264	390	298	300	318	233	305	15	20%
11-Oct	338	349	360	482	509	570	485	470	471	385	388	391	364	428	20	12%
14-Oct	300	351	433	512	474	512	535	445	482	480	443	420	380	444	19	12%
15-Oct	594	711	757	586	639	627	643	572	495	460	424	345	694	580	33	9%
Entire Season	**420**	**517**	**503**	**497**	**506**	**502**	**504**	**474**	**476**	**457**	**419**	**390**	**328**	**475**	**14**	**10%**

-- indicates no data for that hour