# AVIAN AND BAT STUDIES FOR THE PROPOSED DAIRY HILLS WIND PROJECT, WYOMING COUNTY, NEW YORK

## FINAL REPORT

*April – October 2005*

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# 1.0 Introduction and Background

Horizon Wind Energy (Horizon) is developing a renewable energy portfolio for western New York which includes a potential wind power project in Wyoming County. The proposed *Dairy Hills* Wind Project is located in an agricultural setting north and east of the town of Perry, in the Perry, Warsaw, and Covington townships (Figure 1). The exact location and size of the development will be based on a number of factors including economics, electricity markets, transmission constraints, power purchase agreements, permitting, and results of site surveys.

Through the early project evaluation process a number of concerns were raised by the New York Department of Environmental Conservation (NYDEC) and the U.S. Fish and Wildlife Service (USFWS). These concerns included potential project impacts to avian and bat resources, particularly nocturnal migrant birds and bats, migrant raptors, breeding birds, and species of concern which may occupy the site. The agencies requested that data be collected which may be used to describe these resources in the context of the proposed development, assist in addressing potential impacts from the development, and to the extent possible, assist in wind plant design and siting that minimizes risk to avian and bat resources.

A field study that addressed agency concerns and provided site specific data on resources of concern was initiated in April 2005. The principal goals of the study were:

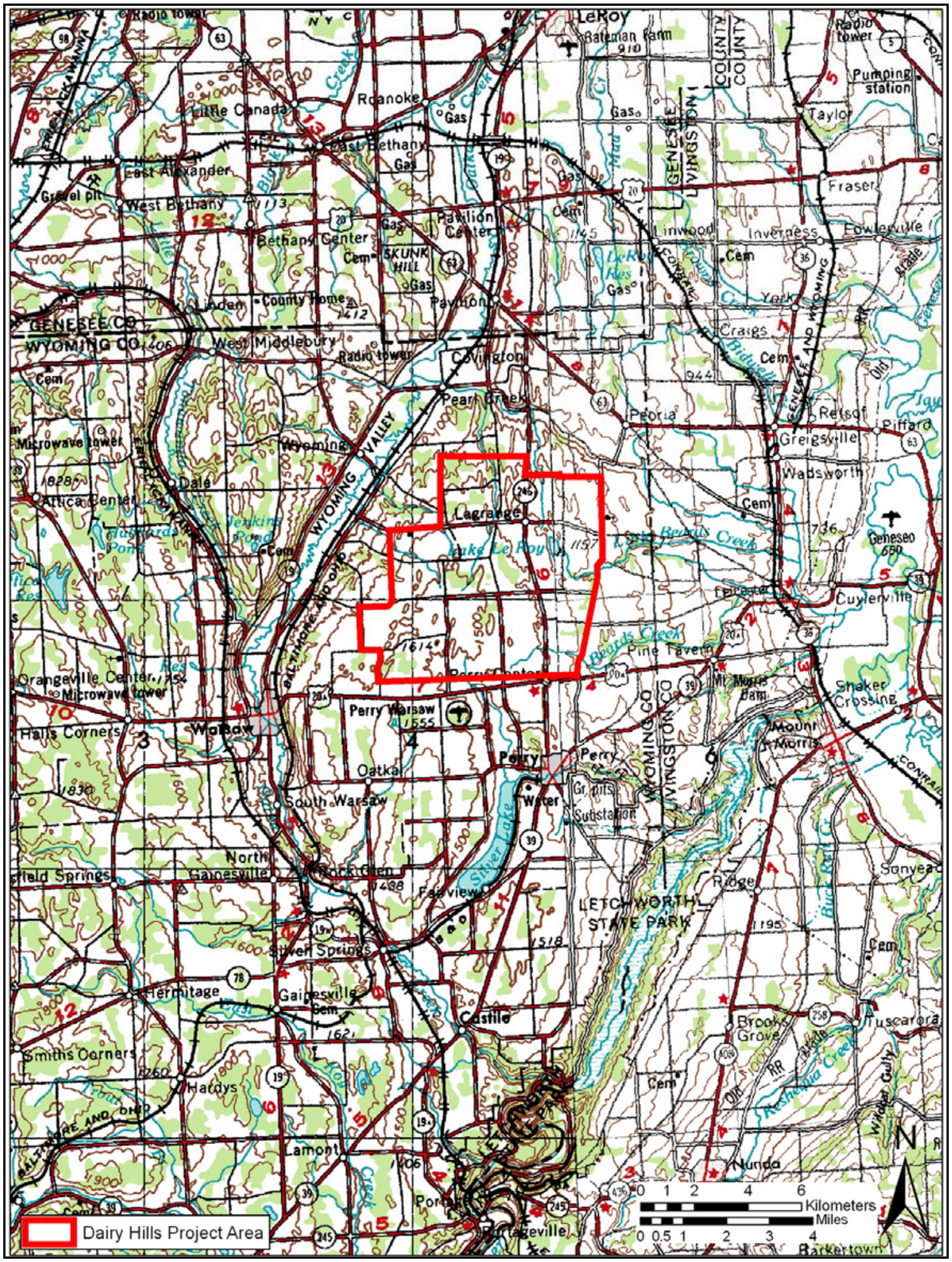
1) Provide information on avian and bat resources and use of the study area that is useful in evaluating potential impacts from wind power development;
2) Provide information on avian and bat migration over the proposed development area that is useful in evaluating the relative risk of the proposed wind project location;
3) Provide information on avian, bat, and sensitive species use of the study area that would help in designing a wind plant that is less likely to expose species to potential collisions with turbines, and;
4) Provide recommendations for further monitoring studies and potential mitigation measures, if appropriate.

The studies included field surveys for avian species, especially spring and fall nocturnal migrants and diurnal migrants with a focus on raptors, breeding birds, fall migrant and resident bats, and state listed or sensitive species. Specific objectives of the study were to (1) describe and quantify nocturnal migration over the proposed project, (2) describe and quantify diurnal raptor migration through the proposed project, (3) describe and quantify breeding bird use in the proposed project area, (4) describe and quantify migrant bats over the proposed project, and (5) identify the presence of any special-status species (e.g., state-listed species) that may occur seasonally in the project area.

The studies were designed to characterize avian (raptors, breeding residents and migrants) use of the proposed development area, summer and migrant bat use of the proposed development area, and provide data that were useful in estimating potential impacts the Dairy Hills project may have on birds and bats. The study protocol was developed with input from personnel of

NYDEC and USFWS, and with the expertise and experience of WEST, which has conducted similar studies for wind energy development throughout the U.S.

**Figure 1. Proposed Dairy Hills wind power project location.**



# 2.0 Study Area

The Dairy Hills project is located along the western edge of the Cattaraugus Highlands sub-zone of the Appalachian Plateau ecozone of New York (Andrle and Carroll 1988). The Cattaraugus Highlands subzone is the western most sub-zone within the Appalachian Plateau and is characterized by deep valleys dissecting flat-topped upland hills (Andrle and Carroll 1988). Water erosion and glaciations were the dominant forces determining topography. Elevation of the subzone varies from about 1000-1800 feet as the general lay of the land transitions from the Great Lakes Plain to the Appalachian Mountains. The predominant vegetation type was historically northern hardwood forest: oaks, beech, sugar maple, white ash, and black cherry; but agricultural clearing has left the region approximately 30% wooded. The relatively flat topped hills have been cleared for farming and grazing pasture to support dairy production. The region generally has cold snowy winters and cool wet summers. Precipitation is approximately 40 inches a year and the mean high temperature in July is about 70°F (Andrle and Carroll 1988).

The land within the project is privately owned and the primary land uses are agriculture (wheat, corn, hay), dairy farms, and residential development. Scattered houses and farms occur throughout the project, often adjacent to the roads with some new homes (<10 years) scattered through the area. The project area is representative of the typical Cattaraugus Highlands ecozone landform – generally hilly country bordered by somewhat deep valleys. The highest elevation of the project area is approximately 1625 feet. Vegetation in the project is a mosaic of open grass/hay fields, cultivated agriculture, scattered deciduous tree wood lots, scattered wetlands and ponds, and developed areas (e.g., farms, residential housing). The deciduous woods are varied and composed primarily of hardwoods (maple, ash, oak, and beech trees), and tend to be small, typically with early- to mid-growth trees. The area is scattered with wetlands which vary from forested wetlands to open ponds. Most of the project development will occur in fields.

# 3.0 Study Components and Methods

The studies consisted of diurnal point count surveys from fixed point locations conducive to observing raptors and other large birds; breeding bird survey point counts at potential turbine locations through the development area; habitat focused surveys for state-listed species, if necessary; nocturnal marine radar sampling during spring and fall migration periods; and AnaBat sampling at the project met tower during spring and fall migration periods and over the whole study area during summer.

### 3.1 Diurnal Point Count Surveys

The objective of the diurnal point count surveys was to estimate spatial and temporal use of the site by migrant raptors and other diurnal migrants. Sampling intensity was designed to document raptor migration through the development area. Initially, existing data from raptor migration watch sites in New York was used to determine appropriate dates for maximizing observations of migrant raptors. The peak windows for migrant sharp-shinned hawks and broad-winged hawks were chosen as the target survey periods. Based on existing data from raptor migration watch sites for the past three years[1], the peak of the sharp-shinned hawk and broad-winged hawk spring migration usually occurs during the last two weeks of April and for the fall migration broad-winged hawk movement concentrates in mid-September and sharp-shinned hawks in approximately the first week of October. Efforts were made to concentrate the surveys in these periods to maximize observations of migrant raptors but actual survey dates were flexible in response to adverse or highly preferable weather conditions.

### *3.1.1 Methods*

Four points were selected along an approximately east-west transect (using public roads) though the project area (Figure 2). The survey points were selected to provide good visibility in all directions while sampling different vegetation, topographic features, and portions of the study area without overlap. An east to west layout was used to minimize the possibility of double counting migrant raptors as they moved north-south through the study area. The surveys emphasized counts and locations of raptors and large birds within approximately 800 m (0.5 mi) of each point.

Each survey plot was a variable circular plot centered on the observation point (Reynolds et al. 1980, Bibby et al. 1992). Survey duration at each point was 60 minutes per visit. Surveys were conducted according to methods used by the Hawk Migration Association of North America (HMANA) with observers continuously scanning the sky and surrounding areas for raptors in the survey area. Surveys were conducted between approximately 0900 and 1500 hours each survey day when weather conditions typically produce thermal uplifts conducive to raptor movement. All raptors and other large birds observed during the survey were assigned a unique observation number and plotted on a map of the survey plot. The date, start and end time of the observation period, and weather information such as temperature, wind speed, wind direction, barometric pressure, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each raptor observed. Flight or movement paths were mapped for all raptors and given the corresponding unique observation number. Approximate flight height at first observation and the approximate lowest and highest flight heights were recorded to the nearest 5 or 10-meter interval. Flight heights were estimated by comparison to nearby objects such as radio or met towers, power poles, and trees.

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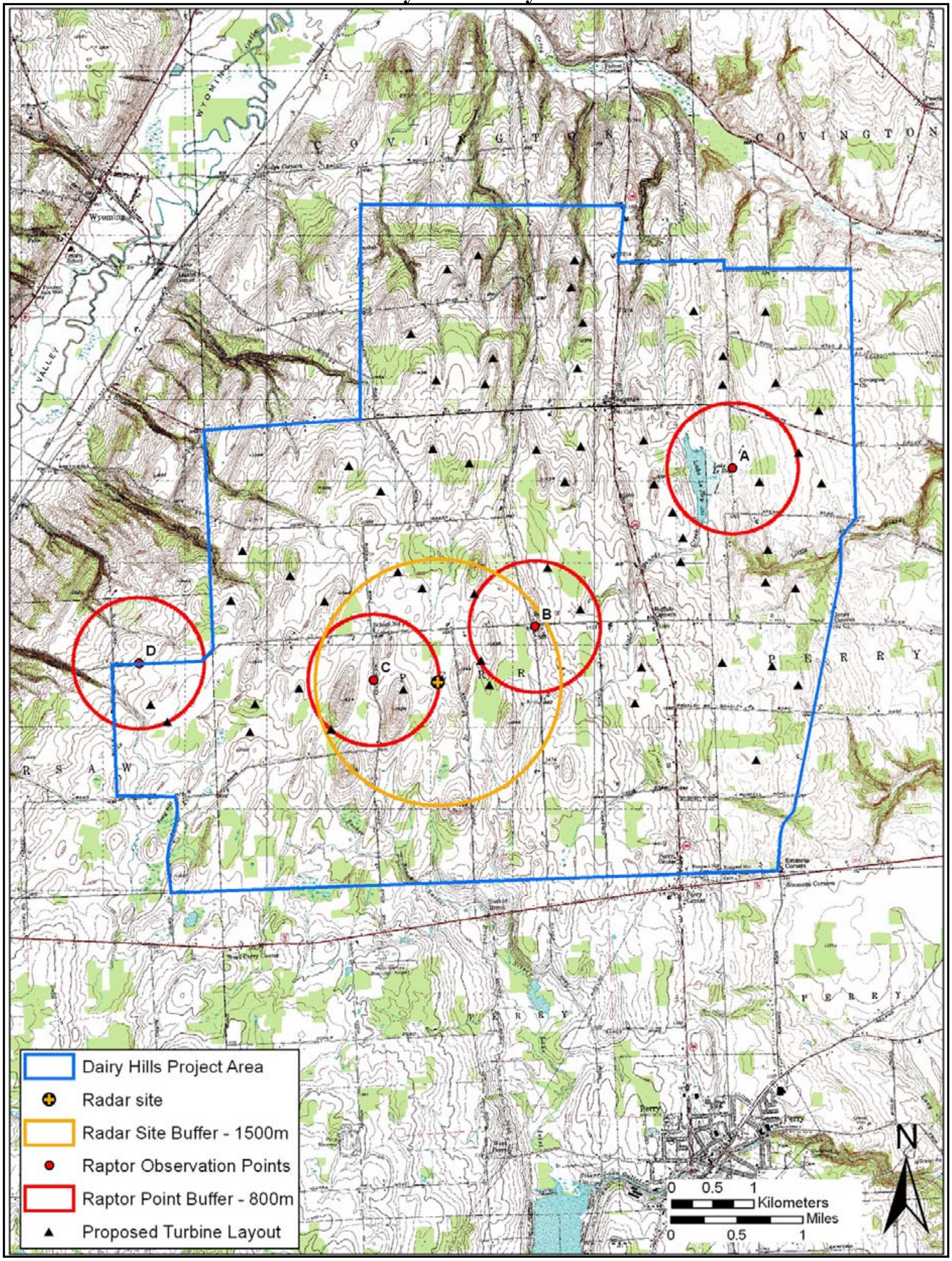
[1] Counts of sharp-shinned hawks and broad-winged hawks from three spring raptor migration watch sites in central and western New York (Ripley Hawk Watch, Braddock Bay, Derby Hill) were examined for the years 2002-2004. On average, approximately 60% of sharp-shinned hawks moved through western New York between April 15 and April 29. The majority of broad-winged hawks moved through between April 18 and May 2. For the fall season, counts from four raptor migration sites throughout New York (Franklin Mountain, Kestrel Haven, Mohonk Preserve, Summitville Hawkwatch), and two in southern Ontario (High Park, Cranberry Marsh) were examined. On average, the majority of broad-winged hawks moved through between September 10 and September 24 and sharp-shinned hawk movement concentrated between approximately September 26 and October 14 (see further discussion in Section 4.0).

**Figure 2. Diurnal point count locations and radar sampling site for the Dairy Hills study area.**



*3.1.2 Results*

In the spring, each fixed point was surveyed five times during the survey window, for a total of 20 surveys. A total of 88 individual large birds in 55 separate groups were recorded during the surveys (Table 1). Fifty (50) individual raptors were observed in 34 different groups. During the fall, each point was surveyed four times for a total of 16 surveys. A total of 221 individual large birds in 33 separate groups were recorded during the fall surveys (Table 1). Forty-eight (48) individual raptors were observed in 24 different groups.

During the spring, turkey vulture was the most commonly seen raptor (60% of all raptor observations). Other raptor species included red-tailed hawk, rough-legged hawk, sharp-shinned hawk, northern harrier, and American kestrel. Red-tailed hawk was the most frequently observed raptor recorded during 50% of the point counts. During the fall, turkey vulture was again the most common raptor (70% of raptor observations) and was observed the most frequently in 50% of the surveys. Sharp-shinned hawk was only observed during the spring and osprey was only observed during the fall (Table 1).

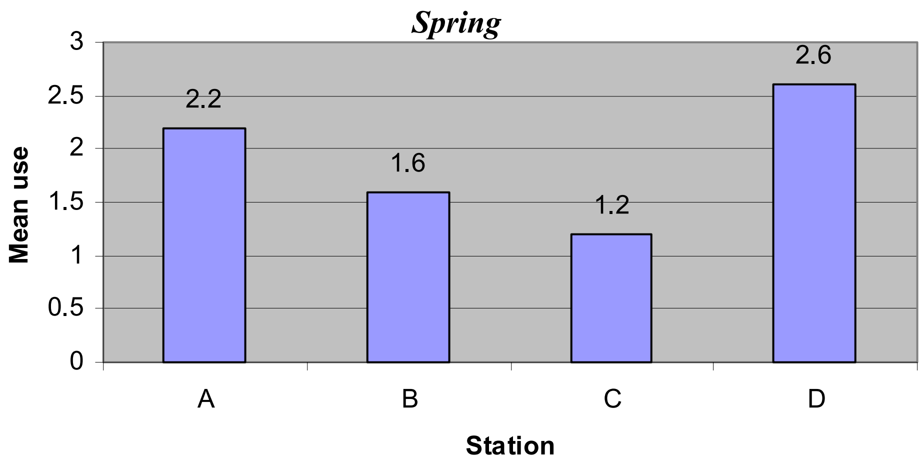
**Table 1. Raptors and other large bird species observed while conducting diurnal point count surveys at the Dairy Hills Site.**

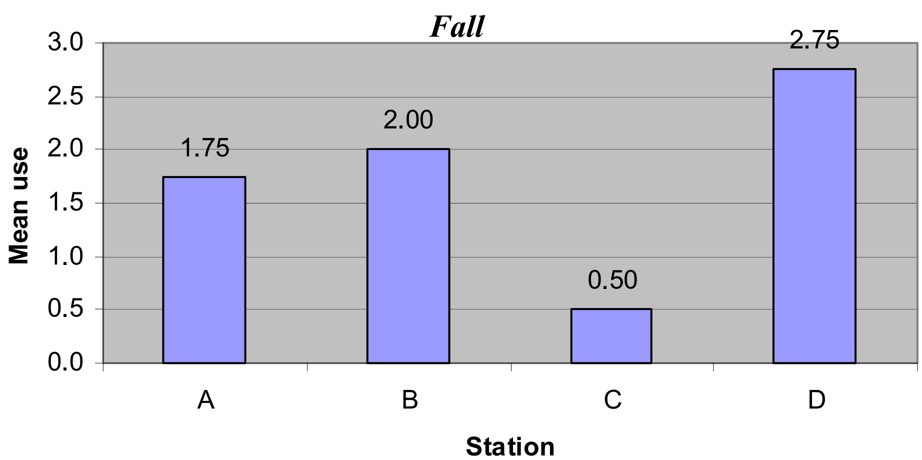
| | Spring | | | | Fall | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of | | | | Number of | | | |
| **Species/Group** | **individs** | **groups** | **use[2]** | **freq[3]** | **individs** | **groups** | **use[2]** | **Freq[3]** |
| **Waterbirds** | **8** | **4** | **0.40** | **10.0** | **116** | **3** | **7.25** | **18.8** |
| great blue heron | 4 | 3 | 0.20 | 10.0 | 0 | 0 | N/A | N/A |
| unidentified gull | 4 | 1 | 0.20 | 5.0 | 116 | 3 | 7.25 | 18.8 |
| **Waterfowl** | **19** | **10** | **0.95** | **25.0** | **157** | **6** | **9.81** | **25.0** |
| Canada goose | 16 | 8 | 0.80 | 25.0 | 145 | 5 | 9.06 | 18.8 |
| mallard | 3 | 2 | 0.15 | 10.0 | 12 | 1 | 0.75 | 6.3 |
| **Raptors** | **50** | **34** | **1.90** | **75.0** | **48** | **24** | **1.75** | **81.3** |
| *Accipiters* | | | | | | | | |
| sharp-shinned hawk | 1 | 1 | 0.05 | 5.0 | 0 | 0 | N/A | N/A |
| *Buteos* | *15* | *14* | *0.65* | *55.0* | *11* | *8* | *0.69* | *31.3* |
| red-tailed hawk | 13 | 12 | 0.60 | 50.0 | 7 | 6 | 0.44 | 31.3 |
| rough-legged hawk | 1 | 1 | N/A | N/A | 2 | 1 | 0.13 | 6.3 |
| unidentified buteo | 1 | 1 | 0.05 | 5.0 | 2 | 1 | 0.13 | 6.3 |
| *Harriers* | | | | | | | | |
| northern harrier | 3 | 3 | 0.15 | 10.0 | 1 | 1 | 0.06 | 6.3 |
| *Falcons* | | | | | | | | |
| American kestrel | 1 | 1 | 0.05 | 5.0 | 1 | 1 | 0.06 | 6.3 |
| *Vultures* | | | | | | | | |
| turkey vulture | 30 | 15 | 1.00 | 40.0 | 34 | 13 | 0.88 | 50.0 |
| *Osprey* | | | | | | | | |
| osprey | 0 | 0 | N/A | N/A | 1 | 1 | 0.06 | 6.3 |
| **Passerines** | **9** | **5** | **0.45** | **20.0** | **235** | **8** | **8.06** | **25.0** |
| American crow | 9 | 5 | 0.45 | 20.0 | 35 | 6 | 1.81 | 25.0 |
| European starling | 0 | 0 | N/A | N/A | 100 | 1 | 6.25 | 6.3 |
| red-winged blackbird | 0 | 0 | N/A | N/A | 100 | 1 | 6.25 | 6.3 |
| **Other Birds** | | | | | | | | |
| pileated woodpecker | 2 | 2 | 0.10 | 10.0 | 0 | 0 | N/A | N/A |
| **Total** | **88** | **55** | **3.80** | | **556** | **41** | **26.88** | |

[2] Mean use = number observed within 800 m of survey point per 60-min survey
[3] Frequency of occurrence = percent of surveys in which species was observed

Raptor use across the study area was relatively similar with the highest use estimates coming at the furthest most west point in both spring and fall (Figure 3). The difference in use between points were not statistically significant.

**Figure 3. Raptor use estimates by survey point on the Dairy Hills site.**




Exposure indices were calculated as the mean use estimates for all surveys (number of birds/60-minute survey), times the percent of birds observed flying, times the percent of birds flying within the zone of risk (defined as the approximate rotor-swept area). Canada goose had the highest exposure index for all species observed, primarily from high use estimates derived from observations of a few large flocks flying (Table 2). Among raptors, turkey vulture had the highest exposure index also due to high use of the area by this species.

**Table 2. Flight height characteristics and exposure indices by species observed during point count surveys at the Dairy Hills site.**

| Species | # flocks flying | # birds flying | % birds flying | Relation to rotor-swept area[4] | | | Exposure Index[5] |
|---|---|---|---|---|---|---|---|
| | | | | below | within | above | |
| ***Waterbirds*** | | | | | | | |
| great blue heron | 3 | 4 | 100.00 | 100.00 | 0.00 | 0.00 | 0.000 |
| unidentified gull | 3 | 20 | 16.67 | 20.00 | 50.00 | 30.00 | 0.278 |
| ***Waterfowl*** | | | | | | | |
| Canada goose | 11 | 155 | 96.27 | 27.74 | 72.26 | 0.00 | 3.111 |
| mallard | 3 | 15 | 100.00 | 0.00 | 100.00 | 0.00 | 0.417 |
| ***Raptor*** | | | | | | | |
| *Accipiters* | | | | | | | |
| sharp-shinned hawk | 1 | 1 | 100.00 | 0.00 | 0.00 | 100.00 | 0.000 |
| *Buteos* | | | | | | | |
| red-tailed hawk | 17 | 19 | 95.00 | 15.79 | 68.42 | 15.79 | 0.343 |
| rough-legged hawk | 2 | 3 | 100.00 | 33.33 | 66.67 | 0.00 | 0.037 |
| unidentified buteo | 2 | 3 | 100.00 | 0.00 | 100.00 | 0.00 | 0.083 |
| *Falcons* | | | | | | | |
| American kestrel | 2 | 2 | 100.00 | 100.00 | 0.00 | 0.00 | 0.000 |
| *Other Raptors* | | | | | | | |
| northern harrier | 4 | 4 | 100.00 | 75.00 | 25.00 | 0.00 | 0.028 |
| turkey vulture | 27 | 62 | 96.88 | 6.45 | 72.58 | 20.97 | 0.664 |
| osprey | 1 | 1 | 100.00 | 0.00 | 100.00 | 0.00 | 0.028 |
| ***Passerines*** | | | | | | | |
| American crow | 10 | 43 | 97.73 | 72.09 | 27.91 | 0.00 | 0.288 |
| European starling | 1 | 100 | 100.00 | 100.00 | 0.00 | 0.00 | 0.000 |
| red-winged blackbird | 0 | 0 | 0.00 | N/A | N/A | N/A | N/A |
| ***Other Birds*** | | | | | | | |
| pileated woodpecker | 2 | 2 | 100.00 | 50.00 | 50.00 | 0.00 | 0.028 |

[4] Defined as the area between approximately 25 and 125 m above ground level
[5] Exposure index = (mean use) * (% individuals flying) * (% flying within rotor-swept area)

## 3.2 Nocturnal Radar Survey

The purpose of the nocturnal radar study was to characterize avian migration over the site and to provide data that could be compared to other similarly studied sites. The primary objective of the radar surveys was to collect information on flight direction, passage rates, and flight altitude of nocturnal migrants at a representative sampling location for the proposed development area. A single mobile radar lab consisting of a marine radar unit mounted on a vehicle was used on the site for the duration of the spring season defined as April 15th thru May 31st and the fall season defined as August 15th thru October 15th. The Furuno FR1510-MKIII radar used in this study was an X-band radar, transmitting at 9,410 MHz with peak power output of 12 kW, similar to other radar labs used to study wind power development sites throughout the U.S. (e.g., Cooper et al. 1991, Harmata et al. 1999, Roy and Pelletier 2005).

### *3.2.1 Methods*

The radar sampling location was determined based on several factors such as constraints of the radar (e.g., minimization of ground interference), safety, and land owner access; but was chosen to provide coverage in the central portion of the project area where the bulk of the development is proposed (Figure 2). The sampling station was fixed for the duration of the spring and fall seasons.

The radar was aligned with magnetic north each night by parking the van in the same location and orientation. To decrease ground clutter, the radar was positioned in a small hollow so that nearby hills and trees acted as radar fence or screen reflecting back the lower portion of the radar main beam, producing a clearer picture of sky beyond. The radar used in this study has several controls which affect detection and tracking of targets. In order to detect and track small targets, the radar operated under the shortest pulse length setting with the gain control turned up to the highest setting. Initially, the anti-clutter controls on the radar were turned down to the lowest setting. The anti-sea clutter control was then slowly turned up to about the point where background noise cleared from the screen enough to see small targets. The anti-rain clutter control was kept at the lowest setting. While in vertical mode, a blind sector was set so that the radar did not transmit energy when the antennae was pointing towards the ground (from 90$^{o}$ to 270$^{o}$), to minimize ground clutter around the radar. The radar trails function was generally set at 30 seconds so that targets could be tracked for long enough to determine direction and speed. Target flight direction was determined by placing the cursor on a target echo within a trail and aligning the offset electronic bearing line along the line of target echoes pointing in the direction of travel. Speed was recorded as the distance a target traveled in 5 seconds (two sweeps of the radar antennae). Speed was determined with the offset variable range marker by placing the cursor on a target echo and measuring the distance between that echo and the third echo in line (i.e., the distance traveled in 2 sweeps of the antennae or 5 seconds). Target height (vertical mode) was measured with an index line (a tangent on the variable range marker) on the monitor relative to a horizontal line running through the point of origin for the radar.

Radar sampling was conducted each night during the study period unless interrupted by inclement weather or unforeseen circumstances (e.g., power failure). Sampling occurred from approximately sunset until sunrise each night. Initially, each night was broken down into 60-min sampling periods that consisted of:

1) one 5-min session to collect weather data (wind speed, wind direction; percent cloud cover; approximate ceiling height; approximate visibility; precipitation; barometric pressure; air temperature) and adjust radar to horizontal mode;
2) one 10-min short-range session (1.5-km range) with the radar in horizontal mode collecting information on migration passage rates;
3) one 15-min short-range session with the radar in horizontal mode collecting information on flight direction and speed;
4) a short break to adjust radar to vertical mode;
5) one 10-min short-range session in vertical mode to collect information on flight altitudes;
6) one 5-min short-range session in the vertical mode to collect information on the spatial distribution and altitudes of birds along the east-west transect axis; and,
7) one 5-min long-range session (3.0-km range) in the vertical mode to collect information on flight altitudes above 3000 m.

After approximately two weeks of sampling in the spring and for the whole fall season, information on passage rates in the vertical mode was collected. A 10-min short-range session (1.5-km range) in vertical mode was added to the sampling protocol to collect information on migration passage rates (see further discussion in Section 4.0).

All data were exported from Microsoft Access and imported into SAS V.8 for further data processing, quality assurance, and analysis. Additional analyses were performed using Matlab V6.5. To determine passage rates in horizontal mode, the 2-dimensional area represented by the radar image was treated as a 1-dimensional "front" perpendicular to the direction of migration, with length equal to 3 km (the diameter of the surveyed area); all targets counted in the radar image during the sampling period were treated as if they had crossed the front. Based on that assumption, passage rate was calculated as number of targets per kilometer per hour.

Mean flight direction was estimated as $\bar{\mu} = \tan^{-1}\left(\bar{y}/\bar{x}\right)$ where $\bar{y} = \sum_{i=1}^{n}\cos\left(\theta_i\right)/n$, $\bar{x} = \sum_{i=1}^{n}\sin\left(\theta_i\right)/n$, and $\theta_i$ was the flight direction for the $i^{th}$ observation (Batschelet, 1981). Dispersion in the data was calculated as $r = \left(\bar{x}^2 + \bar{y}^2\right)^{1/2}$ such that $0 \le r \le 1$. If all observations had exactly the same direction, $r$ = 1; conversely, $r$ = 0 would indicate uniform distribution of directions around the circle.

Mean flight altitude was not adjusted for unequal sampling intensity at different heights or unequal detection probability as a function of distance from the radar unit.

Air speed of targets, $V_a$, was calculated as $V_a = \left[V_g^2 + V_w^2 - 2V_gV_w\cos\left(\Delta\theta\right)\right]$, where $V_g$ = target ground speed, $V_w$ = wind speed, and $\Delta\theta$ was the difference between the target flight direction and wind direction. Hourly weather observations made at ground level were used for estimates of wind speed and direction. Wind direction categorized by field observers as 'N', 'NE', 'E', 'SE', etc.; were transformed to bearings (0°, 45°, 90°, 135°, etc.) for the calculation of $\Delta\theta$. Targets with air speeds less than 6 m/s or greater than 35 m/s were judged not to be migrating birds and were excluded from further analysis.

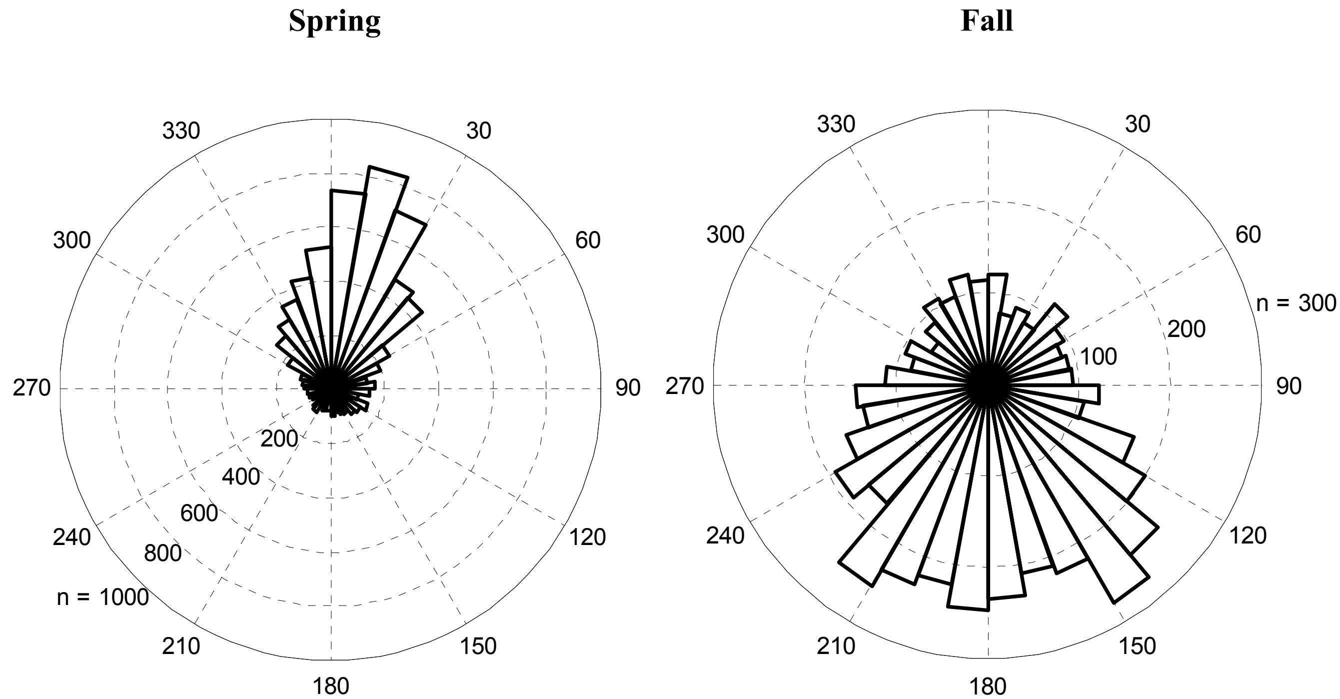
### *3.2.2 Results*

Nocturnal radar surveys were conducted nightly for a 45-day period between April 15 and May 31 and a 60-day period between August 15 and October 15, 2005. During the spring, 5 nights were not sampled due to rainy weather and a number of other nights were interrupted by periods of rain or equipment malfunction. Over the spring study period approximately 277 hours of radar sampling occurred. During the fall, 3 nights were not sampled due to rainy weather and a number of other nights were interrupted by periods of rain moving through. Over the fall study period approximately 472 hours of radar sampling occurred.

#### 3.2.2.1 Flight Direction

Observed flight directions were generally towards the north-northeast in the spring and towards the south in the fall (Figure 4). Mean and dispersion of flight direction were $\bar{\mu}$ = 14.4° and $r = 0.51$ ($n = 8049$ targets) in the spring, and $\bar{\mu}$ = 179.9° and $r = 0.26$ ($n = 5299$ targets) in the fall. As an indication of the northerly spring migration, 78.6% of observations were between 270° and 90°, while 59.3% of observations were between 315° and 45°. In the fall, 66.9% of observations were between 90° and 270°, while 39.9% of observations were between 135° and 225° (Figure 4).

**Figure 4. Observed flight directions at the Dairy Hills radar site.**




3.2.2.2 Passage Rates

*Spring*

The overall mean passage rate in the horizontal mode was 116.9 ± 8.6 targets/km/hr (mean ± SE) (*n* = 277 sample periods) and in the vertical mode was 233.9 ± 17.8 targets/km/hr (mean ± SE) (*n* = 213 sample periods). Mean nightly passage rate was highly variable, but showed a general increasing trend as the season progressed in the horizontal mode (Figure 5) and was somewhat variable over the month of May in the vertical mode (Figure 6). Mean passage rate was greater than 500 targets/km/hr in the horizontal mode on two nights, and 5 nights exceeded 500 targets/km/hr in the vertical mode. Passage rates varied over hours of the night. Mean hourly passage rates tended to be greatest in the middle of the night with lower rates shortly after sunset and before sunrise (Figures 7 and 8).

*Fall*

The overall mean passage rate in the horizontal mode was 64.0 ± 3.0 targets/km/hr (mean ± SE) (*n* = 471 sample periods) and in the vertical mode was 170.3 ± 7.3 targets/km/hr (mean ± SE) (*n* = 463 sample periods). Mean nightly passage rate was highly variable in both horizontal mode (Figures 5) and vertical mode (Figure 6). Mean passage rate exceeded 250 targets/km/hr only once in the horizontal mode, but passage rate exceeded 250 targets/km/hr on 11 nights and 500 targets/km/hr on 3 nights in the vertical mode. Passage rates varied over hours of the night. Mean hourly passage rates tended to be greatest in the middle of the night with lower rates shortly after sunset and before sunrise (Figures 7 and 8).

**Figure 5. Mean ± 1 SE nightly passage rates in horizontal mode.**

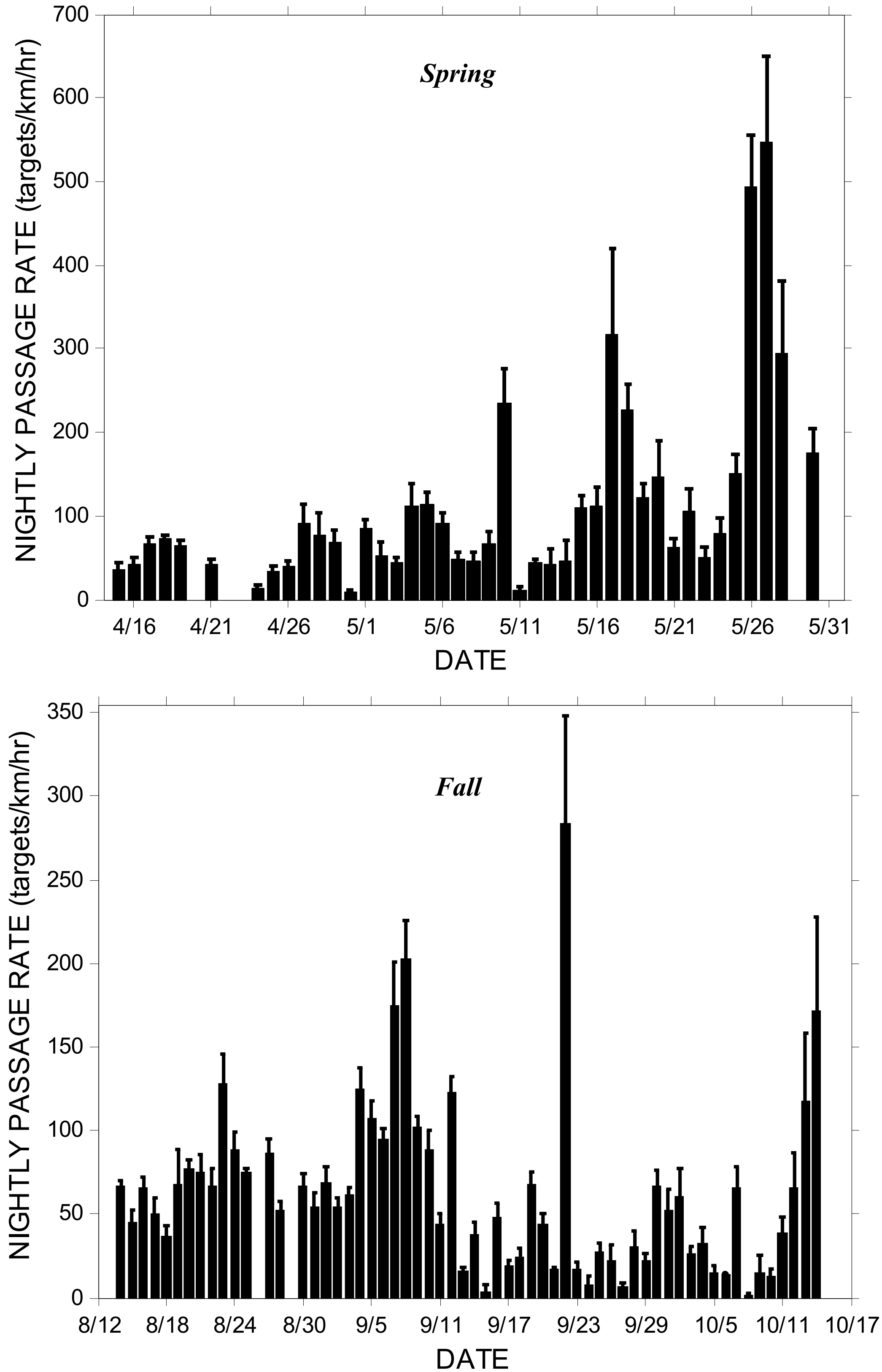


**Figure 6. Mean ± 1 SE nightly passage rates recorded in vertical mode.**

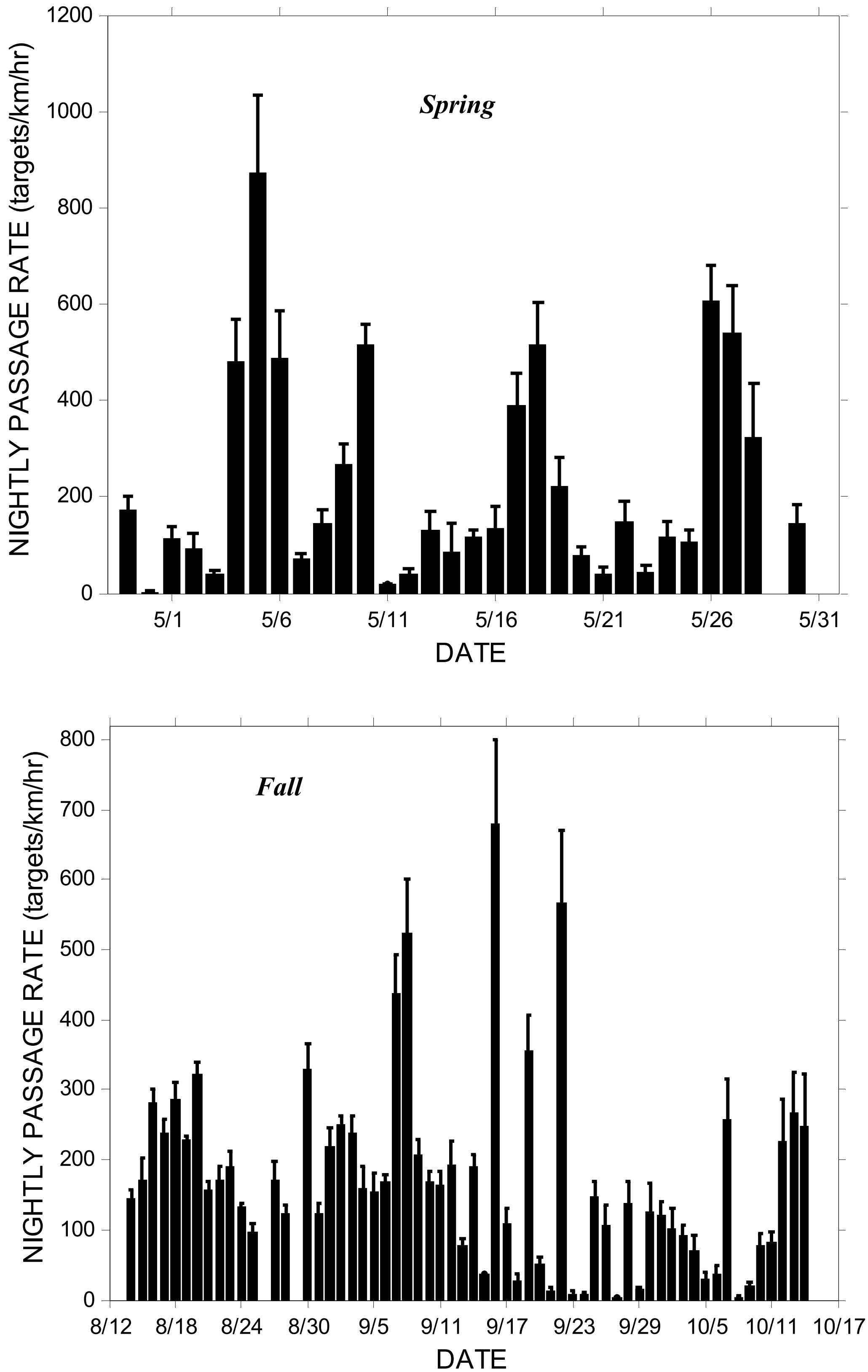
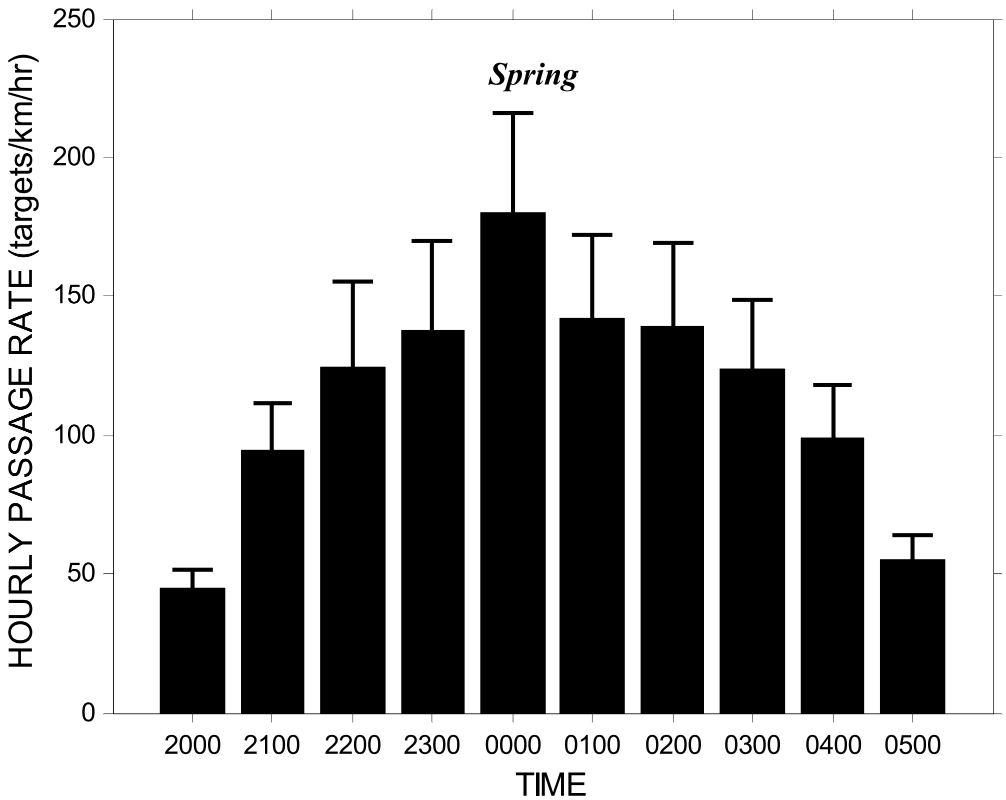


**Figure 7. Mean ± 1 SE hourly passage rates recorded in horizontal mode.**



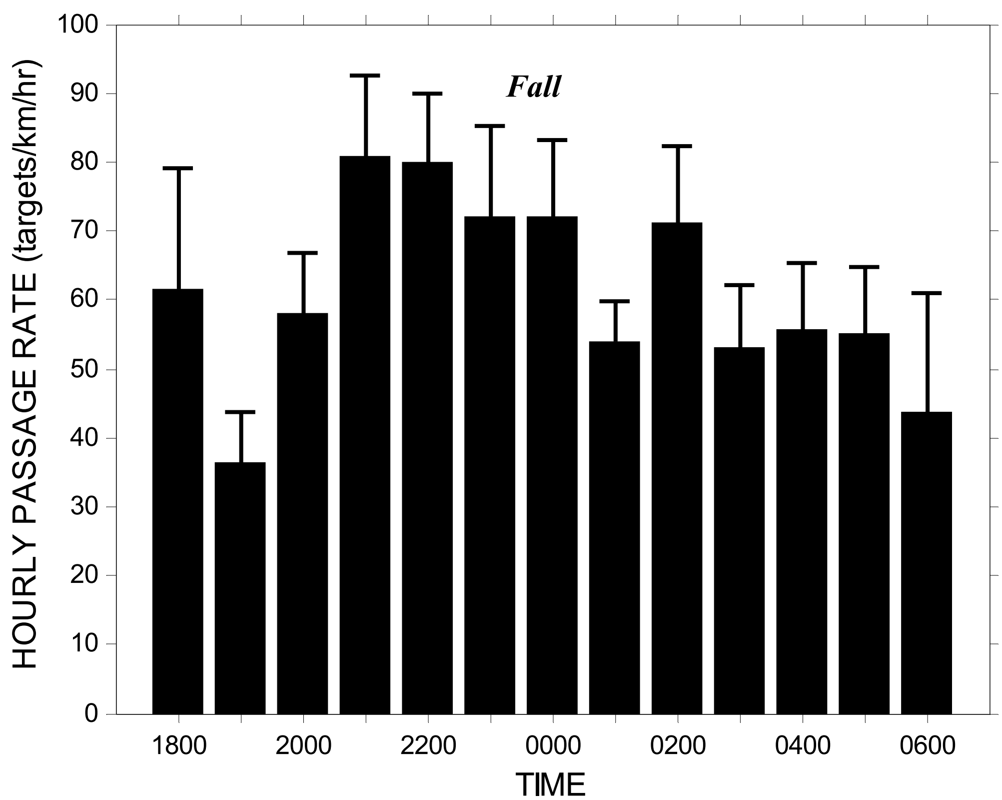
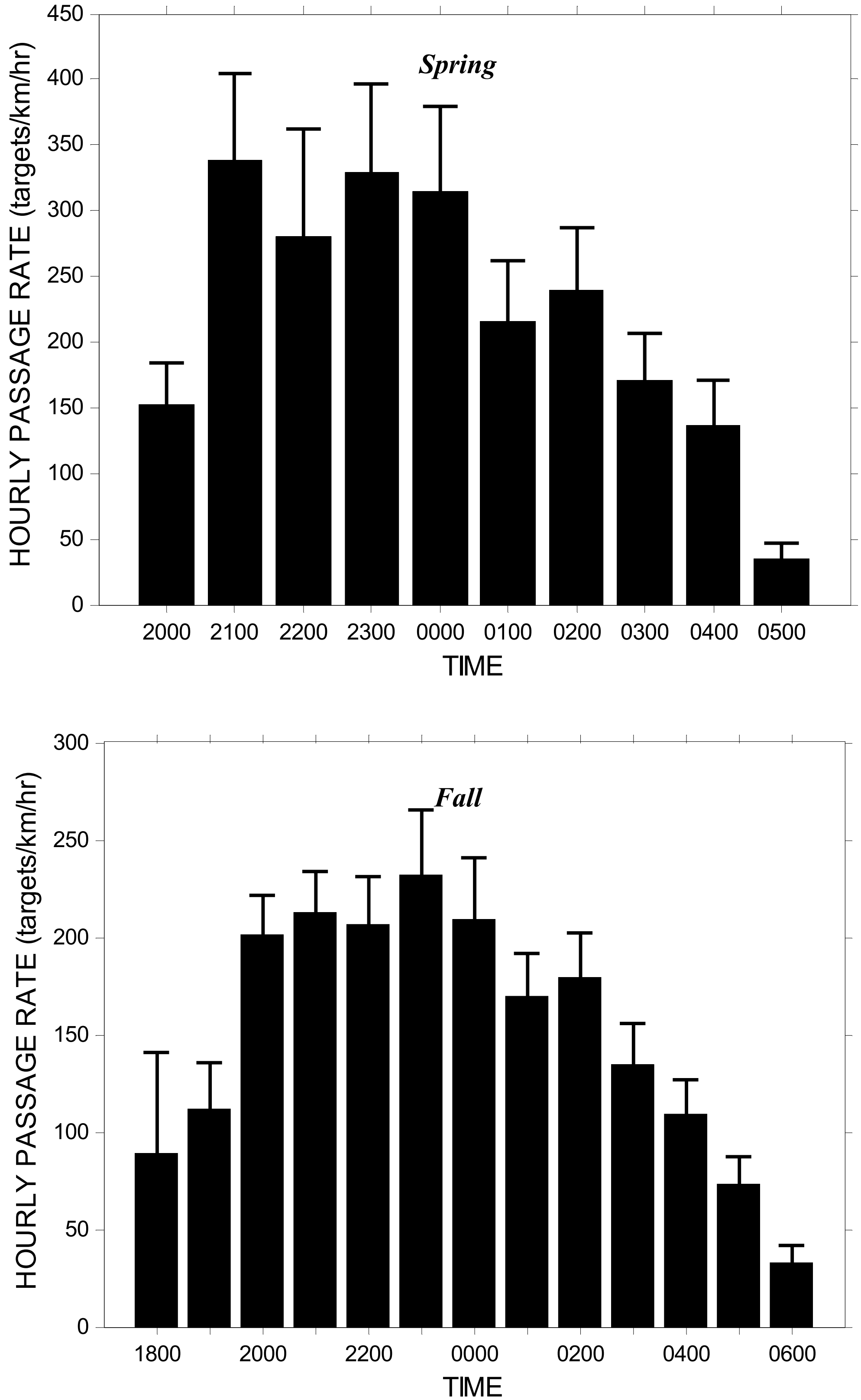



**Figure 8. Mean ± 1 SE hourly passage rates recorded in vertical mode.**



#### 3.2.2.3 Flight Altitudes

*Spring*

For sampling at the 1.5-km range in vertical mode, the mean flight altitude was 397.1 ± 2.3 m (mean ± SE) (*n* = 16310 targets) above radar level (arl)[6]. Most targets were observed at altitudes below 600 m (Figure 9). The highest percentage of targets occurred between 101 and 200 m arl. Approximately 14.9% of targets had flight altitudes less than 125 m (the zone of risk posed by turbines) at the Dairy Hills site. Nightly mean flight altitudes were variable throughout the study period and ranged from approximately 200 m to just over 700 m arl (Figure 10). In contrast, hourly mean flight altitudes were relatively constant (typically about 400 m) (Figure 11) and close to the overall mean flight altitude for the study period. For sampling periods at the 3-km range in vertical mode, 1.6% of targets had flight altitudes greater than 1500 m.

*Fall*

For sampling at the 1.5-km range in vertical mode, mean flight altitude was 465.8 ± 2.1 m (mean ± SE) (*n* = 21756 targets) above radar level. Most targets were observed at altitudes below 500 m (Figure 9). The highest percentage of targets occurred between 101 and 200 m arl. Approximately 9.8% of targets had flight altitudes less than 125 m. Nightly mean flight altitudes were variable throughout the study period and ranged from approximately 200 m to over 700 m arl (Figure 10). In contrast, hourly mean flight altitudes were relatively constant (typically in the 400−500 m range) (Figure 11) and close to the overall mean flight altitude for the study period. For sampling periods at the 3-km range in vertical mode, 1.7% of targets had flight altitudes greater than 1500 m.

[6] Target altitude was measured in relation to a horizontal line running through the point of origin for the radar and thus termed “above radar level”. Height above ground level (agl) is highly variable depending on the topography directly below any given target, and since the spatial location of a target over the ground is not known in the vertical mode, agl is not measurable with the radar.

**Figure 9. Frequency histogram of targets by height class, sampling at 1.5-km range. Height class 1 represents altitudes 0-100 m, class 2 represents altitudes 100-200 m, etc.**

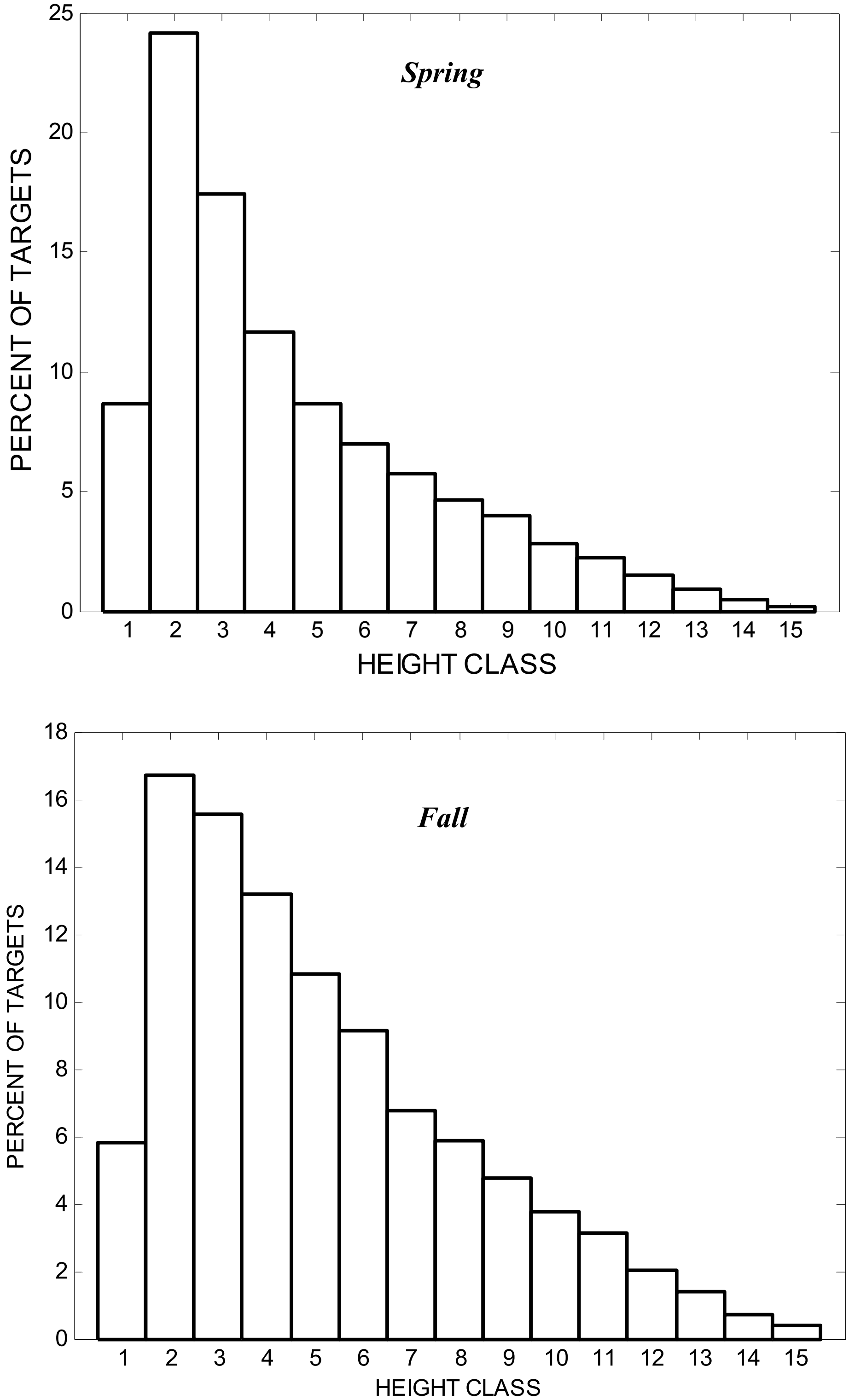
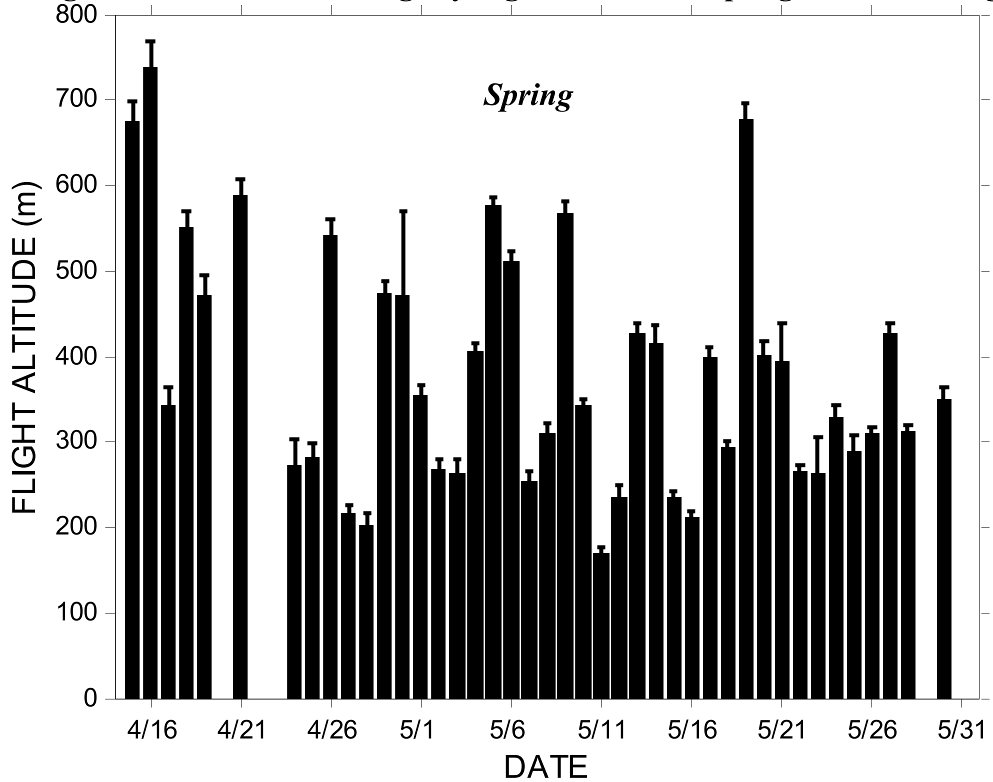


**Figure 10. Mean ± 1 SE nightly flight altitude sampling at 1.5 km range.**



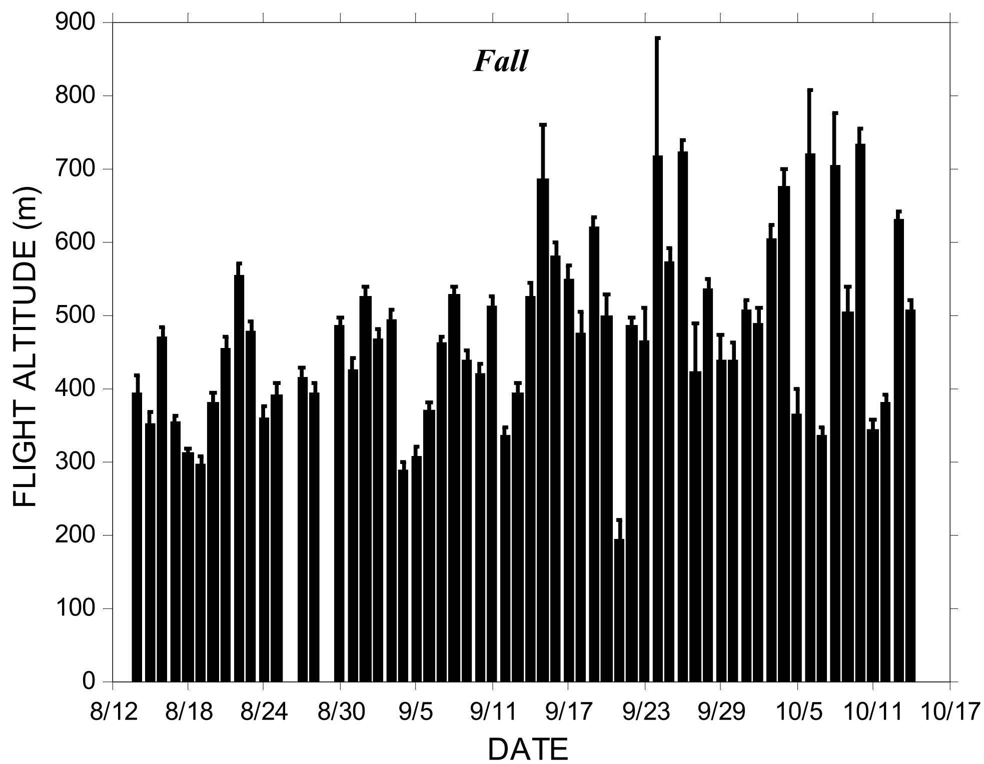
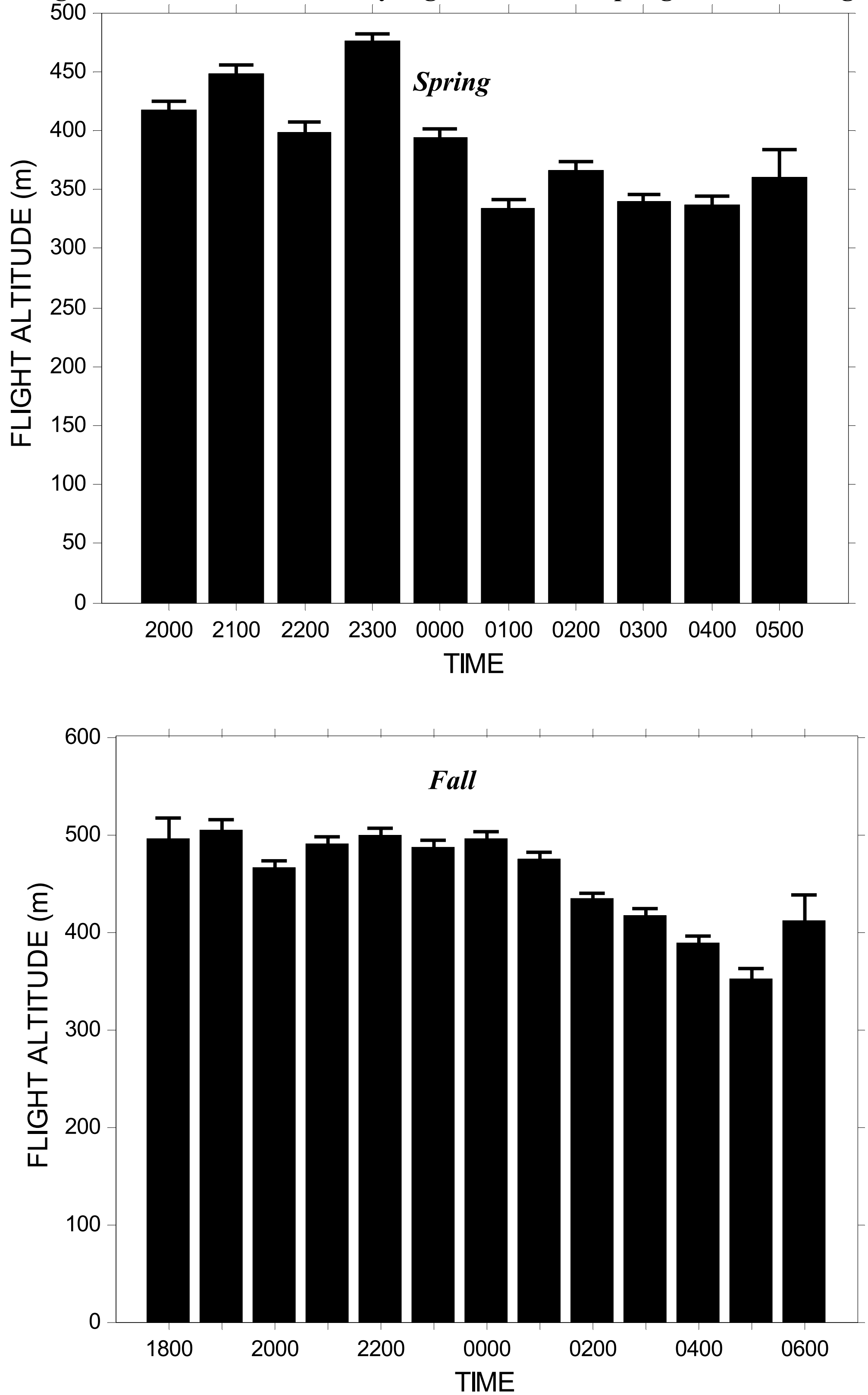



**Figure 11. Mean ± 1 SE hourly flight altitude sampling at 1.5-km range.**

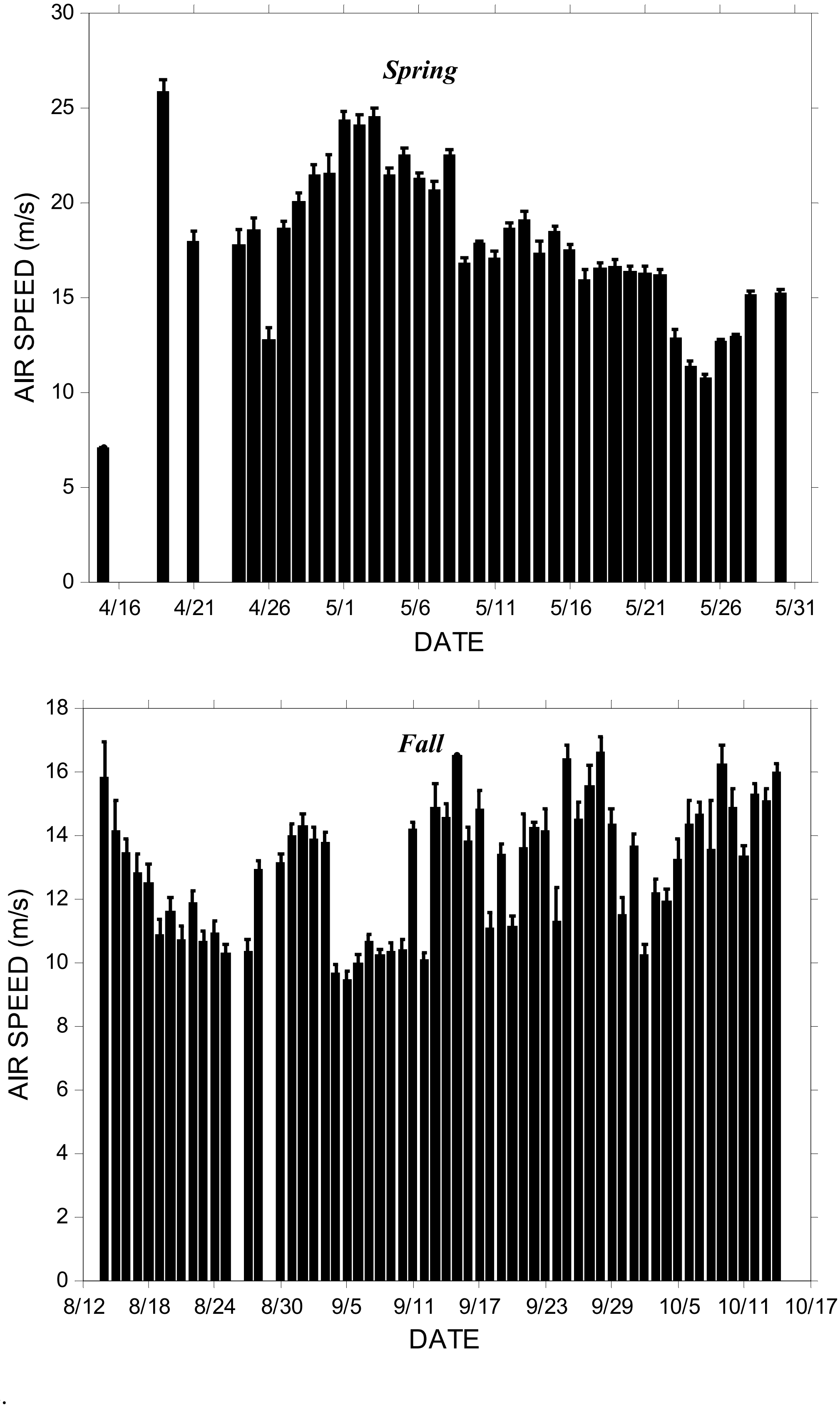


3.2.2.4 Target Speed

*Spring*
Air speed of targets was calculated by adjusting for wind speed and direction (see above). Approximately 5.6% of the targets were excluded because they were moving very slow (< 6 m/s) and 1.0% of the targets were moving very fast (>35m/s). After excluding very slow and very fast targets, overall mean target air speed was $17.6 \pm 0.1$ m/s (mean ± SE) ($n = 6787$ targets). Nightly mean target air speed varied from 7 to 26 m/s (Figure 12).

*Fall*
Approximately 4.8% of the targets were excluded because they were moving very slow (< 6 m/s) (no targets were moving very fast, i.e., >35m/s). After excluding very slow targets, overall mean target air speed was $12.6 \pm 0.1$ m/s (mean ± SE) ($n = 4949$ targets). Nightly mean target air speed varied from approximately 10 to 17 m/s (Figure 12).

**Figure 12. Mean ± 1 SE nightly target air speed.**



### 3.3 Breeding Bird Survey

The objective of the breeding bird surveys was to estimate the spatial and temporal use of the proposed development area by breeding resident birds. The emphasis of the surveys was locating and counting breeding resident birds within the areas proposed for development. The surveys were conducted in the first two weeks of June based on the regional timing recommended for USGS BBS in western New York (USGS 2001).

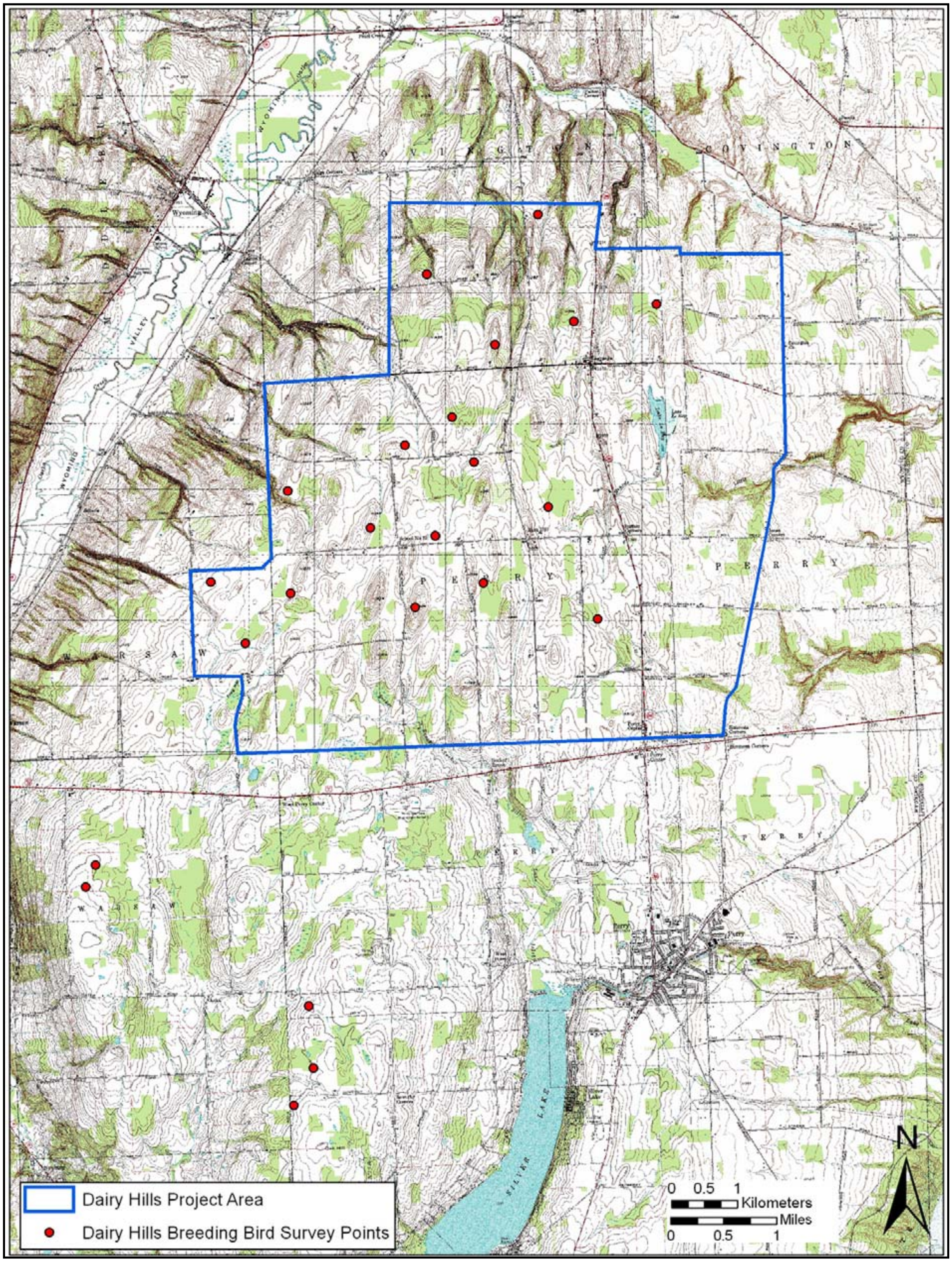
*3.3.1 Methods*

Thirty (30) survey points were established at proposed turbine locations using preliminary project maps provided by Horizon. The survey points were selected to cover as much of the proposed development area and habitat types as possible. Each survey station was marked on a map and GPS coordinates were recorded for each point (Figure 13). The habitat at each survey point was described to examine the applicability of the site to represent other areas within the proposed development area.

U.S. Geological Survey Breeding Bird Survey (USGS 2001) methods were used for the surveys. Each survey plot was a variable circular plot centered on the observation point. All birds observed were recorded, however, the survey effort was concentrated within an approximate 400 m (0.25 mi) radius circle centered on the observation point. All points were surveyed twice during the recommended survey period (early June) and seven days were skipped between the surveys to spread the effort over the breeding season.

Survey periods at each point were 3 minutes long, similar to the BBS method. The date; start and end time of the observation period; and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals of each species, how observed (visual or auditory), and behavior (flying, perching, singing, etc.) were recorded for each observation during the 3-minute count at each survey point.

**Figure 13. Breeding bird survey point count locations for the Dairy Hills study area**



*3.3.2 Results*

Point count surveys were conducted on June 6 and 7 and June 13 and 14, 2005. A total of 747 individual birds were observed in 684 groups (Table 3). On average, slightly more than 12 birds were observed for each point count survey within 200 meters of the observer. Fifty-eight (58) different species were observed during the surveys. Red-winged blackbird, American crow, and savannah sparrow were the most common passerines observed based on use estimates (number observed within 200 m per 3-minute survey). The diversity of species observed is indicative of the mosaic of habitat types at the Dairy Hills site. Several species of interest were recorded during the breeding bird surveys including: northern harrier, a New York state threatened species; horned lark and vesper sparrow, New York state species of concern; and black-billed cuckoo, bobolink, and wood thrush, species on the USFWS 2002 Birds of Conservation Concern list.

**Table 3. Avian species observed while conducting diurnal breeding birds surveys at the Dairy Hills Site.**

| Species/Group | # of individuals | # of groups | use |
|---|---|---|---|
| **Waterfowl** | **14** | **4** | **0.233** |
| Canada goose | 10 | 2 | 0.167 |
| common merganser | 2 | 1 | 0.033 |
| mallard | 2 | 1 | 0.033 |
| **Shorebirds** | | | |
| killdeer | 1 | 1 | 0.017 |
| **Raptors/Vultures** | **6** | **5** | **0.100** |
| *Buteos* | | | |
| red-tailed hawk | 1 | 1 | 0.017 |
| *Northern Harriers* | | | |
| northern harrier | 1 | 1 | 0.017 |
| *Falcons* | | | |
| American kestrel | 2 | 1 | 0.033 |
| *Vultures* | | | |
| turkey vulture | 2 | 2 | 0.033 |
| **Passerines** | **699** | **647** | **11.650** |
| American crow | 80 | 77 | 1.333 |
| American goldfinch | 33 | 26 | 0.550 |
| American robin | 22 | 22 | 0.367 |
| barn swallow | 1 | 1 | 0.017 |
| black-capped chickadee | 5 | 5 | 0.083 |
| blue jay | 13 | 10 | 0.217 |
| bobolink | 32 | 31 | 0.533 |
| brown thrasher | 2 | 2 | 0.033 |
| brown-headed cowbird | 6 | 6 | 0.100 |
| cedar waxwing | 5 | 1 | 0.083 |
| chestnut-sided warbler | 13 | 13 | 0.217 |

| Species/Group | # of individuals | # of groups | use |
|---|---|---|---|
| chipping sparrow | 16 | 16 | 0.267 |
| common grackle | 5 | 5 | 0.083 |
| common yellowthroat | 26 | 26 | 0.433 |
| dickcissel | 1 | 1 | 0.017 |
| eastern kingbird | 2 | 2 | 0.033 |
| eastern meadowlark | 4 | 4 | 0.067 |
| eastern phoebe | 4 | 4 | 0.067 |
| eastern wood-pewee | 16 | 16 | 0.267 |
| European starling | 44 | 15 | 0.733 |
| field sparrow | 14 | 14 | 0.233 |
| gray catbird | 9 | 9 | 0.150 |
| great crested flycatcher | 9 | 9 | 0.150 |
| horned lark | 6 | 6 | 0.100 |
| house sparrow | 2 | 2 | 0.033 |
| house wren | 4 | 4 | 0.067 |
| Nashville warbler | 1 | 1 | 0.017 |
| northern cardinal | 16 | 16 | 0.267 |
| northern mockingbird | 1 | 1 | 0.017 |
| northern oriole | 7 | 7 | 0.117 |
| purple finch | 4 | 4 | 0.067 |
| red-eyed vireo | 15 | 15 | 0.250 |
| red-winged blackbird | 82 | 78 | 1.367 |
| savannah sparrow | 62 | 61 | 1.033 |
| song sparrow | 40 | 40 | 0.667 |
| tree swallow | 9 | 9 | 0.150 |
| unidentified vireo | 1 | 1 | 0.017 |
| vesper sparrow | 29 | 29 | 0.483 |
| willow flycatcher | 9 | 9 | 0.150 |
| wood thrush | 8 | 8 | 0.133 |
| yellow warbler | 40 | 40 | 0.667 |
| yellow-rumped warbler | 1 | 1 | 0.017 |
| | | | |
| **Upland Gamebirds** | **11** | **11** | **0.183** |
| ring-necked pheasant | 9 | 9 | 0.150 |
| wild turkey | 2 | 2 | 0.033 |
| | | | |
| **Doves** | | | |
| mourning dove | 3 | 3 | 0.050 |
| | | | |
| **Other Birds** | **11** | **11** | **0.183** |
| black-billed cuckoo | 2 | 2 | 0.033 |
| chimney swift | 1 | 1 | 0.017 |
| downy woodpecker | 2 | 2 | 0.033 |
| northern flicker | 3 | 3 | 0.050 |
| pileated woodpecker | 1 | 1 | 0.017 |
| red-bellied woodpecker | 2 | 2 | 0.033 |
| | | | |
| unidentified bird | 2 | 2 | 0.033 |
| **All Birds** | **747** | **684** | **12.450** |

### 3.4 Nocturnal AnaBat Surveys

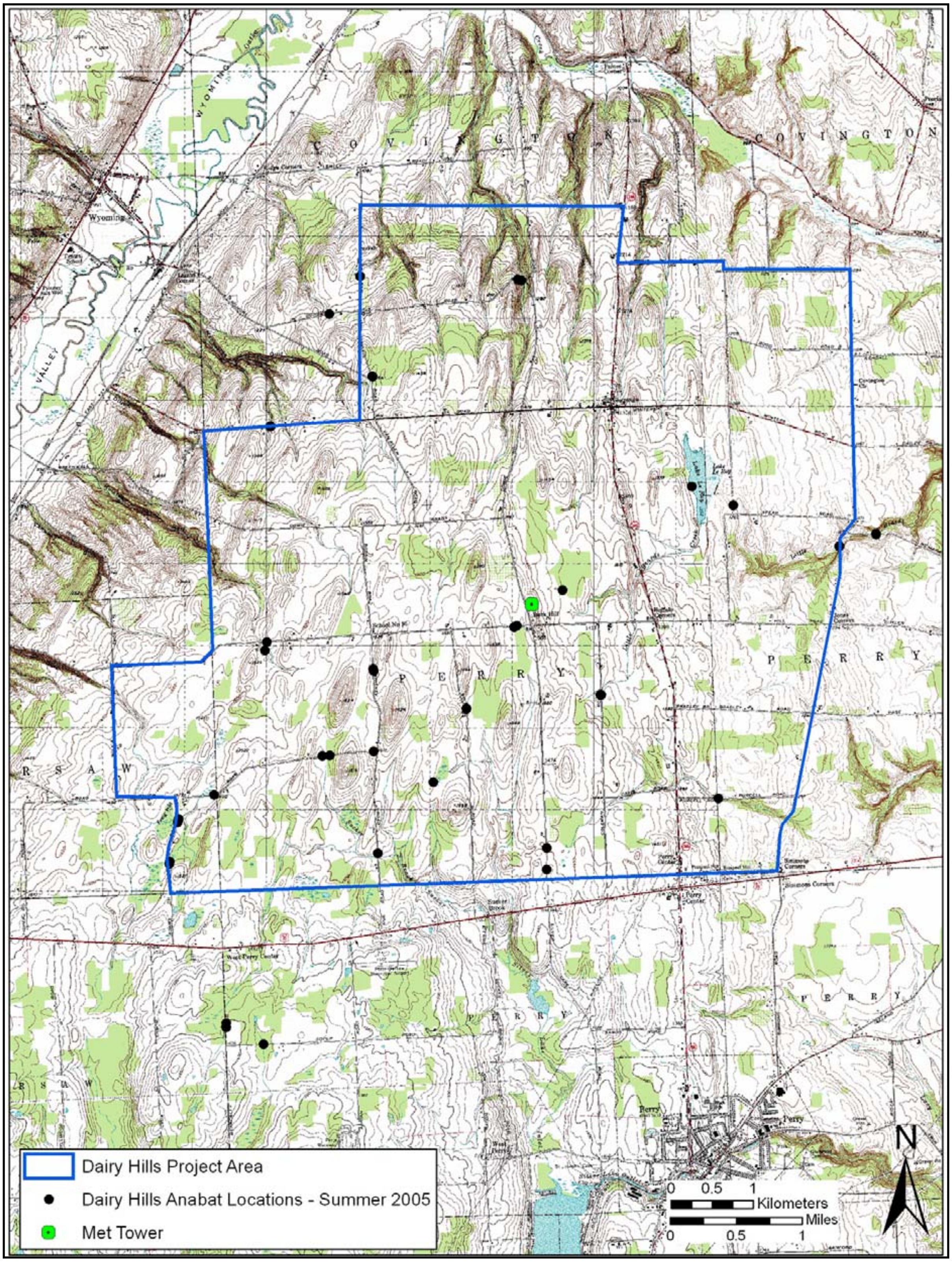
The objective of the nocturnal AnaBat surveys was to record the relative abundance of echo-locating bats flying through the sampling area during summer breeding season and the spring and fall migration seasons.

*3.4.1 Methods*

Bat activity at the study site was recorded using an AnaBat II ultrasonic bat detector attached to a zero-crossing analysis interface module (ZCAIM) which houses a compact flash memory card for temporary download of ultrasonic activity files. To sample continuously on remote mode (automatic data collection), the detector and ZCAIM were powered by a 12V battery. Each AnaBat unit (detector, ZCAIM, and 12V battery) was enclosed inside a plastic box or dry bag with the detector microphone positioned against a PVC tube protruding from the box/bag. This design prevented water from damaging the AnaBat units without compromising the ability of the unit to detect ultrasonic noise in the environment. To limit variation among AnaBats, we calibrated sensitivity settings for each unit prior to data collection. Most AnaBat units were set at or near setting 7 on the sensitivity dial. AnaBat units were removed from the field once per week to download files, recharge batteries, and troubleshoot technical problems. A permanent sampling station was established at the project met tower (Figure 14). Two pulley systems were attached to the met tower guy wires which allowed AnaBat units to be deployed at three different levels: ground level, approximately 25m high (half way up the met tower), and approximately 50m high (near the top of the met tower).

Bat calls were recorded during spring (April 15 – June 2), summer (June 25 – 27, July 8 – 10, and July 23 – 25), and fall (August 16 – October 14). Nights that experienced any number of technical difficulties were not included in the final analyses. During summer and fall, two AnaBat units were positioned at the met tower for unattended or "passive" sampling from approximately sunset to sunrise (2000 to 0600). One unit was located at the base of the met tower ("low") elevated 1 m above ground to increase the sampling space. The second passive unit was located at the top of the met tower ("high") by means of the pulley system which allowed the AnaBat unit to be raised and lowered along the outer guy wire of the met tower. During summer, a third AnaBat unit was located mid-way up the met tower ("middle") attached to the middle guy wire. During spring, only one AnaBat detector was available to passively record calls at the site; it was positioned at the base of the met tower. Each passive AnaBat unit was positioned so that the microphone faced the same cardinal direction for each sampling period. Data gathered from the passive AnaBat units at the met tower were used to calculate bat activity (designated as number of calls/night) present at the site during the sampling periods.

**Figure 14. AnaBat sampling locations for the Dairy Hills study area.**



In addition to the stationary passive units, a "roaming" or mobile AnaBat unit was deployed during the summer to assess resident/breeding bat species present at the site (Figure 14). Roaming sampling was conducted using a handheld AnaBat unit for 9 nights (3 sampling periods of 3 consecutive nights each) at habitats likely to have high numbers of resident bats. To select locations for active sampling, reconnaissance visits were made to the project area during the day time to selected sites based on the presence of travel corridors (trails and roads), linear landscape features (forest edges), and access to water; habitat factors known to be important for bats. Active sampling was conducted from sunset until approximately 4-5 hours after sunset.

Analysis of bat calls was conducted using Analook software (DOS version). Analook displays ultrasonic activity in a graphic format similar to a sonogram used for analysis of bird vocalizations (e.g., frequency versus time). Species identification was aided by the Preliminary Key to the Qualitative Identification of Calls within the AnaBat System (Amelon 2005, unpublished data) where characteristics such as slope, frequency, minimum frequency, consistency of minimum frequency, and shape of pulse assist in the identification of bat vocalizations.

*3.4.2 Results*

The total number of calls and number of calls per night, recorded by each AnaBat unit at the met tower varied by season (Table 4). Technical difficulties, such as power failures, failure to download, data transfer failure, and excessive noise files reduced the effective sampling period to 10 days (May 20 – June 1) in the spring. The AnaBat unit detected 27 bat calls total (2.7 calls/night) during the 10 days of spring sampling. Summer sampling occurred on nine nights. The AnaBat unit positioned at mid-level on the met tower recorded higher numbers of bat vocalizations (9 bat calls; 1.5 calls/night) despite having fewer sampling days (n = 6). Fall sampling at the met tower resulted in 42 days sampled at the high position and 41 days at the ground or low position. The low AnaBat unit did not record the first week of sampling (August 15 – 21), but recorded consistently after that. The high AnaBat unit recorded during the first week of sampling, but had technical difficulties on September 17 – 24 and September 27 – October 2. Despite a similar number of sampling days, the low position AnaBat unit recorded a higher number of calls (n = 263) than the high position unit (n = 33).

Five species of bats were positively identified at the met tower location (Table 5). The majority of calls could not be identified to species either because they did not contain at least five pulses or the call characteristics overlapped more than two species. Relative call frequency was calculated by dividing the number of calls recorded for each species by the total number of calls for each season (Table 5).

**Table 4. Number of sampling days, total number of calls recorded, and calls/night recorded by each AnaBat unit at the met tower for spring, summer, and fall sampling periods.**

| Season | Location | # of sampling days used in analysis | Total # of calls | # calls/night |
|---|---|---|---|---|
| Spring | Met tower low | 10 | 27 | **2.7** |
| Summer | Met tower high | 9 | 7 | 0.78 |
| | middle | 6 | 9 | 1.5 |
| | low | 9 | 5 | 0.56 |
| | **overall** | | **21** | **0.88** |
| Fall | Met tower high | 42 | 33 | 0.79 |
| | low | 42 | 269 | 6.40 |
| | **overall** | | **302** | **3.60** |

As is typical with AnaBat sampling, the majority of vocalizations were unable to be identified due to the few number of pulses per call. Of those calls that were able to be identified to species, *Myotis* calls accounted for most of the vocalizations recorded for all seasons sampled. During spring sampling, one eastern pipistrelle bat call and one big brown bat call were recorded. Summer sampling at the met tower resulted in two *Myotis* species and two eastern red bat calls and one call each of big brown and hoary bat; the remainder were unable to be identified. Species recorded during the fall sampling at the met tower included *Myotis* species, big brown bat, eastern pipistrelle, hoary bat, and eastern red bat.

**Table 5. Relative call frequency of species recorded at the met tower during the sampling periods of each season.**

| Species | | Relative Call Frequency | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Spring | Summer | Fall |
| Big brown bat | *Eptescus fuscus* | 0.04 | 0.05 | 0.15 |
| Eastern red bat | *Lasiurus borealis* | 0 | 0.10 | 0.003 |
| Hoary bat | *Lasiurus cinereus* | 0 | 0.05 | 0.007 |
| *Myotis* species | *Myotis* spp. | 0.37 | 0.10 | 0.26 |
| Eastern pipistrelle | *Pipistrellus subflavus* | 0.04 | 0 | 0.02 |
| No identification | | 0.56 | 0.71 | 0.65 |

Summer sampling with the mobile AnaBat unit recorded 1,138 bat calls over nine nights (Table 6). The objective of the mobile sampling was to identify species and relative abundance of bats using the Dairy Hills site, however, no additional species were recorded during the mobile surveys that were not recorded at the met tower station. Call frequencies and number of calls per night were not calculated for the mobile survey because of unequal survey effort and sampling methods that could result in individual bats being repeatedly recorded, potentially skewing number of bats recorded on any specific night. The most common species based on number of call recorded were big brown bat, eastern red bat, and little brown bat (Table 6).

**Table 6. Summer survey nights and number of detections by species during mobile AnaBat sampling.**

| Species | | Date Sampled | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **6/25** | **6/26** | **6/27** | **7/08** | **7/09** | **7/10** | **7/23** | **7/24** | **7/25** |
| Big brown bat | *Eptescus fuscus* | 51 | 85 | 8 | 0 | 1 | 2 | 0 | 29 | 0 |
| Eastern red bat | *Lasiurus borealis* | 6 | 6 | 15 | 1 | 2 | 64 | 8 | 9 | 1 |
| Hoary bat | *Lasiurus cinereus* | 6 | 3 | 5 | 9 | 0 | 5 | 3 | 8 | 0 |
| Eastern pipistrelle | *Pipistrellus subflavus* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Little brown bat | *Myotis lucifugus* | 3 | 21 | 12 | 11 | 1 | 20 | 24 | 23 | 1 |
| Northern myotis | *Myotis septentrionalis* | 6 | 4 | 5 | 0 | 0 | 0 | 0 | 5 | 0 |
| *Myotis* species | *Myotis* spp. | 4 | 39 | 4 | 13 | 2 | 5 | 11 | 16 | 3 |
| No Species ID | | 15 | 64 | 24 | 25 | 43 | 296 | 34 | 55 | 21 |
| Total Detections/night | | 91 | 223 | 73 | 59 | 49 | 392 | 80 | 145 | 26 |

## 3.5 Sensitive Species Surveys

The objective of the sensitive species surveys was to determine the presence or absence and spatial distribution of state listed avian species on the proposed development areas. A Phase 1 screening report for wildlife resources indicated that short-eared owl, northern harrier, and upland sandpiper, three New York State listed species, could potentially occur in the project area based on habitat and previous documentation (Young and Poulton 2005).

### *3.5.1 Methods*

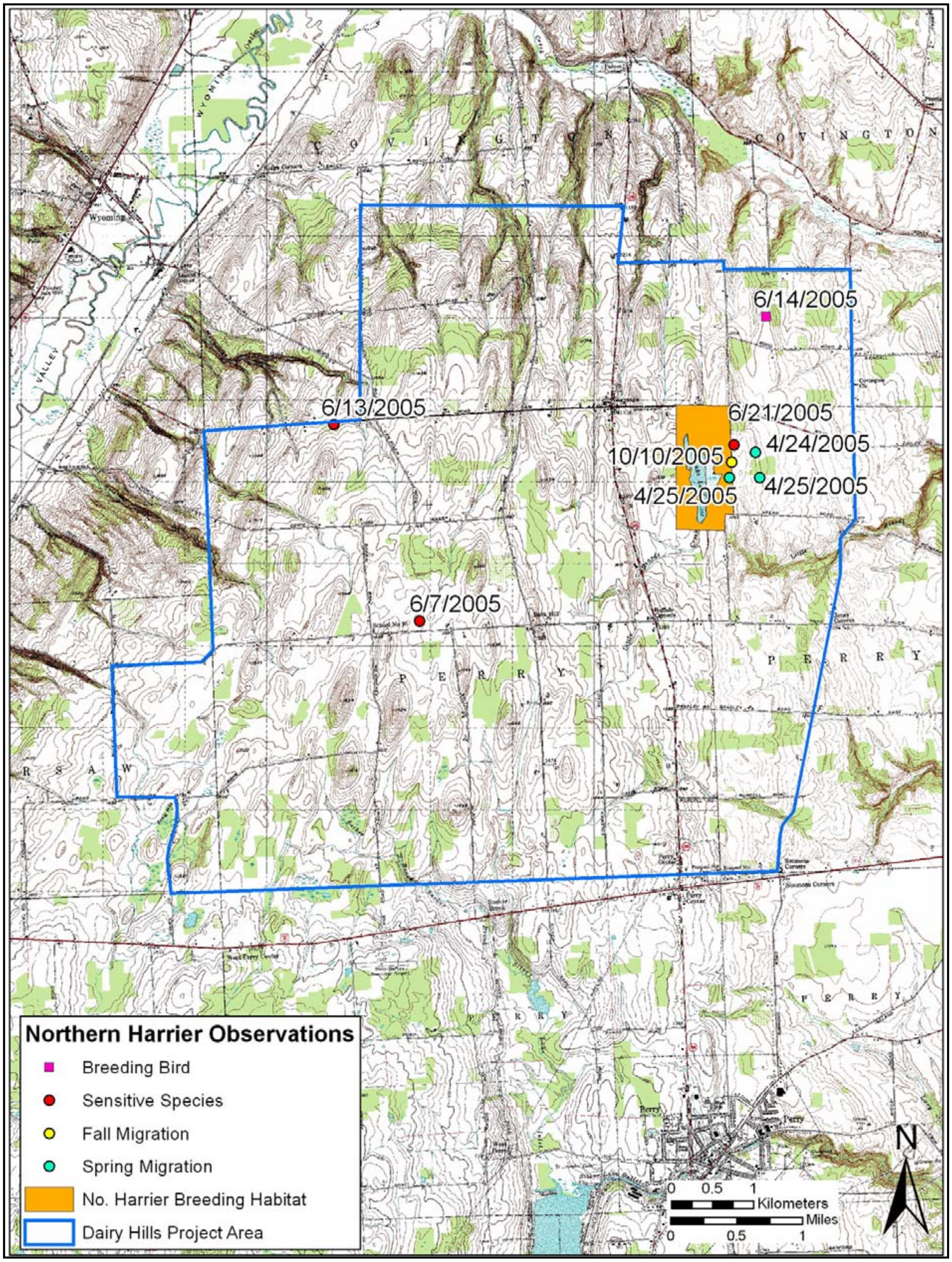
Appropriate nesting habitat for the focal species was located by driving public roads in the study area. Presence/absence surveys of suitable nesting habitat were conducted by traveling adjacent roads and watching for target species. Driving transects of most public roads in the study area were also conducted during the early morning and evening hours when target species would be most active.

*3.5.2 Results*

Only one old field near Lake LeRoy in the northeast portion of the Dairy Hills project was considered suitable habitat not in active agriculture for possible breeding northern harriers, short-eared owls, or upland sandpipers (Figure 15). However, the entire Dairy Hills project area is a mosaic of agriculture fields in various stages and crops including hay meadows. The focal species are often observed in mixed agriculture lands.

Driving surveys in the Dairy Hills project area were conducted on eight days between June 4 and June 22, 2005. Approximately 33.5 hours were spent covering roads in the project area conducting driving surveys. No upland sandpipers or short-eared owls were documented in the project area during the surveys. Three northern harriers were located in the project area during the surveys and one was observed during a breeding bird survey (Figure 13). Additionally, four harriers were recorded during the spring and fall diurnal counts for migrant raptors.

**Figure 15. Sensitive species locations and potential habitat recorded on the Dairy Hills site.**



# 4.0 Discussion

## 4.1 Diurnal Point Count Surveys

The diurnal point count surveys were designed to count migrant raptors through the study area during peak migration for sharp-shinned hawks and broad-winged hawks. Data from established hawk watch sites in New York were examined from the past 3 years (2002-2004) to determine the 2-week period in each season that would maximize observations of these species and hopefully other raptors as well (HMANA 2005). While the peak movement periods for these species varied by year and location, in general, heavy movement of sharp-shinned hawks began between April 17 and April 30 each year. In the fall, heavy movement of sharp-shinned hawks appeared more variable and began between September 10 and October 5. In most cases approximately half the sharp-shinned hawks counted at any given site had moved through within a two week period. For the fall site Franklin Mountain, the peak of sharp-shinned hawk movement occurred between roughly October 5th and 24th each year.

For broad-winged hawks the peak of spring migration was slightly later than sharp-shinned hawks but usually occurred before the end of April. In most years, up to 80% of broad-winged hawks counted at each site moved through between approximately April 18 and April 30, though in some years the heavy traffic continued into early May and there were the occasional high count days throughout May. For the fall season, broad winged hawk migration usually occurred earlier than sharp-shinned hawks between September 10 and September 22.

Based on this information it was determined that the last two weeks of April would be the best time to conduct diurnal point count surveys to maximize spring raptor observations and during the fall the optimal time frame would be from mid-September to mid-October. The survey protocol was designed to provide 18 hours of survey time during these periods that could be compared to the same periods and dates from the established hawk watch sites. Based on the over all east-west distance of the proposed Dairy Hills development area, four survey points (as opposed to 3) were established to provide better coverage of the area and to provide some coverage of the Wyoming Valley to the west. A total of 20 hours of surveys were conducted between April 15 and April 26, 2005 and 16 hours of survey between September 11 and October 10, 2005.

Typical raptor species for western New York were observed during the surveys (see Table 1). Four northern harriers, a New York state threatened species were observed during the surveys. One sharp-shinned hawk was observed in the spring and one osprey in the fall, two New York state species of special concern. Based on a standardization of raptors observed per surveyor hour, the Dairy Hills site has far less traffic than the known hawk watch sites. The nearest spring site to Dairy Hills, Braddock Bay, was somewhat variable over the same survey days; however, the overall mean number of raptors observed per surveyor hour was far greater (Table 7). There are no fall hawk watch sites in western New York. The nearest fall site, Kestrel Haven located in south central New York, was similar to the Dairy Hills site in terms of raptors counted per surveyor hour (Table 7). Sites further east such as Franklin Mountain record greater numbers of migrant raptors which are likely taking advantage of ridgelines of the western Appalachian mountains.

**Table 7. Number of raptors observed per surveyor hour in the project area and at established New York hawk watch sites in 2005.**

| | | SPRING | | |
|---|---|---|---|---|
| **Date** | **Dairy Hills** | **Ripley Hawk** | **Braddock Bay** | **Derby Hill** |
| 4/15/05 | 4 | 27 | 25 | 34 |
| 4/16/05 | 2 | 57 | no survey | 71 |
| 4/17/05 | 3 | 62 | 58 | 70 |
| 4/24/05 | 1 | no survey | 16 | 46 |
| 4/25/05 | 3 | no survey | no survey | 40 |
| Average | 3 | 49 | 33 | 52 |
| | | **FALL** | | |
| **Date** | **Dairy Hills** | **Franklin Mtn** | **Kestrel Haven** | **High Park, ON** |
| 9/11/05 | 2 | 32 | 2 | 4 |
| 9/24/05 | 2 | 8 | 2 | 1 |
| 10/02/05 | 6 | 9 | 1 | 7 |
| 10/10/05 | 1 | 1 | 1 | 1 |
| Average | 3 | 13 | 2 | 3 |

Daily count data acquired from HMANA 2005.

Exposure indices are a method for estimating risk to individual species from wind turbines. The exposure index was calculated from a measure of relative abundance in the area (mean use or number observed per 60-minute survey) times the propensity of a species to fly within the zone of risk (percent of observations flying times the percent flying within the rotor-swept area), defined as the height of the rotor-swept area or approximately 25-125 m above ground level. For the Dairy Hills study area, Canada goose had the highest exposure index due to several relatively large flocks many of which were observed flying within the rotor-swept area. For raptors, turkey vulture had the highest exposure index due again to large use estimates with the majority of the flying vultures observed in the zone of risk. While turkey vultures have been recorded as fatalities at other monitored wind plants, the number of fatalities is relatively small compared to use estimates for this species (see Erickson et al. 2001, 2002).

Based on the data collected in the spring and fall 2005, it does not appear as if the Dairy Hills area will have a concentration of spring or fall raptor movement. In addition, the most common raptor observed on the site was turkey vulture. A few raptor species of concern were observed but not in great numbers. Northern harriers potentially nest in one area of the Dairy Hills site (see below). Raptor use across the study area was relatively similar with a slight increase in numbers along the western edge of the project near the Wyoming Valley. Based on the study results, it is not expected that the Dairy Hills wind project will have a substantial impact to raptors.

## 4.2 Nocturnal Radar Survey

The nocturnal radar study was designed to collect data that could be used to characterize nocturnal migration over the site and also be used in a larger statewide comparison of results from numerous sites (M. Woythal, NYSDEC, pers. comm.). In the analysis, the radar data were not corrected for differences in detectability with distance from the radar unit or due to ground clutter on the radar screen. Also, the 2-dimensional area represented by the radar image was treated as a 1-dimensional 3-km "front" perpendicular to the direction of migration, and all targets counted in the radar image during the sampling period were treated as if they had crossed the front. Thus, passage rate estimates should be considered a sample or index of the actual number of targets passing through the area**.**

Measurements from radar studies potentially are highly variable due to a number of factors including observer bias, the radar settings affecting target detection, and the type of radar used. To minimize these biases, a Furuno FR1510-MKIII radar was used in this study which is the same radar used in numerous other similar radar surveys and efforts were made to standardize data collection and radar settings as much as possible. For example, the radar was operated under the shortest pulse length setting with the gain control turned up to the highest setting. While short wave-length and high gain insure detection of small targets, these settings also have the effect of producing atmospheric or background noise on the screen which consequently can obscure small targets. To "clean up" the screen the anti-sea clutter [which minimizes clutter and noise close to the radar] was slowly turned up to the point where background noise was dispersed and limited primarily to the outer edge of the screen. The anti-rain clutter [which reduces interference from small targets (e.g., rain drops)] was kept at the lowest setting so that no small targets would be eliminated. These settings insure that small targets such as individual passerines can be detected by the radar. Also during sampling, specific functions or capabilities of the radar were used to determine data values to minimize observer bias. The electronic bearing line and variable range marker used in offset mode allowed the compass bearing of a target trail and the speed at which the target was moving to be measured by the radar as opposed to estimated by the observer or measured from the screen.

Overall passage rates were lower at the Dairy Hills site than most other radar studies in New York and the eastern U.S., but in general, results from the site are not largely different from other sites studied (Table 8). Conditions were good throughout the study periods with little insect interference and few nights of sampling missed due to rainy weather. Some nights were partially sampled when rain moved into the area while other nights were missed completely. After calculating target air speeds, fewer than 6% of targets recorded were moving at less than 6 m/second for both the spring and fall.

Mean spring flight direction recorded during this study, $14^o$, and mean fall flight direction, $180^o$ were similar to other studies which have shown a northeasterly heading for spring migrants and southerly heading for fall migrants (Table 8). Mean flight height of targets was approximately 397 m arl in the spring and 465 m arl in the fall are similar to other recent studies in the U.S. Also, the percent of targets which flew through the zone of risk, defined as below 125 m, fell within the range of other studies where flight height was recorded with vertical mode radar.

**Table 8. Results of radar studies at proposed and existing wind project sites in the U.S.**

| Site | Passage Rates (t/km/hr) | | Mean Flight Height (m) | | % Targets below 125 m | | Mean Flight Direction | |
|---|---|---|---|---|---|---|---|---|
| | Fall | Spr | Fall | Spr | Fall | Spr | Fall | Spr |
| Dairy Hills, NY (this report) [vertical mode] | 64 [170] | 117 [234] | 466 | 397 | 10 | 15 | 180 | 14 |
| Prattsburgh, NY (Mabee *et al.* 2004, 2005a) | 200 | 170 | 365 | 319 | 9 | 18 | 177 | 18 |
| Flat Rock, NY (Mabee *et al.* 2005) | 158 | | 415 | | 8 | | 184 | |
| Chautauqua, NY (Cooper *et al*. 2004a,b) | 238 | 395 | 532 | 528 | 5 | 4 | 199 | 29 |
| Wetherfield, NY (Cooper and Mabee 2000) | 168 | | | | | | 179 | 21 |
| Harrisburg, NY (Cooper and Mabee 2000) | 122 | | | | | | 181 | |
| Copenhagen, NY (Cooper *et al.* 1995) | 225 | 192 | | | | | 184 | 12 |
| Cape Vincent, NY (Cooper *et al.* 1995) | | 192 | | | | | | 18 |
| Martinsburg, NY (Cooper *et al*. 1995) | 230 | | | | | | 191 | |
| Searburg, VT (Roy and Pelletier 2005a, 2005b) | 178 | 404 | 556 | 523 | 4 | 6 | 203 | 69 |
| Martindale, PA (Plissner *et al*. 2005) | 187 | | 436 | | 8 | | 188 | |
| Casselman, PA (Plissner *et al*. 2005) | 174 | | 448 | | 7 | | 219 | |
| Mount Storm, WV (Young *et al*. 2004) | 199 | | 410 | | 16 | | 184 | |
| Cotterel Mountain, ID (Cooper et al. 2004c) | 32 | | 565 | | 3 | | 155 | |
| Stateline, OR/WA (Mabee and Cooper 2002) | 23 | 50 | 470 | 625 | 6 | 16 | 165 | 9 |
| Nine Canyon, WA (Mabee and Cooper 2000, 2001) | 31 | 98 | 127 | 472 | 8 | 15 | 181 | 23 |
| Buffalo Ridge, MN (Hawrot and Hanowski 1997) | | 93 | | | | | | |

Note: Some values are approximations based on the limited information provided in the report or averaged over more than one sampling location (e.g., Flat Rock, Mount Storm). Blanks indicate no data or data collected using different methodologies (e.g., parabolic dish versus vertical radar for flight height).

For the Dairy Hills site, migrant passage rate was calculated from both horizontal mode and vertical mode data. Horizontal mode results should be used to compare to previous studies using the same method (see Table 4). However, the vertical mode passage rate is a more accurate index of true passage rate due to the larger air-space over the radar sampled and greatly decreased effects of ground clutter. The horizontal radar configuration provides larger horizontal spatial coverage and thus larger area for possibly detecting a target; however, there are limitations to the height at which the radar samples. Depending on the angle and strength of the radar side-lobes, targets passing higher than roughly 625 m are likely missed. In addition, ground clutter on the radar screen may obscure radar targets in the horizontal mode, so numbers counted are an underestimate of the true number of targets passing overhead. In the vertical mode, the radar samples a wedge shaped area extending from the set limits (e.g., 1.5 km) to the west to the set limits to the east and above the radar. In this configuration there is no ground clutter to obscure targets. Targets can easily be seen at all altitudes up to the set limits (1.5 km) provided the radar settings are capable of detecting small targets. However, targets passing through the radar beam in a perpendicular direction may be missed because they do not leave a trail on the screen and the horizontal plane sampled decreases in length with height above radar. Near the 1.5 km limit only those targets passing over within the area directly above the radar are detectable. While neither method provides a true measure of target passage rates over a given area, the vertical mode estimate is a better indication of true numbers of targets within the sample area.

Migration passage rates at the Dairy Hills site were higher in the spring than in fall in both the horizontal and vertical radar modes. This pattern is similar to other migration studies in western New York at the Chatauqua site, the Searsburg site in Vermont, and two sites studied in the Pacific Northwest where both spring and fall surveys have been conducted (Table 4). During the fall, mean target flight height was greater. In the horizontal mode, more targets would have been flying above the effective sampling area which may partially explain the lower fall passage rates. Also, it is generally believed that fall avian migration may be spread out over a longer time frame than spring migration resulting in fewer targets per survey night.

Based on the data collected in the spring and fall 2005, it does not appear as if the Dairy Hills area occurs within an area with a concentration of spring or fall avian migration. The migration characteristics were similar to numerous other studies conducted at proposed wind projects. It is not expected that the Dairy Hills Wind Project would pose any greater risk to avian migrants than other sites studied. The variation among migrant studies across New York and the northeast (see Table 8) is not great. Most studies have provided results that fall within certain similar parameters with no outliers. It is not expected that additional years of study would yield more accurate or different results for the Dairy Hills site. Impacts to avian migrants from the Dairy Hills wind project are expected to be similar or less than other eastern wind projects studied.

### 4.3 Breeding Bird Survey

The initial survey design for the breeding bird survey was to locate survey stations at proposed turbine locations. Due to the timing of the studies, a preliminary layout of potential turbines was used to establish the survey stations. As a result, when the project layout was finalized, some of the breeding bird survey stations fell outside the primary development area. These survey stations (outside the proposed development) could be used as potential reference areas if post construction surveys are warranted.

Results of the breeding bird surveys were typical of mixed agricultural settings in western New York. No unusual or unique bird observations were made. Many of the species recorded were based on auditory observation of birds singing from nearby wood lots. Three species listed by NYSDEC were observed, northern harrier, horned lark, and vesper sparrow. Northern harrier is a state threatened species and is discussed in the sensitive species survey results. Horned lark and vesper sparrow are listed as Special Concern species for New York (NYSDEC 2003). Three species recorded, black-billed cuckoo, bobolink, and wood thrush, are included on the 2002 Birds of Conservation Concern list for either the Lower Great Lakes/St. Lawrence Plain or Appalachian Mountain regions (USFWS 2002). The Dairy Hills site occurs within the transition between these two regions.

Based on the survey data collected in 2005, the Dairy Hills Site does not appear to have any large or unusual populations of breeding resident birds. Mortality results from two other eastern wind plants studied indicate that turbines on eastern mountain ridgelines result in between 4 and 8 bird fatalities per turbine per year (see Kerns and Kerlinger 2004 and Nicholson 2002, 2003). In both these studies it was estimated that approximately 2/3$^{rd}$ of the avian fatalities were migrants. Provided impacts at Dairy Hills are similar, it is not expected that breeding resident birds are at great risk from the wind project. Due to the diversity of birds recorded in the mixed farmland habitat, the impacts are expected to be spread over several species.

### 4.4 Nocturnal AnaBat Surveys

Four studies of wind projects have recorded both AnaBat detections per night and bat mortality (Table 9). At a fifth site, Mountaineer, West Virginia, some AnaBat data was collected during a bat mortality study, however, this data has not been analyzed or reported (Arnett, 2005, pers. comm.). The number of bat calls per night as determined from AnaBat detectors shows a rough correlation with bat mortality but may be misleading because effort, timing of sampling, and detector settings (equipment and locations) varied among studies. While in most studies the species of bats recorded were not reported, it is probable that the majority of bat calls recorded were of species not at great risk from wind turbines such as Myotis species and big brown bats. The post-construction mortality data collected at existing regional projects appears to be the best available predictor of mortality levels and species composition for proposed wind projects.

The number of bats detected per night at the Dairy Hills site peaked in the fall. Mortality studies of bats at wind projects in the U.S. have shown a peak in mortality in August and September (see Johnson 2005 for a summary). While the survey efforts varied among the different studies, the studies which included AnaBat surveys and fatality surveys showed a general association between the timing of bat calls and timing of mortality, with both peak call rates and peak mortality occurring during the fall. It is expected that bat mortality at the Dairy Hills site will be similar to the other studies in the U.S. with the peak of mortality likely occurring near late August or early September. Spring and summer mortality levels for bats are expected to be low. The species expected to be the most common fatalities would include eastern red bat, hoary bat, and eastern pipistrelle with fewer numbers of big browned bat, little brown bat, northern myotis, and silver haired bat.

**Table 9. Wind projects in the U.S. with both AnaBat sampling data and mortality data for bat species.**

| Project Area | Study Period | Detector nights | Bat activity (#/detector/night) | Mortality (bats/turbine/year) | Reference |
|---|---|---|---|---|---|
| Top of Iowa, IA | Sep 4-Oct 9, 2003; May 26-Sep 24, 2004 | 42 | 34.9 | 10.2 | Koford et al. 2005 |
| Foote Creek Rim, WY | Jun 15-Sep 1, 2000-01 | 39 | 2.2 | 1.3 | Gruver 2002 |
| Buffalo Ridge, MN | Jun 15-Sep 1, 2001 | 216 | 2.1 | 2.2 | Johnson et al. 2003 |
| Buffalo Mountain, TN | Apr 1-Sep 30, 2001-02 | 149 | 23.7 | 20.8 | Fieldler 2004 |
| Mountaineer, WV | Aug 1-Sep 14, 2004 | 33 | 38.3 | 38.0 | Arnett 2005 |

### 4.5 Sensitive Species Surveys

Northern harriers were documented in the Dairy Hills study area during all seasons of study. There is also one area near Lake LeRoy that is considered potential breeding habitat. It is likely that many of the harriers observed were migrants or transients through the area, however, it is possible that harriers were breeding residents in the Dairy Hills area. This species appears to be somewhat common in western New York based on the state Breeding Bird Atlases and is a documented breeding resident in Wyoming County (see Andrle and Carroll 1988, NYSDEC 2005). The agriculture setting of the project certainly provides suitable habitat for northern harriers and they would be expected to occur throughout the region.

Based on the current project layout, no turbines are proposed for the potential northern harrier breeding habitat in the Dairy Hills project; no direct habitat loss impacts are expected. Northern harriers could be at risk of collision with turbines and they have been recorded as fatalities at other wind plants primarily in the western U.S. (see Erickson et al. 2001). While on the breeding grounds, northern harrier behavior which generally includes low level flights and very little soaring, is not likely to put them at great risk from turbines. Of the raptors recorded on the Dairy Hills site, northern harrier had the lowest calculated exposure index based on the flight characteristics recorded.

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