Amherst Community Wind Farm

Avian Baseline Study

Final Report

Prepared by:
John Kearney
John F. Kearney & Associates

for

Mi'Kmaq Wind4All Communities LP

February 2015

Introduction

The Mi'Kmaq Wind4All Communities are proposing the construction of a 6 megawatt, 3 turbine wind energy facility near the Town of Amherst, in Cumberland County, Nova Scotia. This document presents the results of an avian baseline study conducted by John F. Kearney & Associates from April through November 2014 as part of the environmental assessment of the project.

The project area is located on the Chignecto Isthmus, a narrow bridge of land only 17 kilometers in width at its narrowest point. The Isthmus is the only land connection between Nova Scotia and the mainland of North America and separates two major marine bodies; the Bay of Fundy and the Gulf of St. Lawrence. The region is recognized as an important breeding and migration stop-over area for birds. Starting within five kilometers of the Town of Amherst are two National Wildlife Areas, an Important Bird Area, a Ramsar site, and a Hemispheric Shorebird Reserve. A wind energy facility could potentially put birds at risk through collisions with wind turbines, alteration of important breeding or migration stop-over habitats, and the creation of a physical barrier along bird flight paths. Thus, the proposed construction of a wind energy facility near significant bird breeding and migratory areas requires detailed and comprehensive studies to determine the risk to birds and what mitigation measures may be necessary. Thus the components of this study include ground surveys of migration stop-over, diurnal passage, and breeding birds, and acoustic monitoring of nocturnal passage. A radar study conducted by Acadia University during the autumn migration of 2014 is another vital component of the avian baseline study.

Figure 1: Location of Amherst in the Canadian Maritime Provinces

Figure 2: Map Showing Project Area East of the Town of Amherst

Definition of Study Area

The proposed Amherst Community Wind Farm is about three kilometers from the commercial areas of the Town of Amherst. The location of this town in the Maritime Provinces is shown in Figure 1. Figure 2 situates the project area relative to the Town of Amherst. The project area consists of three adjacent parcels of lands that total approximately 1.5 square kilometers in area. These lands are located between two roads that stretch from the Town of Amherst to the surrounding rural communities; the John Black Road to the northwest and the Pumping Station Road to the southeast.

The study area is defined here as the project area plus one control survey transect in the surrounding lands where specific bird surveys will be carried out as described later in this document.

Land Use, Forest Cover, and Topography

Figure 3 is developed from a Google Earth aerial view of the project lands photographed on 18 October 2012. As can be seen in Figure 3, there is intensive use of the lands for economic activities.

In the agricultural sector, there are wild blueberry fields on the northern border and grain and

Figure 3: Land Use in Project Area and Proposed Locations of Turbines (red)

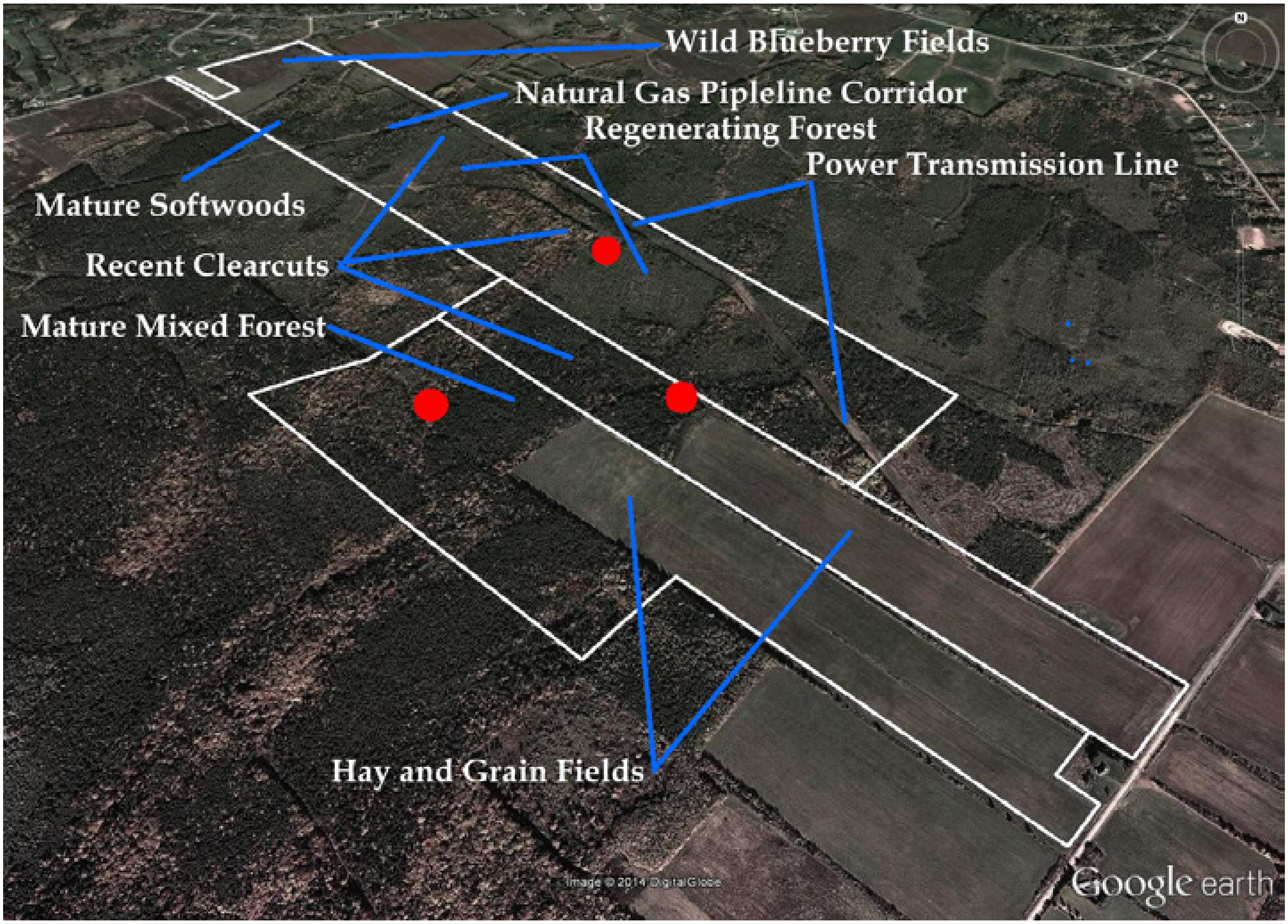
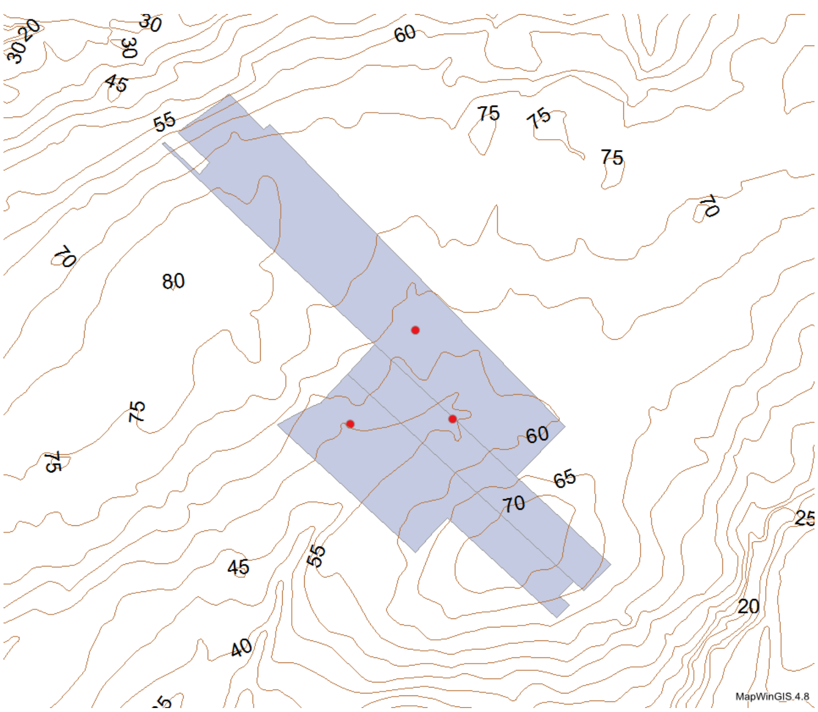


Figure 4: Map Showing Five-Meter Contour Lines in Project Area



hay fields in the southern section of the project lands. Pastures for cattle are located within a few meters of the project lands.

In the energy sector, there is an electric power transmission line and corridor on the east border and southeast section of the project area. There is a natural gas pipeline and corridor intersecting the northern part of the project area.

In the forestry sector, there are several clearcuts including large new clearcuts that have been carried out since the creation of the aerial photo upon which Figure 3 is based. The regenerating forest areas have been used recently as a training area in the art of forest thinning for new forestry workers. There are small patches of mature softwood forest and mature mixed forest remaining on the project lands.

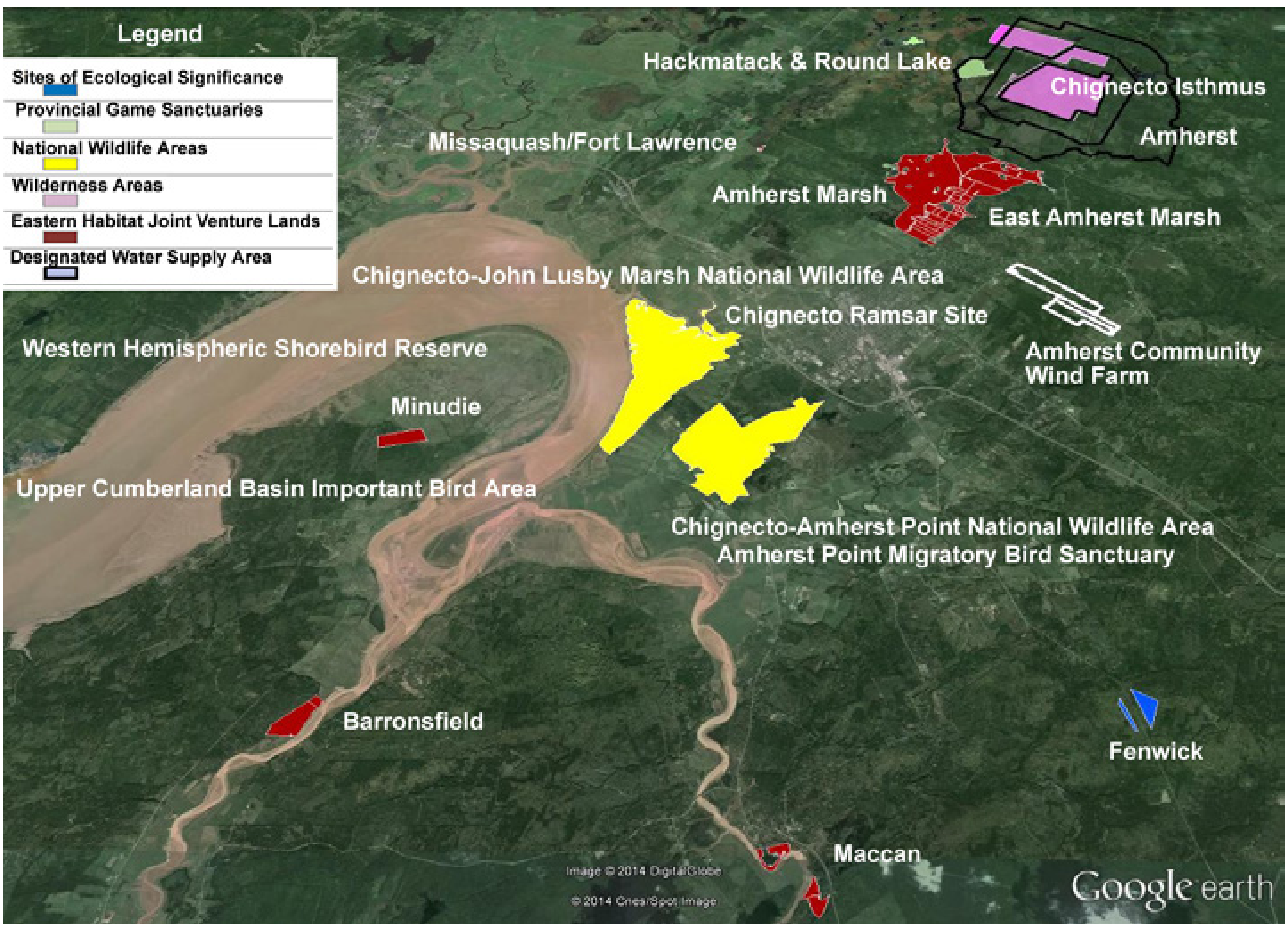
In addition, within 500 meters of the project area are three communication towers, a natural gas relay station, a golf course, and residential homes.

The project area is situated on some of the highest ground in the Nova Scotia portion of the border area with New Brunswick. However, higher ground in this part of Nova Scotia is still relatively low compared to other parts of the province. As shown in Figure 4, the maximum elevation in the project area is between 75 and 80 meters above sea level with a minimum elevation of 55 meters. The base of the proposed turbines would be between 55 and 65 meters above sea level.

Conservation Areas

A number of conservation areas can be found on the Chignecto Isthmus and in the Nova Scotia border region (see Figure 5). The closest to the project area are three freshwater management areas that are Eastern Habitat Joint Venture Lands (Ducks Unlimited, Province of Nova Scotia, and

Figure 5: Conservation Areas within ~15 Kilometers of Project Area



Canadian Wildlife Service). These are East Amherst Marsh, Amherst Marsh, and East Amherst Management Areas. These management areas are contiguous with each other and are 1.9 kilometers from the project area at their shortest distance. Other Eastern Habitat Joint Venture Lands in the vicinity of the project area are Missaquash/Fort Lawrence (7.6 kilometers), Minudie (14.1 kilometers), Maccan (14.4 kilometers), and Barronsfield (17.9 kilometers). One site of ecological significance, Fenwick, is 9.5 kilometers from the project area. The Hackmatack Lake and Round Lake Game Sanctuaries are 13.7 and 13.0 kilometers from the project area. The Chignecto Isthmus Wilderness Area is 6.9 kilometers and the Amherst Designated Water Supply Area is 4.7 kilometers from the project area. Finally the Chignecto National Wildlife Area which is also a Ramsar site consists of two components: John Lusby Marsh and Amherst Point Migratory Bird Sanctuary. These two areas are 7.2 and 6.8 kilometers respectively from the project area. These federal Wildlife Areas are part of the Upper Cumberland Basin Important Bird Area and are also within the Bay of Fundy Western Hemispheric Shorebird Reserve.

Table 1: Status of Breeding Birds Within 5 KM of Project Area as Determined by 8 Point Counts from 2006-2010

Common Name	Status
Bald Eagle	Confirmed breeding
Merlin	Confirmed breeding
Rock Pigeon	Possible breeding
Mourning Dove	Possible breeding
Ruby-throated Hummingbird	Possible breeding
Downy Woodpecker	Possible breeding
Hairy Woodpecker	Possible breeding
Alder Flycatcher	Probable breeding
Blue-headed Vireo	Possible breeding
Red-eyed Vireo	Possible breeding
Blue Jay	Possible breeding
American Crow	Probable breeding
Common Raven	Probable breeding
Black-capped Chickadee	Probable breeding
Red-breasted Nuthatch	Possible breeding
Golden-crowned Kinglet	Possible breeding
Ruby-crowned Kinglet	Possible breeding
Hermit Thrush	Possible breeding
American Robin	Probable breeding
Cedar Waxwing	Possible breeding
European Starling	Confirmed breeding
Nashville Warbler	Possible breeding
Northern Parula	Possible breeding
Yellow Warbler	Possible breeding
Chestnut-sided Warbler	Possible breeding
Magnolia Warbler	Possible breeding
Yellow-rumped Warbler	Possible breeding
Blackburnian Warbler	Possible breeding
American Redstart	Possible breeding
Ovenbird	Possible breeding
Common Yellowthroat	Possible breeding
Chipping Sparrow	Confirmed breeding
Savannah Sparrow	Possible breeding
Song Sparrow	Confirmed breeding
White-throated Sparrow	Possible breeding
Dark-eyed Junco	Probable breeding
Common Grackle	Probable breeding
Purple Finch	Possible breeding
American Goldfinch	Possible breeding

Desktop Survey of Birds in the Study Area

The birds of the Isthmus of Chignecto were extensively documented by Boyer (1972). He describes the dominant bird species found for each habitat type in the region. By far the most important habitats from a conservation perspective are the unique freshwater marshes in the area which are home to a variety of species that are not found elsewhere in Nova Scotia or in more limited numbers. These include grebes, bitterns, less common duck species, rails, marsh wrens, and the Black Tern. For the upland forest such as found in the project area, Boyer lists the dominant bird species as Broad-winged Hawk, Great Horned Owl, Hairy Woodpecker, Downy Woodpecker, Red-eyed Vireo, Swainson’s Thrush, Hermit Thrush, both kinglet and chickadee species, a variety of warblers, Dark-eyed Junco, and White-throated Sparrow. In the agricultural areas adjacent to the upland forest, the dominant species are the common swallow species, American Robin, Yellow Warbler, Bobolink, Savannah Sparrow, and Song Sparrow.

More recent data from the Maritimes Breeding Bird Atlas (Atlantic Canada Conservation Data Centre 2014, Bird Studies Canada et al. 2012) indicate a species composition of breeding birds near the project area that is similar to that described by Boyer. Table 1 shows the breeding status of 39 species of birds found on 8 roadside point counts conducted within 5 kilometers of the project area from June 24 to July 1 between 2006 and 2010. These point counts appear not to have been taken near any wetlands, given the absence of water birds.

Table 2 presents the status of species of conservation concern observed within 5 kilometers of the project area based on data provided by the Atlantic Canada Conservation Data Centre (2014). The table also shows the distance of the observed birds from the project area. None of the birds listed were seen or heard within it. Nonetheless, the data show that there are 28 species of conservation concern within 5 kilometers of the project area of which 3 are listed as threatened under the Species at Risk Act (SARA), an additional 2 ranked as threatened and 1 as special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and 4 out of the 5 threatened species also have legal protection from the Province of Nova Scotia. These species are Barn Swallow, Common Nighthawk, Olive-sided Flycatcher, Bobolink, Least Bittern, and Eastern Wood-Pewee. The Barn Swallow, Common Nighthawk, and Bobolink were less than 3 kilometers from the project area.

Objectives of the Baseline Study

The avian baseline study has three major objectives:

1. To provide information on birds such that the proposed project complies with the federal *Migratory Birds Convention Act*, the *Species at Risk Act*, and associated laws and policies of the Province of Nova Scotia,

2. To provide diurnal and nocturnal information to inform the siting, operation, and monitoring of the proposed project in regard to the direct (mortality from collision and construction activities) and indirect (displacement from habitat, fragmentation of habitat, avoidance of habitat, and flight path barrier) effects on birds, and

3. To provide a quantitative baseline for measuring the impacts of the project in the short and long term and to contribute to a global understanding of wind energy projects on birds.

These objectives will be met through the studies to:

A. Determine the relative abundance of breeding birds in the study area,

B. Determine the abundance of birds in migration stop-over in the study area,

C. Determine the numbers of birds wintering in the study area,

D. Determine the abundance, species composition, and movement patterns of birds in

Table 2: Status of Species of Conservation Concern within Five KM of Project Area

Common Name	COSEWIC	SARA	NS Legal Protection	NS Rarity Rank	NS Status Rank	Distance from Project Area
Barn Swallow	Threatened		Endangered	Breeding-Uncommon	1 At Risk	2.6 ± 0.15
Common Nighthawk	Threatened	Threatened	Threatened	Breeding-Uncommon	1 At Risk	2.7 ± 0.15
Olive-sided Flycatcher	Threatened	Threatened	Threatened	Breeding-Uncommon	1 At Risk	3.3 ± 0.15
Bobolink	Threatened		Vulnerable	Breeding-Uncommon to fairly common	3 Sensitive	2.6 ± 0.15
Least Bittern	Threatened	Threatened		Breeding-Unranked	5 Undetermined	3.8 ± 0.15
Eastern Wood-Pewee	Special Concern		Vulnerable	Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Black Tern	Not At Risk			Breeding-Extremely rare	2 May Be At Risk	3.6 ± 0.15
Marsh Wren				Breeding-Extremely rare	5 Undetermined	3.6 ± 0.15
Virginia Rail				Breeding-Rare	5 Undetermined	4.8 ± 0.15
Willow Flycatcher				Breeding-Rare	3 Sensitive	3.5 ± 0.15
Vesper Sparrow				Breeding-Rare to uncommon	2 May Be At Risk	2.6 ± 0.15
Boreal Chickadee				Uncommon	3 Sensitive	4.2 ± 7.07
Cape May Warbler				Breeding-Perhaps uncommon	3 Sensitive	4.2 ± 7.07
Pied-billed Grebe				Breeding-Uncommon	3 Sensitive	4.2 ± 7.07
Blue-winged Teal				Breeding-Uncommon	2 May Be At Risk	4.2 ± 7.07
Cliff Swallow				Breeding-Uncommon	2 May Be At Risk	4.2 ± 7.07
Gray Catbird				Breeding-Uncommon	2 May Be At Risk	2.6 ± 0.15
Northern Cardinal				Uncommon to fairly common	4 Secure	3.9 ± 0.15
American Bittern				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Killdeer				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Spotted Sandpiper				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Wilson's Snipe				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Yellow-bellied Flycatcher				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Eastern Kingbird				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Tennessee Warbler				Breeding-Uncommon to fairly common	3 Sensitive	2.4 ± 0.15
Bay-breasted Warbler				Breeding-Uncommon to fairly common	3 Sensitive	4.2 ± 7.07
Rose-breasted Grosbeak				Breeding-Uncommon to fairly common	3 Sensitive	2.4 ± 0.15
Pine Siskin				Breeding-Uncommon to fairly common;	3 Sensitive	2.6 ± 0.15

diurnal and nocturnal passage and the risk of collision with wind turbines,

E. Determine the possible effects, besides collisions, of wind turbines and human activities on the breeding, wintering, and migrating birds in the study area including

a) the use of habitats by breeding and wintering birds and migrating birds in stop-over,

b) displacement from habitats,

c) avoidance of habitats,

d) the possible effects of habitat fragmentation on bird populations, and

e) the possible barrier effects on flight pathways.

F. Determine the presence and abundance of species of conservation concern in the study area, the kinds and amount of habitat they require, and the measures required by the project proponents for avoidance or mitigation,

G. Make recommendations for adaptive management of bird habitats and risk abatement at the wind energy facility,

H. Make recommendations for post-construction studies, and

I. Contribute to the national database on avian wind facility studies.

Survey Methods

Eight types of survey methodologies were used to meet the objectives of the study. All the surveys include quantitative survey methodologies consisting of counts within the project area and in the control area (the acoustic surveys are only in the project area).

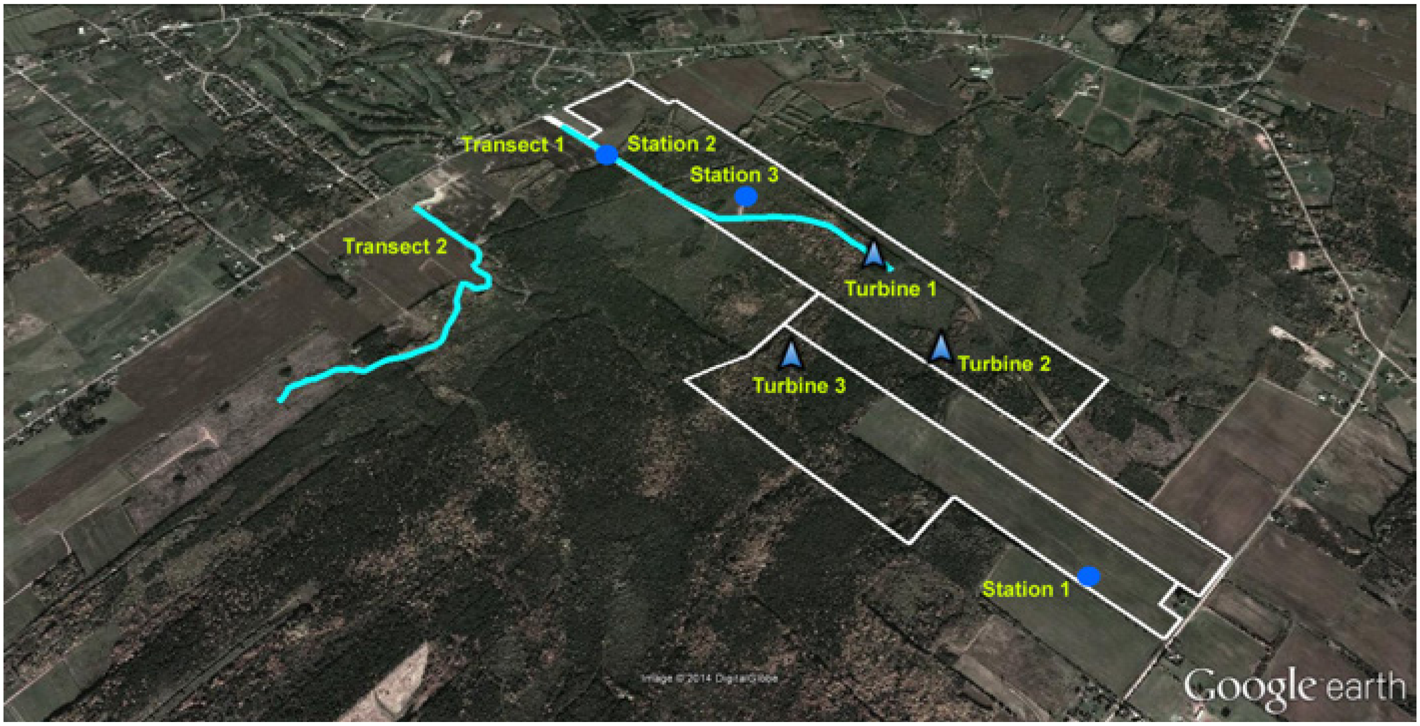
1. MIGRATION STOP-OVER TRANSECTS

Two transects were used for the study of stop-over migration. These transects are shown in Figure 6. The transects were chosen so as to sample representative habitats in the study area, one in the project area (Transect 1) and one in a control area (Transect 2).

Each transect was surveyed once every week during the migration period, April 15-June 7, 2014 and August 15-October 31, 2014. The transects were 1,500 metres in length with all birds recorded in the following distance categories from the observer: <50 meters, 50-100 meters, >100 meters, and flying overhead. The transects are divided into three equal 500-meter segments which represent, when possible, distinct habitat types. Along each transect are six stop counts.

The duration of each stop count is ten minutes with birds recorded in the same distance categories as the rest of the transect. The stop counts provide a finer resolution of habitat utilization by birds in stop-over and increase survey time in a systematic fashion.

Figure 6: Location of Stop-over Transects and Observation/Listening Stations



2. EARLY BREEDING SURVEY

The spring stop-over transects also provide data on early breeding birds using the study area.

3. PEAK BREEDING SURVEY POINT COUNTS

Point counts were made throughout the study area during the month of June in both the project and the control area. The duration of a point count is ten minutes with birds recorded in the same distance categories as for transects and stop counts.

4. DIRECTED SEARCHES FOR SPECIES OF CONSERVATION CONCERN DURING THE EARLY AND PEAK BREEDING SEASONS

In addition to transects and point counts, it was necessary to search out habitats that may be the residences of species of conservation concern. This is especially true for the COSEWIC and SARA listed species that could be found in the study area. Potential habitats for these species were surveyed through general area searches.

5. DIURNAL PASSAGE OBSERVATION

Two observation stations which give a 180-360 degree view of the airspace over sections of the study area were chosen for the study of diurnal passage. These stations are shown in Figure 6 (Station #1 and #2). All birds flying through a given air space were noted by species, flock size, altitude, direction of flight, and proximity to a proposed turbine. For woodpeckers and passerines these observations were focused in the early morning hours, for raptors peak numbers are to be expected from mid-morning to early afternoon, and for many water birds and shorebirds according to the tides. Flying birds seen in apparent diurnal migration during the stop-over transects were also noted along with the flight heading. The diurnal passage study was conducted during the same weeks as the stop-over surveys in both the spring and fall.

6. ACOUSTIC MONITORING OF NOCTURNAL PASSAGE

Acoustic monitoring of nocturnal passage provides data on the species of birds migrating through an area, their relative abundance, and migration timing. Two recording stations were set up and were located at stations #1 and #3 as shown in Figure 6. Recording took place every night from civil sunset to civil sunrise from mid-April to early June and early August to mid November 2014.

At both sites, a Song Meter SM2, made by Wildlife Acoustics, was used as a recording device. The Song Meter is powered by 2 AA and 4 D alkaline batteries. Settings were as follows:

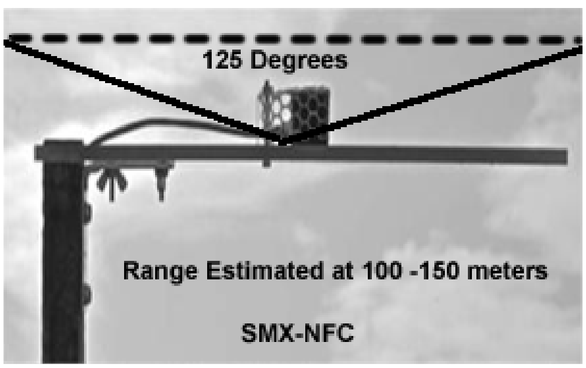
Sampling format: 16 bit

Sampling rate: 24,000 Hz

High pass filter: 1,000 Hz

Pre-amp: 60 dB gain

Storage: 2-32GB SD cards



Wildlife Acoustics also produces a night flight call microphone, the SMX-NFC, to be used with the Song Meter. This weather-resistant microphone rests on a flat horizontal plate creating a pressure zone resulting in a 3-6 dB gain within a beam angle of 125 degrees. Based on experience in Nova Scotia, the range is estimated at 100-150 meters in altitude.

The Song Meter and SMX-NFC microphone were chosen for use in this study since they were also employed by the author at seven other existing or proposed wind energy facilities from 2011 to 2013 in Nova Scotia.

Table 3: Detection Parameters

	High Frequency	Low Frequency
Minimum Frequency	6,000 Hz	2,250 Hz
Maximum Frequency	11,000 Hz	3,750 Hz
Minimum Duration	29 ms	29 ms
Maximum Duration	400 ms	330 ms
Minimum Separation	104 ms	52 ms
Signal to Noise Ratio Parameters		
-- Minimum Occupancy	25.0%	20.0%
-- Threshold	3.5 dB	4.0 dB
Noise Power Estimation Parameters		
-- Block Size	5,000 ms	1,000 ms
-- Hop Size	250 ms	250 ms
-- Percentile	50.0%	50.0%

The detection of night flight calls recorded in the .wav format, and their organization and identification to bird species was conducted using the Raven Pro sound analysis software produced by the Cornell Lab of Ornithology. The detection parameters for high frequency calls (sparrows and warblers) and low frequency calls (thrushes and shorebirds) are shown in Table 3. The review panel of Raven Pro allows for a standardized process to classify, identify, and store night flight calls.

During periods of wind and/or rain, detection software can produce tens of thousands of false positives. This effect is more severe in the low frequency range.

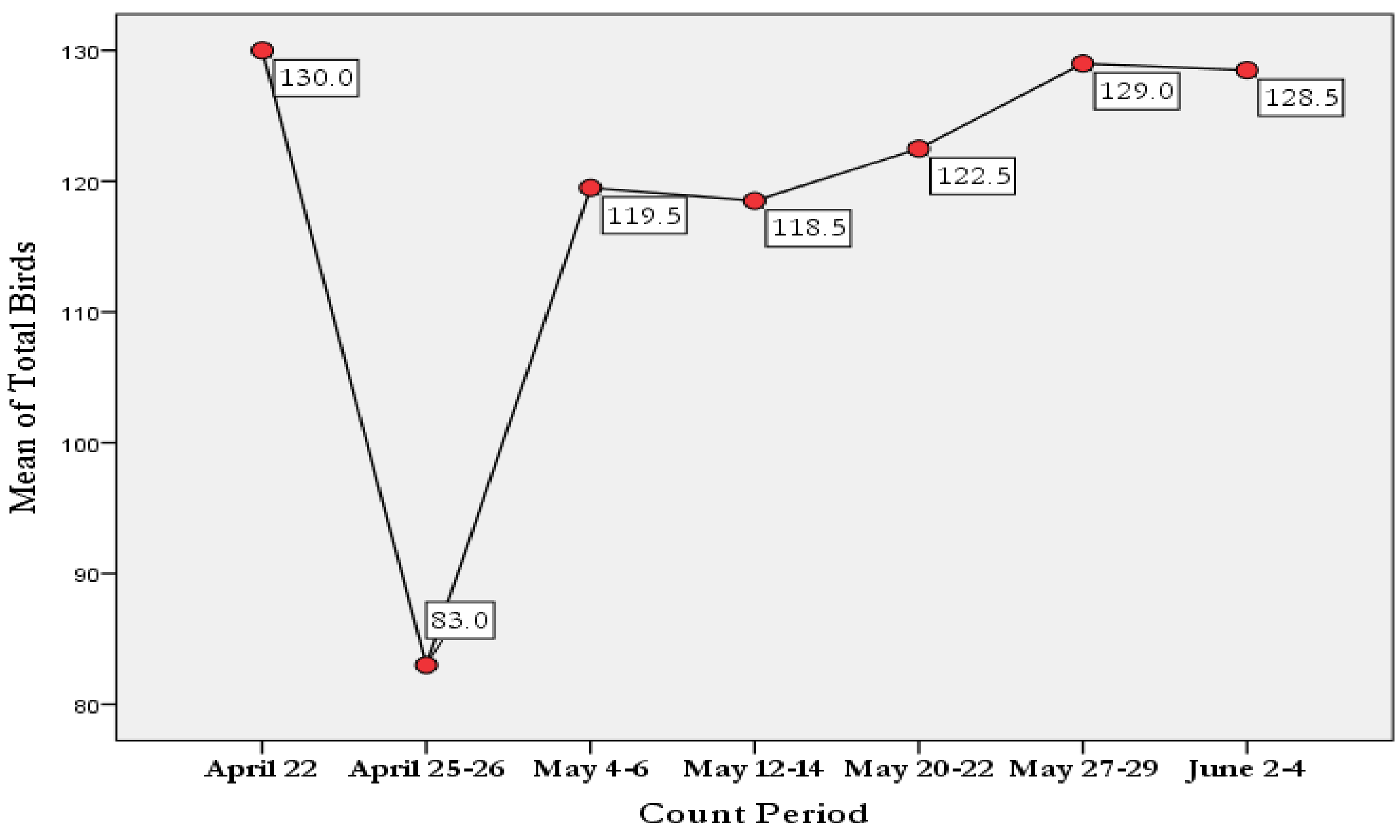
To overcome this problem, a number of bandwidth filters were employed when normal detector runs produced more than 5,000 detections. For the high frequency detector, a bandwidth filter with a minimum of 100 Hz , a maximum of 1000 Hz, and an energy percentile of 40% (the fraction of total energy in the specified bandwidth) proved to be the most effective. For the low frequency detector, a filter with a minimum bandwidth of 100 Hz, a maximum of 500 Hz, and an energy percentile of 40% or more was used. Past studies showed that the high frequency filter captured about 98% of the true positives detected without the filter. For the low frequency detector, the bandwidth filter is less efficient but still captures the majority of night flight calls during the night.

Results

The results of the baseline study will be presented on a seasonal basis from April to October. The analysis for each season consists of three study components.

SPRING MIGRATION

Figure 7: Mean Total Birds on Stop-over Transects by Count Period during the Spring



The study of birds migrating in the spring consists of surveys of migration stop-over, diurnal passage, and nocturnal passage.

MIGRATION STOP-OVER

Figure 8: Birds per Stop-over Transect by Count Period in the Spring

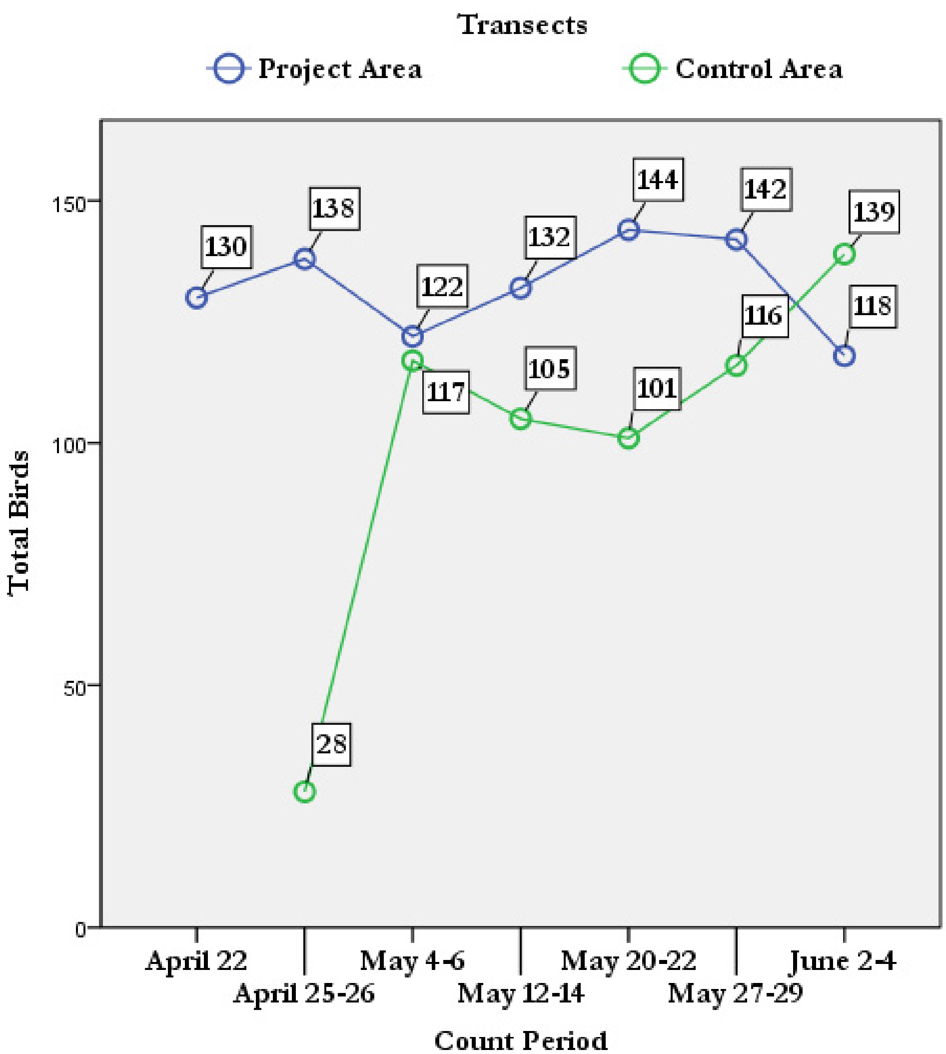


Figure 7 shows the mean number of birds on the stop-over transects by count period during the spring migration. Despite, the dip in the number of birds in late April, there is no statistically significant difference or clear seasonal trend in the number of birds present.

Figure 8 graphs the total birds seen on each transect in the project and control areas. The project transect has a greater number of birds but a statistical T-test indicates that there is not a significant difference in the number of birds on the transects at a 95% confidence level.

Figure 9 plots the mean total species recorded on the transects by count period. As with total birds, a statistical analysis reveals no significant differences between the periods.

The number of birds flying over a transect in the morning is an indication of the strength of diurnal migration that may be taking place. At the same time, the number of birds seen within 50 meters of the transect is the strongest indication of the density of birds in stop-over. Figure 10 compares the mean number of birds within 50 meters of the transect and the mean number of birds flying over the transect by count period. For the spring period, there was a mean number of 60.92 birds within 50 meters of the transect and a mean of 10.46 birds flying over the transect. A statistical T-test confirms that there is a significantly smaller number of birds flying over the transect than seen

Figure 9: Mean Total Species per Transect by Count Period in the Spring

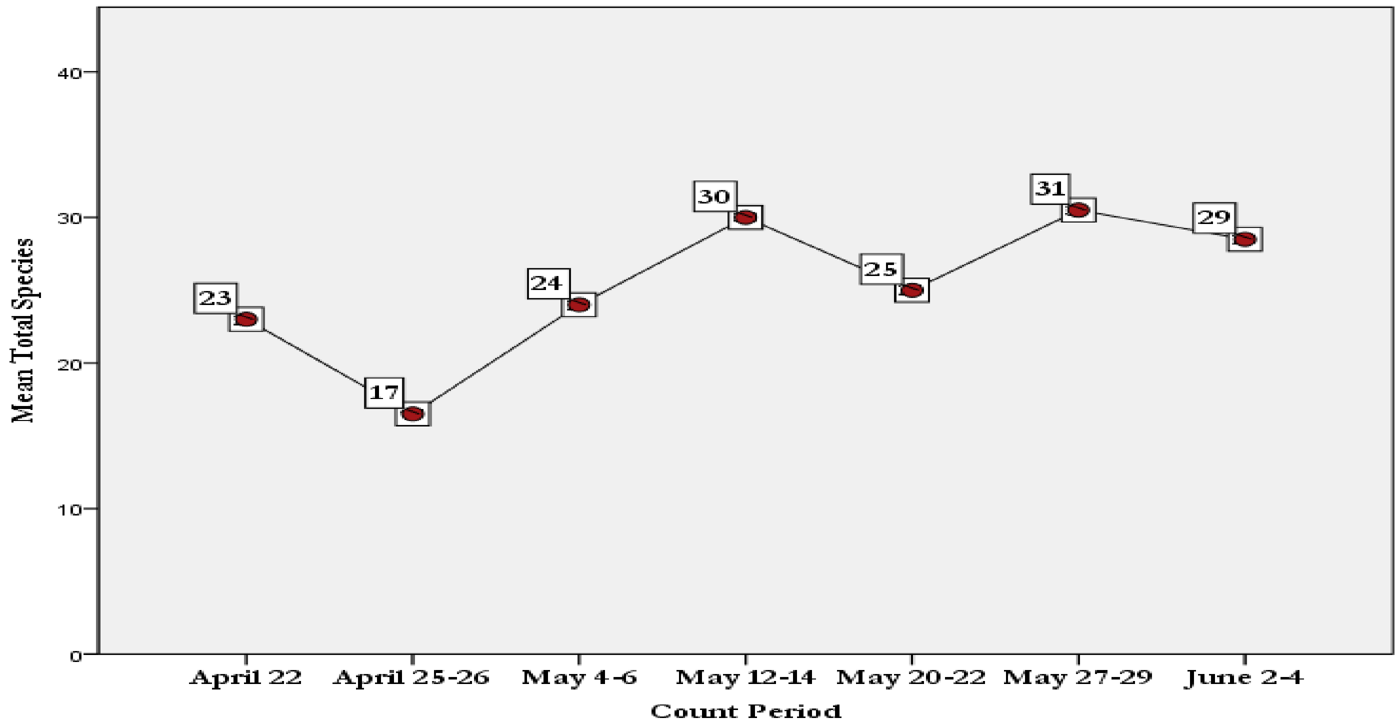


Figure 10: Mean Total Birds by Distance from Transect by Count Period in the Spring

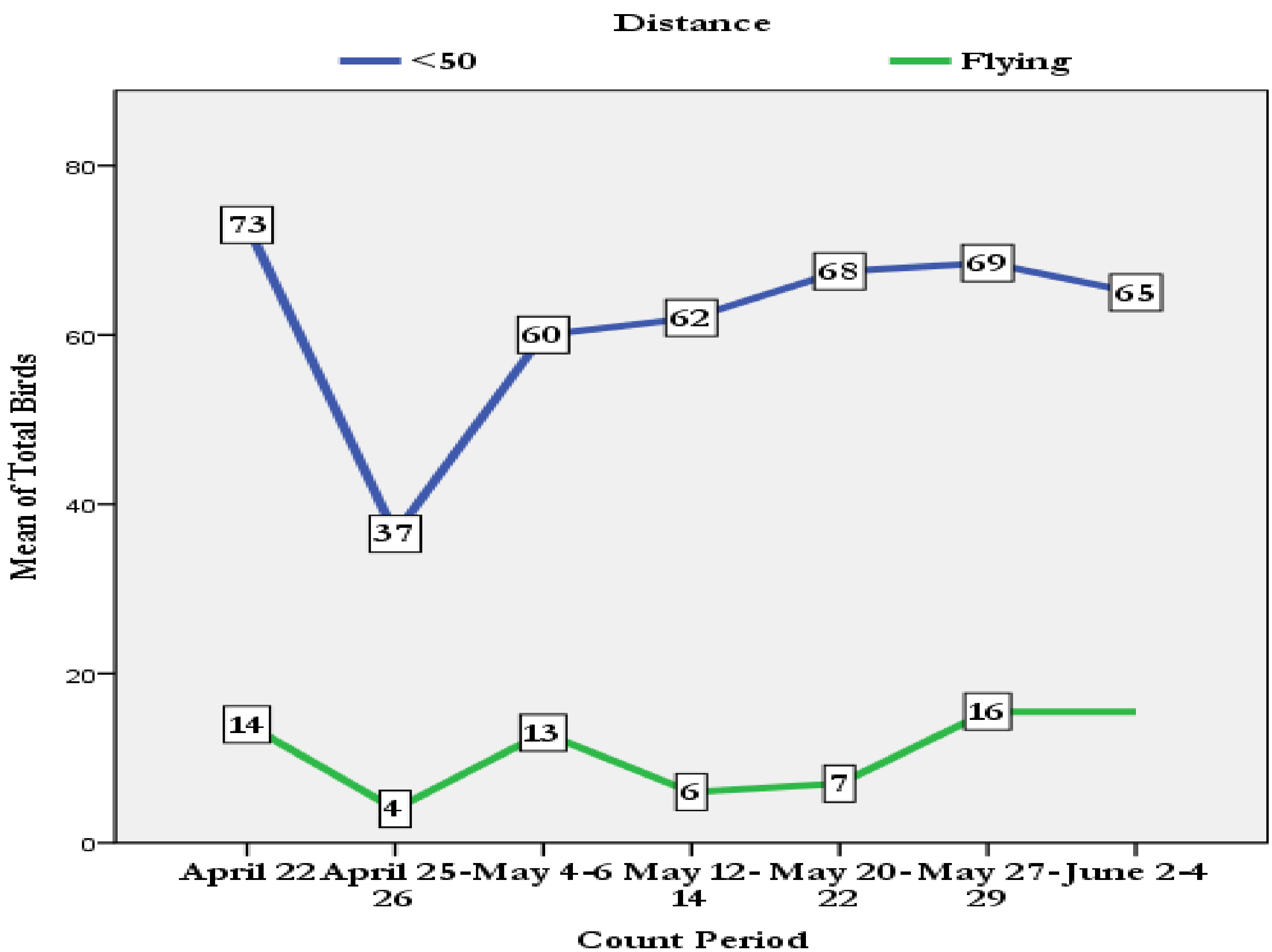


Table 4: Mean Number of Birds on Stop-over Transects Correlated with Relative Humidity at Civil Sunset the Preceding Evening

Relative Humidity	N	Mean	Std. Deviation	Std. Error	95% Confidence Lower Bound	95% Confidence Upper Bound	Minimum	Maximum
<50%	1	118.00					118	118
50-59%	2	131.00	1.414	1.000	118.29	143.71	130	132
60-69%	1	139.00					139	139
70-79%	3	134.33	15.044	8.686	96.96	171.71	117	144
80-89%	2	130.00	11.314	8.000	28.35	231.65	122	138
90-99%	3	107.33	7.767	4.485	88.04	126.63	101	116
100%	1	28.00					28	28
Total	13	117.85	30.293	8.402	99.54	136.15	28	144

Table 5: Twenty Most Abundant Migrant Species on Stop-over Transects in the Spring

Species	Max. per Transect	Total
American Robin	25	220
White-throated Sparrow	24	197
Palm Warbler	13	69
Black-capped Chickadee	12	62
Blue Jay	10	58
Common Yellowthroat	17	57
Hermit Thrush	7	51
Yellow-rumped Warbler	13	48
Dark-eyed Junco	10	47
Purple Finch	7	43
Magnolia Warbler	10	40
Savannah Sparrow	9	40
Song Sparrow	7	30
Northern Flicker	5	25
Northern Parula	5	24
Black-and-White Warbler	4	24
Ruby-crowned Kinglet	5	23
Nashville Warbler	3	16
Black-throated Green Warbler	6	15
Blue-headed Vireo	3	12

on the ground or in trees within 50 meters of the transect at the 95% confidence level.

A forward stepwise automatic linear model, using the Statistical Package for the Social Sciences (SPSS), was employed to determine weather variables affecting the number of birds in stop-over. A number of weather factors at the time of the surveys and at civil sunset the previous evening were incorporated into the model. Only relative humidity at civil sunset had a significant correlation with the total number of birds on the transects in the morning ($p=0.002$). Table 4 shows that the number of birds on the transects was lower at high relative humidities.

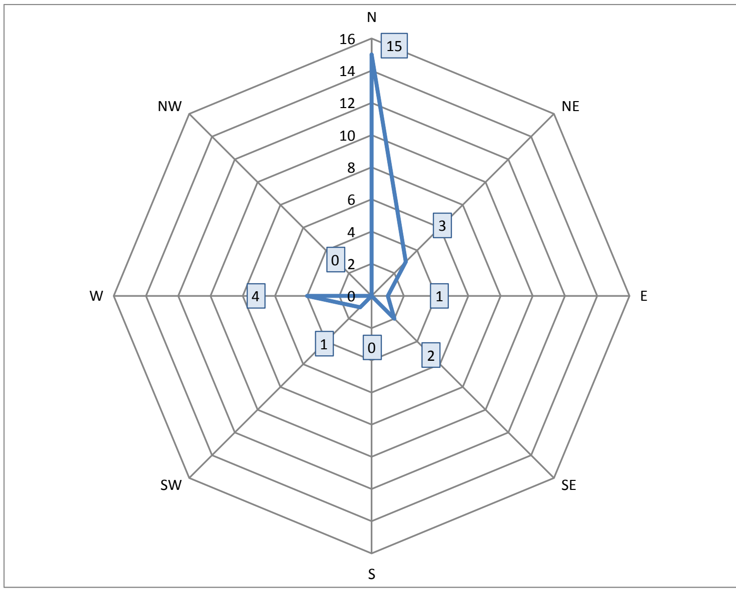
Table 5 shows the most abundant migratory species present on the stop-over transects in the spring; with American Robin, White-throated Sparrow, and Palm Warbler being the top three species detected.

The use of habitats by birds in stop-over in the spring was also analysed. The two transects each consisted of three 500 meter segments of relatively uniform habitat type. These habitats were mixed forest, disturbed mixed forests, clearcuts, and agricultural land. As seen in Table 6, an analysis of variance of the birds detected within 50 meters of the

Table 6: Use of Habitats in Spring Stop-over

Habitat	N	Mean	Std. Deviation	Std. Error	95% Confidence Lower Bound	95% Confidence Upper Bound	Minimum	Maximum
Clearcut	13	8.85	4.160	1.154	6.33	11.36	0	17
Mixed Forest	6	11.50	3.728	1.522	7.59	15.41	6	17
Agricultural	6	2.00	1.265	.516	.67	3.33	0	3
Disturbed Mixed	14	13.71	7.700	2.058	9.27	18.16	3	25
Total	39	9.95	6.617	1.060	7.80	12.09	0	25

Figure 11: Headings of Birds in Diurnal Passage in the Spring



segments indicates that there was a significantly lower number of birds on the agricultural lands.

Three species of migrants had statistically significant preferences for certain habitat types in stop-over. The Hermit Thrush had a preference for disturbed mixed forests, the Palm Warbler for clearcuts and disturbed mixed forest, and Purple Finch for mixed forests.

DIURNAL PASSAGE

The diurnal passage observations from the transects and observation stations re-affirm a low level of diurnal passage in the spring in the study area. Only 26 birds, consisting of 8 different species, were seen that were clearly in diurnal migration. Figure 11 demonstrates that north was the predominate heading of these migrants.

The systematic observation of diurnal migrants and local birds from two observation stations (#1 and #2 in Figure 6) provided information on the altitude of birds flying over the project area and their proximity to the location of proposed turbines. These observations included both diurnal migrants and movements of local birds.

Out of 19 one-half hour observation blocks, there were only 2 blocks in which no flying birds (above tree-top level) were observed. In the 17 remaining blocks, there was a total of 16 observations of 1 to 2 birds that were over the project area but not close to a proposed turbine location (>250 meters). There were 9 other observations of 1 to 4 birds that were within 250 meters of a turbine location. Among these, 2 observations were of birds (one each of Common Raven and American Crow) that were flying below blade height (less than 40 meters). There were 7 observations of a total of 13 birds (2 American Crows, 1 Common Raven, 2 Northern Harriers, 6 Ospreys, and 2 Red-tailed Hawks) that were flying at blade height (40-120 meters). No birds were seen flying above blade height.

NOCTURNAL PASSAGE

Nocturnal acoustic data was collected at two stations, #1 and #3 as shown in Figure 6. In total 343 night flight calls were heard at Station 1 from April 18 to June 10, during the spring migration season. The vast majority were high frequency calls consisting of warblers (178 calls) and sparrows (134 calls). At Station 3 only the high frequency calls were analyzed resulting in 428 calls from May 4 to June 10. At this station there were 150 warbler calls and 270 sparrow calls. Looking only at high frequency calls, Station 1 averaged 6.35 calls per night compared to 11.26 calls per night at Station 3. A breakdown of the night flight calls by family and frequency is shown in Table 7, and the ten most

Table 7: Number of Night Flight Calls by Family and Frequency in the Spring

Frequency	Buntings	Sparrows	Gulls	Warblers	Thrushes	Unknown	Total
High	2	399	0	311	0	16	728
Low	0	0	1	0	16	3	20
Total	**2**	**399**	**1**	**311**	**16**	**19**	**748**

Table 8: Ten Most Common Night Flight Calls in the Spring

Species	Calls
White-throated Sparrow	148
Savannah Sparrow	111
Dark-eyed Junco	74
Ovenbird	44
Sparrow unidentified	34
Magnolia Warbler	34
American Redstart	34
Northern Waterthrush	25
Common Yellowthroat	21
Northern Parula	20

common species are presented in Table 8.

Table 9 presents the number of night flight calls recorded by station and the number of hours after civil sunset for the nine most common species. Warblers (first six columns in table) are primarily recorded in the first three hours after civil sunset (60% or more) and especially in the first hour (up to 52%). The Savannah Sparrow was also recorded largely in the first 3 hours after civil sunset (64%) while the other two sparrow species, Dark-eyed Junco and White-throated Sparrow, were recorded primarily in 6th and 7th hours after civil sunset, that is, in the two hours before civil sunrise (100% and 68% respectively). All species but two were recorded in more or less equal numbers at the two stations. White-throated Sparrows and Dark-eyed Juncos were recorded in much greater numbers at Station 3. This location is a clearcut area; a preferred stop-over habitat for these two species. This

Table 9: Percentage of Night Flight Calls by Hours of the Night, Species, and Station in the Spring

Hours after Civil Sunset	American Redstart	Common Yellowthroat	Magnolia Warbler	Northern Parula	Northern Waterthrush	Ovenbird	Savannah Sparrow	Dark-eyed Junco	White-throated Sparrow	Total
0	**26%**	**43%**	**44%**	**15%**	**52%**	**43%**	**36%**	**0%**	**12%**	**25%**
Station 3	15%	19%	15%	10%	24%	20%	8%	0%	5%	9%
Station 1	12%	24%	29%	5%	28%	23%	28%	0%	7%	15%
1	**18%**	**5%**	**6%**	**20%**	**12%**	**14%**	**11%**	**0%**	**2%**	**7%**
Station 3	6%	5%	3%	10%	4%	5%	5%	0%	0%	3%
Station 1	12%	0%	3%	10%	8%	9%	6%	0%	2%	5%
2	**26%**	**19%**	**12%**	**25%**	**0%**	**9%**	**17%**	**0%**	**4%**	**10%**
Station 3	15%	5%	6%	20%	0%	7%	6%	0%	1%	5%
Station 1	12%	14%	6%	5%	0%	2%	11%	0%	3%	5%
3	**15%**	**19%**	**12%**	**15%**	**4%**	**14%**	**8%**	**0%**	**5%**	**8%**
Station 3	9%	10%	6%	5%	4%	5%	4%	0%	1%	3%
Station 1	6%	10%	6%	10%	0%	9%	5%	0%	4%	5%
4	**3%**	**14%**	**18%**	**25%**	**24%**	**11%**	**7%**	**0%**	**7%**	**9%**
Station 3	3%	10%	9%	10%	8%	5%	5%	0%	3%	5%
Station 1	0%	5%	9%	15%	16%	7%	2%	0%	4%	4%
5	**9%**	**0%**	**9%**	**0%**	**8%**	**9%**	**8%**	**99%**	**14%**	**23%**
Station 3	3%	0%	3%	0%	4%	7%	3%	99%	14%	20%
Station 1	6%	0%	6%	0%	4%	2%	5%	0%	1%	3%
6	**3%**	**0%**	**0%**	**0%**	**0%**	**0%**	**13%**	**1%**	**54%**	**19%**
Station 3	3%	0%	0%	0%	0%	0%	10%	0%	53%	18%
Station 1	0%	0%	0%	0%	0%	0%	3%	1%	1%	1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Habitat of Station 2 is a clearcut; nearest woodland is 250 meters away
Habitat of Station 1 is a hay field; nearest woodland is 400 meters away

suggests there may be a relation between number and species of birds recorded just before dawn and the stop-over habitat in which the recording station is located.

A negative binomial generalized linear model was used to explore the relationship between the number of night flight calls per night and weather conditions. The model indicated that relative humidity, barometric pressure, and wind direction were significant factors affecting the number of calls in a night. The largest number of calls were recorded with northeast winds, a relative humidity over 80%, and a barometric pressure over 101.00 kPa. The two nights with the highest call counts during the spring migration were May 12 and 21. The count of flight calls at each recording station and the mean weather conditions for the calls are shown in Table 10. On both these nights it appears that a light northeast wind with high humidity, and pressure falling from relatively elevated levels

Table 10: Mean Weather Conditions for Flight Calls on Peak Nights of Nocturnal Migration in the Spring

Date	Station	Call Count	Mean Wind Direction	Mean Wind Speed	Mean Pressure	Mean Change in Pressure	Mean Temp.	Mean Humidity	Dominant Species
12-May	1	5	NE	11.60	102.09	0.05	1.90	92.80	Savannah Sparrow
	3	66	NE	2.10	102.04	-0.01	-0.60	99.85	White-throated Sparrow
21-May	1	18	NE	5.89	101.07	-0.02	10.43	95.00	Mixed Warblers
	3	77	NE	6.03	101.15	-0.03	10.25	96.61	Dark-eyed Junco

resulted in the descent of a significant number of sparrows, the Dark-eyed Junco and White-throated Sparrow. Note that this took place at the recording station (#3) with the stop-over habitat most appropriate for these two species. On May 12, 65% of the calls were recorded during the last hour before civil sunrise and 86% during the same time period on May 21.

Figure 12: Comparison of Night Flight Calls with Total Birds on Stop-over Transects by Date in the Spring

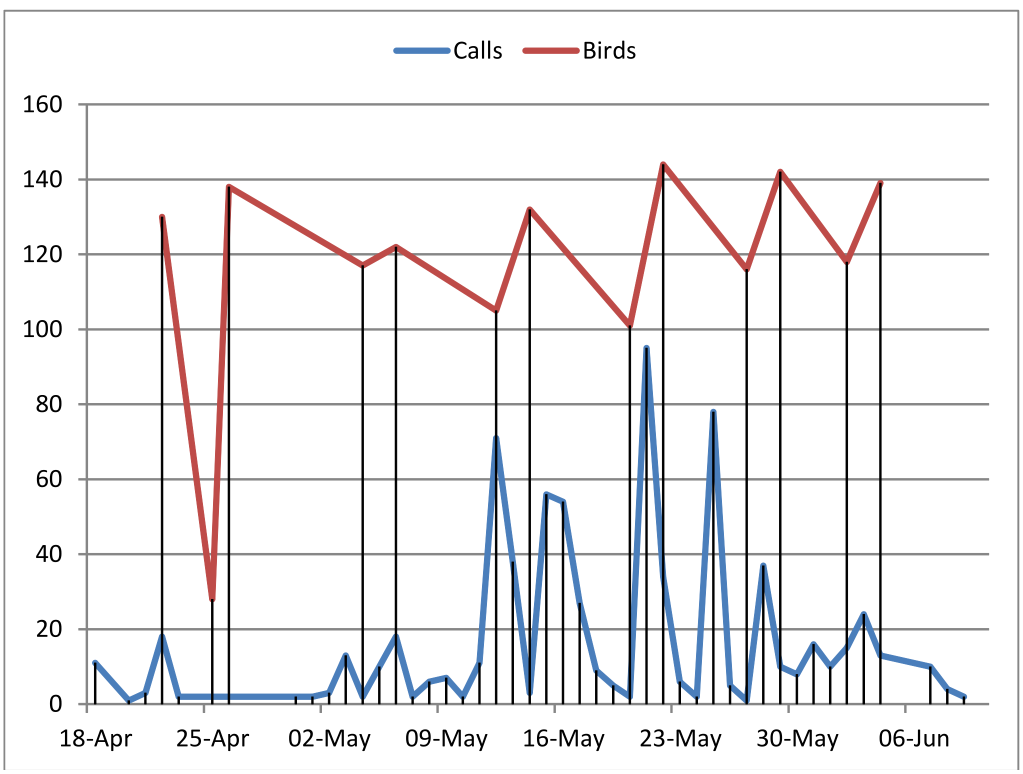
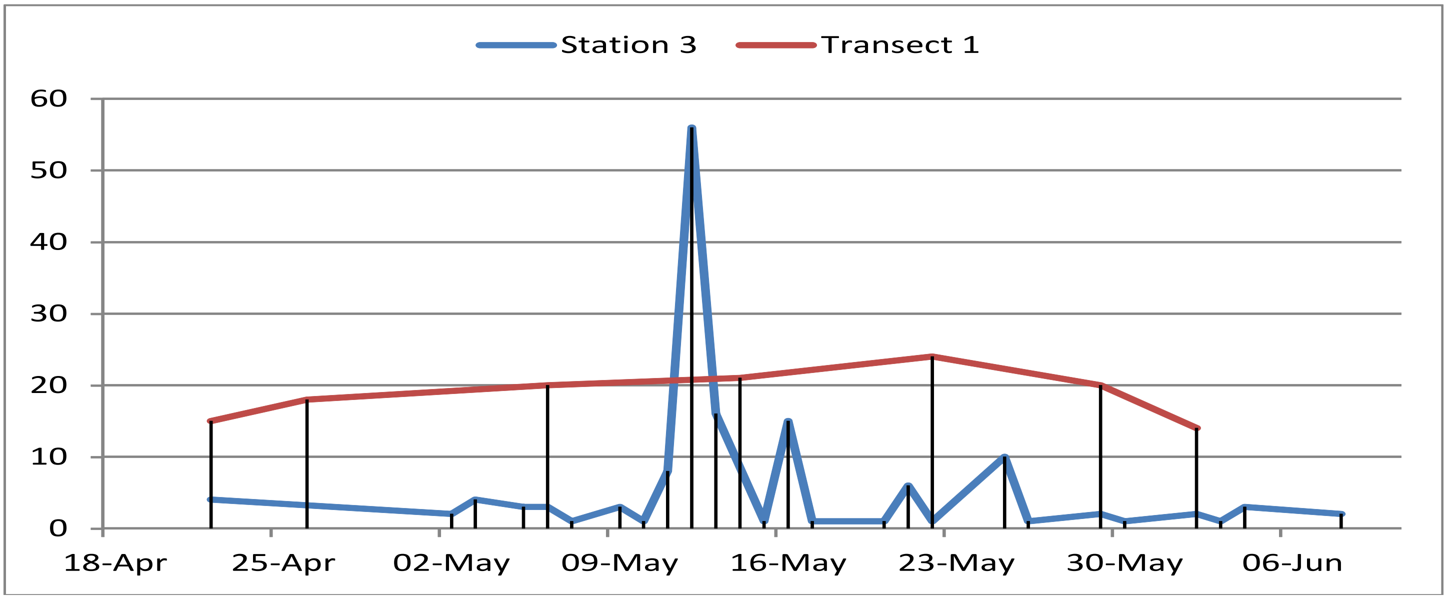


Figure 12 shows the relationship between the number of night flight calls recorded and processed and the total number of birds on the stop-over transects by date. The number of flight calls and the number of birds on the transects follow a similar pattern from May 12-25. Otherwise, however, there are more birds on the transects than might be indicated by the number of flight calls. However, if one examines the results coming from recording Station 3 which is located on Transect 1 for the White-throated Sparrows detected only on that transect in stop-over, there is a clearer relationship between the count of flight calls and birds on the transect.

Figure 13: Comparison of Night Flight Calls at Station 2 and Total Birds in Stop-over Transect 1 for White-throated Sparrow by Date in the Spring



The period of late April to the third week of May consists of stop-over birds arriving and departing, followed by a period primarily of departure in the last week of May.

BREEDING SEASON

Common Nighthawk in Flight

The breeding season is divided into three parts: nocturnal breeding birds, early breeding birds, and peak breeding birds. Breeding surveys focused on the peak breeding birds.

NOCTURNAL/CREPUSCULAR BREEDING BIRDS

Nocturnal breeding birds were surveyed by acoustic monitoring. Data processing for Station #1 (see Figure 6) showed that American Woodcocks were already engaged in courtship displays by April 18, the first night of recording. Common Nighthawks were first recorded on May 29 at Station 3 and on June 10 at Station 1. Common Nighthawks were frequently recorded during evening and morning

Table 11: Early Breeding Birds Detected in Study Area

Species	Number
American Black Duck	15
Mallard	13
Ruffed Grouse	16
Spruce Grouse	1
Downy Woodpecker	1
Hairy Woodpecker	4
Pileated Woodpecker	1
Gray Jay	4
Common Raven	28
Common Grackle	20

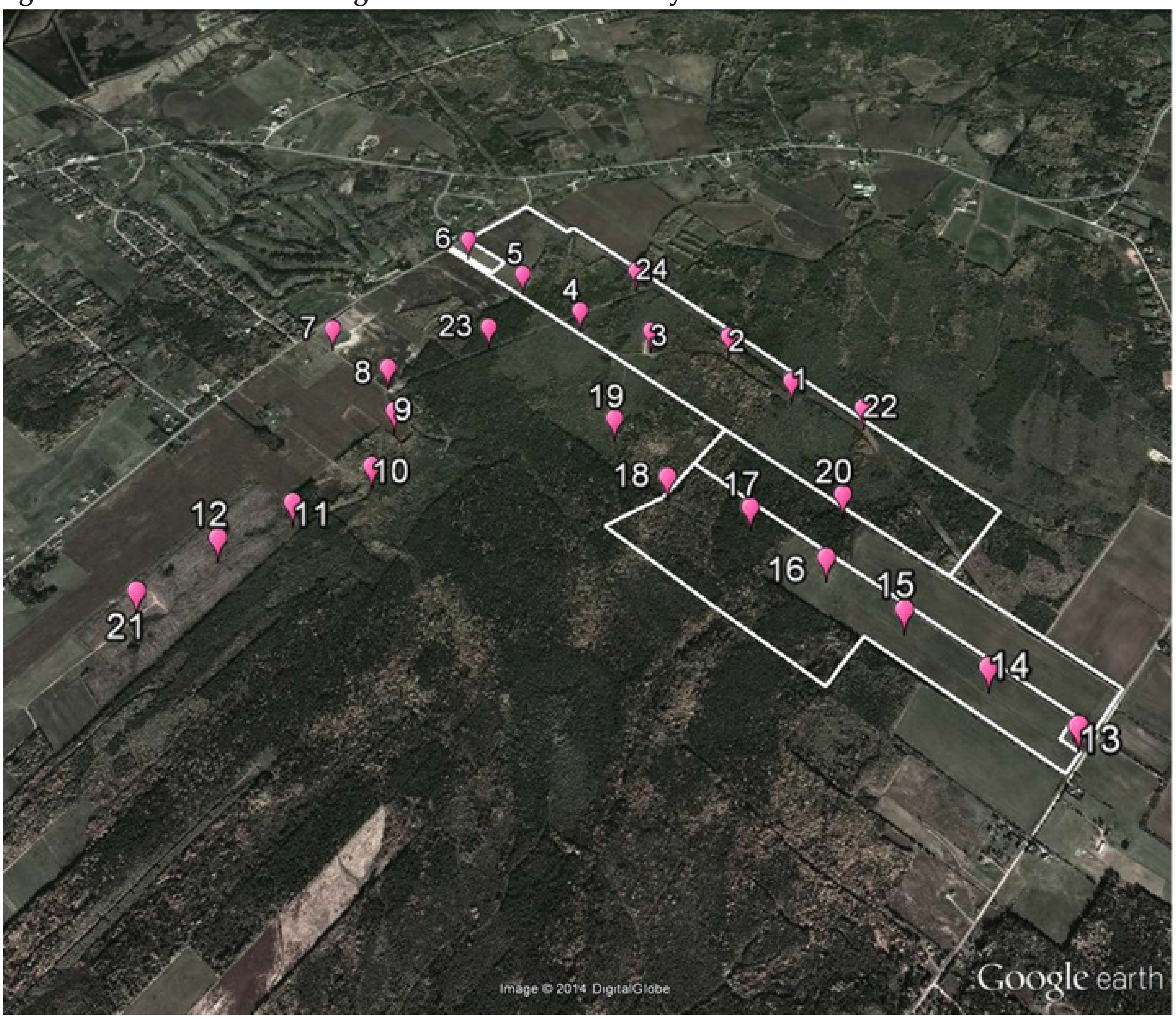
twilight hours when recording started again August 11 and on a number of nights thereafter. These data suggest that Common Nighthawks bred in the project area.

No owls were recorded. However, a Great Horned Owl was observed on the control transect on September 30; most likely a locally breeding bird.

EARLY BREEDING

A number of species breed early in the spring and are thus not as actively engaged in courtship and breeding activities by the time the peak season arrives in June. Table 11 lists a number of these species detected during the stop-over transects.

Figure 14: Location of Breeding Point Counts in the Study Area

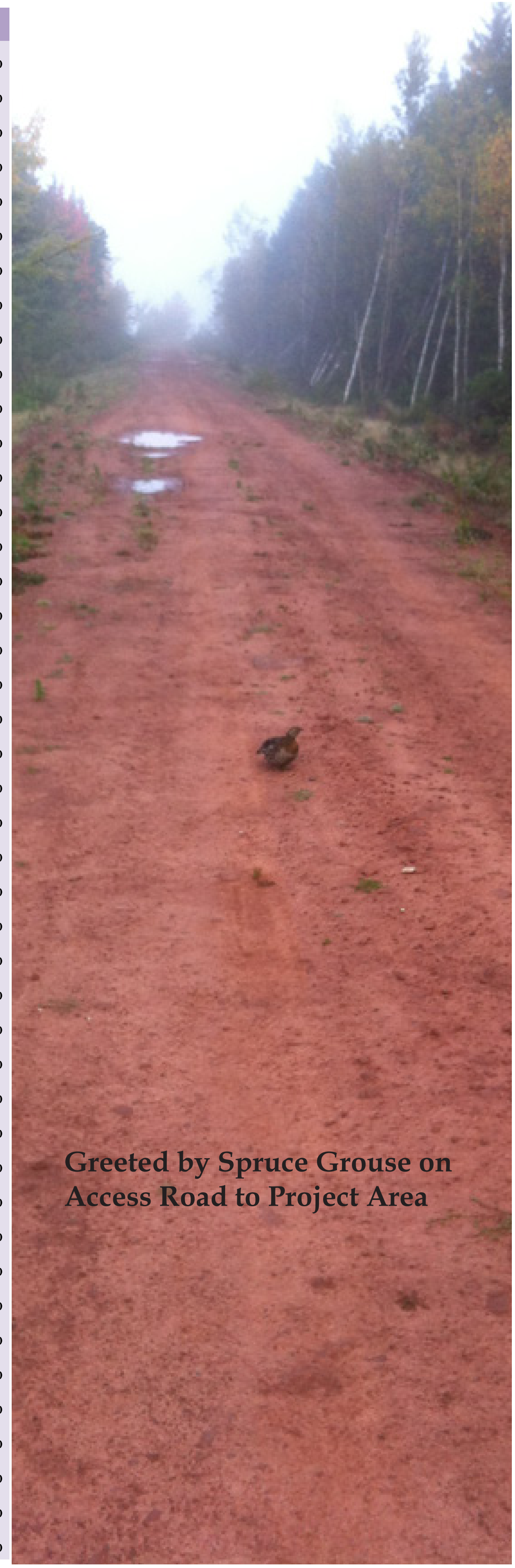


PEAK BREEDING BIRDS

The location of the 24 peak breeding point counts in the study area is shown in Figure 14.

Table 12: Abundance of Breeding Birds in Study Area by Species

Species	Total	Mean	Frequency
American Robin	74	3.08	83.33%
American Crow	52	2.17	79.17%
Ring-necked Pheasant	27	1.13	66.67%
Red-eyed Vireo	23	0.96	62.50%
White-throated Sparrow	40	1.67	45.83%
Hermit Thrush	14	0.58	45.83%
Common Yellowthroat	17	0.71	41.67%
Dark-eyed Junco	16	0.67	41.67%
Song Sparrow	21	0.88	37.50%
Magnolia Warbler	11	0.46	37.50%
Mourning Dove	9	0.38	37.50%
Alder Flycatcher	17	0.71	33.33%
Savannah Sparrow	16	0.67	29.17%
Northern Parula	7	0.29	29.17%
Yellow-rumped Warbler	7	0.29	25.00%
Black-and-White Warbler	6	0.25	25.00%
Purple Finch	6	0.25	25.00%
Blue Jay	7	0.29	20.83%
Black-throated Green Warbler	6	0.25	20.83%
American Goldfinch	6	0.25	20.83%
Blue-headed Vireo	5	0.21	20.83%
Palm Warbler	5	0.21	16.67%
Chestnut-sided Warbler	4	0.17	16.67%
Black-capped Chickadee	4	0.17	12.50%
Northern Flicker	3	0.13	12.50%
American Redstart	3	0.13	12.50%
Common Raven	4	0.17	8.33%
Tree Swallow	3	0.13	8.33%
Nashville Warbler	3	0.13	8.33%
Swainson's Thrush	2	0.08	8.33%
European Starling	24	1.00	4.17%
Golden-crowned Kingle	2	0.08	4.17%
Green-winged Teal	1	0.04	4.17%
Osprey	1	0.04	4.17%
Yellow-bellied Sapsucker	1	0.04	4.17%
Pileated Woodpecker	1	0.04	4.17%
Olive-sided Flycatcher	1	0.04	4.17%
Yellow-bellied Flycatcher	1	0.04	4.17%
Least Flycatcher	1	0.04	4.17%
Red-breasted Nuthatch	1	0.04	4.17%
Winter Wren	1	0.04	4.17%
Ruby-crowned Kinglet	1	0.04	4.17%
Blackburnian Warbler	1	0.04	4.17%
Common Grackle	1	0.04	4.17%



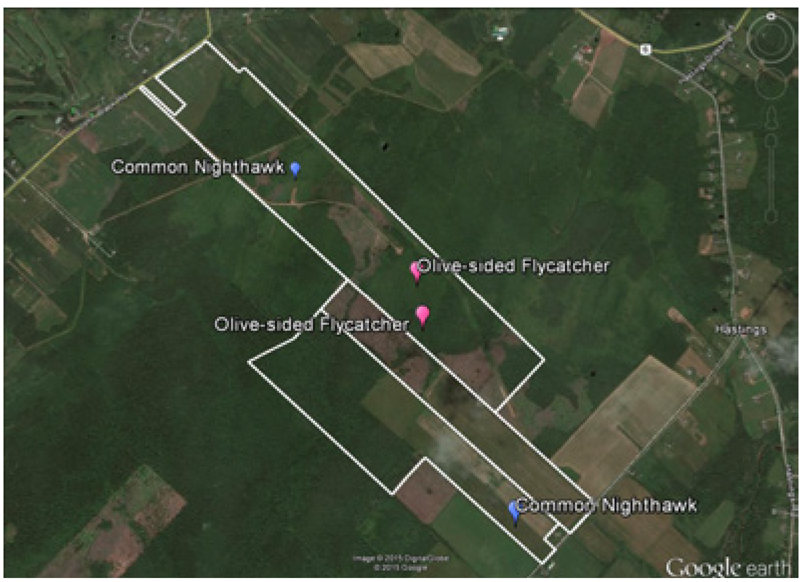
Greeted by Spruce Grouse on Access Road to Project Area

Table 12 lists the total number, mean number, and frequency of occurrence of birds on the breeding point counts by species.

Given the land use patterns in the study area, the most common birds are both forest birds and those associated with agricultural lands. The most common bird, American Robin, is one that benefits equally from forested and agricultural habitats. The second and third most common birds are American Crows and Ring-necked Pheasant, two largely agriculturally dependent species. The next seven most common species are forest or forest-edge associated species. These are Red-eyed Vireo, White-throated Sparrow, Hermit Thrush, Common Yellowthroat, Dark-eyed Junco, Song Sparrow, and Magnolia Warbler.

Figure 15 shows the location of the two species of birds that are listed as "threatened" by Canada Species at Risk Act (SARA). Two Olive-sided Flycatchers (perhaps the same one but on different days) were heard calling in a recent clearcut near the east side of the project area. As mentioned previously, the Common Nighthawk, also listed as "threatened", was detected by the acoustic recording equipment in two portions of the project area.

Figure 15: Location of SARA "Threatened" Species Detected during the Breeding Season



AUTUMN MIGRATION

As with the spring migration, the studies of autumn migration consist of three survey components; migration stop-over, diurnal passage, and nocturnal passage.

MIGRATION STOP-OVER

The mean total birds seen on the stop-over transects during the autumn is plotted in Figure 16. There were two peaks in the birds observed; the first during the period September 16-17 and the second on October 14-15. Despite these peaks, an analysis of variance indicates no statistically significant seasonal trend in the abundance of birds on the stop-over transects. In contrast, an analysis of variance indicates a seasonal difference in the mean number of species on the transects in the autumn. As seen in Figure 17, there is a sharp downward trend in the number of species in the month of October.

The total birds on each transect, one in the project area and one in the control area, is shown in Figure 18. The two transects follow a corresponding pattern with the control transect showing higher numbers during the two peak periods in mid-September and mid-October. Nonetheless, an independent T-test indicates that there is no statistically significant difference in the total birds

Figure 16: Mean Total Birds on Stop-over Transects by Count Period in the Autumn

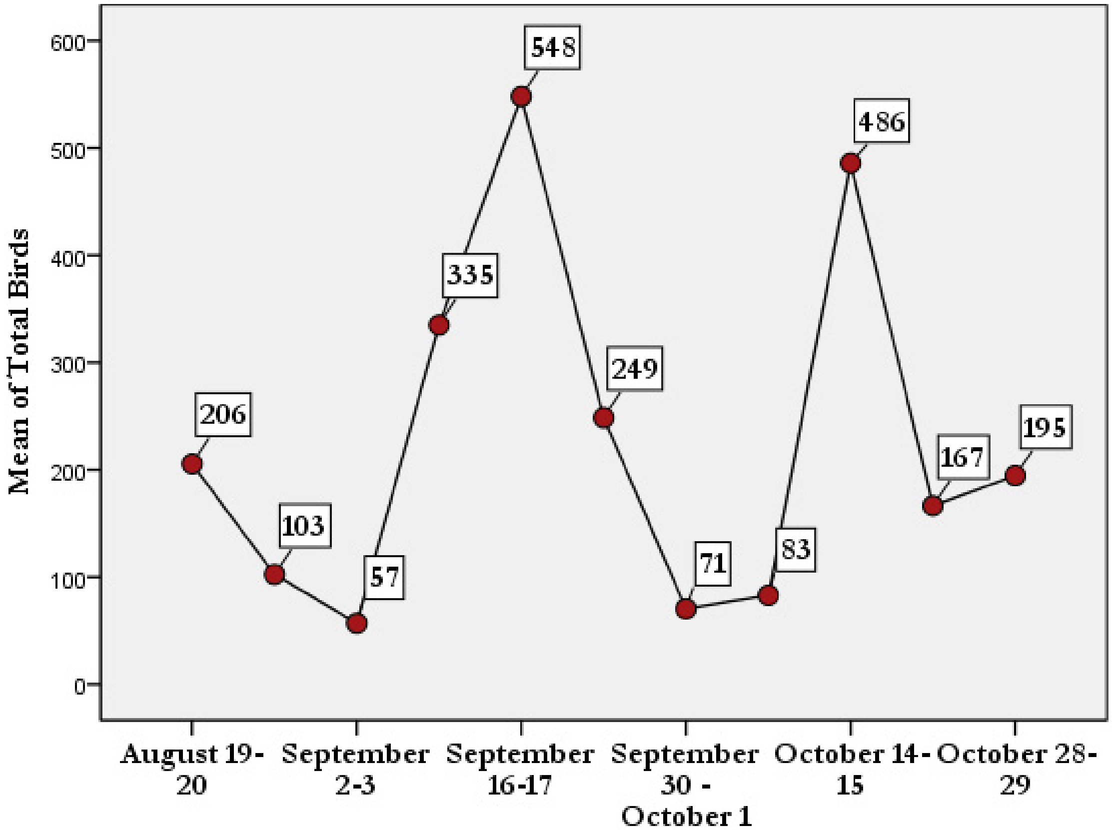


Figure 17: Mean Total Species on Stop-over Transects by Count Period in the Autumn

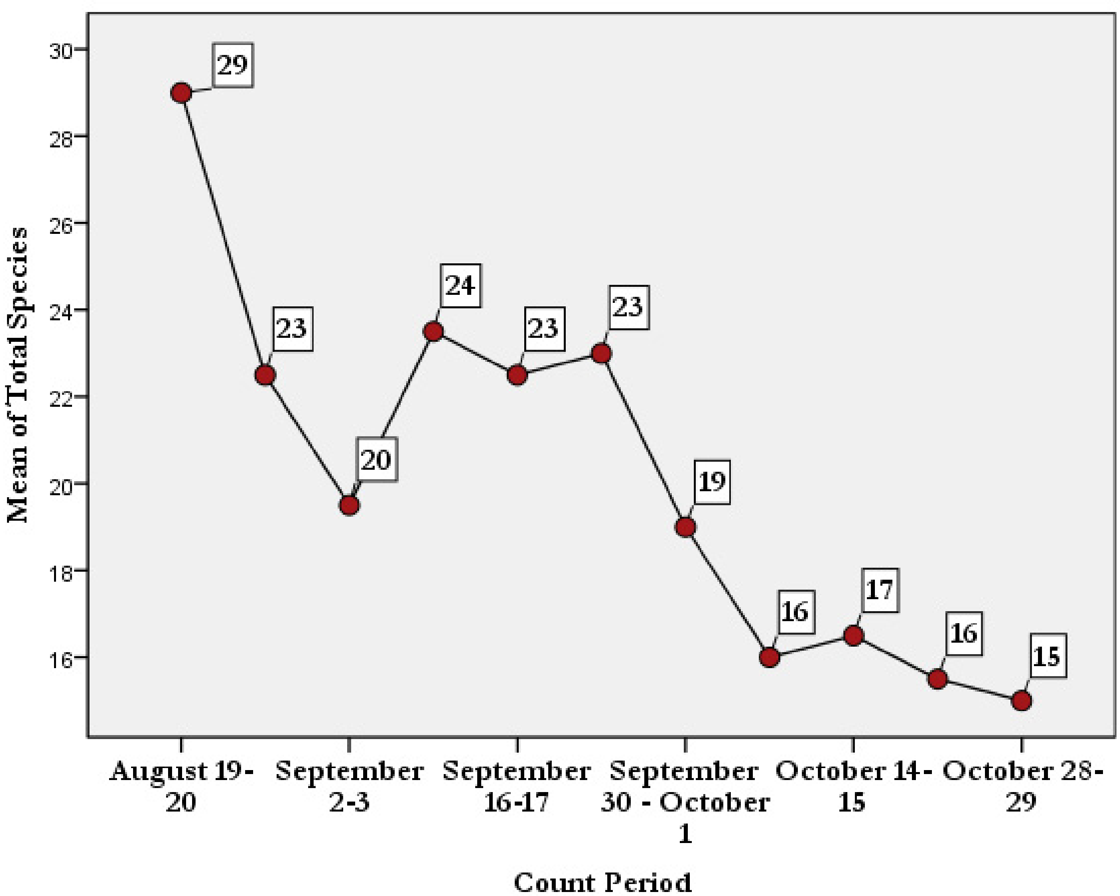


Figure 18: Total Birds per Transect by Date in the Autumn

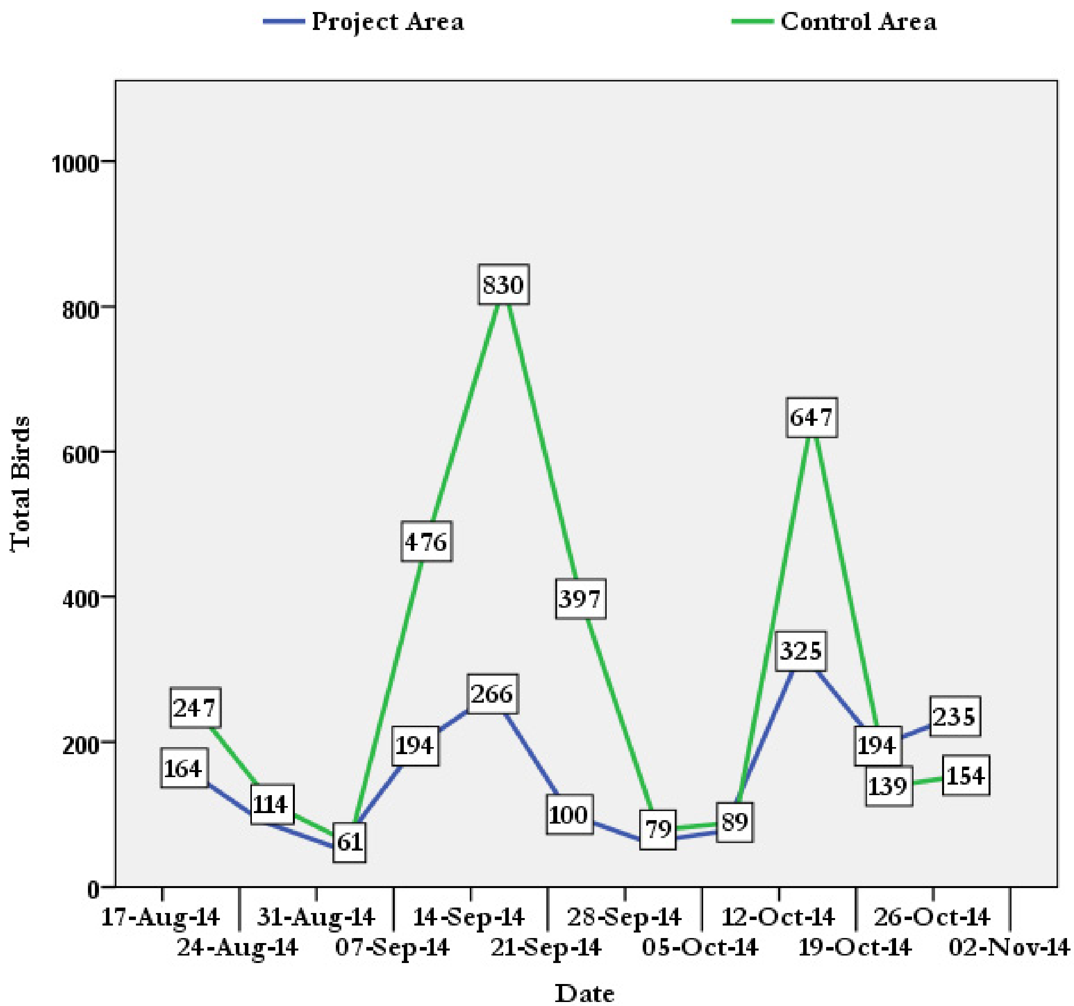


Table 13: Twenty Most Abundant Species on Stop-over Transects in the Autumn

Species	Total
Common Grackle	1943
American Robin	483
Double-crested Cormorant	393
Blue Jay	277
Red-winged Blackbird	245
American Crow	236
Ring-billed Gull	168
White-throated Sparrow	136
European Starling	117
Black-capped Chickadee	110
Savannah Sparrow	96
Dark-eyed Junco	80
Common Yellowthroat	57
Ring-necked Pheasant	57
Yellow-rumped Warbler	52
Song Sparrow	49
Palm Warbler	49
Common Raven	46
Purple Fince	43
Magnolia Warbler	32

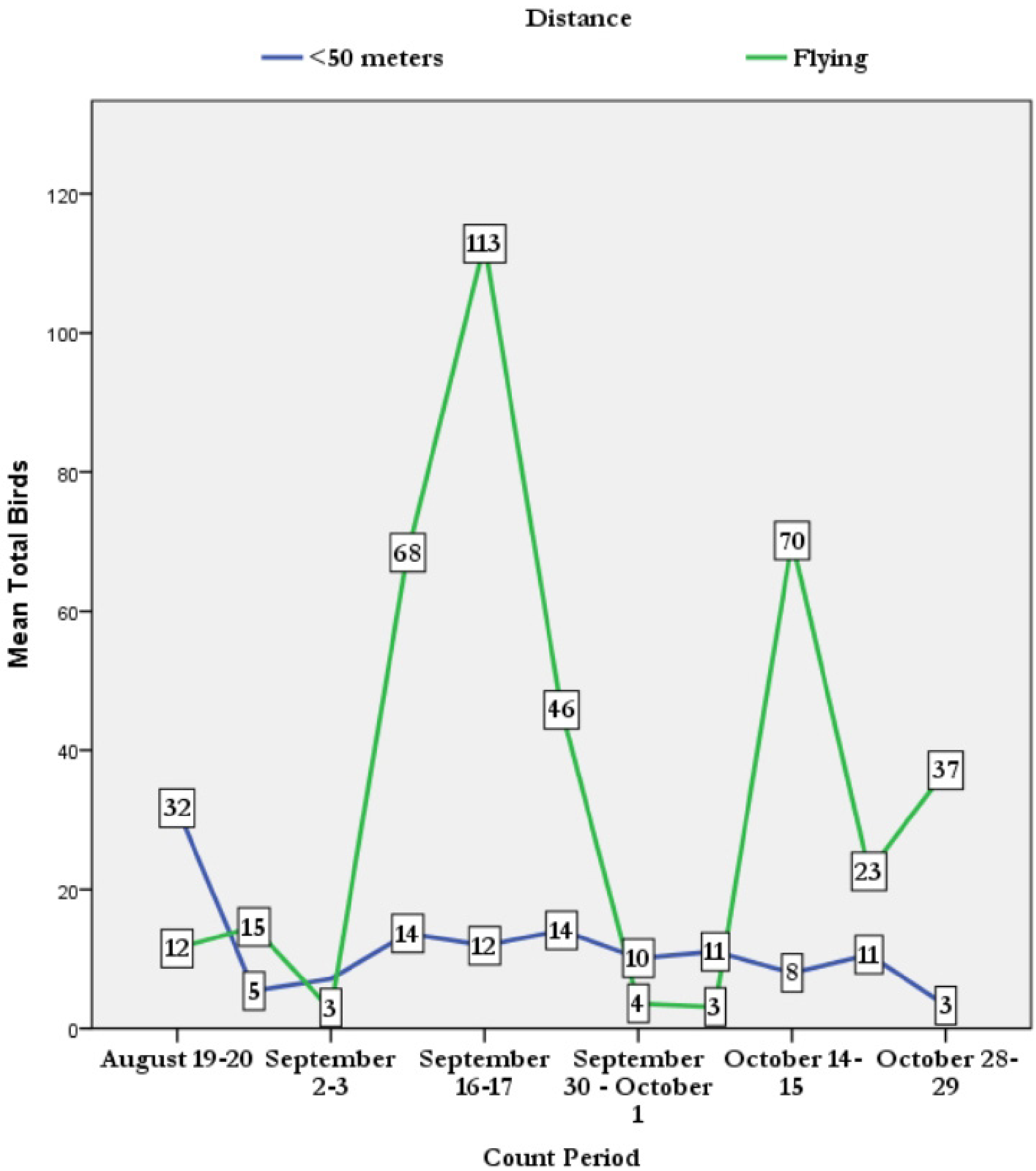
occurring on the two transects.

Table 13 lists the twenty most abundant birds on the stop-over transects in the autumn.

As in the spring migration, there is a statistically significant difference in the mean number of birds observed from the transect at a distance of less than 50 meters compared to those birds seen flying over the transect. However, unlike the spring, and as seen in Figure 19, the number of birds flying over the transects is much greater than those on the ground or in the trees within 50 meters. The mean number of birds within 50 meters is 46.45 and for flying birds it is 147.09. This could indicate a high degree of diurnal passage at the time the transect lines are walked as discussed in the next section.

Automatic linear modeling was employed in SPSS to determine possible weather facts affecting the number of birds in stop-over (based on the number of birds within 50-meters of

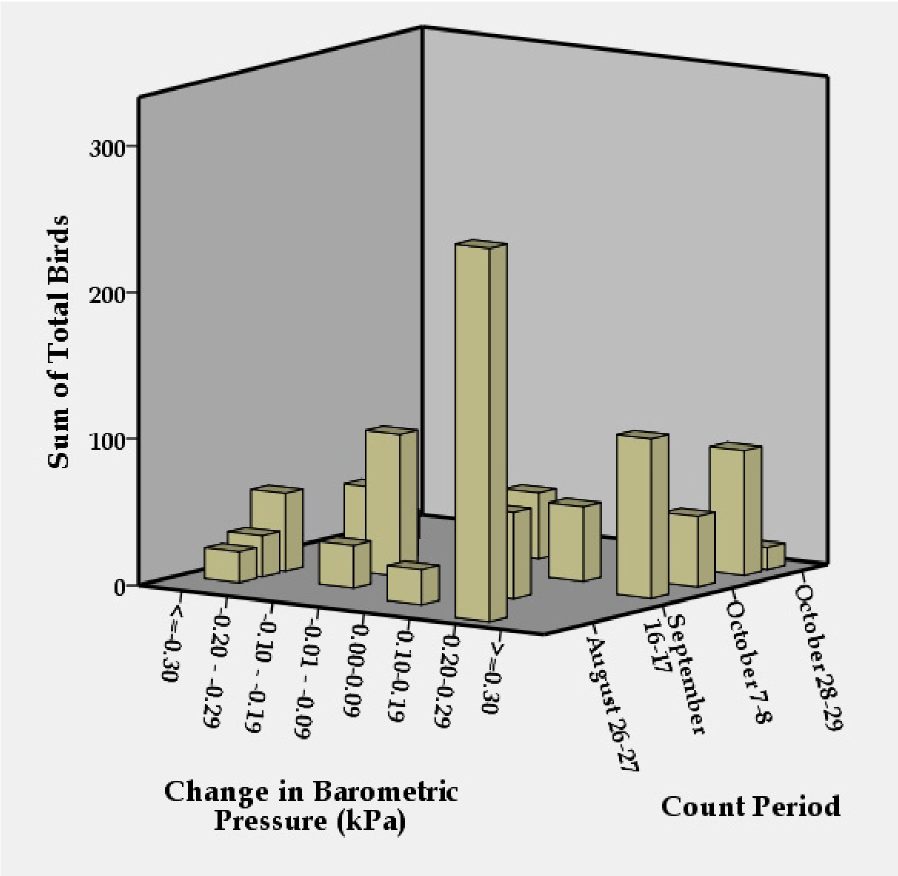
Figure 19: Mean Total Birds by Distance from Transect in the Autumn



the transect). A generalized linear model was then employed to test for significant effects. Barometric pressure at civil sunrise of between 100.00 and 100.99 kilo pascals, wind speeds of less than 20 km/hour during the survey, and rising barometric pressure during the previous night had statistically significant positive effects on the number of birds in stop-over. Figure 20 shows the relationship between the number of birds within 50 meters of the transect and the change in barometric pressure between civil sunset and civil sunrise during the night preceding the survey by count period.

An analysis of variance (ANOVA) of the total birds seen within 50 meters of the 3 segments and 6 stop-counts of each transect found statistically significant habitat preferences for seven species of birds in stop-over. Golden-crowned Kinglets and Hermit Thrushes preferred a mixed forest habitat. Blue Jays were found primarily in disturbed mixed forests. Palm Warblers and White-throated Sparrow preferred clearcuts or early regenerating forests while the Savannah Sparrow and the non-migratory Ring-necked Pheasant were found on agricultural lands.

Figure 20: Relationship of the Sum of All Birds within 50 meters of the Transect and the Change in Barometric Pressure Between Civil Sunset and Civil Sunrise the Previous Night by Count Period in the Autumn



DIURNAL PASSAGE

Diurnal migration was much more apparent in the autumn than in the spring. Compared to a total of 26 diurnal migrants seen in the spring, there were 3,918 birds counted flying during the day in the autumn. Figure 20 displays the heading of these birds. The dominant heading is northeast with 1,930 birds flying in that direction. The secondary heading is southwest with 844 birds. However a large number of these diurnal observations included Common Grackles and Red-winged Blackbirds. Although these two species are diurnal migrants, their movements largely to the northeast in the early morning suggests that they were moving from a night time roost in the Amherst marshes to feed in agricultural lands in the surrounding areas. A further factor to consider is the number of birds that are nocturnal migrants that are terminating or re-orienting their flights in the early morning hours.

Figure 21 shows the flight heading of those species of birds that are primarily diurnal migrants and excludes blackbirds and nocturnal migrants from the analysis. Here the pre-dominant direction is southwest; a heading appropriate for diurnal migration in the autumn.

Figure 22 displays the heading of nocturnal migrants by time of day. In the first hour after sunrise, the primary heading is northwest, in the second hour it is west, and for the next 7 hours it is

Figure 21: Heading of All Birds Flying during the Day in the Autumn; N=3918

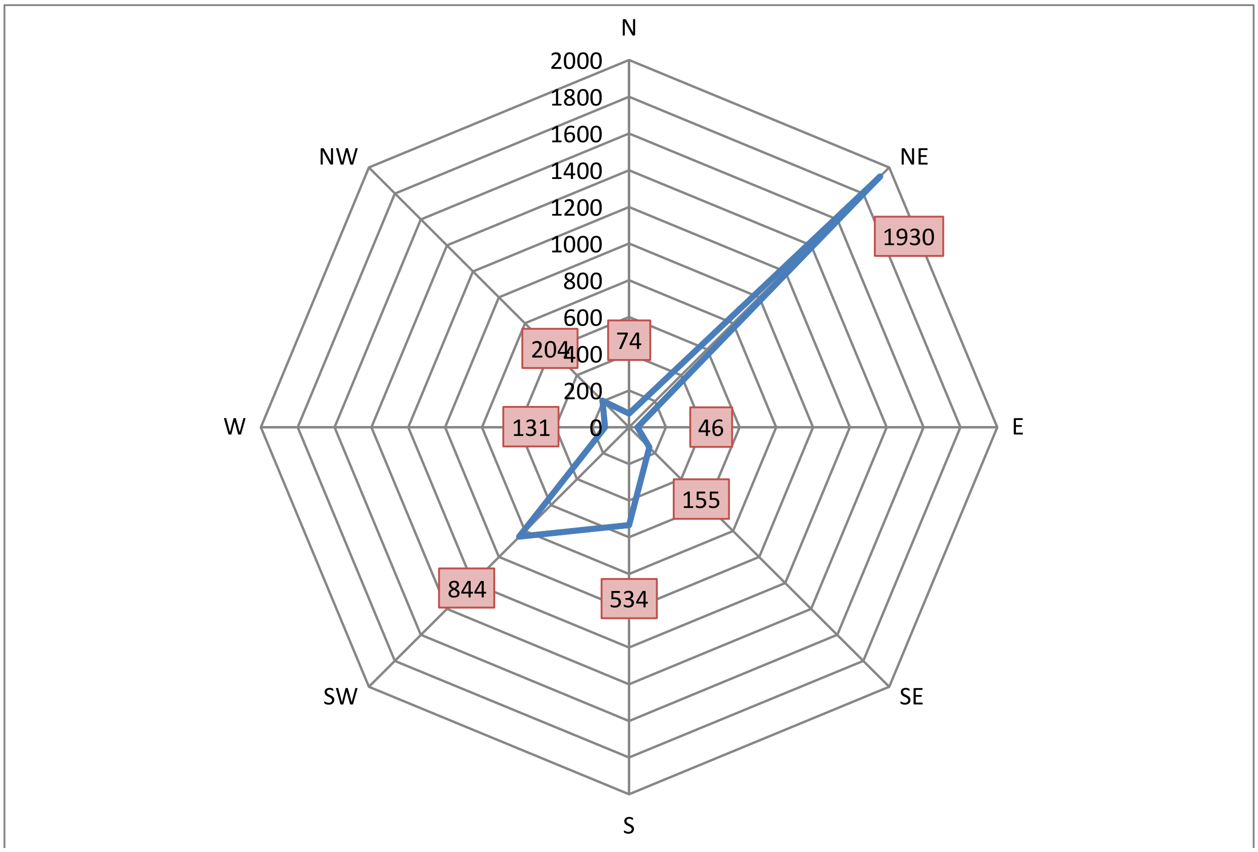


Figure 22: Heading of Diurnal Migrants in the Autumn; N=675

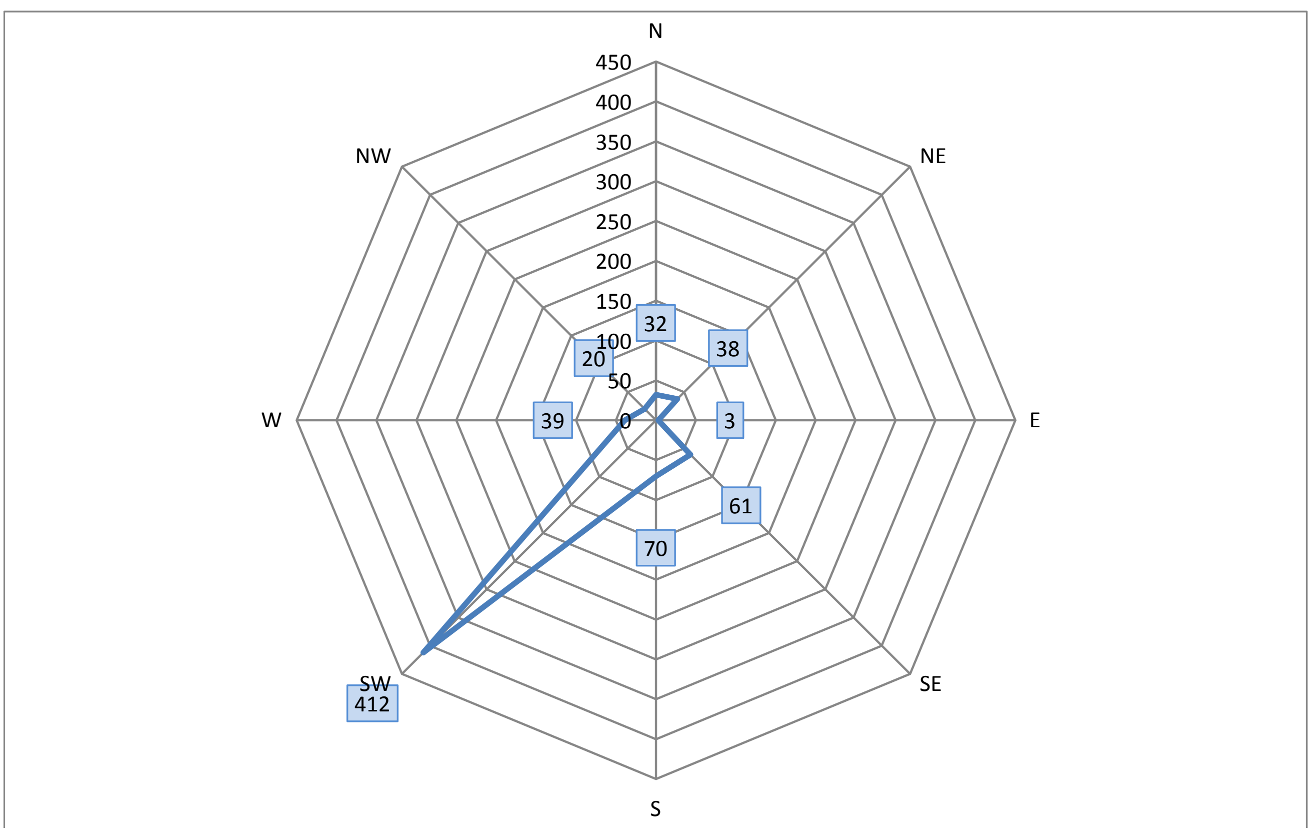


Figure 23: Heading of Nocturnal Migrants by Time of Day in the Autumn

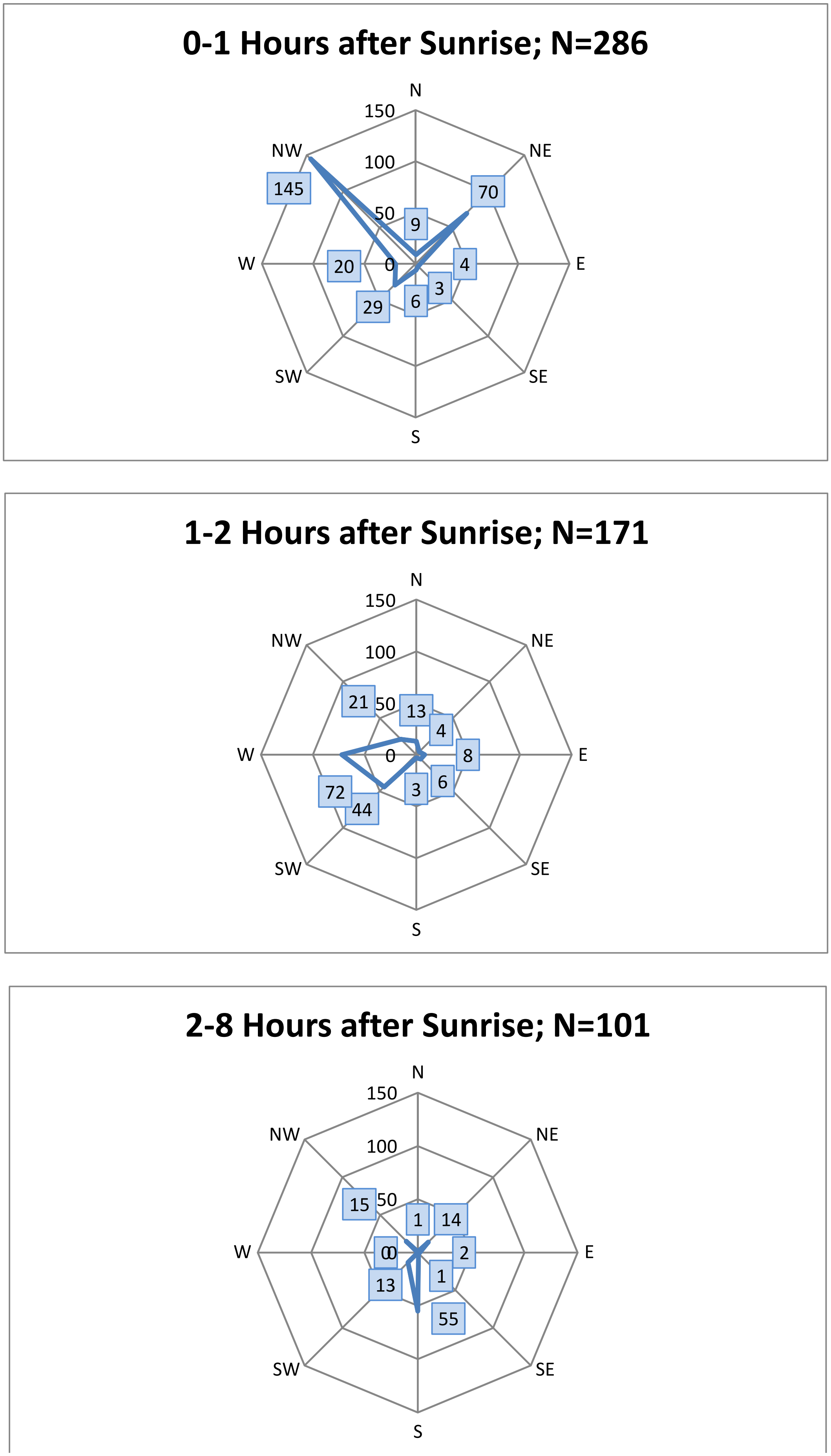


Table 14: Summary of Altitudinal Observations in the Autumn

Turbine Area*	Number of Observations	Altitude Category**	Number of Observations	Number of Birds
No	56	1	33	918
		2	23	160
		3	0	0
Yes	31	1	17	87
		2	13	76
		3	1	2
Total	87		87	1,243

* No means greater than 250 meters from proposed turbine location

** 1=Less than 40 meters; 2=40-120 meters; 3=greater than 120 meters

south. There is a corresponding decrease in the number of nocturnal migrants seen during those time categories from 286 to 171 to 101. This pattern indicates an early morning re-orientation of nocturnal migrants to the northwest, backing in the next hour to west and southwest.

Table 14 summarizes the altitudinal data available. These data were collected through systematic observations on the transects and at the observation stations (See Figure 6). Most birds were flying below blade height (less than 40 meters) while 19% were at blade height (40-120 meters). Systematic observations at Station #1, where there is the most direct view of the proposed turbine locations, yielded the same result with 18% of birds observed at blade height.

It is important to note, however, that the altitudinal data collected through systematic observation always commenced after the completion of the stop-over transects. This means that the observations do not include data for the first 1.5 to 2 hours after sunrise when diurnal migration was the most intense. Random notes on flight altitudes during the first 1.5 hours after sunrise show two flocks of grackes, one of 180 birds and another of 670 birds, flying at 40-120 meters on September 16 and 17 respectively. Another common diurnal migrant in the early morning, the Double-crested Cormorant would also fly at the 40-120 meter altitude category.

Table 15: Ten Most Abundant Species in Diurnal Passage in the Autumn

Species	Number
American Robin	419
Double-crested Cormorant	393
Blue Jay	195
Passerines unspecified	56
Finches unspecified	32
Bobolink	26
Purple Finch	18
Cedar Waxwing	14
Yellow-rumped Warbler	14
Canada Goose	9

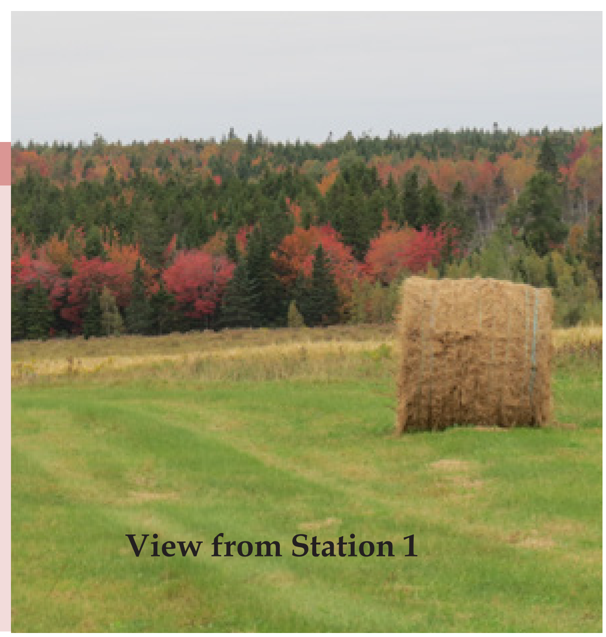
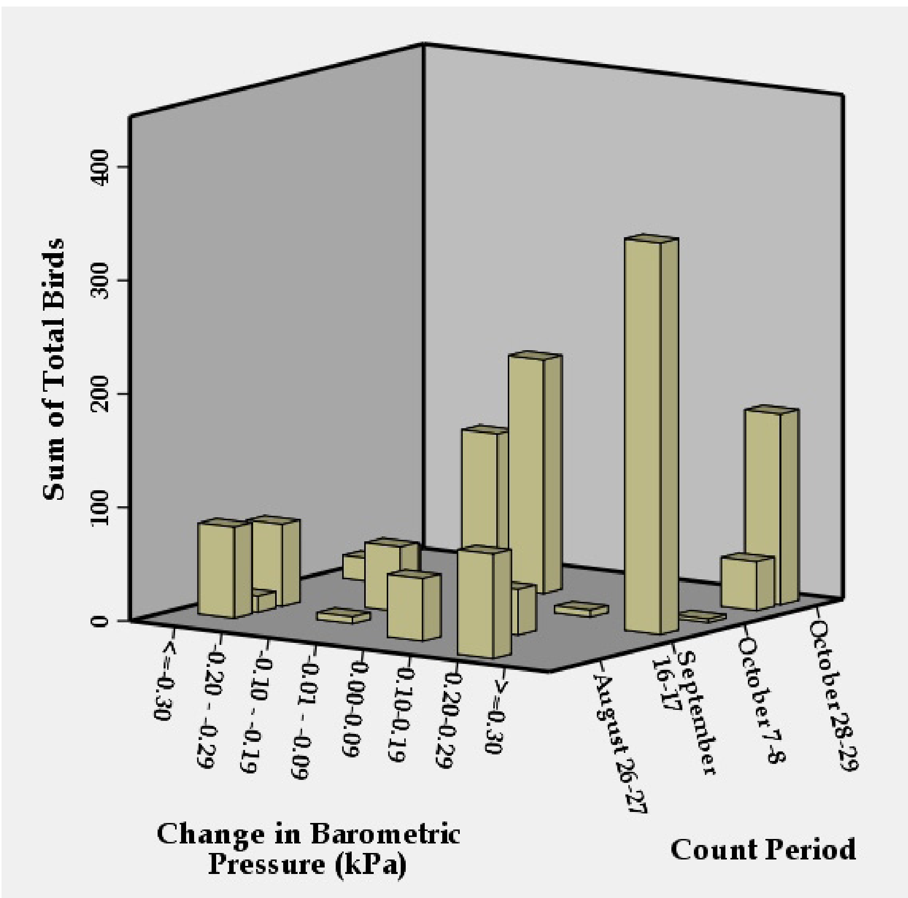

View from Station 1

Table 15 lists the ten most abundant species in diurnal passage (excludes local non-migrating birds).

A automated linear model in SPSS was used to identify key weather effects on diurnal passage. A generalized linear model was then employed to test the significance of these weather variables on the number of birds in diurnal passage on the transects based on the number of birds (excluding all blackbirds) in the flying over the transect distance category. Significant positive effects were found with the combination of rising barometric pressure through the night, relative humidity

Figure 24: Relationship of the Sum of All Birds (Excluding Blackbirds) Flying over the Transects and the Change in Barometric Pressure Between Civil Sunset and Civil Sunrise the Previous Night by Count Period in the Autumn



of 80-89% at civil dawn, and a temperature of 1-5 degrees during the transect survey.

Figure 24 shows the increasing number of birds in morning flight (diurnal and re-orienting nocturnal migrants) later in the season and the trend toward greater number of birds with rising barometric pressure.

NOCTURNAL PASSAGE

Nocturnal acoustic data in the autumn was collected at two stations, #1 and #3, as shown in Figure 6.. At Station 1, both high frequency and low frequency night flight calls were processed. At

Table 16: Types of Flight Calls Recorded at Stations 1 and 3 in the Autumn

Type of Call	Station 1	Station 3
High Frequency	5,637	6,229
Sparrows	1,184	1,958
Warblers	4,297	3,931
Others	156	340
Low Frequency	1,225	N/A
Thrushes	976	N/A
Others	249	N/A
Total	6,862	6,229

Station 3, only the high frequency calls were processed. The processed recordings yielded a total of 13,091 night flight calls. Table 16 shows the breakdown of flight calls by station. There were 592 more high frequency flight calls recorded at Station 3 and Station 1, due largely to the higher number of sparrows at Station 3. Table 17 shows the number of flight calls recorded for each taxon. The most common species were Magnolia Warbler, White-throated Sparrow, and Savannah Sparrow (all have high frequency calls). The most common species giving

Table 17: Number of Flight Calls at Stations 1 and 3 by Taxon in the Autumn

Taxon	Calls	Taxon	Calls
Magnolia Warbler	1,295	Duck, unidentified	32
White-throated Sparrow	1,258	Semipalmated Plover	28
Savannah Sparrow	1,054	Black-throated Blue Warbler	22
Blackpoll Warbler	768	Black-capped Chickadee	22
Common Yellowthroat	761	Least Sandpiper	21
Swainson's Thrush	660	Nelson's Sparrow	20
American Redstart	631	Tennessee Warbler	19
Warbler of Genus *Setophaga* , unidentified	596	Killdeer	15
Ovenbird	576	Wilson's Snipe	14
Warbler, unidentified	489	Greater Yellowlegs	12
Black-throated Green Warbler	451	Bobolink	11
Chestnut-sided Warbler	450	Rose-breasted Grosbeak	10
Northern Parula	383	Vesper Sparrow	10
Sparrow, unidentified	366	American Tree Sparrow	9
Yellow-rumped Warbler	266	Indigo Bunting	9
Bay-breasted Warbler	264	Unknown Bird Species	8
American Woodcock	249	White-crowned Sparrow	6
Hermit Thrush	238	Clay-colored Sparrow	6
Black-and-White Warbler	187	Fox Sparrow	3
Yellow Warbler	179	Golden-winged Warbler	3
Songbird, unidentified	163	Field Sparrow	3
Song Sparrow	163	Orange-crowned Warbler	2
Cape May Warbler	137	Great Blue Heron	2
Canada Warbler	121	Thrush of the Genus *Catharus* , unidentified	2
Blackburnian Warbler	117	Black Scoter	2
Dark-eyed Junco	115	Blue-winged Warbler	2
Nashville Warbler	109	Dickcissel	2
Mourning Warbler	104	Yellow-throated Warbler	2
Palm Warbler	102	Flycatcher of the Genus *Myiarchus* , unidentified	2
American Robin	88	Alder Flycatcher	1
Sparrow of Genus *Melospiza* , unidentified	71	Gray-cheeked Thrush	1
Chipping Sparrow	56	Wood Thrush	1
Warbler of Genus *Oreothlypis* , unidentified	54	Gull, unidentified	1
Prairie Warbler	56	Yellow-bellied Flycatcher	1
Northern Waterthrush	50	Grasshopper Sparrow	1
Golden-crowned Kinglet	45	Boreal Chickadee	1
Canada Goose	40	Prothonotary Warbler	1
Veery	38	Henslow's Sparrow	1
Wilson's Warbler	32	Black-bellied Plover	1
		Grand Total	13,091

Table 18: Number of Night Flight Calls by Hours after Civil Sunset in the Autumn

Hours after Civil Sunset	Calls
0	656
1	1,949
2	1,959
3	1,687
4	1,116
5	781
6	639
7	634
8	519
9	802
10	1,143
11	1,068
12	138
Total	**13,091**

low frequency calls were Swainson's Thrush and Hermit Thrush. In all, 67 taxon were identified to the species level which represented 86% of the calls recorded and processed.

The distribution of night flight calls through the hours of the night are presented in Table 18. The highest number of calls is in the period of 1 hour to 4 hours after civil sunset and then again at 10 to 11 hours after civil sunset. These might be seen as representing a period of ascent and a period of descent. However, the situation is more complicated as shown in Table 19. Here data are presented for the number of calls of some of the most common species during different periods of the night. Very few birds (0-16% of total calls) were detected between civil sunset and astronomical sunset which are respectively about one half hour and one hour and three-quarters after sunset. A high percentage of warbler species (the first five species in the Table 19) are recorded during true night, that is, between astronomical sunset and astronomical sunrise. For these species, 81 to 94 percent of calls are recorded in this period. For White-throated

Table 19: Number and % of Night Flight Calls by Periods of the Night for Selected Species in the Autumn

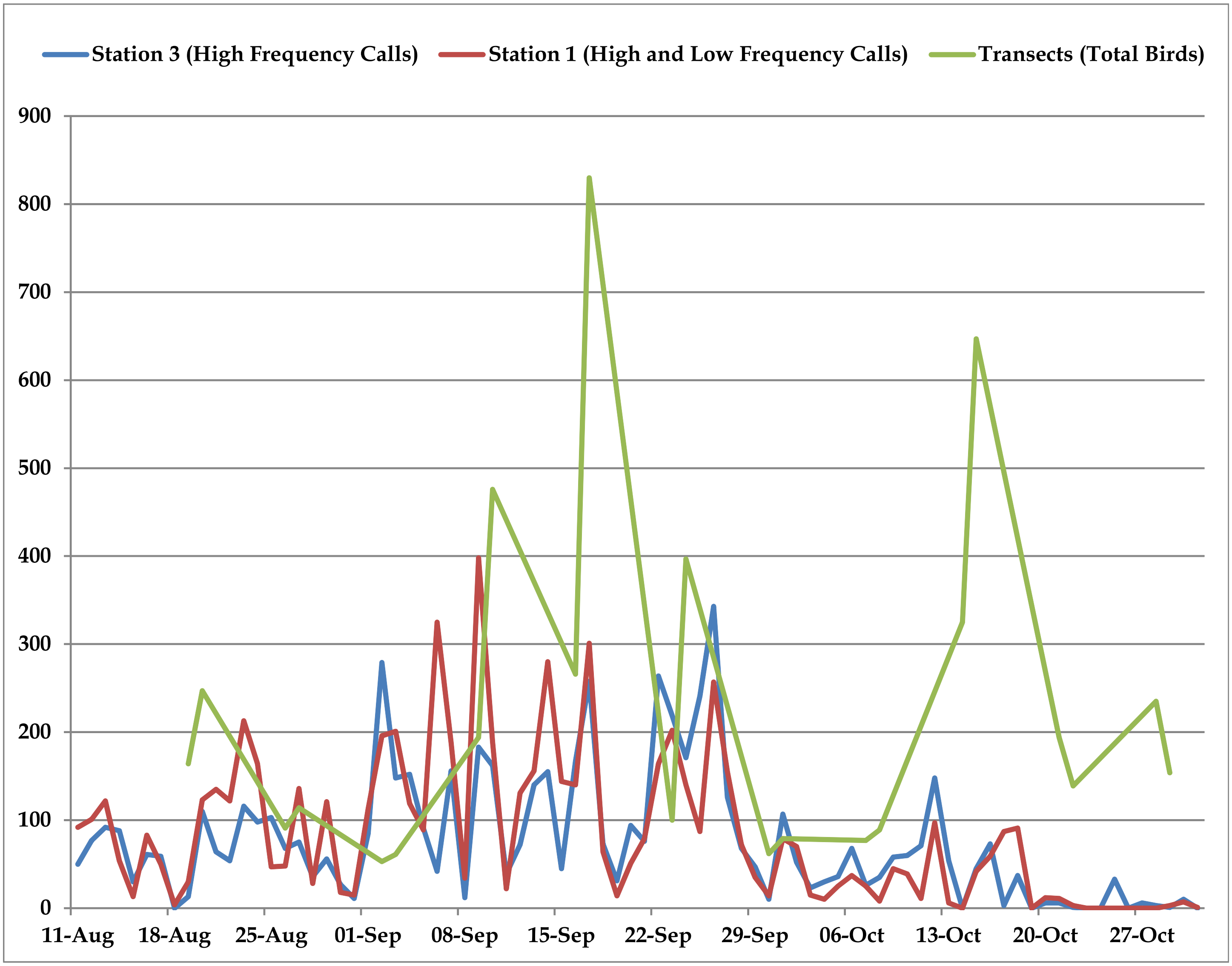
	American Redstart	Blackpoll Warbler	Common Yellowthroat	Magnolia Warbler	Ovenbird	Savannah Sparrow	White-throated Sparrow	Hermit Thrush	Swainson's Thrush
Civil Sunset to Astronomical Sunset	64	123	25	177	51	82	10	0	15
%	10.14%	16.02%	3.29%	13.67%	8.85%	7.78%	0.79%	0.00%	2.27%
Astro Sunset to Astro Sunrise (Night)	512	629	712	1,077	489	593	276	71	161
%	81.14%	81.90%	93.56%	83.17%	84.90%	56.26%	21.94%	29.83%	24.39%
Astronomical Sunrise to Civil Sunrise	55	16	24	41	36	379	972	167	484
%	8.72%	2.08%	3.15%	3.17%	6.25%	35.96%	77.27%	70.17%	73.33%
Total	631	768	761	1,295	576	1,054	1,258	238	660

Recording Unit at Station 1

Sparrows and the two thrush species, 70 to 77 percent of night flight calls are detected between astronomical and civil sunrises, that is, about one and three-quarters hours to one half hour before sunrise. The Savannah Sparrow is intermediate to the patterns seen for warblers and the White-throated Sparrow and thrushes.

The relationship between nocturnal migration and the number of birds on the transects during the day are graphed in Figure 25. There is considerable correspondence in the pattern of the results from the three surveys. The transect counts spike much higher after mid-

Figure 25: Comparison of the Number of Night Flight Calls with Total Birds on Survey Transects



September due to the number of diurnal migrants and blackbirds flying over the transects. Figure 26 plots the number of night flight calls of the White-throated Sparrow at Station 3, located on Transect 1, with the stop-over counts of White-throated Sparrows on that transect. Table 19 indicates that there should be large numbers of White-throated Sparrow on the ground on this transect given the descent of these sparrows in the hours just before dawn. However, Figure 26 suggests a high daily variability in the number of White-throated Sparrows in nocturnal passage and stop-over as well as the possibility of early morning dispersion of the sparrows away from the transect or low detectability on stop-over counts.

Figure 27 comparison night flight call counts of Common Yellowthroats at both recording stations to the total birds detected on the stop-over surveys. The spikes in night flight call counts seem to indicate both arrivals and departures in relation to stop-over counts.

A negative binomial generalized linear model indicated that only the mean change in

Figure 26: Comparison of Night Flight Call Counts and Stop-over Counts of White-throated Sparrows at Station 3 and Transect 1 in the Autumn.

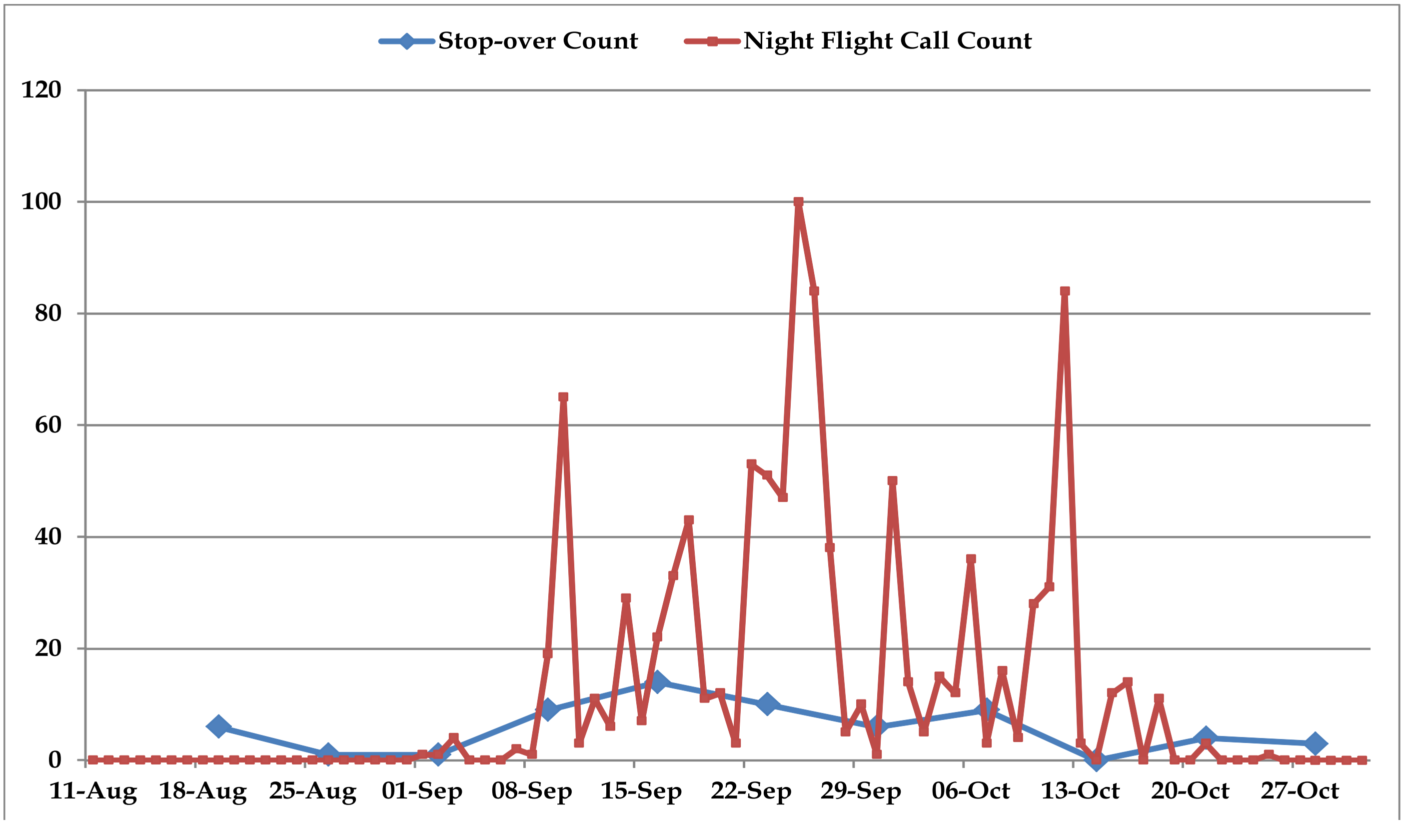
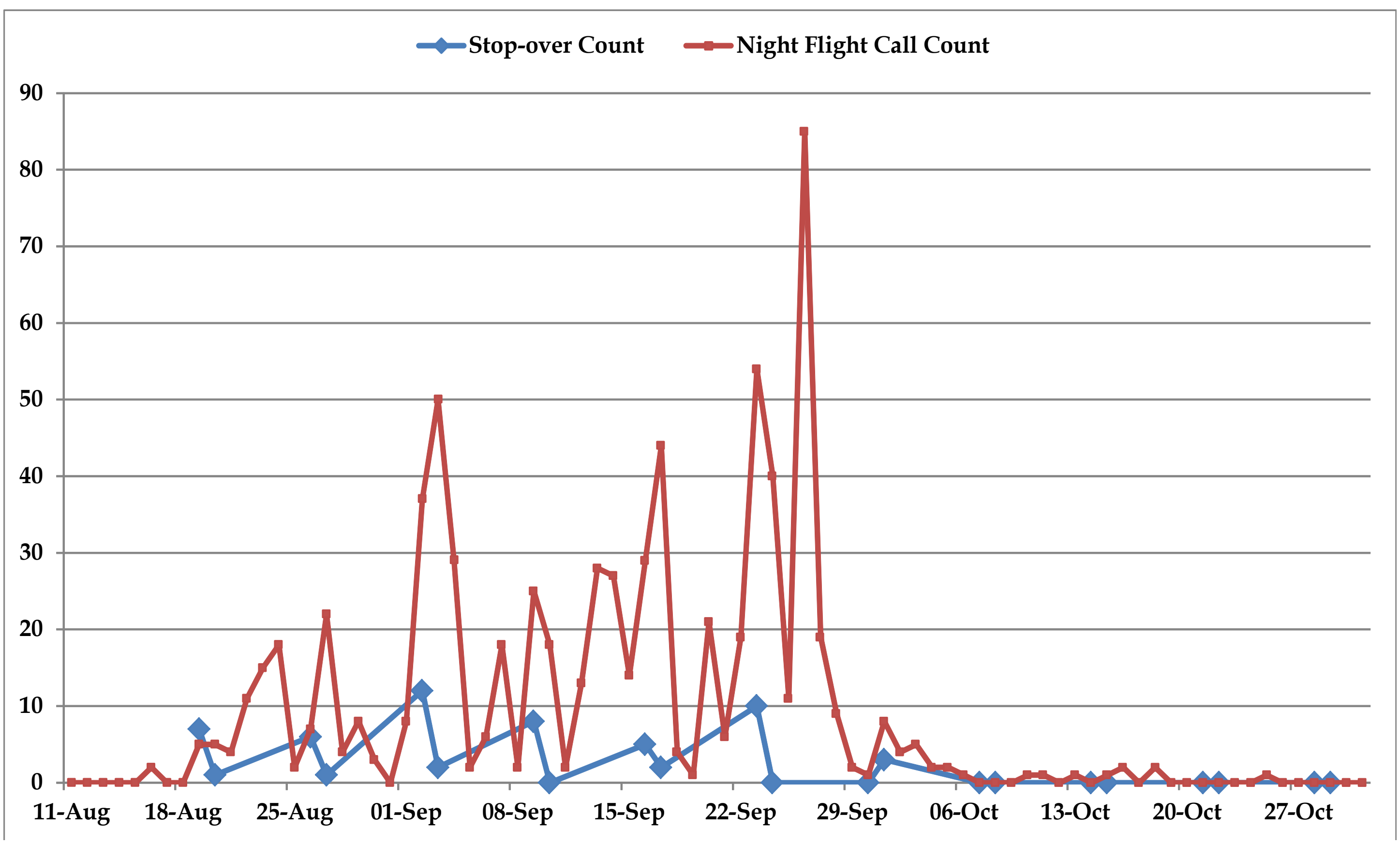
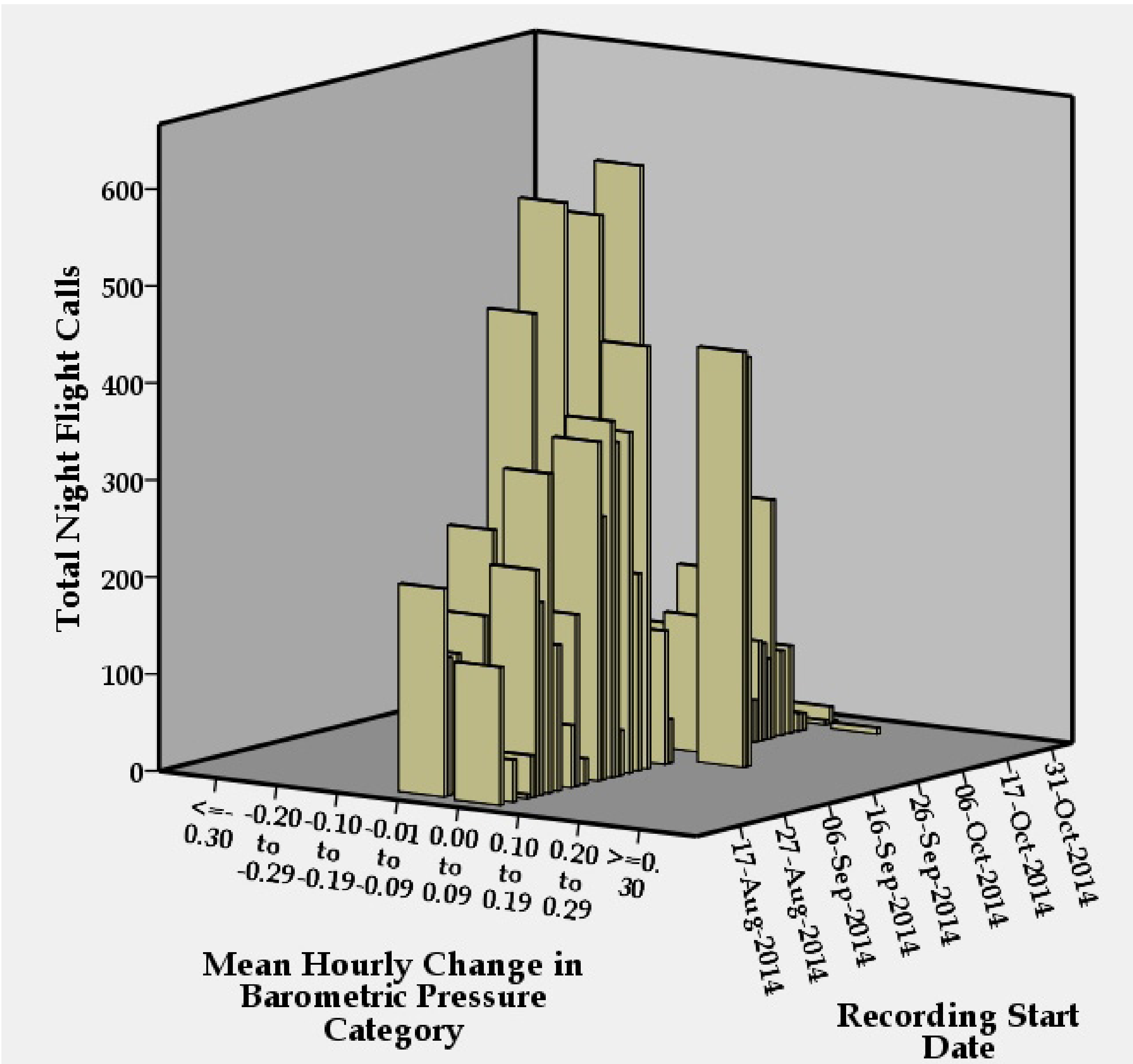


Figure 27: Comparison of Night Flight Call Counts and Stop-over Counts of Common Yellowthroats at both Stations and Transects in the Autumn



barometric pressure per hour for all flight calls in a night had a significant effect on the total number of night flight calls recorded. Most flight calls were recorded with a mean hourly change in barometric pressure of -0.09 to 0.09, with most of the highest counts occurring on a falling pressure (see Figure 28).

Figure 28: Relationship of Total Flight Calls Per Night and the Mean Hourly Change in Barometric Pressure by Date in the Autumn



Species of Conservation Concern

An annotated list of all the species of conservation concern recorded in the study area in 2014 is given in Table 20. A total of 32 species of conservation concern were detected through field studies or acoustic monitoring. All birds listed as “endangered”, “threatened”, or “vulnerable” under the Species at Risk Act, by the Committee on the Status of Endangered Wildlife in Canada, or by the Province of Nova Scotia are treated further in the discussion section that follows.

Table 20: Annotated List of Species of Conservation Concern in the Study Area

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Common Loon	May be at Risk				1 bird flying over the project area on October 28 and 1 over the control area on October 29
Turkey Vulture	Sensitive				1 over the project area on September 30
Killdeer	Sensitive			Low	Recorded acoustically over project area; 1 on August 11, 8 on September 9, and 6 on October 10
Greater Yellowlegs	Sensitive				Recorded acoustically over project area; 3 on September 12 and 9 on October 17
Whimbrel	Sensitive				Heard flying over project area on August 27
Wilson`s Snipe	Sensitive				Recorded acoustically over the project area; 1 on September 27
Common Nighthawk	Threatened	Threatened	Threatened		Recorded acoustically over project area; 1st on June 10 then heard regularly in one hour after sunset and one hour before sunrise in early August. See text in discussion section
Belted Kingfisher				High	1 seen in project area on August 26 and September 9
American Kestrel				Mid	1-2 birds seen regularly in project area near Pumping Station Road in the spring, 1 seen in control area on September 3
Olive-sided Flycatcher	Threatened	Threatened	Threatened		1-2 birds as possible breeders in project area (see text in discussion section)
Yellow-bellied Flycatcher	Sensitive				1 in project area during breeding season
Great Crested Flycatcher	May be at Risk				2 calls of a Myiarchus flycatcher, possibly this species recorded acoustically on September 18
Gray Jay	Sensitive				1 seen in project area on May 14 and 29 and 2 in control area on May 12; these probably represent breeding birds. In the autumn, 3 were in the project area on August 9 and October 14, 2 on August 26 and 1 on September 23 and 30. 2 were in the control area on September 24
Tree Swallow	Sensitive				2 were in the project area on June 16 and thus possible breeders
Barn Swallow	Endangered		Threatened		7 were flying over project area on August 26. See text in discussion section
Boreal Chickadee	Sensitive				2 in project area on May 6; 1 in project area on September 9 and 23, and October 14. 1 recorded acoustically on September 22 over project area.
Golden-crowned Kinglet	Sensitive				One in project area on June 17 thus possible breeder. 1 in project area on 22 April. 2 in control area on October 15, and 1 on September 10 and October 22 and 29. Recorded acoustically in project area from August 11 to October 12 on 15 nights with peak call count at 12 on August 21.

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Ruby-crowned Kinglet	Sensitive				1 in project area during breeding season on June 19
Wood Thrush	Undetermined		Threatened		1 recorded acoustically in project area on September 2. See text in discussion section
Tennessee Warbler	Sensitive				Recorded acoustically in project area on 7 nights from September 2-17 with a maximum of 2 calls per night on September 4
Cape May Warbler	Sensitive				1 seen in control area on May 27. Recorded acoustically in project area on 23 nights from August 11 to September 25. A total of 72 calls with a maximum of 11 in a night on September 12
Bay-breasted Warbler	Sensitive				1 seen in control area on May 12. Recorded acoustically in project area in the spring on June 2. Recorded acoustically in the project area in the autumn on 41 nights from August 11 to September 28. Maximum call count of 12 on September 14.
Blackpoll Warbler	Sensitive				3 seen in project area on September 16 and 2 on September 23. 1 seen in control area on May 27, September 9, and October 1. Recorded acoustically in project area in spring on 4 nights from May 25 to June 3 with a maximum of 2 calls on June 3. Recorded acoustically in the project area in autumn from August 16 to October 10 with a total of 477 flight calls with the maximun of 56 calls on September 14
Canada Warbler	Endangered	Threatened	Threatened		Recorded acoustically in the project area in the autumn on 22 nights from August 11 to September 17 with a total of 65 calls and a peak of 11 calls on August 23. See text in discussion section
Wilson's Warbler	Sensitive				1 seen in the control area on September 3. Recorded acoustically in the project area in the spring with on 1 call on June 3 and on 14 nights in the autumn from August 16 to September 27 with a peak call count of 5 on August 23
Vesper Sparrow	May be at Risk				Recorded acoustically in the project area on September 10 and 17 with 1 call each night
Rose-breasted Grosbeak	Sensitive				1 seen in the control area on May 27. Recorded acoustically in the project area in the autumn with one call on six nights from September 1 to 23.
Indigo Bunting	Undetermined				Recorded acoustically in the project area with one call on the nights of August 21 and October 22

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Bobolink	Vulnerable		Threatened		Seen flying over the project area during the day on 5 ocassions from August 19 to 27 and once over the control area on August 19. 21 were seen in stop-over in the project area on August 26. Recorded acoustically in the project area in the autumn on 5 nights from August 20 to September 15 with a maximum of 5 calls on August 29. See text in discussion section
Pine Grosbeak	May be at Risk				1 seen in diurnal passage on October 21 in the project area and 4 in the control area on October 29
Pine Siskin	Sensitive				1 seen in diurnal passage in the spring in the project area on May 29 and 1 to 5 birds seen in diurnal passage in the autumn in the project and control areas from October 7 to 15
Evening Grosbeak				High	1 seen in diurnal passage in the spring in the control area on May 12. 1 to 7 birds seen in diurnal passage in the project and control areas in the autumn from October 14 to 29

Discussion

The proposed Amherst Community Wind Farm is located in a highly industrialized setting. These industries include forestry, agriculture, energy, telecommunications, and recreation. A small wind energy facility would not have a major impact on the level of disturbance on bird habitat that already exists. Nonetheless, there are species, including species of conservation concern, that can take advantage of this disturbance. Two SARA listed species detected during the course of the baseline study are such opportunists. The Common Nighthawk takes advantage of clearings created by agriculture and forestry, and the Olive-sided Flycatcher is frequently heard on territory in very recent clearcuts.

Both of these species are aerial insectivores, but only the Common Nighthawk would regularly feed near blade height. No data can be found on the impact of wind turbines on the Common Nighthawk. However extensive studies at communications towers report very low mortality for Common Nighthawk (Stevenson and Anderson 1994).

While Olive-sided Flycatchers are attracted to recent clearcuts for nesting, there is evidence that this forestry practice is an ecological trap for the species. Studies indicate low breeding success rates for this species in clearcuts (Robertson and Hutto 2007). While a clearcut may resemble a forest disturbed by burning, the number of predators in a clearcut is likely much higher and a possible factor in the low breeding success rates for this species of flycatcher.

There is suitable habitat in the project area for a species listed as “threatened” by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) and as “vulnerable” by the Province of Nova Scotia, the Bobolink. Area searches for Bobolinks were conducted several times in the hay fields of the project area but none were found. These fields did provide stop-over habitat in the autumn migration, with a flock of 21 of these birds seen on August 26. Small numbers of Bobolinks were also detected in diurnal and nocturnal passage in late August to mid-September.

There is suitable habitat for another species listed as "endangered" by the Province of Nova Scotia and "threatened" by COSEWIC, the Barn Swallow. Area searches turned up no Barn Swallows during the breeding season for this species in the project or control area. A flock of seven Barn Swallows was seen flying over the study area in the autumn on August 26.

Table 21: Total Canada Warbler Night Flight Calls during the Autumn at Eight Existing or Proposed Wind Energy Sites in Nova Scotia

Location	Canada Warbler Night Flight Calls
Gulliver's Cove	53
Amherst Station 1	64
Amherst Station 3	52
Glasgow Head	7
Spinney Gully	5
Browns Mountain-Weaver Mountain	46
Browns Mountain	37
Nuttby Mountain	4
Loganville Ridge	6

The acoustic monitoring of nocturnal passage recorded one Wood Thrush flying over the project area on September 2. This species is listed as "threatened" by COSEWIC.

The Canada Warbler, a SARA listed "threatened" species was recorded in relatively high numbers during the course of acoustic monitoring during the autumn migration. Table 21 lists the number of night flight calls of Canada Warbler recorded at eight existing or proposed wind energy sites in Nova Scotia. Station 1 at the proposed Amherst site had the highest numbers of calls of this species.

Table 22: Total High Frequency Night Flight Calls Recorded during the Spring at Nova Scotia Locations

Location	Year	Total
Glasgow Head, Guysborough Co.	2013	596
Amherst Station 3, Cumberland Co.	2014	428
Brown's Mountain, Antigonish Co.	2012	404
Spinney Gully, Guysborough Co.	2013	361
Loganville, Pictou Co.	2012	355
Weaver Mountain, Pictou County	2012	352
Amherst Station 1, Cumberland Co.	2014	323
Digby Neck, Digby Co.	2012	321
Nuttby Mountain, Colchester Co.	2012	263
Total		3,403
Average		378

There was light diurnal passage in the study area during the spring. For nocturnal passage, Table 22 compares the total high frequency (sparrow and warblers) night flight calls recorded at the study area compared to seven other existing or proposed wind energy sites in Nova Scotia during the spring period. The numbers for Station 1 are below average while those at Station 3 are above average but well below the highest count recorded in the province.

Table 23: Mean Total Birds Counted on Spring Stop-over Transects at Six Wind Energy Sites in Nova Scotia

Site	Years	Transects	Repetitions	Mean
Digby	2012	2	16	128.50
Amherst	2014	2	13	117.85
Glen Dhu	2008-2012	5	75	102.99
Canso	2013	4	21	88.76
Fairmont	2013	1	6	87.00
Nuttby	2011-2012	4	33	79.67

As shown in Table 23, spring stop-over counts were higher than other sites except for Digby Neck. These relatively high counts at Amherst are likely due to the presence of birds that prefer edge and disturbed habitats. The three most common species in stop-over at Amherst in the spring were species that seek disturbed habitats; American Robin, White-throated Sparrow, and Palm Warbler.

Nesting birds that could be displaced by the proposed wind energy facility are those that are sensitive to industrial noise such as White-throated Sparrow, Red-eyed Vireo, Blue-headed Vireo, and Yellow-rumped Warbler (Bayne et al. 2008). Similarly, the small breeding duck population might avoid entering the area to nest (Loesch et al. 2013). To avoid the wind turbines, the behaviour of locally breeding Ospreys and American Kestrels would be altered. The risk of collision for these two species appears to be mitigated by what seems to be the lack of conditions conduive to thermal or orographic lift in the project area. Despite the presence of birds that soar (ravens, gulls, and raptors), only a few were observed doing so over the area close to the proposed turbines (14 birds in the spring and 11 birds in the autumn).

Table 24: Comparison of Stop-over Counts and High Frequency Night Flight Call Counts at Eight Sites in Nova Scotia

		Stop-over Transects				Acoustic Recordings		
Location	County	Distance from Coast	Mean Birds/Day	% Flying	Year	Calls/ Season	Mean/ night*	Year
Gulliver's Cove	Digby	<1 km	286	65	2012	10,002	213	2011
Amherst Station 1	Cumberland	7 km	227	65	2014	5,637	88	2014
Amherst Station 3						6,229	106	
Glasgow Head	Guysborough	<1 km	107	34	2013	2,016	94	2013
Spinney Gully						1,383	21	
Browns Mountain-Weaver Mountain	Antigonish- Pictou	12-16 km	79	21	2008	7,899	152	2011
Browns Mountain	Antigonish	12 km	54	11	2011-2012	4,529	-	2011
Nuttby Mountain	Colchester	20 km	48	14	2011-2012	1,271	-	2011
Loganville Ridge	Pictou	14 km	-	-	2011	2,095	-	2011

* September 2 to October 15

In contrast to the spring migration, the number of birds in all three components of the autumn migration surveys was high; stop-over, nocturnal passage, and diurnal passage. Table 24 compares stop-over counts and nocturnal passage recordings at eight existing or proposed wind energy sites in Nova Scotia. The stop-over counts in Amherst approached the high counts at Digby Neck in mean total birds and were on a par with that location for the percentage of birds that were in flight in the morning. For nocturnal migration, Amherst was in the middle range of total and mean number of high frequency night flight calls.

The large number of birds in the air over the Amherst site in first two hours of the day (morning flight) consisted of three components; true diurnal migrants, re-orienting nocturnal migrants, and non-migratory movements to local feeding areas. The inappropriate direction of the nocturnal migrants in the early morning is consistent with the reports of Van Doren et al. (2014) and support the view of re-orientation over the study area. The American Robin was dominant in this group. The non-migratory movements were primarily large flocks of Common Grackles and Red-winged Blackbirds. Some of these flocks could also have been engaged in diurnal passage. Most diurnal migration was represented by Double-crested Cormorants, Blue Jays, and winter finches. The weather conditions favouring morning flight; rising barometric pressure, relative humidity less than 90%, and low temperatures indicates an association with the passage of cold fronts despite the lack of appropriate wind direction (Weidner et al. 1992). The northeast to southwest ridge line through the northern portion of the study area is also consistent with the conditions under which the observation of large morning flights occur (Weidner et al. 1992, Van Doren et al. 2014).

This study along with the companion radar study highlights the need for using a variety of methodologies to gain a comprehensive assessment of the factors affecting birds in the development of wind energy facilities.

The most recent review of the literature on the causes of bird collisions at wind energy facilities emphasizes that it is the complex interaction of a variety factors that can lead to fatalities (Marques et al. 2014). Bird densities alone, while important, do not translate into higher mortality. Rather fatality rates depend on differential use within the facility (Marques et al. 2014). There is a need to synthesize the many individual studies of the impact of wind energy on birds in Nova Scotia to determine what types of bird species behaviours, site characteristics, and wind farm features combine to result in bird mortality. Such an understanding would aid in the optimal siting of wind turbines and the types of mitigation measures that can be employed.

Post-construction studies should repeat all aspects of the avian baseline study for two years, employing a Before-After-Control Impact (BACI) approach. BACI studies provide the most reliable and statisitically informative results in determining impacts (Marques et al. 2014, Hanson et al. 2009). At the same time, a mortality study should be conducted following the guidelines of Canadian Wildlife Service (Environment Canada 2007) and the Ontario Ministry of Natural Resources (2011).

References

Atlantic Canada Conservation Data Centre. 2014. Data Report 5212: Amherst, NS. edited by Data Manager Prepared by J. Churchill.

Bayne, E. M., L. Habib, and S. Boutin. 2008. "Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest." Conservation Biology 22 (5):1186-93.

Bird Studies Canada, Environment Canada-Canadian Wildlife Service, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry. 2012. "Maritimes Breeding Bird Atlas Database." http://www.mba-aom.ca/.

Boyer, George F. 1972. *Birds of the Border Region*, *Canadian Wildlife Service Occasional Paper No. 8*. Ottawa: Canadian Wildlife Service.

Environment Canada, Canadian Wildlife Service. 2007. Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds.

Hanson, Alan, Ian Goudie, Anthony Lang, Carina Gjerdrum, Richard Cotter, and Garry Donaldson. 2009. A Framework for the Scientific Assessment of Potential Project Impacts on Birds. Atlantic Region: Canadian Wildlife Service Technical Report Series Number 508.

Loesch, Charles R., Johann A. Walker, Ronald E. Reynolds, Jeffrey S. Gleason, Neal D. Niemuth, Scott E. Stephens, and Michael A. Erickson. 2013. “Effect of wind energy development on breeding duck densities in the Prairie Pothole Region.” The Journal of Wildlife Management 77 (3):587-598.

Marques, Ana Teresa, Helena Batalha, Sandra Rodrigues, Hugo Costa, Maria João Ramos Pereira, Carlos Fonseca, Miguel Mascarenhas, and Joana Bernardino. 2014. “Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies.” Biological Conservation 179:40-52.

Ontario Ministry of Natural Resources. 2011. Birds and Bird Habitats: Guidelines for Wind Power Projects.

Robertson, Bruce A., and Richard L. Hutto. 2007. “Is Selectively Harvested Forest an Ecological Trap for Olive-sided Flycatchers.” *The Condor* 109:109-121.

Stevenson, H. M., and B.H. Anderson. 1994. *The Birdlife of Florida.* Gainesville: University Presses of Florida.

Van Doren, Benjamin M., Daniel Sheldon, Jeffrey Geevarghese, Wesley M. Hochachka, and Andrew Farnsworth. 2014. “Autumn morning flights of migrant songbirds in the northeastern United States are linked to nocturnal migration and winds aloft.” *The Auk* 132 (1):105-118.

Weidner, David S., Paul Kerlinger, David A. Sibley, Paul Holt, Julian Hough, and Richard Crossley. 1992. “Visible Morning Flight of Neotropical Landbird Migrants at Cape May, New Jersey.” The Auk 109 (3):500-510.

Acknowledgements

Cover photo of Gray Jay by Jeff Skevington, Creative Commons Licence, Attribution, 2.0 Generic

Photo on page 18 of Common Nighthawk by Paul Hurtado, Creative Commons Licence, Attribution-ShareAlike, 2.0 Generic

Other photos and figures by John Kearney.

This document conforms to Google Earth policies for commercial use: http://www.google.com/permissions/geoguidelines.html.