

Abstract

This document reports on the studies of avian migration stop-over, and diurnal and nocturnal passage in the vicinity of the proposed Sable Wind Project. When compared to other wind energy sites, birds in stop-over were moderately high but the nocturnal passage of passerines, as detected by acoustic monitoring, was low. The number of shorebirds recorded at night was greater than would have been anticipated by daytime studies of these birds, past and present.

Introduction

This report presents an analysis of the results of the autumn migration studies conducted by John F. Kearney & Associates at the proposed Sable Wind site in 2013. These studies complement the radar study being conducted by Acadia University.

The study components reported here are the surveys of migration stop-over, diurnal passage, and nocturnal passage in the Project Area and in a Control Area, both near Canso, Guysborough County, Nova Scotia.

Study Area

The study area is composed of a Project Area and a Control Area. These are outlined on the map in Figure 1. The Project Area is defined by the Sable Wind Project Team and represents the area designated for the construction of six wind turbines and access roads. The Control Area is defined by the consultant, John F. Kearney & Associates, and represents an area close to the Project Area with similar habitats and meteorological conditions. Conducting quantitative studies in the Project Area and Control Area during the pre- and post-construction periods can provide a means of measuring the impact of the wind farm on avifauna.

Methods

1. Early Shorebird Stop-over Area Searches

A total of six area searches for migrating shorebirds in stop-over were conducted. Early shorebird migration begins in mid-July before the start of passerine migration in mid-August. The area searches were conducted in the vicinity of Glasgow Head and Spinney Gully on July 17 and 25 and August 2 and 6. The remainder of shorebird stop-over was monitored during the stop-over transects.

2. Migration Stop-over Transects with Stop Counts

Four transects were used for the study of stop-over migration. These transects are shown in

Figure 1: Map of Study Area Showing Proposed Turbines, Stop-over Transects, and Observation/Listening Stations

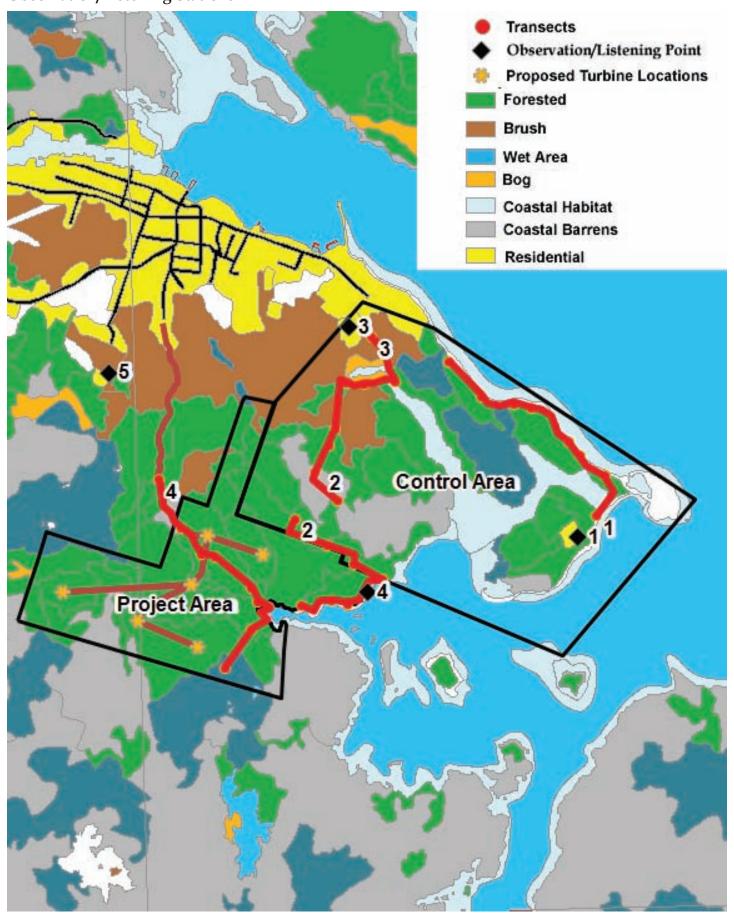


Figure 1. The transects were chosen so as to sample representative habitats in the study area, two in the Project Area (Transects 2 & 4) and two in the Control Area (Transects 1 & 3).

Transects were surveyed on a rotational basis during the migration period, August 18 to October 24. Walking the transect began in the first hour after sunrise and lasted about two hours. Three surveys were conducted every 10 days for a total of 21 surveys. The transects were 1,500 metres in length with all birds recorded in the following distance categories from the observer: <50 metres, 50-100 metres, >100 metres, and flying overhead. The transects were 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.

Analysis was conducted using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS). Geographic information was mapped and analyzed using a Garmin eTrex GPS, Map Source GPS software, and MapWindow open-source GIS software. Weather data was obtained online from the Environment Canada historical database for Hart Island, located 1.2 kilometers from the nearest transect.

3. Diurnal Passage Observation

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. Some of these stations were also used as listening stations for acoustic recording of night flight calls. The five observation/listening stations are shown in Figure 1.

Systematic observations of birds flying through a given air space were noted by species, flock size, altitude, direction of flight, and distance from the Project Area. Observations were recorded in 30-minute time blocks. 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. Birds seen in diurnal passage during the conduct of the transects were also noted as to their species, flock size, and direction of flight.

The analysis tools were the same as those used for the stop-over transects.

4. Acoustic Monitoring of Nocturnal Passage

Location of Listening Stations

The location of listening stations was chosen on the basis of their proximity to the Project Area, their elevation relative to sea level, and ease of access for the frequent collection of data cards and changing of batteries. One station was established at sea level in the Project Area along the shore of Spinney Gully (Station 4 in Figure 1). The microphone was mounted on a two-meter pole for a total

elevation of about 2 meters above sea level. A second station was setup at Glasgow Head, 30 meters above sea level (Station 1 in Figure 1). The microphone was mounted a four meter pole for a total elevation of about 34 meters above sea level. The station is located about 1 kilometer northeast of the Project Area. A third and backup listening station was established next to a private residence on Sterling Street in the Town of Canso (Station 5 in Figure 1). The microphone was mounted on a two meter pole on a hill 40 meters above sea level for a total elevation of 42 meters. It was also about 1 kilometer from the Project Area and to the northwest.

Recording Equipment

At all three 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



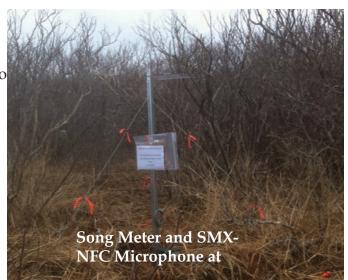
Wildlife Acoustics also produces a night flight call microphone, the SMX-NFC, to be used with the Song Meter. This weather-resistant microphone rests on a flat horizontal plate creating a pressure zone resulting in a 3-6 dB gain within a beam angle of 125 degrees.

The Song Meter and SMX-NFC microphone were chosen for use in this study since they were also employed by the author at five other existing or proposed wind energy facilities during 2011 to 2012 in Nova Scotia.

The Song Meter firmware was programmed to start recording at civil

sunset and sunrise at the latitude and longitude of each recording device.

Another type of recording equipment was also used at the Camp Glasgow listening station. This was the 21c produced by Old Bird. This "bucket" unit has a microphone, preamp, and AC power connector. It thus requires an external power source and recorder (in this case a laptop computer). The





settings were as follows:

Sampling format: 16 bit Sampling rate: 22,000 Hz High pass filter: 1,000 Hz Pre-amp: Unknown gain

Storage: Hard disk drive

The 21c also requires recording software to be used on the recording device. The i-Sound WMA MP3 Recorder Professional was used to record .wav files on the laptop computer. This software was manually set to record between civil sunset and civil sunrise for one-week blocks of time.

Detection and Analysis Software

The detection of night flight calls in the .wav files, 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 1.

Table 1: Detection Parameters

	High Frequency	Low Frequency
Minimum Frequency	6000 Hz	2250 Hz
Maximum Frequency	11000 Hz	3750 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	4.0
Noise Power Estimation Parameters		
Block Size	5000 ms	1000 ms
Hop Size	250 ms	250 ms
Percentile	50.0	50.0

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 during normal detector runs in attempt to eliminate or reduce the number of false detections produced by rain and wind. 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. In a total of 62 test runs, the use of this bandwidth filter reduced the number of detections by 87% while producing 98% of the number of true positives found by the detector without the bandwidth filter. When the true positives produced by the two methods were combined, the number of true positives averaged 108% of the maximum number of true positives produced by any single method.

For the low frequency detector, the tests were more difficult to perform due to the number of detector runs producing tens of thousands of detections, even with the bandwidth filter. Nonetheless, the most effective results, based on 22 test runs, were obtained with a minimum bandwidth of 100 Hz, a maximum of 500 Hz, and a energy percentile of 40%. The number of detections was reduced by 70% and the number of true positives was 106% of that produced by the detector without the bandwidth filter. The combination of true positives from both methods averaged 114% of the maximum produced by any single method alone. Nonetheless in many cases, given the amount of wind in the Canso area, this bandwidth filter often produced too many false detections (tens of thousands) to be useful. In these cases the energy percentile was increased to 50 to 80% to obtain manageable numbers for analysis. These higher percentages reduced the number of true positives detected and this was compensated for by manual searching of weaker flight calls in the time periods around the detections of these high energy calls.

For the analysis of the recordings of the SMX-NFC microphone at Glasgow Head, two detector runs were made (with and without the bandwidth filters). For Spinney Gully, the recordings were analyzed only with the detector settings using the bandwidth filters.

Recordings were made at Glasgow Head from August 6 to November 3 while recordings at Spinney Gully date from August 7 to October 22.

Results

The results for the study of stop-over, diurnal passage, and nocturnal passage will be reported under separate headings. A final section of the results will analyze the fall migration of shorebirds as determined by the combined methods of area searches, stop-over transects, and nocturnal acoustic monitoring.

Stop-over Transects

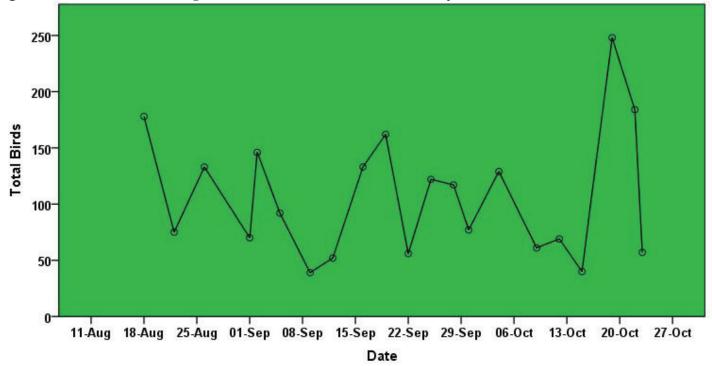
A number of factors can affect the number and kinds of birds in stop-over during the migration period. The factors analyzed in this study include season, weather, tides, habitat, and topography.

Effects of Seasonality

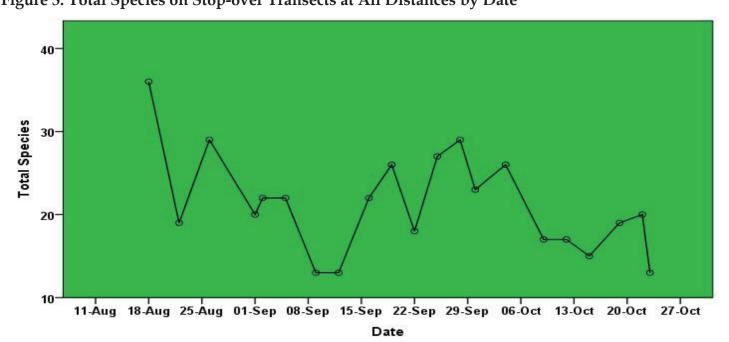
Figure 2 shows the total number of birds seen on the stop-over transects at all distances from the observer during the autumn migration. An Analysis of Variance (ANOVA) indicates that there were no significant differences in the number of birds seen throughout the fall migration.

The number of species on the transects do, however, vary significantly through the season. As

Figure 2: Total Birds on Stop-over Transects at All Distances by Date



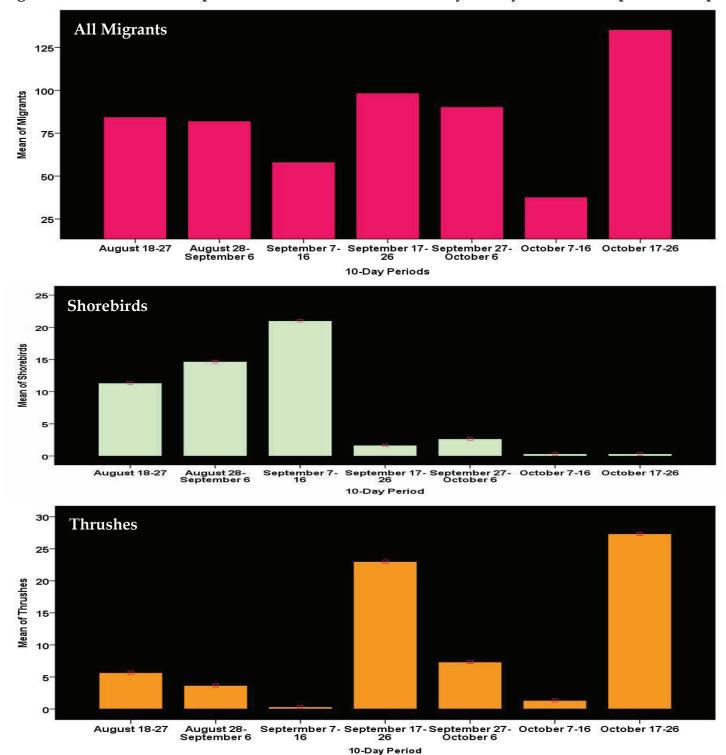
seen in Figure 3, the highest number of species occurred in the early fall and the lowest at the end of Figure 3: Total Species on Stop-over Transects at All Distances by Date

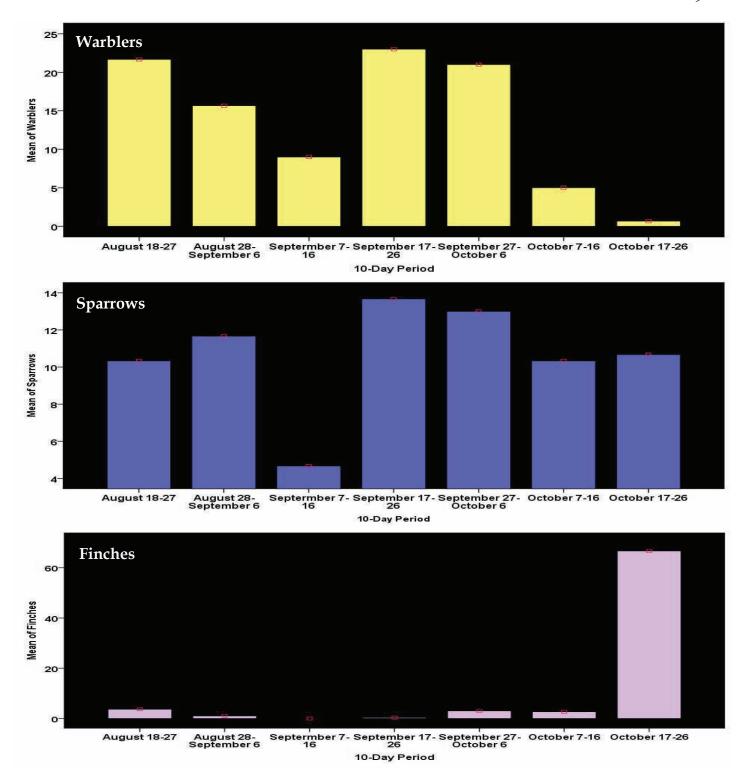


the season.

The numbers of birds on the stop-over transects were further analyzed by removing the local, largely non-migratory birds from the calculations. These local birds include Herring Gull, Great Black-backed Gull, American Crow, and Common Raven. The total migrants were then analyzed by their mean number in stop-over during 10-day periods, and then further sub-divided into the major species groups that were seen during the autumn. These are shorebirds, thrushes, warblers, sparrows, and finches. Figure 4 shows the trends for each species grouping.

Figure 4: Total Birds on Stop-over Transects at All Distances by 10-Day Periods for Species Groups





Of these groups, only the warblers and the finches showed statistically significant variations in the presence of migrants in stop-over, observed at all distances, during the autumn season. According to an Analysis of Variance (ANOVA), the warblers had two peaks, one early in the season (August 18-27) and again in late September and early October (September 17-October 6). The finches peaked at the end of the autumn period (October 17-26). When analyzed for birds within 50 meters of the observer, warblers, finches, and thrushes had significant variations in seasonal abundance. The thrushes which included Hermit Thrush and American Robin peaked in the ten-day period of September 17-26.

Effects of Meteorological Conditions

Current weather conditions had no statistically significant effects on the number of birds in stop-over.

Effects of Tides

Tidal height had a significant effect on the number of waterbirds in stop-over. Waterbirds include geese, ducks, loons, cormorants, herons, shorebirds, gulls, and terns. The results of a univariate general linear model is shown in Tables 2 and 3. The model indicated that the number of waterbirds on the stop-over transects at all distances was significantly greater at high tide (tide height of 1.0-1.5 meters) at the 95% confidence level. On the other had the tidal direction, rising or falling,

Table 2: Mean Number of Waterbirds at All Distances on Stop-over Transects at All Distances by Tide Height and Direction

, , ,	Std.					
Tide Height		Mean	Deviation	N		
0-0.5 M Rising						
0-0.5 M	Kising	7.00	4.359			
	Falling	12.33	3.215			
	Total	9.67	4.502			
0.6-1.0 M	Rising	20.00	9.165			
	Falling	29.00	0.000			
	Total	23.60	8.142	5		
1.1-1.5 M	Rising	49.20	28.578	5		
	Falling	43.20	39.808	5		
	Total	46.20	32.822	10		
Total	Rising	29.73	26.837	11		
	Falling	31.10	30.105	10		
	Total	30.38	27.721	21		

had no significant effect on the number of birds.

Effects of Habitat

Stop-over transects were classified into six habitat pes:

- 1) Spruce-Fir
- 2) Mixedwood and Brush
- 3) Jack Pine Barrens
- 4) Bog
- 5) Coastal Spruce-Fir
- 6) Coastal Mixedwood and Brush

The last two habitat types were coastal marsh or beach on one side of the transect and woodland or brush on the other side.

Table 3: Tests of Between Subject Effects on Number of Waterbirds on Stop-over Transects at All Distances

Source		Type III Sum of	df	Mean Square	F	Sig.
TideHeight	Hypothesis	5299.725	2	2649.863	4.478	.027
	Error	10059.356	17	591.727		
TideDirect	Hypothesis	2.777	1	2.777	.005	.946
	Error	10059.356	17	591.727		

The level of analysis was limited to birds found within 50 meters of the transect. For migrants within 50-meters of the observer on stop-counts, the only statistically significant relationship was the avoidance of bogs by birds in stop-

over. For species groupings, sparrows had a statistically significant preference for coastal spruce-fir and coastal mixedwood and brush. There was some evidence that thrushes preferred spruce-fir forests. When the analysis was extended to the 500 meter segments of a transects, it was found that waterbirds were significantly more numerous in the coastal spruce-fir habitat.

At the species level, only two species were found to have strong statistically significant habitat preferences within 50 meters of the stop counts. The Red-eyed Vireo preferred the mixedwood and brush habitat (non-coastal) while the Song Sparrow preferred the coastal spruce-fir. Within 50 meters of the segments, American Crow had a significant preference for coastal spruce-fir.

Effects of Topography

Topographic features such as hills, depressions, configuration of the coastline, and human settlements may have an effect on the number of birds in stop-over. The Project Area and Control Area represent different configurations of these factors Thus, an analysis was made of the number of the total number of birds and migrants in the Project Area compared to the Control Area.

As shown in Tables 4 and 5, when all birds on the transects at all distances were considered, total numbers were significantly higher in the Control Area than in the Project Area. However, due to the proximity of the Control Area to human settlements, fairly high numbers of crows and gulls were counted. When the analysis is limited to migrants, there is no significant difference between the Project Area and the Control Area.

Table 4: Total Birds and Migrants on Transects at All Distances in Project and Control Area

					Std.
				Std.	Error
Area		N	Mean	Deviation	Mean
Total	Project	10	80.80	36.566	11.563
Birds	Area				
	Control	11	130.18	60.882	18.356
	Area				
Migrants	Project	10	66.70	38.693	12.236
	Area				
	Control	11	99.18	55.962	16.873
	Area				

Diurnal Passage

The two types of diurnal passage observations, from observations points and while conducting the stop-over transects, were combined in this analysis. Figure 5 shows the number of birds in diurnal passage and their flight headings for various species groups.

In all cases the predominant

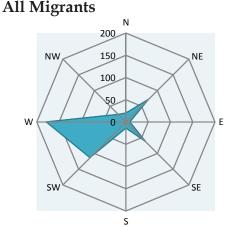
Table 5: Independent Samples Tests for Total Birds and Migrants on Transects at All Distances in Project and Control Areas

	Equa	Test for lity of ances		7		Equality o			
	г	C: -	,	10	Sig. (2-	Mean	Std.	95% Coi Lower	nfidence
Total Birds Equal	F 1.392	Sig253	-2.223	df 19	tailed)	Differen -49.382	Error 22.211	-95.871	-2.893
variances assumed Equal variances not	1.392	.203	-2.276	16.605	.039	-49.382	21.695	-95.237	-3.527
assumed Migrants Equal variances	.680	.420	-1.531	19	.142	-32.482	21.215	-76.885	11.921
assumed Equal variances not assumed			-1.558	17.810	.137	-32.482	20.843	-76.304	11.341

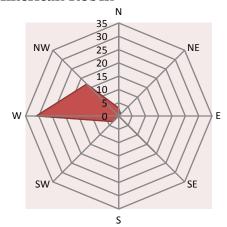
heading was west or southwest. For American Robins the main heading was west with a secondary heading to the northwest. For Broad-winged Hawk, it was west with some movement north. For warblers and total migrants, the predominant heading is west with a secondary heading to the southwest. For finches it was the reverse; a predominant heading southwest with a secondary heading to the west.

These diurnal movements were very conspicuous on many days when their was a west wind. Figure 6 shows the total number of birds in diurnal passage with each wind direction. Most birds

Figure 5: Flight Headings of Birds in Diurnal Passage by Species Groups



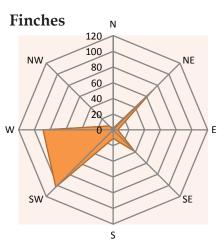
American Robin

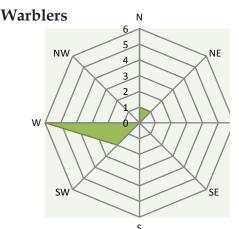


(90%) were seen in diurnal passage on mornings when there was a west wind (55%) or a southeast wind (35%).

One such morning with a west wind was October 4th when 58 Broad-winged Hawks were seen heading mostly in a westerly direction in one 30 minute period. They were moving in a broad front from the Town of Canso to the forests surrounding Spinney Gully.

On the October 19th, there was a strong west wind (30-40 km/hr) at dawn. Large flocks of finches were seen descending along the outer reaches of Chapel Gully and moved westward over the peninsula for most of the morning. A total of 88 Purple Finches passed over one of the stop-over transects in a two-hour period. On October 22nd, with a light southeast wind, over a hundred finches were seen moving in various directions near Glasgow Head. At the Glasgow Head, a flock of 80 finches, mainly Purple Finches, tried repeatedly to head out over the ocean but kept returning back to land. Many were seen later heading in a southwest direction along the coastline.





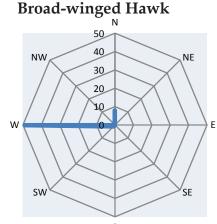
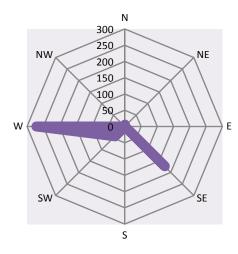


Figure 6: Number of Birds in Diurnal Passage by Wind Direction



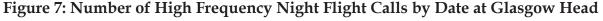
Nocturnal Passage

The analysis of the recordings of nocturnal flight calls will be separated into those occurring in a high frequency range, 6-11 kilohertz, and a low frequency range, 2.25 to 3.75 kilohertz. In the study area the high frequency range is primarily composed of warblers and sparrows while the low frequency encompasses the calls of thrushes and shorebirds.

Glasgow Head

Figure 7 presents the distribution of the high frequency night flight calls over the length of the autumn season. A peak occurred on September 21 with smaller peaks in the period from September 15 to October 2. Table 6 displays the number of high frequency night flight calls per night. Figure 8 indicates that the

number of warblers detected at Glasgow Head greatly outnumber the sparrows. Table 7 shows that two thirds of the high frequency calls were in the five hours after civil sunset (from 11:20 PM to 2:00 AM during the course of the autumn season).



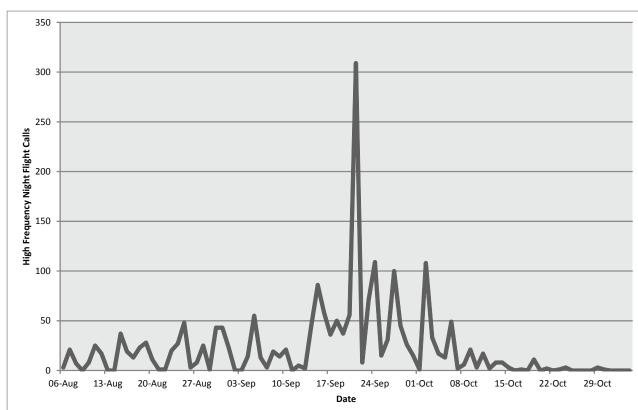


Table 6: High Frequency Night Flight Calls Per Night at Glasgow Head

Calls per Night	Number of Nights	% of Total
0	18	20.00%
1-25	48	53.33%
26-50	15	16.67%
51-100	6	6.67%
>100	3	3.33%

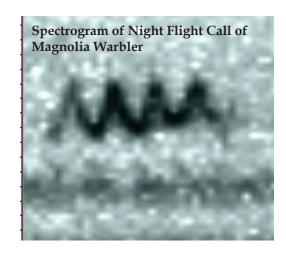


Table 7: High Frequency Night Flight Calls by Hours after Civil Sunset at Glasgow Head

Hours after Civil Sunset	Number of Calls	% of Total	Cummulative %
<1	133	6.61%	6.61%
1	241	11.98%	18.59%
2	279	13.87%	32.46%
3	275	13.67%	46.12%
4	216	10.74%	56.86%
5	198	9.84%	66.70%
6	147	7.31%	74.01%
7	140	6.96%	80.96%
8	169	8.40%	89.36%
9	129	6.41%	95.78%
>9	85	4.22%	100.00%

Figure 8: High Frequency Night Flight Calls of Warblers and Sparrows by Date at Glasgow Head

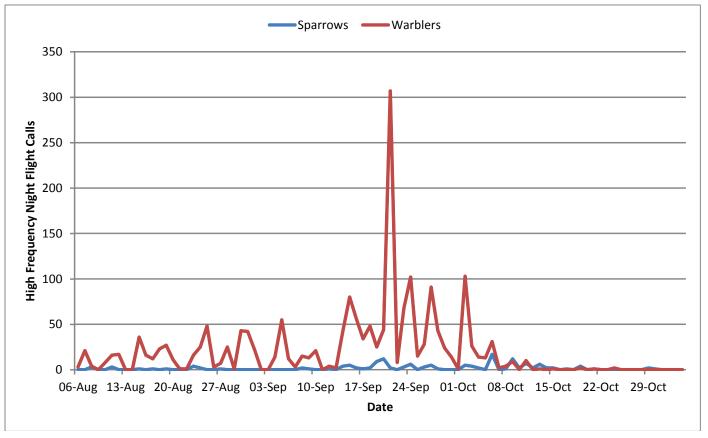
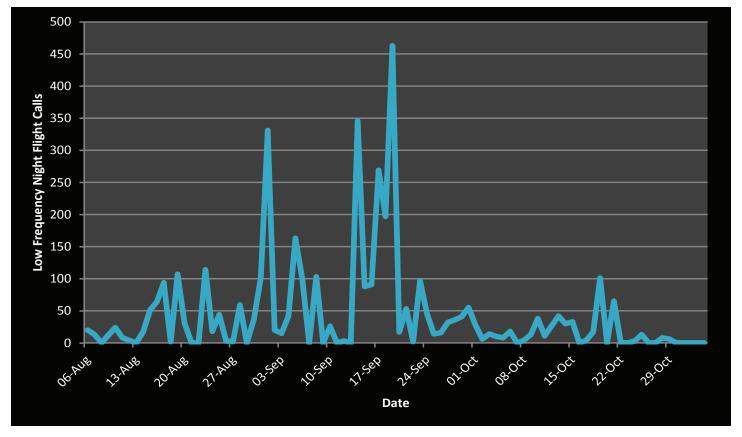


Figure 9 shows the number of low frequency night flight calls during the autumn period at





Glasgow Head. There are a few large spikes in the pattern of calls, one on September 1 (354 calls), a second on September 14 (392 calls), and the largest peak on September 19 (500 calls).

Table 8 gives the number of low frequency calls per night at Glasgow Head. There are more nights with no calls detected and more nights with a high number of calls (>50) than was found for the high frequency distribution through the autumn.

Table 8: Low Frequency Calls per Night at Glasgow Head

Calls per Night	Number of Nights	% of Nights
0	21	23.60%
1-25	32	35.96%
26-50	14	15.73%
51-100	11	12.36%
>100	11	12.36%

Figure 10 charts the number of shorebirds, terns, and thrushes over the course of the autumn season at Glasgow Head. Shorebirds are by far the most numerous of the taxonomic groups represented by the low frequency calls. Other taxons, too small to be plotted, include tanagers, longspurs and buntings, and blackbirds. Table 9 list the shorebird species detected and the number of flight calls recorded for each species.

Table 10 shows that the pattern of flight calls through the night for the low frequency band is quite different than for high frequency. Two-thirds of the low frequency calls were in the

seven hours after civil sunset as compared to five hours for the high frequency calls.

Figure 10: Low Frequency Night Flight Calls of Shorebirds, Terns, and Thrushes by Date at Glasgow Head

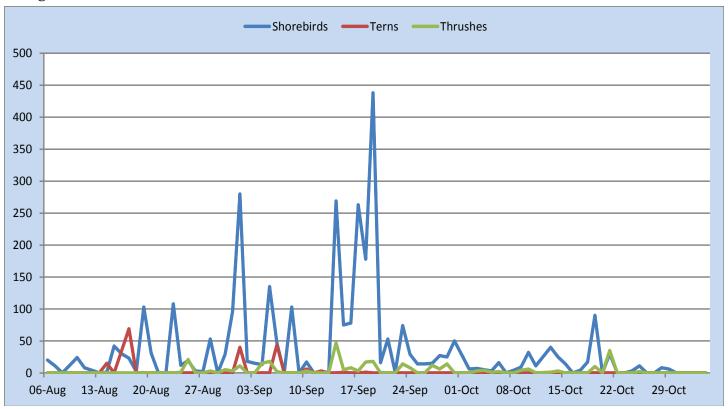
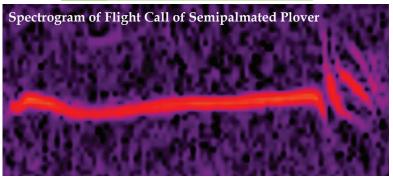


Table 9: Total Night Flight Calls of Shorebird Species at Glasgow Head

Black-bellied Plover	2
American Golden Plover	18
Semipalmated Plover	895
Killdeer	1
Greater Yellowlegs	1,547
Lesser Yellowlegs	32
Solitary Sandpiper	1
Willet	3
Spotted Sandpiper	33
Whimbrel	273
Ruddy Turnstone	16
Semipalmated Sandpiper	79
Least Sandpiper	115
White-rumped Sandpiper	1
Pectoral Sandpiper	139
Dunlin	25
Short-billed Dowitcher	20
Sandpiper unspecified	49

Table 10: Low Frequency Night Flight Calls by Hours after Civil Sunset at Glasgow Head

Hours after Civil Sunset	Number of Calls	% of Total	Cummulative
<1	575	14.52%	14.52%
1	179	4.52%	19.04%
2	208	5.25%	24.29%
3	313	7.90%	32.20%
4	350	8.84%	41.04%
5	153	3.86%	44.90%
6	239	6.04%	50.93%
7	721	18.21%	69.14%
8	352	8.89%	78.03%
9	346	8.74%	86.77%
>10	524	13.23%	100.00%



Spinney Gully

Figure 11 shows the distribution of high frequency night flight calls at Spinney Gully over the course of the autumn season. Calls peaked on September 21 while there were nights with smaller peaks ranging from August 30 to October 2.

Figure 11: Number of High Frequency Night Flight Calls by Date at Spinney Gully

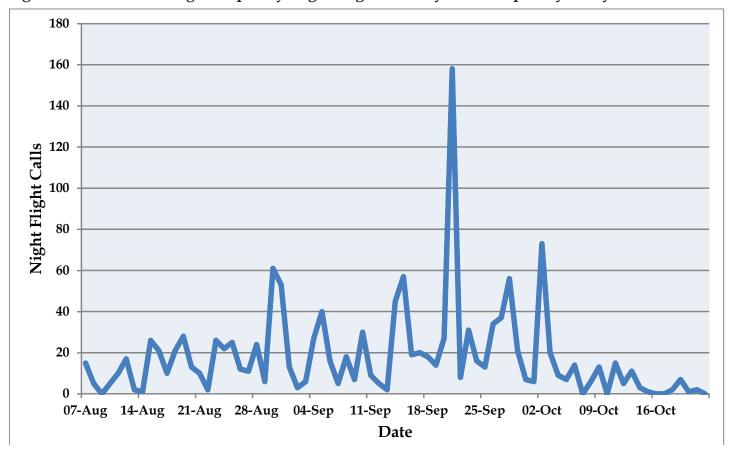


Table 11: Number of High Frequency Night Flight Calls per Night at Spinney Gully

Calls per Night	Number of Nights	% of Nights
0	6	7.79%
1-25	54	70.13%
26-50	11	14.29%
51-100	5	6.49%
>100	1	1.30%

Table 12: High Frequency Night Flight Calls by Hours after Civil Sunset at Spinney Gully

Princy			
Hours			
after			
Civil	Number	% of	Cummulative
Sunset	of Calls	Total	%
<1	76	5.47%	5.47%
1	202	14.54%	20.01%
2	184	13.25%	33.26%
3	155	11.16%	44.42%
4	142	10.22%	54.64%
5	116	8.35%	62.99%
6	99	7.13%	70.12%
7	91	6.55%	76.67%
8	113	8.14%	84.81%
9	73	5.26%	90.06%
>9	138	9.94%	100.00%

Table 11 presents the number of high frequency night flight calls per night and Table 12, the number of calls by hour after civil sunset. Most nights (78%) had 25 calls or less. Two-thirds of all calls through the season were detected within 5 to 6 hours after civil sunset.

Out of a total of 1,383 high frequency calls, 1,122 or 81% were warblers. The most common warblers were Common Yellowthroat (208 calls), Blackpoll Warbler (190 calls), Magnolia Warbler (91 calls), and American Redstart (61 calls). Only 197 or 14% were sparrows. The most common sparrows were Song Sparrow (59 calls) and Savannah Sparrow (57 calls).

Figure 12 presents the number of low frequency night flight calls per night throughout the autumn season at Spinney Gully. The calls reach a peak on September 18, having been preceded by a few smaller peaks from August 11 to September 16.

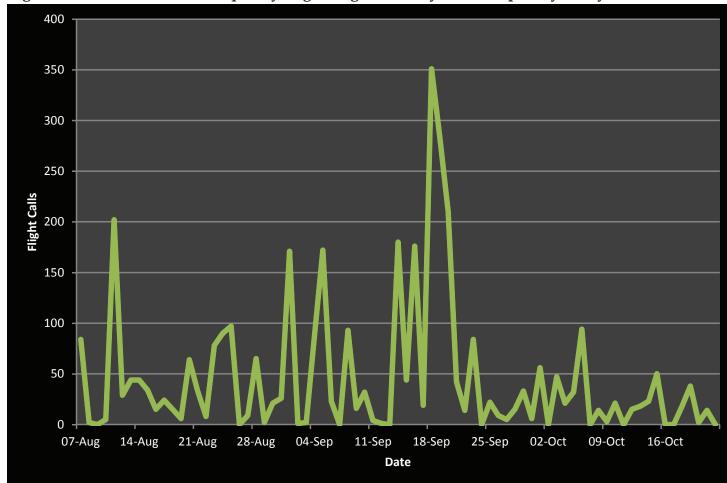


Figure 12: Number of Low Frequency Night Flight Calls by Date at Spinney Gully

Table 13 gives the number of low frequency night flight calls per night at Spinney Gully while Table 14 shows the distribution of the calls through the night. Compared to high frequency calls at Spinney Gully, the low frequency calls show a more even distribution of nights with few calls and those with many calls. In contrast to high frequency calls that are concentrated in the first five to six hours after civil sunrise, the low frequency calls are concentrated in the hours just preceding civil sunrise.

Out of 3,559 low frequency night flight calls at Spinney Gully, 3,060 or 86% were shorebirds

Table 13: Number of Low Frequency Night Flight Calls per Night at Spinney Gully

Calls per	Number	% of
Night	of Nights	Nights
0	11	14.29%
1-25	33	42.86%
26-50	14	18.18%
51-100	11	14.29%
>100	8	10.39%

Table 14: Low Frequency Night Flight Calls by Hours after Civil Sunset at Spinney Gully

Guily			
Hours			
after			
Civil	Number	% of	Cummulative
Sunset	of Calls	Total	%
<1	374	10.53%	10.53%
1	161	4.53%	15.07%
2	179	5.04%	20.11%
3	100	2.82%	22.92%
4	220	6.20%	29.12%
5	100	2.82%	31.93%
6	127	3.58%	35.51%
7	367	10.34%	45.85%
8	614	17.29%	63.14%
9	583	16.42%	79.56%
>9	726	20.44%	100.00%

(plovers and sandpipers). Thrushes accounted for 236 or 7% of low frequency calls, and terms for 157 or 4%.

Shorebird Migration

Table 15: Results of Shorebird Searches in the Study Area

Study Alea				
Date	17-Jul	25-Jul	02-Aug	06-Aug
Black-bellied Plover			2	1
Semipalmated Plover			31	18
Greater Yellowlegs	2	3	3	3
Lesser Yellowlegs Willet	10	1	7	2
Spotted Sandpiper	10 4	7 7	7 1	2
Semipalmated Sandpiper			6	1
Least Sandpiper			1	
Short-billed Dowitcher		1		
Total	16	19	51	25

Area Searches

Table 15 tabulates the results of the general area searches for shorebirds for the Project Area and Control Area combined. Figure 13 shows the areas surveyed. The great majority of shorebirds noted were seen in the vicinity of Glasgow Head. The timing of the searches was aimed at the weeks that would normally encompass the peak shorebird migration in Nova Scotia. The results indicate very low numbers of shorebirds in stop-over at this time.

Stop-over Surveys

Table 16 presents the number of shorebirds seen on the stop-over transects from August 18 to October 23. Transect 1 (see Figure 1) corresponds with the Glasgow Head, Transect 2 with Spinney Gully, and Transect 3 with Chapel Gully. As with the area searches,

Figure 13: Location of Shorebird Area Searches in July and Early August



Table 16: Shorebirds on Stop-over Transects, August 18 to October 23

Species	Glasgow Head	Spinney Gully	Chapel Gully	Total
Black-bellied Plover	1	0	1	2
Semipalmated Plover	76	0	1	77
Killdeer	0	0	1	1
Greater Yellowlegs	6	6	4	16
Willet	0	0	2	2
Spotted Sandpiper	7	1	0	8
Whimbrel	8	7	2	17
Semipalmated Sandpiper	8	0	0	8
Least Sandpiper	4	0	1	5
Baird's Sandpiper	1	0	0	1
Pectoral Sandpiper	0	0	4	4
Total	111	14	16	141

Table 17: Flight Calls of Shorebirds Recorded during Autumn Season

Autumm Season		
Species	Glasgow Head	Spinney Gully
Black-bellied Plover	2	8
American Golden Plover	18	28
Semipalmated Plover	895	447
Killdeer	1	0
Greater Yellowlegs	1,547	1,432
Lesser Yellowlegs	32	61
Solitary Sandpiper	1	0
Willet	3	1
Spotted Sandpiper	33	176
Whimibrel	273	255
Ruddy Turnstone	16	7
Semipalmated Sandpiper	79	73
Least Sandpiper	115	103
White-rumped Sandpiper	1	1
Pectoral Sandpiper	139	31
Dunlin	25	36
Short-billed Dowitcher	20	366
Sandpiper unspecified	49	36

the largest numbers of shorebirds are near Glasgow Head. The results again indicate low numbers overall.

Acoustic Monitoring

Table 17 lists the number of flight calls for each species detected by the recording equipment during the autumn at the two monitoring sites, one at Glasgow Head, the other at Spinney Gully. Individual shorebirds often give more than one call while passing over or near the recording equipment. Thus the number of birds is likely smaller than the number of calls detected. Nonetheless the large number of flight calls detected and the higher species richness is not expected, given the smaller number of shorebirds and species seen during the daytime surveys. At the same time, the relative equality in the numbers of flight calls detected at Glasgow Head and Spinney Gully is not expected due to the larger numbers of birds seen at Glasgow Head during the day.

Species of Conservation Concern

Table 18 provides an annotated list of the species of conservation concern and their conservation status as determined by the Nova Scotia Department of Natural Resources (NSDNR), the Species at Risk Act (SARA), and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Of all the species listed in Table 18, three are classified as "threatened". These are Wood Thrush, Canada Warbler, and Bobolink. All three species were detected during nocturnal migration by acoustic monitoring (see

Table 18 for details). Only the Canada Warbler was seen during the daytime on the ground. It was located on Transect 3 (the Chapel Gully Trail) on August 26.

Table 18: An Annotated List of the Species of Conservation Concern in the Study Area and Their Conservation Status

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Northern Pintail	May be at Risk				1 in Control Area on 9 September on transect
Common Loon	May be at Risk				1 in Project Area on 28 September and 12 October; 1 in Control Area on 15 October on transects
American Golden- Plover	Sensitive				1 in Project Area on 1 September on transect; 18 flight calls at Glasgow Head and 28 at Spinney Gully for season
Killdeer	Sensitive			Low	1 in Control Area on 4 October on transect; 1 flight call at Glasgow Head
Greater Yellowlegs	Sensitive				8 in Project Area and 10 in Control Area on transects; 1547 night flight calls at Glasgow Head and 1432 at Spinney Gully for season
Willet	May be at Risk				2 on transect in Control Area on 26 August; 3 flight calls at Glasgow Head and 1 at Spinney Gully for the season
Spotted Sandpiper	Sensitive				7 on transects in Control Area and 1 in Project Area; 33 flight calls at Glasgow Head and 176 at Spinney Gully for season

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Whimbrel	Sensitive				17 on transects in Project Area and 10 in Control Area; 273 flight calls at Glasgow Head and 255 at Spinney Gully for the
Semipalmated Sandpiper	Sensitive				8 in Control Area on transects; 79 flight calls at Glasgow Head and 73 at Spinney Gully for season
Common Tern	Sensitive				17 in Project Area and 17 in Control Area on transects; 213 tern flight calls (unknown species) at Glasgow Head and 158 at Spinney Gully for the season
Belted Kingfisher				High	1 in Project Area on transect on 12 September and 1 in Control Area on 26 August and 16 September
Gray Jay	Sensitive				2 on transect in Project Area on 9 October and 1 on 15 October
Tree Swallow	Sensitive				1 on transect in Control Area on 4 October
Boreal Chickadee	Sensitive				1 on transect in Project Area and 8 in Control Area for the season
Golden-crowned Kinglet	Sensitive				19 on transects in Project Area and 43 in Control Area for season
Ruby-crowned Kinglet	Sensitive				1 on transect in Control Area on 26 August and 1 in Project Area on 30 September

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Eastern Bluebird	Sensitive				3 night flight calls on 14 September at Glasgow Head
Wood Thrush			Threatened		4 night flight calls on 5 September at Glasgow Head
Tennessee Warbler	Sensitive				3 night flight calls at Glasgow Head and 2 at Spinney Gully for the season
Cape May Warbler	Sensitive				14 night flight calls at Glasgow Head and 3 at Spinney Gully for the season
Bay-breasted Warbler	Sensitive				25 night flight calls at Glasgow Head and 18 at Spinney Gully for the season
Blackpoll Warbler	Sensitive				1 on transect in Project Area and 5 in Control Area for season; 532 night flight calls at Glasgow Head and 190 at Spinney Gully for the season
Wilson's Warbler	Sensitive				14 night flight calls at Glasgow Head and 6 at Spinney Gully for the season
Canada Warbler	Endangered	Threatened	Threatened		1 on transect in Control Area on 26 August; 7 night flight calls at Glasgow Head and 5 at Spinney Gully for the season
Vesper Sparrow	May be at Risk				4 night flight calls at Glasgow Head for the Season
Rose-breasted Grosbeak	Sensitive				12 night flight calls at Glasgow Head and 1 at Spinney Gully for the season

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	COSEWIC Priority Candidates	Annotation
Bobolink	Vulnerable		Threatened		19 night flight calls at Glasgow Head and 1 at Spinney Gully for the season
Pine Siskin	Sensitive				1 on transect in Project Area and 16 in Control Area for the season

Discussion

Table 19 compares the results of this study with those at other exisiting or proposed wind energy sites in Nova Scotia. In all cases, the same stop-over transect methodology and the same acoustic equipment and settings were used. The number of birds on stop-over surveys at Glasgow

Table 19: Comparison of Stop-over Transects and High Frequency Night Flight Call Detections at Wind Farm Sites in Nova Scotia

			Stop-over	Acoustic Recordings		
Location	County	Distance from Coast	Mean Birds/Day	Year	Calls/ Season	Year
Gulliver's Cove	Digby	<1 km	224	2012	10,002	2011
Glasgow Head	Guysborough	<1 km	107	2013	2,016	2013
Spinney Gully	Guysborough	<1 km	107	2013	1,383	2013
Browns Mountain	Antigonish	12 km	54	2011-2012	4,529	2011
Browns Mountain-Weaver Mountain	Antigonish- Pictou	12-16 km	79	2008	7,899	2011
Loganville Ridge	Pictou	14 km	-	2011	2,095	2011
Nuttby Mountain	Colchester	20 km	48	2011-2012	1,271	2011

Head and Spinney Gully is only surpassed by Gulliver's Cove in Digby County. The latter site also has the highest number of high frequency (warbler and sparrow) night flight calls. In contrast, the high frequency calls at Glasgow Head and Spinney Gully are among the lowest of all the sites.

A major difference between Glasgow Head and Spinney Gully and all the other sites is the

relatively high counts of shorebirds as detected in the acoustic monitoring. Although low frequency data was collected at all the other sites, the method of processing was only capable of indicationg that thrushes and thrush-like birds were much more numerous than shorebirds. It did not provide total numbers of low frequency calls.

The environmental impact statement for the Canso Wind Farm, prepared by Barrington Wind Energy and AMEC, in 2006 also notes low numbers of shorebirds in the study area. Birds searched for during the day were mainly in the vicinity of Glasgow Head, again as presently. This same study noted larger concentrations of shorebirds at New Harbour, approximately 40 km southwest of the study area.

It is also important to note that a high percentage of the shorebirds detected by acoustic monitoring were recorded in the hours just before civil dawn. When stop-over surveys began within the first hour after sunrise, there were few shorebirds to be seen. This was especially true for Spinney Gully.

These observations lead to the hypothesis that shorebirds are descending from higher flight altitudes to less than about 150 meters between astronomical and civil dawn but not landing in the study area. This hypothesis would be further supported by the higher number of call detections in the first hour after civil sunset, an indication that migrants would be gaining altitude at this time.

Finally the diurnal passage observations provide some evidence that the study area may be a focal point for the descent and re-orientation of nocturnal migrants during the autumn. This was especially evident in the instances involving Purple Finches. It may also explain why shorebirds are present for a limited time before dawn and after sunset.