

# Nocturnal Acoustic Monitoring South Canoe Wind Farm Autumn 2015

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## **Abstract**

Nocturnal acoustic monitoring near South Canoe Lake in the autumn of 2015 indicated high numbers of migrating warblers with peak numbers in the early part of the night and moderately high numbers of thrushes in pre-dawn descent. The number of Canada Warblers, listed as threatened by the Species at Risk Act, were the highest recorded at any monitoring station in Nova Scotia operating since 2011. High call counts for Common Nighthawks, another threatened species, indicated a possible migration staging area near the station.

## **Introduction**

The South Canoe Wind Farm consists of 34 wind turbines with a 102 megawatt capacity on 2,800 hectares of land located 25 kilometers southwest of Windsor, Nova Scotia.

This study reports on the results of the first season of nocturnal acoustic monitoring of bird migration as part of a two-year post-construction bird and bat study. Most of the birds that fly over a wind energy facility do so at night during their spring and autumn migration. Thus it is important to measure the intensity of this migration that is at or near the level of the blade sweep of the wind turbines. Specially designed microphones and recording equipment can be used to determine this migration density. The night flight calls made by birds, mostly small to medium-sized songbirds, can be classified through spectrographic analysis and identified, often to the species level.

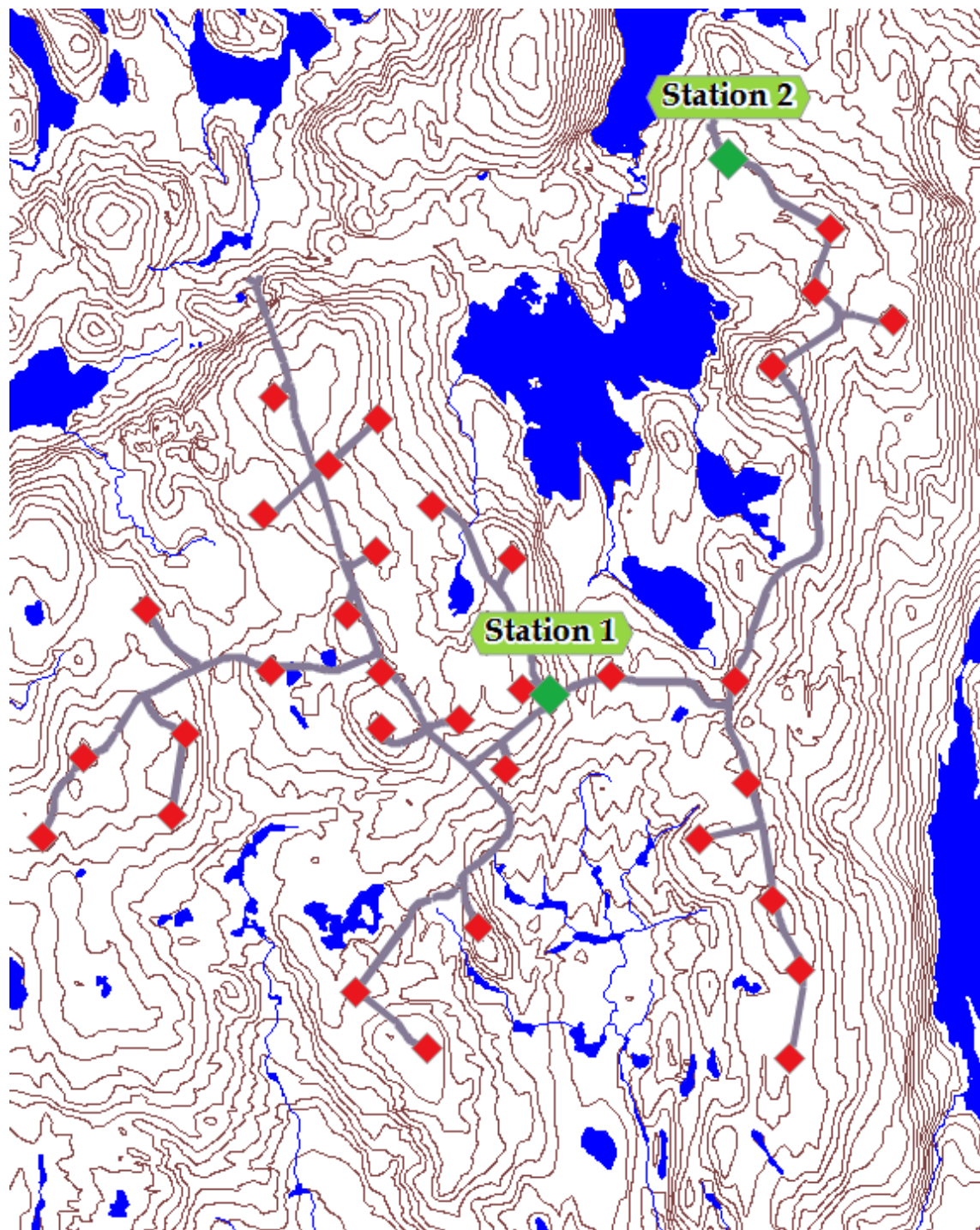
## **Location of Monitoring Stations**

A total of two acoustic monitoring stations were deployed in the autumn of 2015. These are shown in Figure 1. Station 1 is located near the centre of the project lands. The closest turbine, #17, is 219 meters from the station. Station 2 is located at the periphery



of the project lands with the closest turbine being 971 meters (#24) from the station. Station 2 was chosen for analysis since it is less affected by wind turbine noise.

**Figure 1: Location of Monitoring Stations**



## Acoustic Methods

Acoustic monitoring of nocturnal passage provides data on the species of birds migrating through an area, their relative abundance, and migration timing. Recording took place every night from civil sunset to civil sunrise from 15 August to 22 October 2015 (inclusive). 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

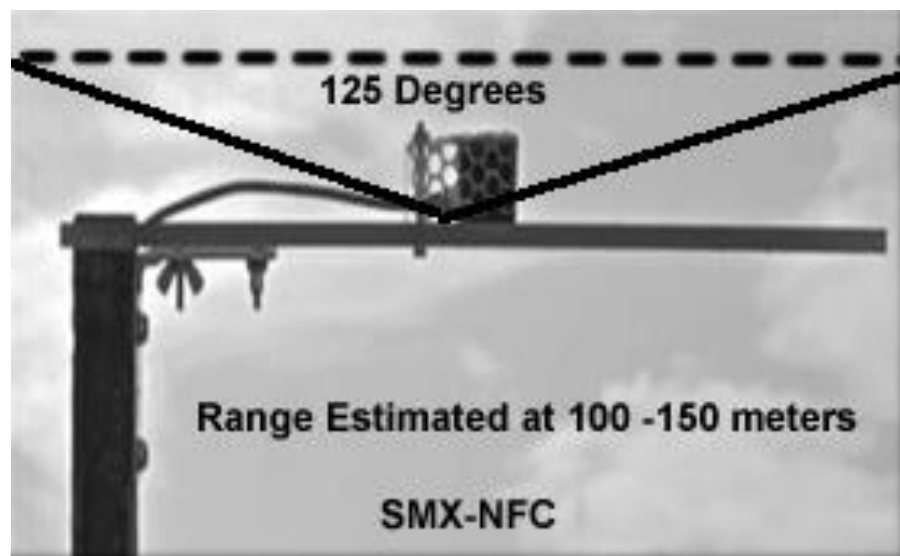
High pass filter: 1,000 Hz

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 (see Figure 2). Based on experience in Nova Scotia, the range is estimated at 100-150 meters in altitude.

**Figure 2: Flight Call Microphone**



The Song Meter and SMX-NFC microphone were chosen for use in this study since they were also employed by the author at thirteen other existing or proposed wind energy facilities from 2011 to 2015 in Nova Scotia.

The detection of night flight calls 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. The review panel of Raven Pro allows for a standardized process to classify, identify, and store night flight calls.

**Table 1: Detection Parameters**

	High Frequency	Low Frequency
<b>Target Signal Parameters</b>		
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
<b>Signal to Noise Ratio Parameters</b>		
Minimum Occupancy	25.0	20.0
Threshold	3.5	4.0
<b>Noise Power Estimation Parameters</b>		
Block Size	5000 ms	1000 ms
Hop Size	250 ms	250 ms
Percentile	50.0	50.0

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 up to 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. The use of the filters can be supplemented by a systematic search of those times of a given night where most of the night flight calls were detected.

## Results

A total of 9,953 night flight calls were recorded during the autumn migration. Total high frequency calls (small songbirds like warblers and sparrows) were 7,869 while total low frequency calls (medium to large-sized birds like thrushes and water birds) were 2,084.

Figure 3 shows the total flight calls by date. The peak date was 16 September when 1,082 flight calls were recorded. The chart also shows that flight calls declined rapidly after 22 September.

**Figure 3: Total Calls by Date**

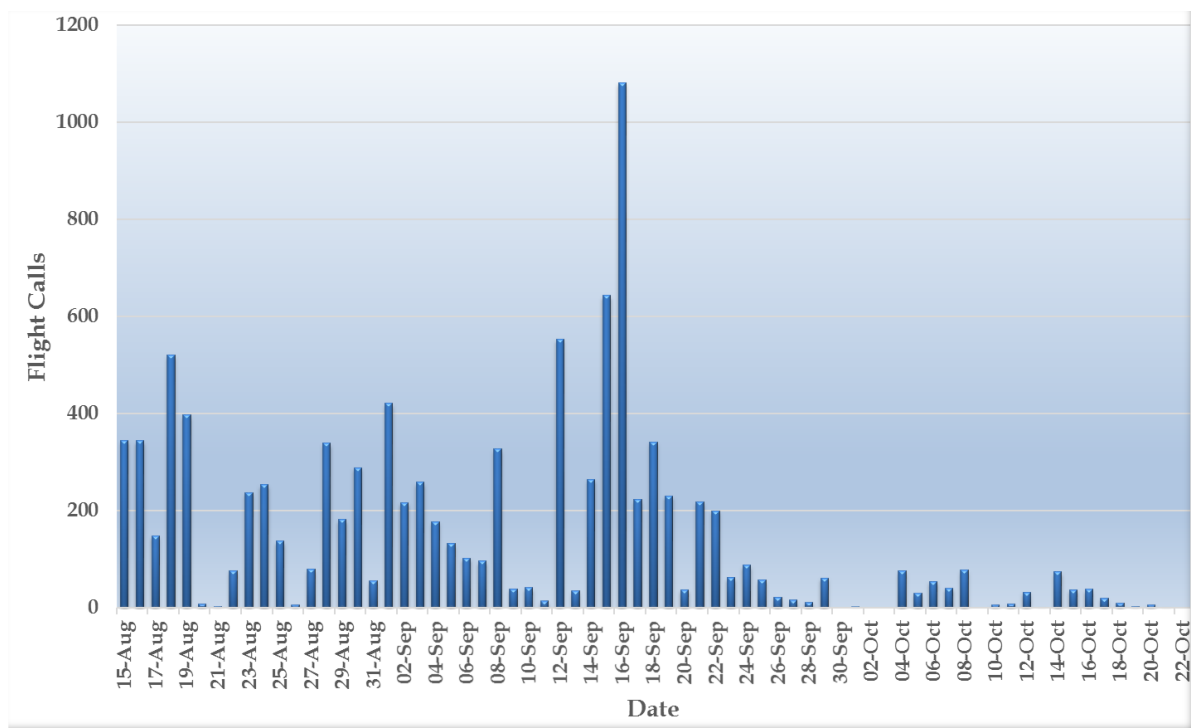


Figure 4 shows the mean number of total calls by 10-day periods. This aggregation attenuates the effect of daily changes in weather and highlights seasonal trends. Thus it can be noted that the peak occurs in the period of 7-16 September with a mean of 310 calls per night. The mean number of calls rapidly declines after this period. Using an Analysis of Variance (ANOVA), these seasonal differences in the mean number of flight calls by 10-day period are statistically significant at the 95% confidence level.

**Figure 4: Mean Total Calls by 10-day Period**

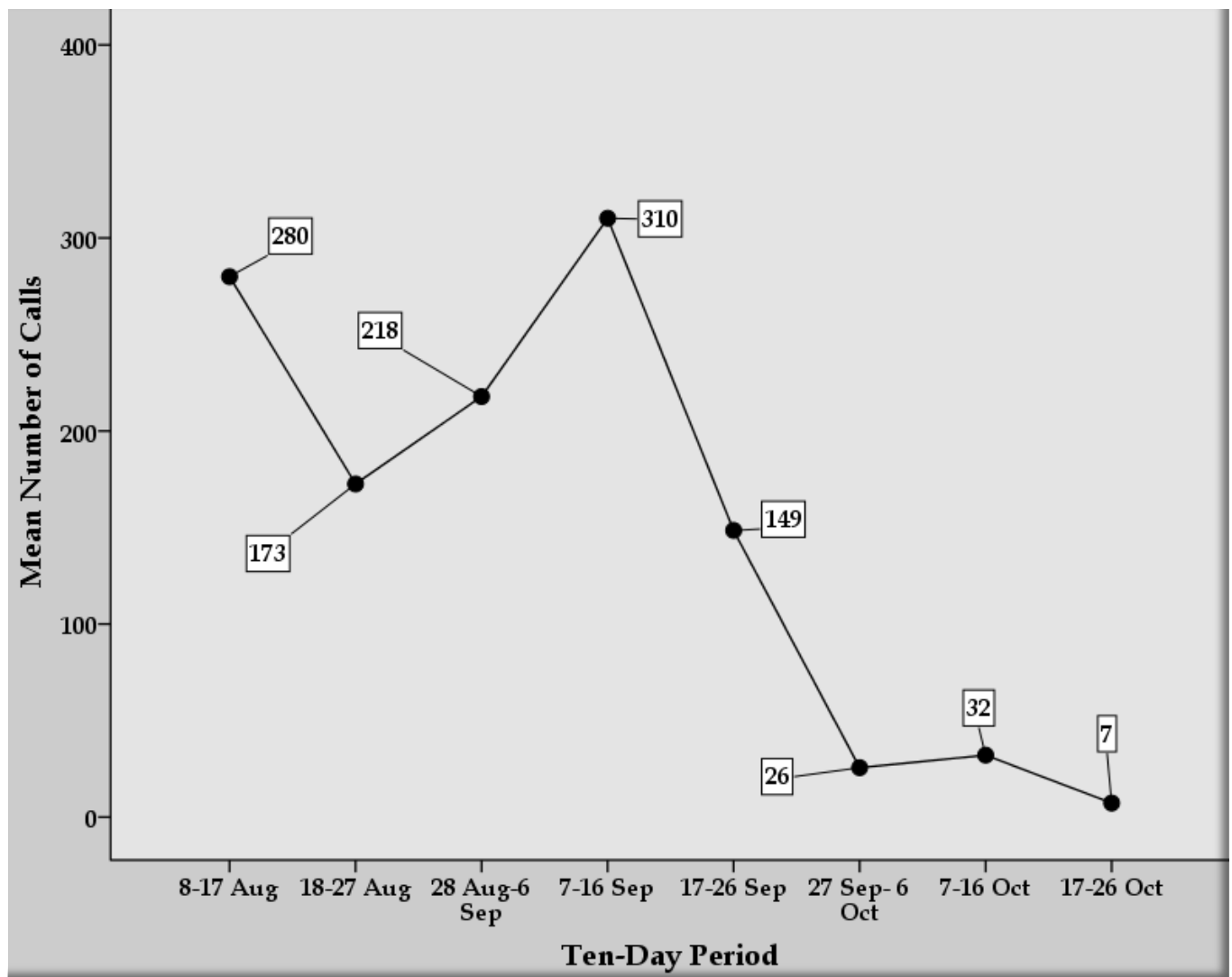
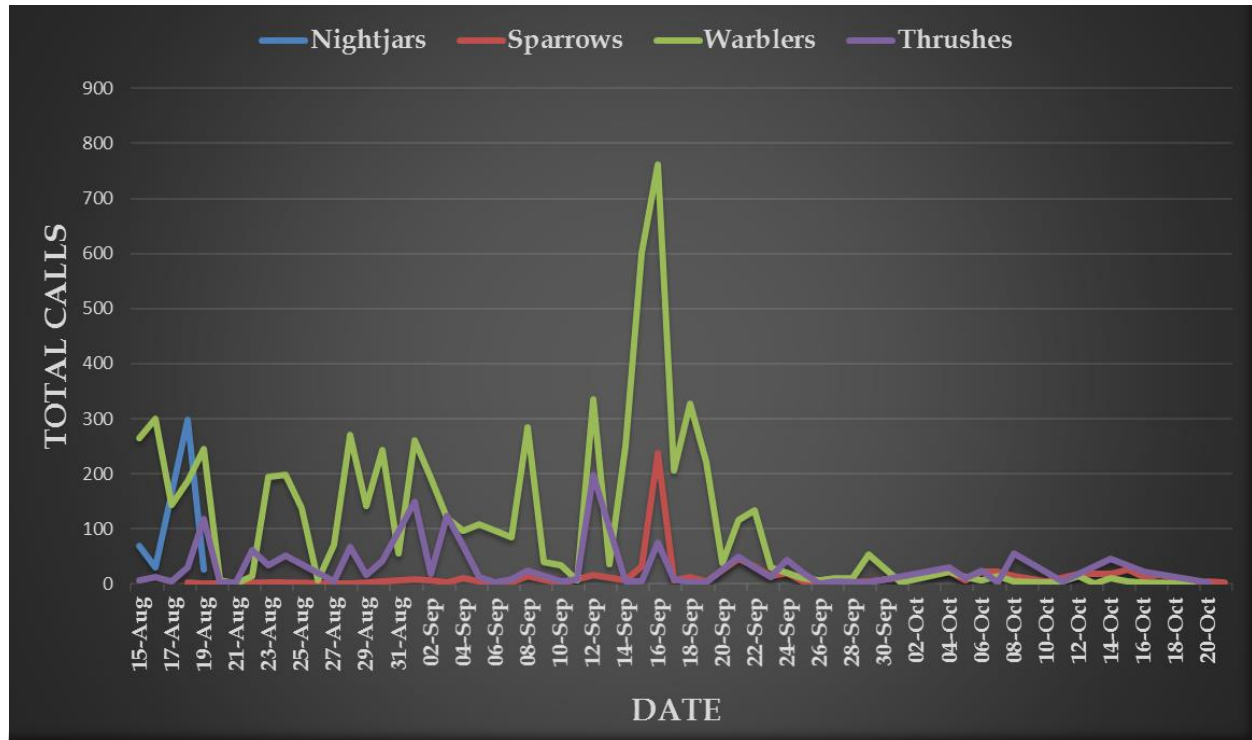


Figure 5 graphs the total calls by the major families of birds detected in the acoustic recordings. The most common family is the warbler family with a total of 7,080

night flight calls during the autumn. The next most common is the thrush family with 1,539 calls. The sparrows are next with 714 calls and the nightjars account for 426 calls.

**Figure 5: Total Calls by Family by Date**



Mid-September is the peak period for warblers, sparrows, and thrushes whereas the nightjars peaked at 299 calls nearly a month earlier on 18 August. The nightjars consist of one species, the Common Nighthawk. This species is listed as “threatened” by the Species at Risk Act (SARA) and will be discussed later in relation to species of conservation concern.

Table 2 lists the twenty most common species recorded during the autumn of 2015. The table also provides an estimate of the minimum number of individual birds that these calls represent. One bird may call multiple times while passing within range of the microphone or multiple birds may be calling to each other as they pass within range of the microphone. The estimate is based on counting any three calls that are less than one minute apart as one bird. For species that have multi-syllabic calls the estimate is adjusted accordingly. Thus the given estimates are, in most cases, very conservative



estimates of the number of birds of a given species.

**Table 2: Twenty Most Common Species Recorded**

<b>Species</b>	<b>Total Calls</b>	<b>Estimated Minimum Individuals</b>
Common Yellowthroat	1,390	952
Swainson's Thrush	1,166	580
Magnolia Warbler	1,071	763
Blackpoll Warbler	938	673
Ovenbird	636	503
American Redstart	605	446
Common Nighthawk	426	148
Black-and-White Warbler	359	295
Hermit Thrush	340	148
Northern Parula	296	231
Savannah Sparrow	242	161
White-throated Sparrow	240	173
Black-throated Green Warbler	238	166
Chestnut-sided Warbler	194	142
Blackburnian Warbler	160	133
Nashville Warbler	148	115
Canada Warbler	112	94
Bay-breasted Warbler	100	83
Yellow-rumped Warbler	87	80
Palm Warbler	77	68

Table 3 indicates the status of those species that are of conservation concern as determined by the Nova Scotia Government, the Species at Risk Act (SARA), and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The last column in the Table 3 provides annotations on the occurrence of the species in the acoustic recordings in the autumn of 2015.

The two species listed as “threatened” in Schedule 1 of the Species at Risk Act occurred in relatively large numbers in the Station 2 acoustic recordings at the South Canoe Wind Farm. These are Common Nighthawk and Canada Warbler.

**Table 3: Annotated List of Species of Conservation Concern**

Species	NSDNR Rank	SARA Schedule 1	COSEWIC Listed	Annotation
Black-crowned Night-Heron	May be at Risk			1 on 24 September
Greater Yellowlegs	Sensitive			3 on 27 August & 21 on 25 September
Black-billed Cuckoo	May be at Risk			1 on 16 September
Common Nighthawk	Threatened	Threatened	Threatened	70 on 15 August, 30 on 16 August, 299 on 18 August, & 27 on 19 August
Golden-crowned Kinglet	Sensitive			1 on 8 September
Eastern Bluebird	Sensitive			1 on 30 August
Tennessee Warbler	Sensitive			27 from 23 August to 18 September
Cape May Warbler	Sensitive			56 from 15 August to 18 September
Bay-breasted Warbler	Sensitive			100 from 15 August to 23 September
Blackpoll Warbler	Sensitive			938 from 23 August to 16 October
Pine Warbler	Undetermined			6 from 1 September to 7 October
Canada Warbler	Endangered	Threatened	Threatened	112 from 15 August to 16 September
Wilson's Warbler	Sensitive			30 from 19 August to 17 September
Vesper Sparrow	May be at Risk			1 on 1 September
Scarlet Tanager	Undetermined			2 on 23 August
Rose-breasted Grosbeak	Sensitive			12 from 19 August to 4 September
Indigo Bunting	Undetermined			1 on 8, 12, 19, & 29 September
Bobolink	Vulnerable		Threatened	1 on 3 September

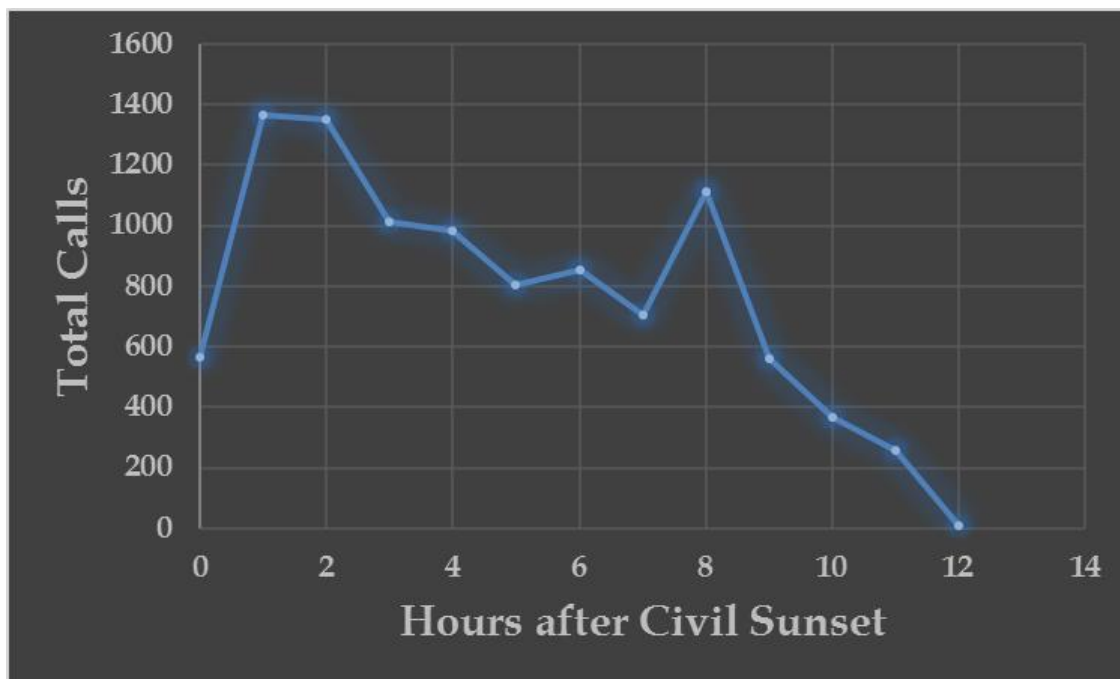
Since the Common Nighthawk both migrates and forages in the twilight hours, it is difficult to know if the many calls heard represent small foraging family flocks over South Canoe Lake that repeatedly flew past Station 2 or were a stream of migrants passing over the area. Given that calls built to a peak over several days and then stopped abruptly on 20 August, the most likely scenario is that South Canoe Lake is a migration staging area for Common Nighthawks.

The 112 Canada Warbler night flight calls at Station 2 is the highest number ever recorded at one station in the autumn out of ten other recording stations dating back to 2011. The second highest number was 64 at Amherst in 2014.

Some of the rare birds detected during the study included Indigo Bunting, Vesper Sparrow, Baltimore Oriole, Eastern Bluebird, Black-crowned Night-Heron, Golden-winged Warbler, Lark Sparrow, and Scarlet Tanager.

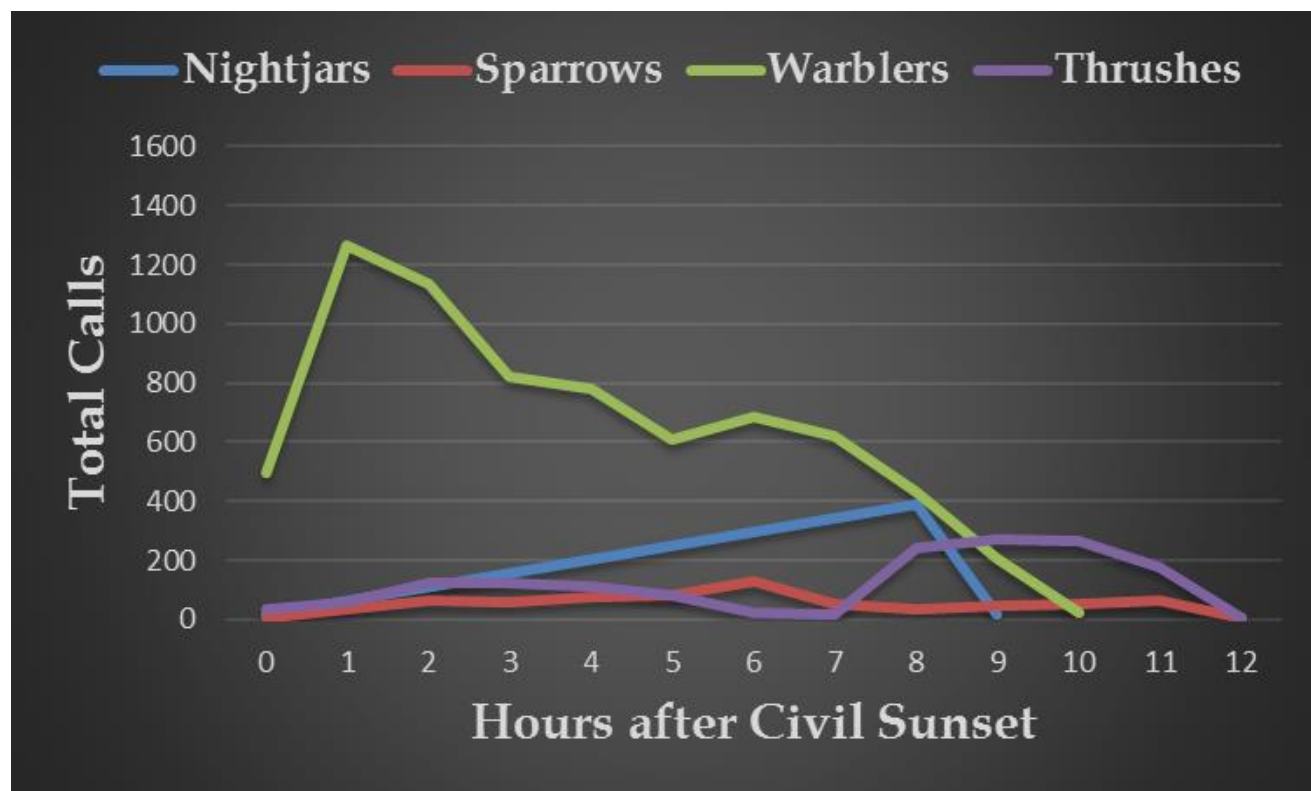
An analysis of the distribution of flight calls throughout the night is illustrated in Figure 6. During the autumn migration period calls peaked once early in the evening, at 1-2 hours after civil sunset, and again later at 8 hours after civil sunset.

**Figure 6: Total Calls by Hour after Civil Sunset**



As seen in Figure 7, these peaks correspond to differences in the abundance of different bird families through the night. Most notably, warblers peak in the first hour after civil sunset while thrushes and nightjars peak in the 8<sup>th</sup> to 10<sup>th</sup> hour. Sparrows have a small peak in the middle of the night.

**Figure 7: Calls by Family by Hour after Civil Sunset**



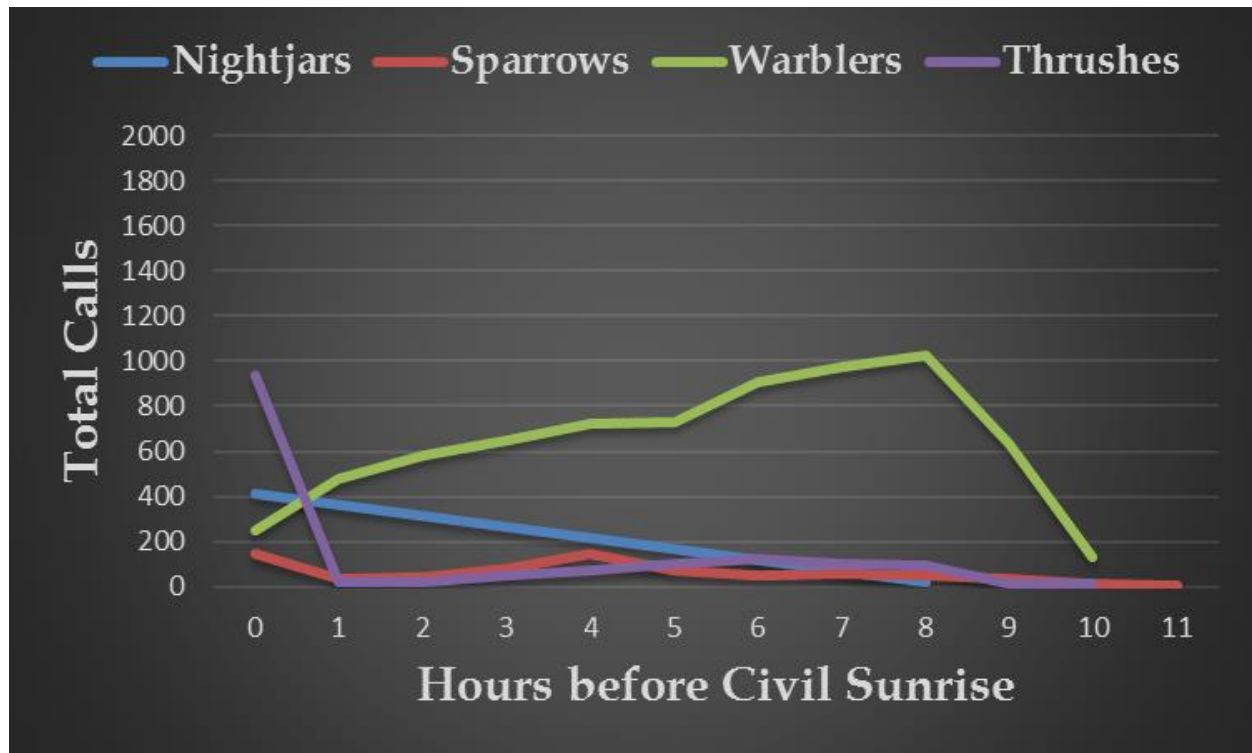
Due to the lengthening of the duration of darkness as the autumn advances, it is also fruitful to examine the nightly distribution of calls from the perspective of civil sunrise. As shown in Figure 8, there is a kind of reverse pattern in the calls of birds relative to civil sunrise. In the one hour before civil sunrise there is a clear phenomenon known as the thrush descent. After flying at a higher altitude during the night, thrushes descend like clockwork in the hour before civil sunrise. In the early autumn, Swainson's Thrushes dominant while later in the autumn this descent consists mainly of Hermit Thrushes.

In the case of the nightjars, and in particular, the Common Nighthawk, it is again



difficult to distinguish between migratory flights and foraging flights.

**Figure 8: Calls by Family by Hour before Civil Sunrise**



A forward stepping, automatic linear model, using the Statistical Package for the Social Sciences (SPSS), was used to measure weather effects on the number of calls recorded on an autumn night. Upper air data was derived from the Environment Canada station in Yarmouth and surface data was obtained from the Environment Canada weather station in Kentville. The model was able to account for 46.7% of the variability in the total number of flight calls per night (adjusted  $r^2$ ). Weather factors having a significant effect on total flight calls at the 95% confidence level were surface temperature at civil sunset, wind direction at 100 meter altitude at 2100 hours, surface wind direction at civil sunset, and relative humidity at civil sunset. Wind speed at 100 meters at 2100 hours also had an effect but at 90% confidence level. More specifically, the number of calls increased when the temperature was above 16° C (40% of the effect), the wind direction at 100 meters was from the northwest and northeast (20%), surface winds were from the northwest, northeast, southeast, and calm (18%), and the

relative humidity was from 70-89% (16%).

## Discussion

Since 2011, the author has conducted autumn acoustic monitoring at 11 stations on sites at or near wind energy facilities using the same equipment and methodology. Table 4 lists the total high frequency (warbler and sparrow) night flight calls recorded at these stations. Station 2 at the South Canoe Wind Farm ranks 3<sup>rd</sup> in the total number of calls per season and fourth in the mean number of calls per night during the period of 2 September to 15 October.

**Table 4: Comparison of High Frequency Night Flight Calls in the Autumn at Acoustic Monitoring Stations in Nova Scotia, 2011-2015**

Location	County	Calls/ Season	Mean/night*	Year
Gulliver's Cove	Digby	10,002	213	2011
Weaver Mountain	Pictou	7,899	152	2011
South Canoe Station 2	Lunenburg	7,869	114	2015
Glasgow Head	Guysborough	6,333	128	2015
Amherst Station 3	Cumberland	6,229	106	2014
Amherst Station 1	Cumberland	5,637	88	2014
Browns Mountain	Antigonish	4,529	-	2011
Loganville Ridge	Pictou	2,095	-	2011
Glasgow Head	Guysborough	2,016	94	2013
Winter Bog	Guysborough	1,796	35	2015
Spinney Gully	Guysborough	1,383	21	2013
Nuttby Mountain	Colchester	1,271	-	2011
* September 2 to October 15				

One would expect high call counts in coastal areas where birds often concentrate during stop-over. However, South Canoe Lake and Weaver Mountain (ranked second in Table 3) are both located in central portions of the province. This seems to suggest that there may be a flyway for songbirds, in particular, warblers, down the centre of the province in the autumn.

Given the high numbers of Common Nighthawks detected in the recordings in

mid-August, it is recommended that investigations be conducted in the second year of post-construction monitoring to better understand this phenomenon and to evaluate if there is a need for risk mitigation.