

Final Report
Post-Construction Bird and Bat Monitoring, 2010-2011
Maryvale Wind Project

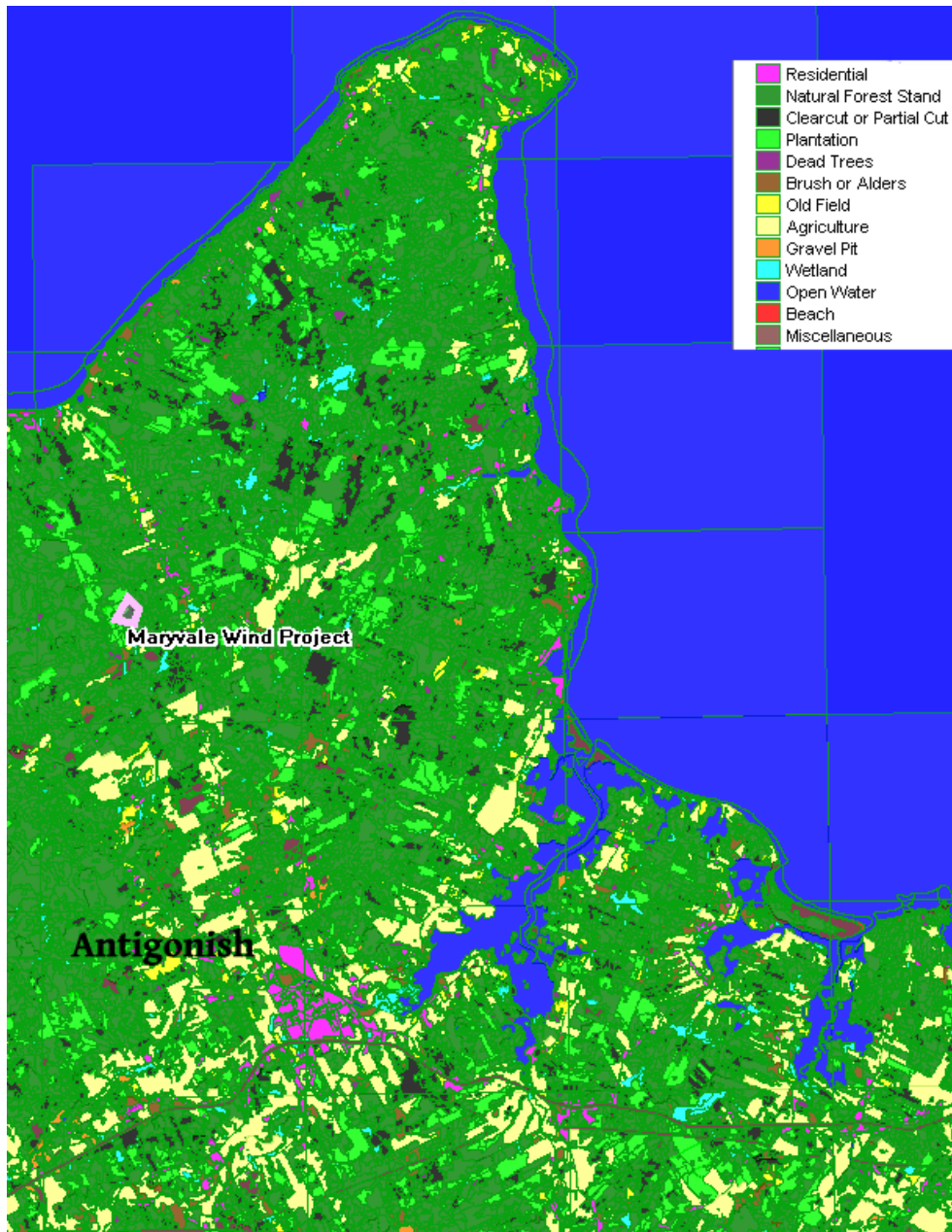


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Introduction

This document reports the results of a post-construction monitoring program for birds and bats at the Maryvale Wind Project, during the period June 2010 through October 2011. This wind energy facility consists of 4 turbines with a total capacity of 6 megawatts. It is located on about 25 hectares of land in the Antigonish County highlands about 15 kilometers north of the Town of Antigonish (See Figure 1).

Figure 1: Location of the Maryvale Wind Project in Northeastern Nova Scotia



The consultant was employed to carry out the post-construction monitoring in June 2010. A monitoring plan was developed by the consultant and subsequently approved by Environment Canada and the Nova Scotia Department of Natural Resources. The post-construction monitoring consisted of three components:

- 1) Breeding Bird Survey,
- 2) Mortality Study for Birds and Bats, and
- 3) Monitoring for Olive-sided Flycatcher, a species listed as “Threatened” under the *Species at Risk Act* of Canada and identified as a confirmed breeder near the wind energy site during the baseline study (Stevens 2009).

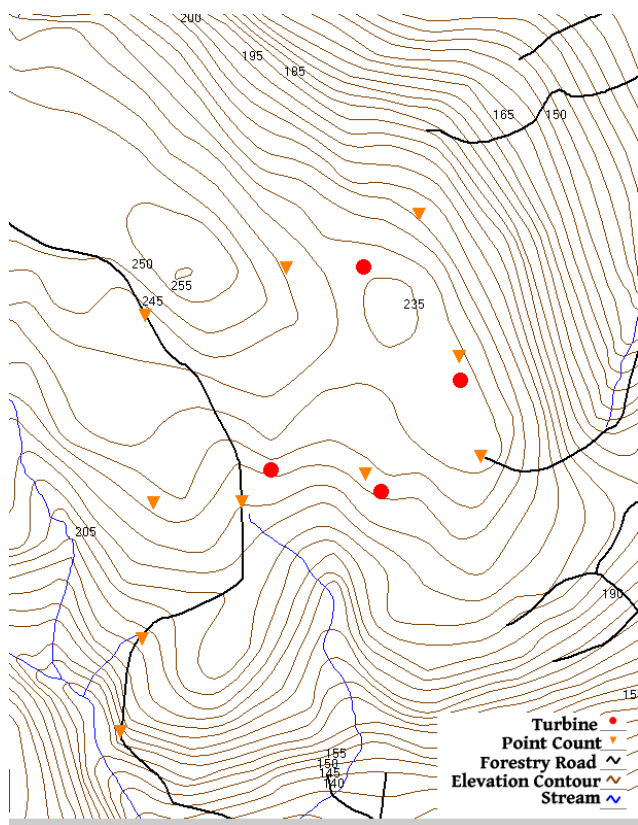
Migration stop-over and diurnal passage studies were not conducted during the post-

construction stage since the baseline study indicated that it was not an important stop-over or passage area, and the wind energy facility covered only a small area.

Breeding Bird Survey

The breeding bird surveys were carried out from April into August with the most focused efforts occurring in June during the peak breeding season.

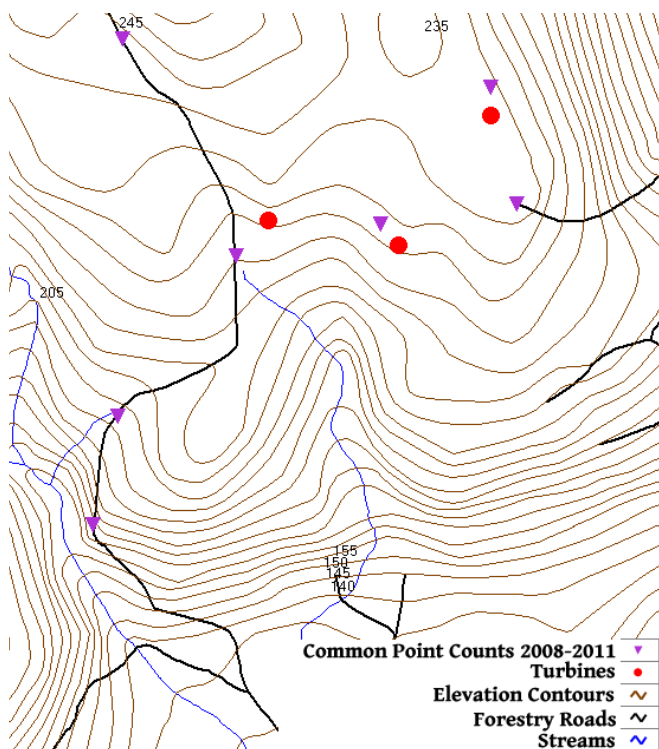
Figure 2: Baseline Study Point Counts in 2008



Since this work did not commence until June in 2010, it was not possible to do an early breeding bird survey. In 2011, both an early breeding bird survey (May) and a peak breeding bird survey (June) were carried out by using a point count methodology (see also Environment Canada, 2007). Nocturnal and crepuscular nesters were surveyed in late April using the methods recommended by Bird Studies Canada (Takats et al. 2001). Observations of breeding evidence were noted throughout the breeding period of this area, April to August.

A point count is a survey method in which the observer records all the birds seen and heard during a 10-minute interval at each point count station. Figure 2 shows the 10 point counts that were carried out in late June and early July in 2008 during the baseline study.

Figure 3: Point Counts Surveyed in both Baseline and Post-Construction Studies (2008, 2010-11)



The breeding bird surveys in 2010 and 2011, tried to include all of the 10 baseline study point counts. However, construction activities had significantly altered the landscape in some places, making it difficult to access exactly the same point count stations. Thus Figure 3 shows the 7 point counts that are identical in location in the years 2008, 2010, and 2011.

Figure 4 shows the 20 point count stations that were established for surveys in both 2010 and 2011. These include the 7 point count stations used from 2008.

As can be seen in Figure 5, the point counts and turbine locations are largely located in areas that were forested before wind farm construction (Nova Scotia 2003). As one moves eastward and southward with declining elevation toward residential areas, there is a

mixture of old fields, alders, small clearcuts, hayfields, and blueberry fields.

Figure 4: Point Counts Surveyed in Post-Construction Studies

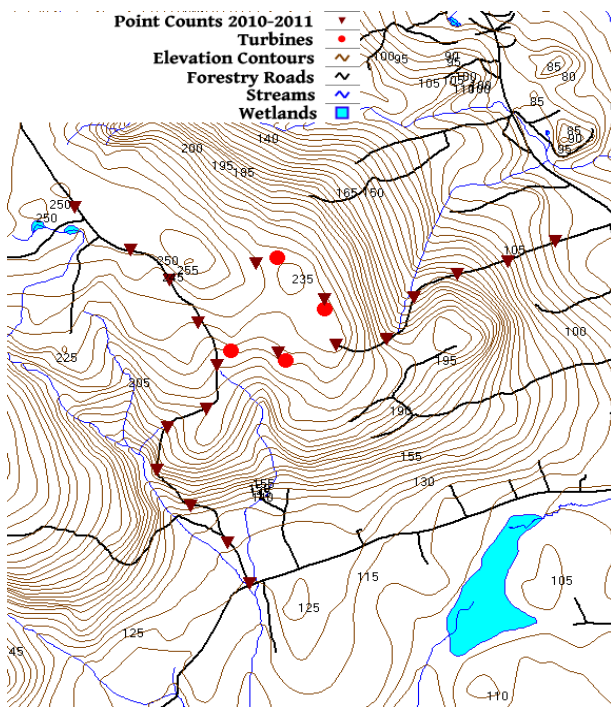
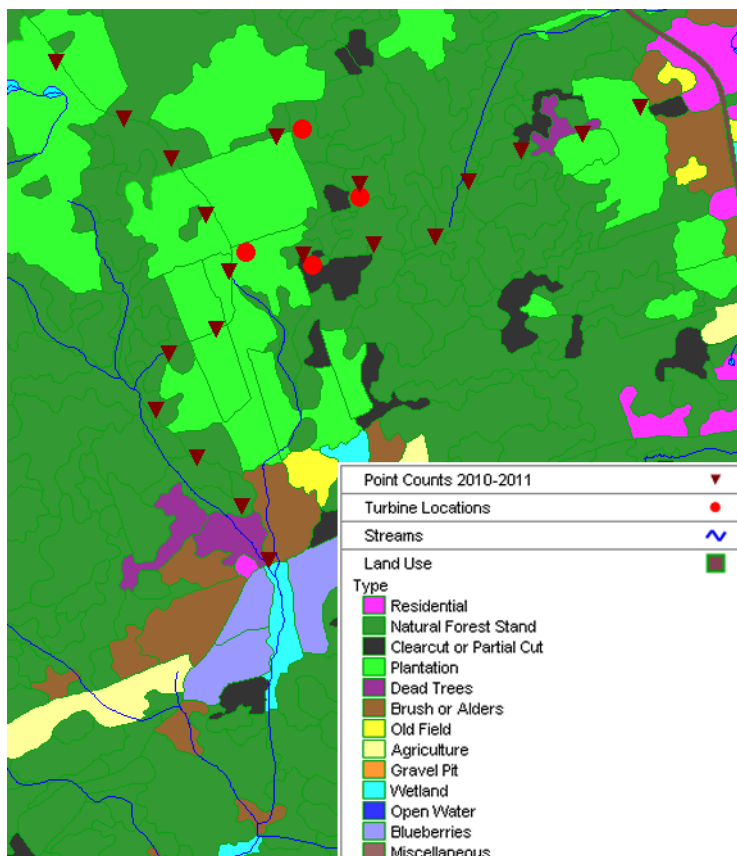


Figure 5: Land Use in the Study Area



Among the seven point counts from the baseline study that were surveyed in 2010-2011, two of these were substantially changed by turbine and road construction. These are point counts 7 and 14 in Figure 6. The other point counts within or close to the project boundary (12, 13, 15), were close to terrain already disturbed before construction. None of the 13 new point counts underwent any substantial change between 2010 and 2011.

Figure 6 also demonstrates that the survey point counts are distributed among softwood, hardwood, and mixed forest habitats.

Ovenbird



The abundance indices for the early breeding bird species occurring on 30% or more of the point counts in 2011 are given in Table 1. Since some early nesters do not start nesting until the latter part of May, the number of valid point counts for which a bird seen or heard can be counted varies for each species. The most abundant early nester was the Ovenbird, seen on 89% of valid point counts for that species, followed by the American Robin (70%), Blue-headed Vireo (56%), White-throated Sparrow (45%), and Ruby-crowned Kinglet (44%). No nocturnal or crepuscular birds were heard during their breeding period.

Figure 6: Forest Cover Types in the Study Area

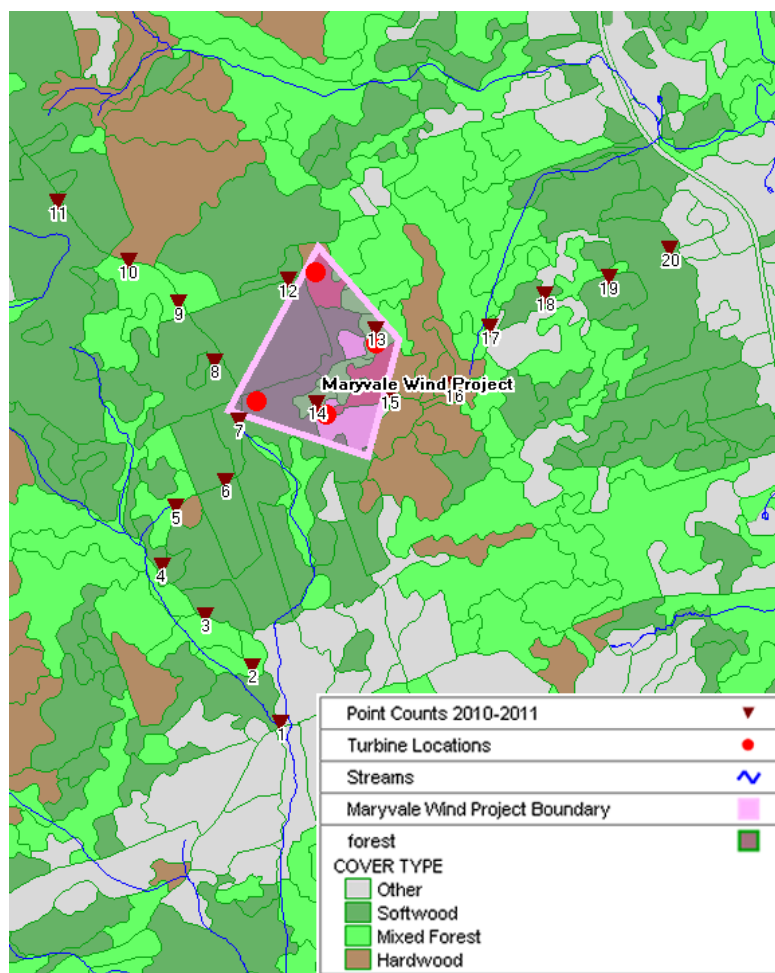


Table 2 shows the abundance indices for the species occurring on 30% or more of the peak breeding point counts in 2008 along with the indices for the same species in 2010 and 2011. The most common peak breeding birds in all three years were Red-eyed Vireo, White-throated Sparrow, American Robin, and Ovenbird with these four species occurring on 60% to 90% of all point counts.

Due to the relatively small number of point counts in 2008, statistical analysis of population trends is limited. Nonetheless a number of statistical tests were run on the data for the three years of surveys. These tests included an Analysis of Variance, and the Welch, Brown-Forsythe, Tukey, and Tamhane's T2 tests (all parametric tests), and the Mann-Whitney-Wilcoxon non-parametric test. All tests were made at the 95% level of confidence.

These tests indicated that there was a significant increase in the total number of birds on the point count stations between the years 2008 and 2011 with a mean of 9.20 in 2008 and 12.70 in 2011 (see Table 3). At the same time, all of the tests showed a significant increase in the number of Red-eyed Vireo between 2008 and 2011 from a mean of 1.10 in 2008 to 2.05 in 2011. The same was true for the American Robin, increasing from 0.40 in 2008 to 1.80 in 2011. Less robust evidence showed possible significant decreases in Mourning Dove (0.20 to 0.00), Cedar Waxwing (0.40-0.00), Mourning Warbler (0.40-0.05) in 2008 to 2010, a decrease in Blue Jay (0.20-0.00) from 2008 to 2011, and a decrease in Dark-eyed Junco (1.20-0.55) in 2010 to 2011.

Statistical analysis of the seven point counts surveyed in all three years showed a similar trend.

Table 1: Abundance Indices for Early Breeding Birds in 2011

Species	N	Total	Mean	Frequency
Ovenbird	9	23	2.56	89%
American Robin	20	26	1.30	70%
White-throated Sparrow	20	18	0.90	45%
Blue-headed Vireo	9	5	0.56	56%
Ruby-crowned Kinglet	9	5	0.56	44%
Dark-eyed Junco	20	8	0.40	40%
Common Raven	20	7	0.35	30%
Species	7	5.10		
Total Birds		150	7.50	

Significant increases occurred for both Red-eyed Vireo and American Robin with the mean per point count increasing from 1.00 to 2.57 and 0.43 to 2.14 for these species respectively between 2008 and 2011. No other significant changes could be detected in the analysis of this sub-group of point count

stations. The abundance indices for those species occurring in 30% or more of these seven point counts in

2008 and in subsequent years are presented in Table 4.

Table 2: Abundances Indices for Peak Breeding Birds, 2008-2012

Species	2008				2010				2011			
	Total	Mean	%	Rank	Total	Mean	%	Rank	Total	Mean	%	Rank
Red-eyed Vireo	11	1.10	80%	1	25	1.25	85%	3	41	2.05	90%	1
White-throated Sparrow	11	1.10	80%	2	29	1.45	60%	2	18	0.90	60%	4
Ovenbird	9	0.90	90%	3	20	1.00	65%	5	31	1.55	70%	3
Dark-eyed Junco	8	0.80	50%	4	24	1.20	75%	4	11	0.55	35%	7
Black-throated Green Warbler	6	0.60	50%	5	4	0.20	15%	15	5	0.25	25%	15
American Robin	4	0.40	40%	6	29	1.45	65%	1	36	1.80	70%	2
Cedar Waxwing	4	0.40	30%	7	0	0.00	0%	0	12	0.60	5%	6
Northern Parula	4	0.40	40%	8	7	0.35	35%	7	8	0.40	30%	8
Magnolia Warbler	4	0.40	30%	9	9	0.45	40%	6	13	0.65	50%	5
Black-and-White Warbler	4	0.40	40%	10	4	0.20	20%	16	4	0.20	20%	18
Mourning Warbler	4	0.40	40%	11	1	0.05	5%	37	8	0.40	30%	9
Alder Flycatcher	3	0.30	30%	12	4	0.20	20%	13	6	0.30	20%	11
Common Yellowthroat	3	0.30	30%	13	3	0.15	15%	21	1	0.05	5%	33
American Goldfinch	3	0.30	30%	14	4	0.20	20%	19	5	0.25	20%	16
Species		7.90				7.75				7.70		
Total Birds		9.20				11.35				12.70	Increase	

Table 3: Statistically Significant Changes in Bird Populations in the Study Area, 2008, 2010-2011

Species	Year	Confidence				Type of Test (p-value)						Mann-Whitney Comparison	Years
		Standard Interval 95%				Brown-				Wilcoxon			
		Mean	Deviation	Lower	Upper	ANOVA	Welch	Forsythe	Tukey		Tamhane's T2		
Red-eyed Vireo	2008	1.10	0.88	0.47	1.73						>0.05		2008-2010
	2010	1.25	0.72	0.91	1.59	0.016	0.04	0.014	0.042	N/A		0.036	2008-2011
	2011	2.05	1.23	1.47	2.63				0.035	N/A		0.030	2010-2011
American Robin	2008	0.40	0.52	0.03	0.77				N/A	0.021		0.036	2008-2010
	2010	1.45	1.43	0.78	2.12	0.049	0	0.023	N/A	0.007		0.021	2008-2011
	2011	1.80	1.70	1.00	2.60					>0.05			2010-2011
Total Birds	2008	9.20	3.05	7.02	11.38						>0.05		2008-2010
	2010	11.35	4.48	9.26	13.44		>0.05					0.034	2008-2011
	2011	12.70	5.16	10.28	15.12					>0.05			2010-2011

Table 4: Abundance Indices for Seven Point Counts Conducted in all Three Years 2008, 2010-2011

Species	2008				2010				2011			
	Total	Mean	%	Rank	Total	Mean	%	Rank	Total	Mean	%	Rank
White-throated Sparrow	9	1.29	100%	1	5	0.71	43%	5	6	0.86	71%	4
Ovenbird	7	1.00	100%	2	10	1.43	100%	2	12	1.71	86%	3
Red-eyed Vireo	7	1.00	86%	3	10	1.43	100%	1	18	2.57	86%	1
Dark-eyed Junco	7	1.00	57%	4	9	1.29	86%	3	6	0.86	57%	6
Black-throated Green Warbler	4	0.57	57%	5	1	0.14	14%	17	2	0.29	29%	10
American Robin	3	0.43	43%	6	9	1.29	57%	4	15	2.14	86%	2
Mourning Warbler	3	0.43	43%	7	1	0.14	14%	20	6	0.86	57%	5
Common Yellowthroat	3	0.43	43%	8	1	0.14	14%	21	0	0.00	0%	0
American Goldfinch	3	0.43	43%	9	2	0.29	29%	9	1	0.14	14%	23
Total Species	20	8.71			22	6.86			23	7.71		
Total Birds	68	9.71			65	9.29			88	12.57		

Another way of determining the possible impact of a wind energy facility on breeding bird populations is to conduct point counts at increasing distance from the turbines in similar habitats. In this case, the point counts are in woodland habitats of varying degrees of maturity. Point count data was analyzed in two groups, those less than 500 meters of a wind turbine and those greater than 500 meters of a turbine. Most of the point counts in 2008 were within 500 meters of a proposed turbine. Analysis of the data for 2010 showed no statistically significant differences for the two data sets. However, in 2011, the analysis pointed to some differentiation in the point counts closer to the wind turbines. Table 5 shows the abundance indices of woodland birds in these two groupings in 2011; those point counts within 500 meters of a wind turbine and those greater than 500 meters.

Table 5: Abundance Indices of Breeding Birds by Distance from Wind Turbines

Species	<500 m				>500 m			
	Total	Mean	%	Rank	Total	Mean	%	Rank
Red-eyed Vireo	21	2.33	89%	1	20	1.82	91%	1
American Robin	19	2.11	78%	2	17	1.55	64%	2
Ovenbird	16	1.78	78%	3	15	1.36	64%	3
Dark-eyed Junco	9	1.00	67%	4	2	0.18	9%	18
White-throated Sparrow	8	0.89	67%	5	10	0.91	55%	5
Magnolia Warbler	7	0.78	67%	6	6	0.55	36%	7
Mourning Warbler	7	0.78	56%	7	1	0.09	9%	27
American Goldfinch	5	0.56	44%	8	0	0.00	0%	0
Purple Finch	4	0.44	44%	9	0	0.00	0%	0
Least Flycatcher	3	0.33	33%	11	4	0.36	18%	8
Black-and-White Warbler	3	0.33	33%	13	1	0.09	9%	26
Cedar Waxwing	0	0.00	0%	0	12	1.09	9%	4
Northern Parula	0	0.00	0%	0	6	0.55	36%	6
Hermit Thrush	2	0.22	22%	17	4	0.36	36%	9
Species	1	9.00			1	6.64		
Birds	127	14.11			127	11.55		
N=9					N=11			

The non-parametric analysis indicated that there was significantly greater species diversity at the point counts within 500 meters of the wind turbine. One might surmise that this greater diversity is a result of the edge effect created by the wind facility. Indeed, those species significantly more abundant in the less than 500 meter range of a turbine were those that tend to be associated with edge or disturbed habitats. These species were Mourning Warbler (mean of 0.78 within 500 meters and 0.09 beyond 500 meters), Dark-eyed Junco (1.00 and 0.18), Purple Finch (0.44 and 0.00), and American Goldfinch (0.56 and 0.00). Table 6 presents the statistical data for these species.

The distribution of breeding birds by habitat is shown Table 7. Each point count was assigned one of five possible habitat types:

- 1 – Disturbed (clearcut or early succession)
- 2 – Disturbed alongside mature deciduous forest

3 – Mixed forest

4 – Coniferous forest

5- Mature deciduous forest

The point counts for 2010 and 2011 were pooled and analyzed based on the maximum count of each species over the two year period.

Table 6: Significant Differences in Bird Populations by Distance from Turbine in 2011

Species	Distance	Mean	Standard Deviation	Confidence Interval 95%		ANOVA	Type of Test (p-value)		
				Lower	Upper		Welch	Brown- Forsythe	Mann-Whitney- Wilcoxon
Mourning Warbler	<50	0.78	0.83	0.14	1.42	0.020	0.041	0.041	0.024
	>50	0.09	0.30	-0.11	0.29				
Dark-eyed Junco	<50	1.00	0.87	0.33	1.67	0.031	0.031	0.031	0.015
	>50	0.18	0.60	-0.22	0.59				
Purple Finch	<50	0.44	0.53	0.04	0.85	0.011	N/A	N/A	0.016
	>50	0.00	0.00	0.00	0.00				
American Goldfinch	<50	0.56	0.73	0.56	0.73	0.020	N/A	N/A	0.016
	>50	0.00	0.00	0.00	0.00				
Total Species	<50	9.00	2.78	6.86	11.14		>0.05		0.046
	>50	6.64	2.38	5.04	8.23				

As can be seen in Table 7, the greatest number of birds and highest diversity is found in the disturbed habitats. Point counts in the clearcut and early succession forest had a mean of 11.50 species and 22.50 individual birds while those in disturbed areas alongside a mature forest had a mean of 9.80 species and 15.20 individuals. The means for a mixed forest were lower than one might expect for the Pictou-Antigonish Highlands (usually higher than for coniferous or mature deciduous) at 5.71 species and 8.86 individuals. The means for coniferous forest and mature deciduous were 8.00 and 7.67 for mean number of species respectively, and 11.67 for individuals for both habitat types. The colour-coding in Table 7 gives some insight into the habitat preferences of individual species.

Finally, Table 8 presents a list of the breeding status of sixty-one species of birds identified as possible, probable, or confirmed breeders in the study area using the criteria developed for the Maritimes Breeding Bird Atlas (Bird Studies Canada n.d.). In total, between 2008 and 2011, 17 possible breeding species, 26 probable species, and 18 confirmed species were noted.

Species of Conservation Concern – Olive-sided Flycatcher

From the baseline study, the Olive-sided Flycatcher was identified as the primary species of conservation concern in the project area. In 2008, this species was seen and heard singing at Point Count #4 (see Figure 7) on June 1st. It was subsequently seen and heard on several occasions, and an adult was seen feeding young. However, after the 1st sighting on June 1st, the location of the flycatcher observations are not recorded in the data of the study.

Table 7: Mean Abundance at Point Counts by Habitat, 2010-2011

Species	Disturbed	Disturbed beside Mature Deciduous	Mixed Forest	Coniferous	Mature Deciduous
	1	2	3	4	5
Alder Flycatcher	1.00	0.60	0.29	0.00	0.00
American Crow	2.00	0.00	0.14	0.00	0.00
American Goldfinch	0.50	0.60	0.14	0.33	0.00
American Redstart	1.50	0.40	0.00	0.00	0.33
American Robin	3.00	3.40	1.86	1.33	2.00
Black-and-White Warbler	0.00	0.40	0.00	0.00	0.00
Black-capped Chickadee	0.00	0.80	0.00	0.33	0.00
Blue-headed Vireo	0.00	0.60	0.29	0.00	0.67
Blackburnian Warbler	0.00	0.00	0.14	0.00	0.33
Blue Jay	0.00	0.20	0.00	0.00	0.00
Black-throated Green Warbler	0.00	0.20	0.14	1.00	0.33
Cedar Waxwing	6.00	0.00	0.00	0.00	0.00
Common Grackle	0.00	0.20	0.00	0.67	0.00
Common Raven	0.00	0.00	0.14	0.00	0.00
Common Yellowthroat	1.00	0.20	0.14	0.00	0.00
Chestnut-sided Warbler	0.00	0.00	0.14	0.00	0.00
Dark-eyed Junco	1.50	1.00	0.86	1.33	2.33
Eastern Wood Pewee	0.00	0.00	0.14	0.00	0.00
Golden-crowned Kinglet	0.00	0.00	0.00	0.33	0.00
Hairy Woodpecker	0.00	0.00	0.14	0.00	0.00
Hermit Thrush	0.00	0.60	0.29	0.67	0.67
Least Flycatcher	0.00	0.40	0.14	0.00	1.00
Magnolia Warbler	1.50	0.60	0.43	1.67	0.33
Mourning Dove	0.00	0.00	0.00	0.00	0.33
Mourning Warbler	0.50	1.00	0.00	0.00	0.33
Nashville Warbler	0.00	0.00	0.00	0.33	0.00
Northern Flicker	0.50	0.20	0.43	0.00	0.00
Northern Parula	0.00	0.80	0.57	0.33	0.67
Northern Waterthrush	0.00	0.00	0.00	0.00	0.33
Olive-sided Flycatcher	0.00	0.00	0.14	0.00	0.00
Ovenbird	1.00	1.80	1.29	0.33	2.00
Pileated Woodpecker	0.00	0.00	0.14	0.00	0.33
Purple Finch	0.00	0.00	0.14	0.33	0.00
Rose-breasted Grosbeak	1.00	0.00	0.00	0.00	0.33
Ruby-crowned Kinglet	0.50	0.00	0.14	1.33	0.00
Red-eyed Vireo	2.50	2.60	1.43	1.67	2.33
Song Sparrow	2.50	0.20	0.14	0.00	0.00
Swainson's Thrush	0.00	0.40	0.14	0.67	0.00
Winter Wren	0.00	0.00	0.00	0.00	0.33
White-throated Sparrow	3.00	1.60	1.29	1.67	1.67
Yellow-bellied Flycatcher	0.00	0.00	0.00	0.33	0.00
Yellow-rumped Warbler	0.50	0.00	0.00	0.33	0.00
Total Species	11.50	9.80	5.71	8.00	7.67
Total Birds	22.50	15.20	8.86	11.67	11.67

Table 8: Breeding Status of Birds in the Study Area, 2008-2011

Species	Possible Breeding	Probable Breeding	Confirmed Breeding
Ruffed Grouse		D	
Sharp-shinned Hawk	H		
Red-tailed Hawk		P	
Wilson's Snipe		D	
Mourning Dove		T	
Ruby-throated Hummingbird	H		
Yellow-bellied Sapsucker		D	
Downy Woodpecker	H		
Hairy Woodpecker	S		
Northern Flicker			FY
Pileated Woodpecker	S		
Olive-sided Flycatcher			FY
Eastern Wood Pewee	S		
Yellow-bellied Flycatcher	S		
Alder Flycatcher		T	
Least Flycatcher		T	
Blue-headed Vireo			FY
Red-eyed Vireo			FY
Blue Jay	H		
American Crow			FY
Common Raven		P	
Black-capped Chickadee			FY
Boreal Chickadee			FY
Red-breasted Nuthatch		T	
White-breasted Nuthatch		P	
Winter Wren		T	
Golden-crowned Kinglet			FY
Ruby-crowned Kinglet			FY
Veery		T	
Swainson's Thrush		T	
Hermit Thrush		P	
American Robin			FY
Cedar Waxwing		P	
European Starling			FY
Nashville Warbler	S		
Northern Parula			FY
Chestnut-sided Warbler		T	
Magnolia Warbler			FY
Black-throated Blue Warbler	S		
Yellow-rumped Warbler		P	
Black-throated Green Warbler			FY
Blackburnian Warbler		T	
Palm Warbler		P	
Black-and-White Warbler			CF
American Redstart	S		
Ovenbird		P	
Northern Waterthrush	S		
Mourning Warbler		T	
Common Yellowthroat		T	
Rose-breasted Grosbeak		T	
Chipping Sparrow	S		
Song Sparrow			FY

**Red-eyed Vireo****American Robin****White-throated Sparrow**

Lincoln's Sparrow	S		
Swamp Sparrow	S		
White-throated Sparrow			FY
Dark-eyed Junco			FY
Common Grackle	H		
Pine Grosbeak	H		
Purple Finch		P	
American Goldfinch		T	
Evening Grosbeak		P	
Total:	17	26	18
Total Breeding:	61		

H Species observed in its breeding season in suitable nesting habitat

S Singing male(s) present, or breeding calls heard, in suitable nesting habitat in breeding season

P Pair observed in suitable nesting habitat in nesting season

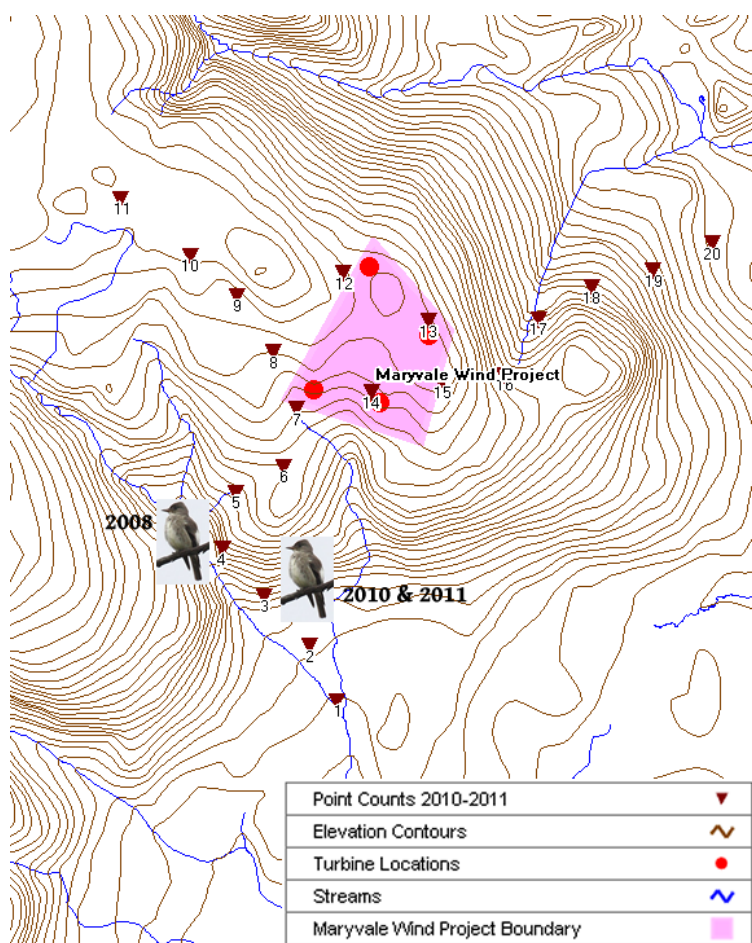
T Permanent territory presumed through registration of territorial song, or the occurrence of an adult bird, at the same place, in breeding habitat, on at least two days a week or more apart, during its breeding season

D Courtship or display, including interaction between a male and a female or two males, including courtship feeding or copulation

FY Recently fledged young (nidicolous species) or downy young (nidifugous species), including incapable of sustained flight

CF Adult carrying food for young

Figure 7: Location of Olive-sided Flycatchers in Study Area, 2008 and 2010-2011



On June 3rd, 2010, an Olive-sided Flycatcher was singing at Point Count #3, about 250 meters from the 2008 documented sighting (see Figure 7). It was not seen again anywhere in the study area, despite repeated attempts, in 2010.

On May 27th, 2011, an Olive-sided Flycatcher was again singing at Point Count #3. Repeated visits to that site, which included the use of playing recordings of the song of the Olive-sided Flycatcher, failed to detect the species again until finally, on July 7th, 2011, an Olive-sided Flycatcher was seen at Point Count #3. It was not singing but making its pip-pip-pip call. This was heard before use of a playback recording. No other Olive-sided Flycatchers were seen on that occasion or thereafter at this site.

In summary, these observations suggest that the Olive-sided Flycatcher still nests near the project area but at a distance such that it is difficult to find on a regular basis.

Mortality Study of Birds and Bats

The same methods were used in the mortality study for birds and bats. Search grids were constructed shortly after the commencement of the research contract. Following the guidelines proposed by Broders and Burns (2010), the grids were 80 X 80 meter squares around the turbines divided into 50 smaller rectangles that were 8X20 meters. However, none of the turbines had enough space around them to accommodate a full 80X80 square without going into the woods. As a result, the search area was often considerably less. This was compensated for by the searching of a certain amount of “extended” area outside the 80X80 metre area. The grid layouts for all four turbines are shown in Figure 8 (A&B). Carcass searching, scavenger trials, and searcher testing were conducted according to the recommendations of the Canadian Wildlife Service (Environment Canada 2007b).

Figure 8 (A) Search Grid Layouts for Turbines 1 & 2 at Maryvale Wind Project

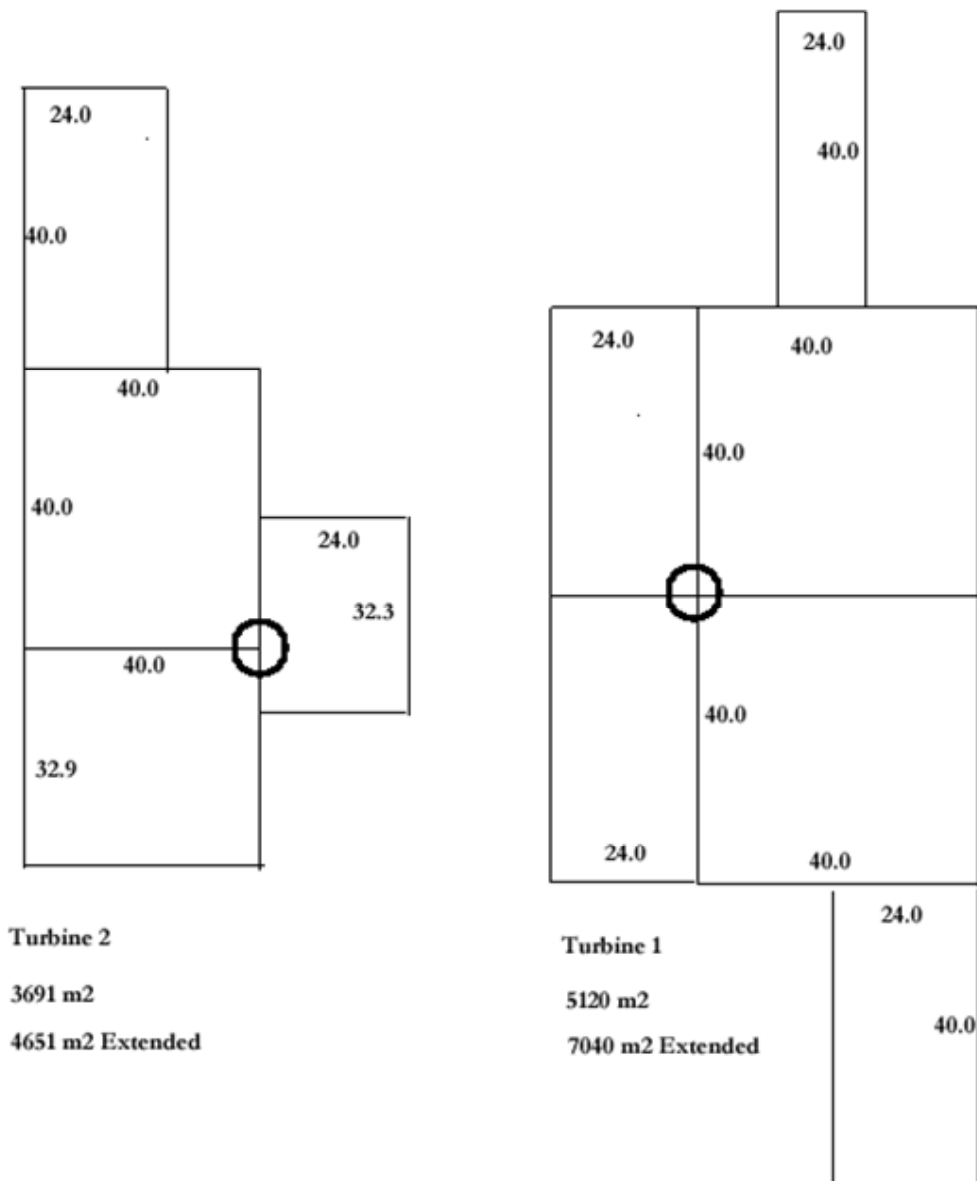
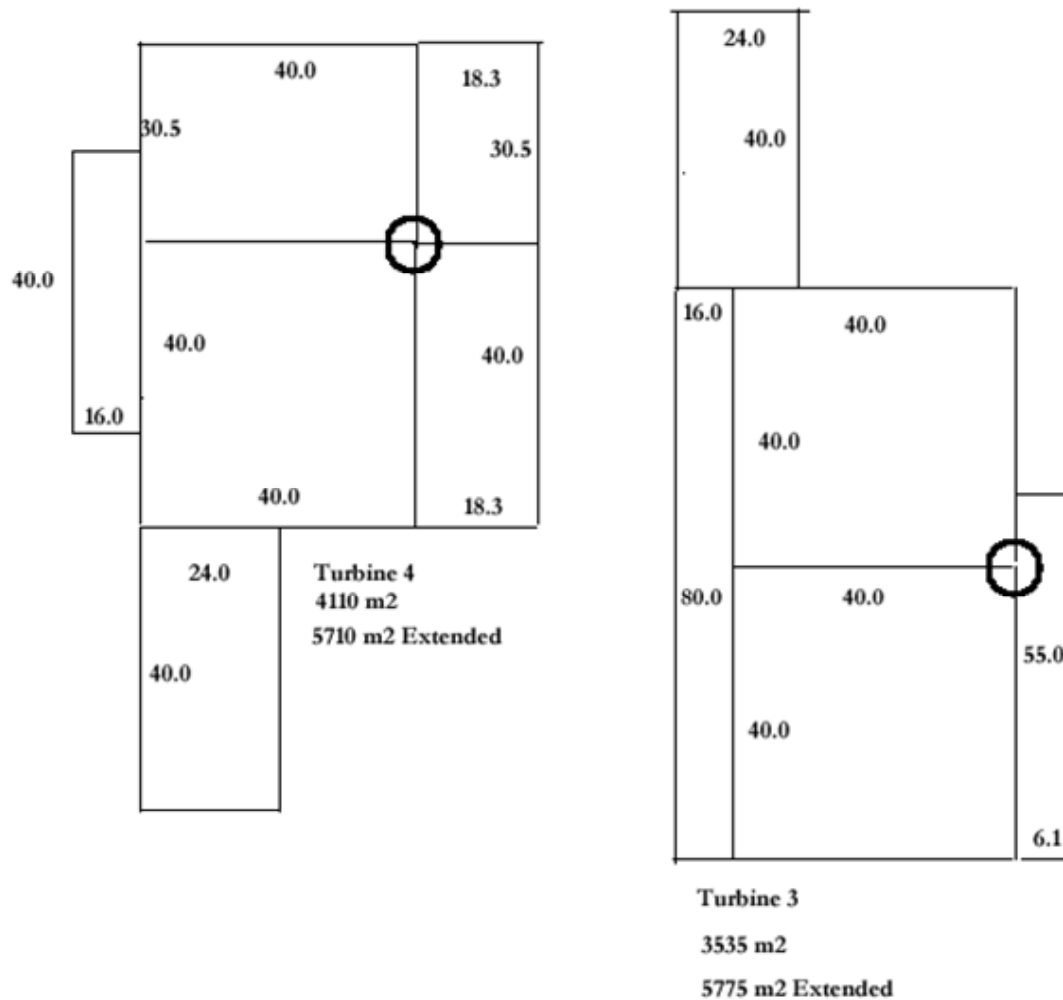


Figure 8 (B): Search Grid Layouts at Turbines 3 & 4 at Maryvale Wind Project



Searches commenced on June 30, 2010 and continued until October 29, 2010. They started again on April 11, 2011 and lasted until October 31, 2011. Each turbine was searched three times a week during the migration season and once a week during the breeding period. Scavenger and searcher trials were conducted in all three seasons.

No bats were found in the two-year search period and thus no analysis of bat mortality was undertaken. Three bird carcasses or bird parts were found over the two-year search period, and all within 40 meters of a turbine. The birds were a Red-eyed Vireo and American Robin in 2010, and an unidentifiable bird bone in 2011.

As recommended by the Canadian Wildlife Service, the analysis of mortality followed the guidelines of the Ontario Ministry of Natural Resources (2011) using the following equation:

$$C = c / (Se * Sc * Ps) \text{ where}$$

C=the corrected number of bird mortalities,

c=the number of carcasses found,

Se=proportion of carcasses expected to be found by searchers (searcher efficiency),

Sc=proportion of carcasses not removed by scavengers over the search period, and

Ps=percent of area searched

The results of the analysis are shown in Table 9. The estimated mortality for the 80 x 80 meter grids was 1.28/turbine in 2010, 0.53/turbine in 2011, and 0.87/turbine/year for the two-year period. The average estimated mortality in Canada is 4.6 plus or minus 0.48 (95% CL) birds per turbine per year (Ryan Zimmerling, personal communication). However, this figure is based on a larger, 50 meter radius circular search area. Using the Maryvale Wind Project data to extrapolate to this larger search area, a comparable estimated mortality would be 1.56/turbine in 2010, 0.66/turbine in 2011, and 1.07/turbine/year in the 2010-2011 period.

Table 9: Results of Bird Mortality Study

Study Component	2010	2011	2010-2011
Proportion of Carcasses not Removed by Scavengers	0.82	0.89	0.86
Searcher Efficiency	0.76	0.82	0.79
Proportion of Area Searched (80 X 80 m grids)	0.62	0.64	0.64
Number of Bird Carcasses Found	2	1	3
Estimated Mortality /turbine/year	1.28	0.53	0.87
Estimated Mortality 50 m Radius Circle (extrapolated)/turbine/year	1.56	0.66	1.07

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