

#### **Abstract**

This chapter presents the results of early and peak breeding surveys in the study area from 2007-2012. The analysis compares changes in the abundance of breeding birds in the project area of wind farm development and in a control area. Point count habitat was used as indicators of habitat change in the study area. A total of 29% of all point counts underwent substantial to total change over five years. All of this change was due to forestry in the control area and most was due to wind farm construction in the project area. Three species of birds showed statistically significant declines in the project area during post-construction surveys as compared to pre-construction surveys. These were the Black-throated Green Warbler, Olive-sided Flycatcher, and Yellow-rumped Warbler. There were no significant increases of any bird species in the project area. The Eastern Wood-Pewee declined significantly in the control area while Ruby-crowned Kinglet and Dark-eyed Junco increased. The Golden-crowned Kinglet, Yellow-bellied Sapsucker, and Hairy Woodpecker declined in both the project and control areas. The declining trend exhibited to some degree by all the woodpecker species of the deciduous forest warrants further investigation.

#### Introduction

This chapter analyzes the results of breeding bird surveys conducted before and after the construction of Glen Dhu Wind Energy in 2010. In six years of pre- and post-construction surveys, from 2007 to 2012, 1,469 point counts or transect stop-counts were made. This extensive data base makes it possible to derive a number of statistically significant results about the changes in breeding bird populations that occurred during that time.

## **Methods**

The breeding season is divided into two parts; early breeding and peak breeding. Some birds, such as the White-winged Crossbill or Common Raven, begin breeding activities as early as February. Local owls and woodpeckers are breeding in late winter and early spring while some migrants that winter not too far south of Nova Scotia, such as American Robins and Common Grackles, have started breeding by the first week of May. Those species beginning their breeding activities during the first week of May or earlier are treated here as early breeding birds. The analysis of their presence in the study area is conducted for the weeks from mid-March to 2 June. There were no surveys of early breeding birds in the first year of the study in 2007.

By the second week of June, spring migration is over and most birds, including the majority of neo-tropical migrants, are on their breeding territories. The analysis of the peak breeding season in the study area is conducted for the weeks from 3 June through the first week of July. Since most of the early breeding birds have not completed breeding activities by the beginning of June, these species are analyzed twice, once in the early breeding season and again in the peak breeding season.

Figure 1: Location of Point/Stop Count Stations in the Study Area, 2007-2012

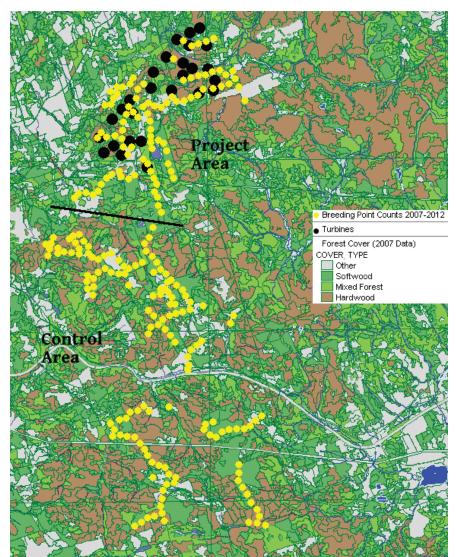


Table 1: Number of Point Counts/Stop-Count Stations and Total Counts by Season

	•	
	Number of	Number of
	Stations	Counts
<b>Early Breeding Season</b>	94	592
Peak Breeding Season	228	901

Table 2: Number of Point Counts/Stop-Counts by Season and Year

Season	2007	2008	2009	2010	2011	2012
<b>Early Breeding</b>	0	216	22	81	129	120
Peak Breeding	27	204	56	205	206	203

Table 3: Number of Point Counts/Stop-Counts by Area and Project Phase

ĺ											
		Pre-	Construction		Post-Construction						
	Season	Project Area	Control Area	Total	Project Area	<b>Control Area</b>	Total				
	Early Breeding	77	161	238	251	79	330				
	Peak Breeding	139	148	287	240	374	614				
٠	Total	216	309	525	491	453	944				

The unit of analysis in the early breeding season is both the stop-count (conducted while walking the stop-over transects) and the point count. These two units are comparable only in the 50-metre distance band as explained in the chapter on spring migration.

The unit of analysis in the peak breeding season is the point count. All birds seen or heard during a tenminute time period are counted and their distance from the observer is categorized as being <50 metres, 50-100 metres, >100 metres, and flying overhead.

The number of point count/
stop-count stations and the total
number of counts by season are shown
in Table 1. The location of the point/
stop count stations is presented in
Figure 1. The stations located in the
Project Area are above the black

line on the map in the general vicinity of the wind turbines. Those stations in the Control Area are below the black line. Table 2 gives the number of point counts/stop-counts by year and Table 3, the number by area and project phase.

A number of parametric and non-parametric statistical test were used to determine significant changes in species abundance in the study area and the use of habitats.

These tests are the parametric tests of Analysis of Variance (ANOVA), Welch Test, Brown-Forsythe Test,

Tamhane's T2 Pairwise Comparison, and the non-parametric Wilcoxon-Mann-Whitney Test.

Table 4: Habitat Changes at Point/Stop Count Stations in Study Area, 2007-2012

	Degree	of Habitat Cl	nange			Leg	end	
Change Code	Project Area	Control Area	Total	%	Code	Name	Description	Example
0	38	81	119	52.19	0	No change	No disturbance	Looks the same as last year
1	7	10	17	7.46	1	Small change	Noticeable disturbance	Grading of forestry road
2	8	17	25	10.96	2	Moderate change	Change that might affect bird habitat	Widening of forestry road
3	20	28	48	21.05	3	Substantial change	Change having a definite effect on bird habitat	Clearcut part of habitat
4	18	1	19	8.33	4	Total change	Total or near total disturbance of habitat	Clearcut all or most of habitat
Total	91	137	228	100.00	Total	Total	Total	Total

#### Habitat

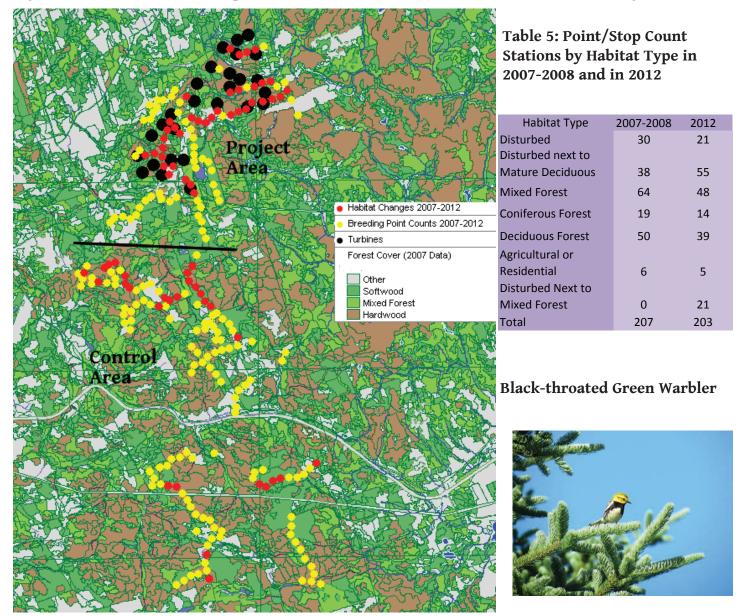
Table 4 lists the habitat changes that occurred at the point/stop count stations between 2007 and 2012. Out of 228 stations, habitat changes occurred at 48% of them over the six-year period. Substantial or total change occurred at 29% of the stations. The location of the stations with substantial or total change is presented in Figure 2.

Most of the small to moderate changes resulted from the grading or widening of forestry roads both in the project and control areas. Substantial changes in the control area were the result of clear cutting while substantial change in the project area was a result both of wind farm construction and forestry. Stations undergoing total change were almost entirely from wind farm construction.

Point/stop count stations were classified into one of 7 habitat types based on forest succession and disturbance patterns in the study area. These habitat types are described in the spring migration chapter of this document. The distribution of point/stop count stations by habitat type in 2007-2008 and in 2012 is listed in Table 5. The forestry practices and wind farm construction taking placing over the six-year period led to increases in mature deciduous next to disturbed areas and mixed forest next to disturbed areas. Correspondingly, there were decreases in the number of stations in homogenous stands of mature deciduous, coniferous, and mixed forest. As indicators of total change in the forest in the study area, the

changes at these stations point to a 24-30% increase in forest fragmentation in six years.

Figure 2: Location of Point/Stop Count Stations with Substantial to Total Habitat Change, 2007-2012



# Early Breeding Birds

A summary of the early breeding birds observed in the study area is given in Table 6. Of the 15 species seen in the <50 metre distance band, the most common is the American Robin with a total of 249 seen in 5 years. The mean number of American Robins per count was 0.61, and they were noted at 42.1% of 388 point/stop counts during the breeding period of this species. The other top-ranked species were Darkeyed Junco, seen on 22.9% of counts, Song Sparrow (15.3%), Yellow-bellied Sapsucker (11.6%), and Black-capped Chickadee (9.1%).

Table 7 shows the use of six habitat types by early breeding birds. For each habitat type, the mean number of each species counted within the 50-metre distance band is shown as well as the existence of any statistically significant relationships. Three early breeding bird species have statistically significant relationships with specific habitat types. The Song Sparrow shows a strong preference for disturbed

Table 6: Summary of the Abundance of Early Breeding Birds, 2008-2012, in the <50-M Distance Band

Species	N	Sum	Mean	Frequency	Rank
American Robin	388	249	0.61	42.1%	1
Dark-eyed Junco	388	121	0.30	22.9%	2
Song Sparrow	388	78	0.19	15.3%	3
Yellow-bellied Sapsucker	388	56	0.14	11.6%	4
Black-capped Chickadee	388	53	0.13	9.1%	5
Ruffed Grouse	436	32	0.07	6.2%	7
Hairy Woodpecker	538	36	0.06	5.4%	6
Blue Jay	388	19	0.05	3.2%	8
Northern Flicker	388	13	0.03	3.2%	9
Downy Woodpecker	526	13	0.02	2.4%	10
Pileated Woodpecker	550	4	0.01	0.5%	11
Gray Jay	538	4	0.01	0.7%	12
White-breasted Nuthatch	388	2	0.00	0.5%	13
American Crow	526	1	0.00	0.2%	14
Black-backed Woodpecker	490	1	0.00	0.2%	15

habitats and to a lesser degree with disturbed areas next to mature deciduous and with mixed forests. The Yellow-bellied Sapsucker likes mature forests but especially the edges of mature deciduous along disturbed areas. The Hairy Woodpecker has a preference for mature deciduous and is not very likely to found during the breeding season in disturbed areas or

Table 7: Mean Number of Early Breeding Birds in the <50-M Distance Band Showing Statistically Significant Relationships at the 95% Confidence Level

		Disturbed				
		Next to				Disturbed
		Mature		Coniferous	Mature	Next to
Species	Disturbed	Deciduous	Mixed Forest	Forest	Deciduous	Mixed Forest
American Robin	0.78	0.53	0.80	0.39	0.43	0.71
Dark-eyed Junco	0.20	0.36	0.48	0.18	0.19	0.38
Song Sparrow	0.46	0.17	0.19	0.00	0.00	0.05
Yellow-bellied Sapsucker	0.05	0.22	0.09	0.18	0.16	0.05
Black-capped Chickadee	0.10	0.06	0.25	0.18	0.13	0.19
Hairy Woodpecker	0.02	0.06	0.06	0.02	0.16	0.09
Ruffed Grouse	0.02	0.09	0.08	0.14	0.07	0.04
Blue Jay	0.08	0.00	0.05	0.13	0.04	0.00
Northern Flicker	0.07	0.02	0.06	0.00	0.00	0.00
Downy Woodpecker	0.01	0.03	0.02	0.00	0.06	0.03
Pileated Woodpecker	0.01	0.00	0.00	0.00	0.03	0.00
Gray Jay	0.02	0.01	0.01	0.00	0.00	0.00
White-breasted Nuthatch	0.00	0.00	0.00	0.00	0.03	0.00
American Crow	0.01	0.00	0.00	0.00	0.00	0.00
Black-backed Woodpecker	0.00	0.00	0.00	0.00	0.01	0.00

Statistically significant habitat relationships per ANOVA

Positive habitat relationship (darker = stronger)-per Tamhane's T2

Negative habitat relationship (darker=stronger)-per Tamhane's T2

coniferous forests.

Table 8 presents the statistically significant changes (at the 95% confidence level) in early breeding bird populations during the study in the <50-metre distance band. Only the Northern Flicker showed some tendency to decline in the project area. In the control area, there was statistical evidence of decreases in the populations of Song Sparrow and Yellow-bellied Sapsucker and increases in Hairy Woodpecker and Ruffed Grouse. However, only the Song Sparrow passed all statistical tests as being a species in decline.

Table 8: Statistically Significant Changes in Early Breeding Bird Abundance in the 50-M Band of Point/Stop Counts by Area and Project Phase, 2008-2012 (95% Confidence Level)

							Pre/Post Constructio	n						
			Project Ar	rea				Control Area						
	Me	Mean					Me	an		p-Value				
Species	Pre	Post	ANOVA	W	BF	WMW	Pre	Post	ANOVA	W	BF	WMW		
Song Sparrow							0.21	0.06	0.027	0.019	0.019	0.026		
Yellow-bellied Sapsucker							0.20	0.10				0.045		
Ruffed Grouse							0.03	0.10				0.019		
Hairy Woodpecker							0.04	0.13				0.025		
Northern Flicker	0.03	0.00	0.024			0.006			•					
Pre=Pre-Construction Mean	; Post=Po	st-Cons	struction N	⁄lean;	ANO	VA=Anal	sis of Variance Test;	W=Wals	sh Test; BF=	Brown-	Forsythe	Test;		
WMW=Wilcoxen-Mann-Wh	itney Tes	t; green	colour=in	creas	e; red	d colour=	decrease							

Table 9 summarizes the abundance of peak breeding birds in the 50-metre distance band of point counts for the years 2007-2012. In the peak breeding season, the Red-eyed Vireo, occurring on 57% of point counts, surpasses the American Robin (49%) as the most common breeding bird. The next most common peak breeding birds in this distance interval are Ovenbird (44%), White-throated Sparrow (35%), Magnolia Warbler (41%) and Black-throated Green Warbler (40%).

The mean count for 44 species of peak breeding birds in the 50-metre distance band showing statistically significant habitat relationships at the 95% confidence level is presented in Table 10.

The birds showing the strongest preference for the dominant mature deciduous forest are Ovenbird, Red-eyed Vireo, American Redstart, Least Flycatcher, and Hairy Woodpecker. The Red-eyed Vireo and American Redstart also have a strong affinity to the edges of the deciduous forest next to disturbed areas while the Least Flycatcher has a preference for this edge effect.

The species with a strong preference for the coniferous forest are Black-throated Green Warbler, Swainson's Thrush, Magnolia Warbler, Ruby-crowned Kinglet, and Yellow-rumped Warbler.

The species showing the strongest preference for the mixed forest was the Yellow-bellied Flycatcher and Blackburnian Warbler. All the species with a strong preference for coniferous forests were also well represented in mixed forests as were Red-eyed Vireos and American Redstarts from the deciduous forest.

The species having a strong preference for disturbed areas were White-throated Sparrow, Black-and-White Warbler, Common Yellowthroat, Chestnut-sided Warbler, Song Sparrow, Alder Flycatcher, and

Table 9: Summary of the Abundance of Peak Breeding Birds in the <50-M Distance Band, 2007-2012

Species	N	Sum	Mean	Frequency	Rank	Species	N	Sum	Mean	Frequency	Rank
Red-eyed Vireo	841	698	0.83	57.0%	1	Boreal Chickadee	901	29	0.03	3.0%	34
American Robin	901	717	0.80	48.5%	2	Swamp Sparrow	901	26	0.03	2.1%	35
Ovenbird	901	553	0.61	44.1%	3	Blackburnian Warbler	621	17	0.03	2.7%	36
White-throated Sparrow	901	496	0.55	34.5%	4	American Goldfinch	377	12	0.03	2.1%	37
Black-throated Green Warbler	901	483	0.54	40.4%	5	Common Grackle	901	20	0.02	0.8%	38
Magnolia Warbler	901	465	0.52	40.8%	6	Ruby-throated Hummingbird	841	13	0.02	1.4%	39
Dark-eyed Junco	901	284	0.32	25.3%	7	Black-throated Blue Warbler	841	14	0.02	1.7%	40
Common Yellowthroat	901	253	0.28	22.0%	8	Ruffed Grouse	901	7	0.01	0.8%	41
American Redstart	841	232	0.28	22.0%	9	Downy Woodpecker	901	6	0.01	0.6%	42
Ruby-crowned Kinglet	901	217	0.24	21.2%	10	Mourning Dove	901	5	0.01	0.6%	43
Black-and-White Warbler	901	185	0.21	19.2%	11	Tree Swallow	901	5	0.01	0.2%	44
Alder Flycatcher	841	165	0.20	16.5%	12	Red-breasted Nuthatch	901	11	0.01	1.2%	45
Swainson's Thrush	841	156	0.19	16.4%	13	Winter Wren	901	10	0.01	1.1%	46
Hermit Thrush	901	156	0.17	15.6%	14	Northern Waterthrush	901	12	0.01	1.3%	47
Song Sparrow	901	133	0.15	10.3%	15	Rose-breasted Grosbeak	901	7	0.01	0.8%	48
Blue-headed Vireo	901	122	0.14	12.4%	16	Olive-sided Flycatcher	841	7	0.01	0.8%	49
Least Flycatcher	841	114	0.14	9.9%	17	Eastern Wood-Pewee	841	6	0.01	0.7%	50
Mourning Warbler	621	82	0.13	11.6%	18	Bay-breasted Warbler	841	6	0.01	0.7%	51
Yellow-rumped Warbler	901	92	0.10	7.7%	19	Yellow Warbler	901	8	0.01	0.6%	52
Northern Parula	841	84	0.10	9.5%	20	Pileated Woodpecker	901	2	0.00	0.2%	53
Black-capped Chickadee	901	82	0.09	6.1%	21	American Crow	901	4	0.00	0.4%	54
Purple Finch	901	74	0.08	7.8%	22	Spruce Grouse	901	1	0.00	0.1%	55
Chestnut-sided Warbler	841	67	0.08	7.4%	23	Red-tailed Hawk	901	3	0.00	0.3%	56
Yellow-bellied Sapsucker	901	50	0.06	5.0%	24	Sharp-shinned Hawk	901	1	0.00	0.1%	57
Cedar Waxwing	841	53	0.06	3.0%	25	Belted Kingfisher	901	2	0.00	0.2%	58
Golden-crowned Kinglet	901	48	0.05	4.8%	26	Eastern Kingbird	901	1	0.00	0.1%	59
Lincoln's Sparrow	841	40	0.05	4.0%	27	Brown Creeper	901	4	0.00	0.4%	60
Nashville Warbler	901	33	0.04	3.6%	28	Rusty Blackbird	901	1	0.00	0.1%	61
Northern Flicker	901	33	0.04	3.4%	29	White-winged Crossbill	901	1	0.00	0.1%	62
Yellow-bellied Flycatcher	621	24	0.04	3.7%	30	Pine Siskin	901	2	0.00	0.2%	63
Hairy Woodpecker	901	30	0.03	3.3%	31	Cape May Warbler	841	3	0.00	0.1%	64
Blue Jay	901	30	0.03	2.9%	32	Canada Warbler	841	3	0.00	0.4%	65
Gray Jay	901	24	0.03	1.6%	33	Evening Grosbeak	621	3	0.00	0.3%	66

Lincoln's Sparrow.

The Mourning Warbler showed a strong preference for disturbed areas next to deciduous forest with the Chestnut-sided Warbler also showing a strong affinity to this habitat type.

Only Common Yellowthroat demonstrated a moderate preference for disturbed habitats next to either mature deciduous or mixed forests.

The American Robin showed equally strong preferences for agricultural, residential, and disturbed forest areas.

Table 10: Mean Count for 44 Species of Peak Breeding Birds in the <50-M Distance Band Showing Statistically Significant Relationships at the 95% Confidence Level

		Disturbed					Disturbed
		Next to				Residential	Next to
		Mature	Mixed	Coniferous	Mature	or	Mixed
Species	Disturbed	Deciduous		Forest	Deciduous	Agricultural	Forest
Ovenbird	0.09	0.74	0.50	0.18	1.28	0.00	0.37
Red-eyed Vireo	0.58	1.19	0.70	0.15	1.22	0.00	0.43
American Robin	1.17	0.69	0.72	0.82	0.56	1.68	1.22
American Redstart	0.21	0.37	0.27	0.04	0.38	0.00	0.14
Black-throated Green Warbler	0.30	0.37	0.64	1.46	0.37	0.14	0.63
Least Flycatcher	0.02	0.31	0.04	0.00	0.25	0.00	0.00
Hermit Thrush	0.12	0.22	0.17	0.11	0.23	0.05	0.08
White-throated Sparrow	1.27	0.67	0.48	0.18	0.20	0.36	0.63
Dark-eyed Junco	0.37	0.32	0.29	0.51	0.20	0.23	0.41
Black-and-White Warbler	0.32	0.25	0.22	0.08	0.14	0.14	0.16
Swainson's Thrush	0.12	0.11	0.24	0.45	0.11	0.11	0.27
Magnolia Warbler	0.58	0.33	0.71	1.26	0.10	0.23	0.67
Northern Parula	0.11	0.13	0.11	0.00	0.10	0.11	0.05
Black-capped Chickadee	0.09	0.07	0.13	0.11	0.07	0.00	0.10
Hairy Woodpecker	0.05	0.03	0.02	0.00	0.06	0.00	0.00
Mourning Warbler	0.17	0.35	0.09	0.00	0.06	0.00	0.03
Ruby-crowned Kinglet	0.28	0.06	0.33	0.79	0.05	0.09	0.35
Common Yellowthroat	0.81	0.41	0.15	0.07	0.03	0.32	0.37
Purple Finch	0.13	0.09	0.07	0.07	0.03	0.09	0.18
Yellow-bellied Sapsucker	0.02	0.12	0.04	0.04	0.03	0.00	0.08
Blackburnian Warbler	0.05	0.01	0.05	0.02	0.02	0.00	0.00
Chestnut-sided Warbler	0.19	0.18	0.02	0.00	0.02	0.17	0.05
Yellow-rumped Warbler	0.10	0.00	0.16	0.39	0.02	0.14	0.10
Cedar Waxwing	0.24	0.08	0.02	0.03	0.01	0.06	0.09
Golden-crowned Kinglet	0.09	0.00	0.09	0.14	0.01	0.05	0.06
Northern Flicker	0.08	0.04	0.03	0.00	0.01	0.14	0.06
Yellow-bellied Flycatcher	0.02	0.02	0.08	0.09	0.01	0.00	0.00
Song Sparrow	0.64	0.18	0.02	0.01	0.01	0.50	0.06
Alder Flycatcher	0.71	0.24	0.14	0.07	0.00	0.22	0.14
Lincoln's Sparrow	0.23	0.03	0.03	0.01	0.00	0.17	0.02
Nashville Warbler	0.13	0.01	0.04	0.07	0.00	0.00	0.00
Boreal Chickadee	0.04	0.01	0.04	0.13	0.00	0.05	0.02
Swamp Sparrow	0.06	0.00	0.07	0.01	0.00	0.09	0.00
American Goldfinch	0.18	0.08	0.00	0.00	0.00	0.11	0.00
Common Grackle	0.02	0.00	0.03	0.00	0.00	0.45	0.00
Mourning Dove	0.00	0.01	0.00	0.00	0.00	0.00	0.04
Tree Swallow	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Olive-sided Flycatcher	0.02	0.01	0.00	0.00	0.00	0.11	0.02
Bay-breasted Warbler	0.00	0.00	0.00	0.07	0.00	0.00	0.00
Pileated Woodpecker	0.02	0.00	0.00	0.00	0.00	0.00	0.00
American Crow	0.01	0.00	0.00	0.00	0.00	0.14	0.00
White-winged Crossbill	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Yellow Warbler	0.01	0.00	0.00	0.00	0.00	0.32	0.00

Statistically significant habitat relationships per ANOVA
Positive habitat relationship (darker = stronger)-per Tamhane's T2
Negative habitat relationship (darker=stronger)-per Tamhane's T2

Table 11: Statistically Significant Changes in Peak Breeding Bird Abundance in the 50-M Band of Point Counts by Area and Project Phase, 2008-2012 (95% Confidence Level)

	ean	Proje	ct Area		Pre/Post Construction												
	ean					Control Area											
		Pre Post			p-Va	lue		Me	ean		p-Va	lue					
	Post	ANOVA	W	BF	WMW	Pre	Post	ANOVA	W	BF	WMW						
						0.57	0.39	0.022									
0.68	0.38	0.000	0.001	0.001	0.001												
						0.40	0.53		0.044	0.044							
						0.24	0.35		0.033	0.033							
						0.13	0.28	0.001	0.000	0.000	0.001						
0.38	0.23	0.011	0.017	0.017	0.021												
						0.14	0.22		0.041	0.041							
						0.19	0.10				0.043						
0.21	0.08	0.008	0.010	0.010	0.014												
0.19	0.06	0.003	0.011	0.011	0.003												
0.04	0.10		0.046	0.046													
						0.09	0.03	0.010	0.033	0.033	0.007						
0.13	0.03	0.001	0.004	0.004	0.000	0.11	0.02	0.000	0.003	0.003	0.000						
0.09	0.03	0.034			0.048	0.05	0.02	0.039			0.039						
						0.09	0.02	0.000	0.002	0.002	0.000						
						0.03	0.01	0.030			0.030						
						0.02	0.00	0.005			0.005						
						0.03	0.00	0.001			0.001						
									-		0.006						
0.02	0.00	0.020			0.022					,							
						0.01	0.00	0.210			0.021						
	0.38 0.21 0.19 0.04 0.13 0.09	0.38	0.38	0.38	0.38 0.23 0.011 0.017 0.017  0.21 0.08 0.008 0.010 0.010  0.19 0.06 0.003 0.011 0.011  0.04 0.10 0.046 0.046  0.13 0.03 0.001 0.004 0.004  0.09 0.03 0.034	0.38 0.23 0.011 0.017 0.017 0.021  0.21 0.08 0.008 0.010 0.010 0.014  0.19 0.06 0.003 0.011 0.011 0.003  0.04 0.10 0.046 0.046  0.13 0.03 0.001 0.004 0.004 0.000  0.09 0.03 0.034 0.048	0.40 0.24 0.13 0.38 0.23 0.011 0.017 0.017 0.021 0.14 0.19 0.21 0.08 0.008 0.010 0.010 0.014 0.19 0.06 0.003 0.011 0.011 0.003 0.04 0.10 0.046 0.046 0.09 0.13 0.03 0.001 0.004 0.004 0.000 0.11 0.09 0.03 0.034 0.034 0.09 0.03 0.02 0.03 0.02 0.001 0.002 0.002	0.40	0.40 0.53	0.40	0.40 0.53						

Pre-to-post construction increases and decreases in the population of breeding birds found within the 50-metre distance band in the Project Area and Control Area are listed in Table 11. Species showing a statistically significant decline at the 95% confidence level in all parametric and non-parametric tests in the Project Area were Black-throated Green Warbler, Alder Flycatcher, Mourning Warbler, and Yellowrumped Warbler. No species increased in the Project Area. Species showing statistically significant declines in the Control Area were Yellow-bellied Sapsucker and Hairy Woodpecker. The Control Area also had statistically significant increases in the numbers of Ruby-crowned Kinglets. The Golden-crowned Kinglet declined in both the Project Area and the Control Area. All these changes will be discussed further later in this chapter.

Table 12 presents a summary of the abundance of peak breeding birds at all distances (<50 metres, 50-100 metres, >100 metres, and flying overhead). Differences between the mean, frequencies, and ranks of birds at <50 metres and at all distances is largely due to those species that are often and easily heard at distances greater than 50 meters. These would include such species as White-throated Sparrow, Hermit Thrush, Swainson's Thrush, and Alder Flycatcher. An additional 14 species were seen at all distances than in just the 50-metre distance band.

Table 12: Summary of the Abundance of Peak Breeding Birds at All Distances, 2007-2012

Species	N	Sum	Mean	Frequency	Rank	Status	Species	N	Sum	Mean	Frequency	Rank	Status
Red-eyed Vireo	841	1249	1.49	78.8%	1	Cnfrm	·	621	17	0.03	2.7%	41	Prbbl
White-throated Sparrow	901	1230	1.37	56.4%	2	Cnfrm	Mourning Dove	901	29	0.03	3.0%	42	Prbbl
American Robin	901	1163	1.29	60.9%	3	Cnfrm	Pileated Woodpecker	901	27	0.03	3.0%	43	Prbbl
Ovenbird	901	945	1.05	58.6%	4	Cnfrm	Pine Siskin	901	23	0.03	1.4%	44	Pssbl
Black-throated Green Warbler	901	692	0.77	51.6%	5	Cnfrm	<b>Evening Grosbeak</b>	621	18	0.03	2.1%	45	Prbbl
Magnolia Warbler	901	521	0.58	43.3%	6	Cnfrm	Ruby-throated Hummingbird	841	13	0.02	1.4%	46	Pssbl
Hermit Thrush	901	440	0.49	34.6%	7	Cnfrm	Black-throated Blue Warbler	841	16	0.02	1.9%	47	Cnfrm
Swainson's Thrush	841	376	0.45	32.9%	8	Cnfrm	Ruffed Grouse	901	14	0.02	1.6%	48	Cnfrm
Dark-eyed Junco	901	390	0.43	32.3%	9	Cnfrm	Winter Wren	901	21	0.02	2.1%	49	Prbbl
Ruby-crowned Kinglet	901	354	0.39	31.2%	10	Prbbl	Belted Kingfisher	901	14	0.02	1.6%	50	Cnfrm
Alder Flycatcher	841	313	0.37	23.7%	11	Prbbl	White-winged Crossbill	901	21	0.02	0.6%	51	Pssbl
Common Yellowthroat	901	311	0.35	25.3%	12	Cnfrm	Eastern Wood-Pewee	841	10	0.01	1.2%	52	Prbbl
American Redstart	841	259	0.31	24.0%	13	Cnfrm	Downy Woodpecker	901	13	0.01	1.3%	53	Cnfrm
Song Sparrow	901	251	0.28	16.2%	14	Cnfrm	Tree Swallow	901	11	0.01	0.8%	54	Cnfrm
Mourning Warbler	621	142	0.23	19.2%	15	Cnfrm	Red-breasted Nuthatch	901	12	0.01	1.3%	55	Prbbl
Black-and-White Warbler	901	191	0.21	19.9%	16	Prbbl	Northern Waterthrush	901	13	0.01	1.4%	56	Pssbl
Least Flycatcher	841	149	0.18	12.4%	17	Prbbl	Rose-breasted Grosbeak	901	11	0.01	1.2%	57	Prbbl
Purple Finch	901	153	0.17	15.3%	18	Cnfrm	<b>Bay-breasted Warbler</b>	841	6	0.01	0.7%	58	Pssbl
Yellow-bellied Sapsucker	901	154	0.17	14.0%	19	Cnfrm	Red-tailed Hawk	901	7	0.01	0.8%	59	Prbbl
Blue-headed Vireo	901	143	0.16	14.8%	20	Cnfrm	· ·	901	5	0.01	0.3%	60	Cnfrm
Northern Parula	841	110	0.13	12.2%	21	Cnfrm		601	5	0.01	0.4%	61	Pssbl
Blue Jay	901	110	0.12	8.8%	22	Prbbl	•	601	6	0.01	0.3%	62	Cnfrm
Yellow-rumped Warbler	901	99	0.11	8.1%	23	Cnfrm		601	8	0.01	0.4%	63	Prbbl
Cedar Waxwing	841	91	0.11	4.9%	24	Cnfrm	0	601	8	0.01	0.1%	64	Pssbl
Black-capped Chickadee	901	94	0.10	7.1%	25	Cnfrm	•	621	7	0.01	0.5%	65	Pssbl
Chestnut-sided Warbler	841	83	0.10	8.9%	26	Cnfrm	•	901	1	0.00	0.1%	66	Pssbl
Lincoln's Sparrow	841	85	0.10	8.8%	27	Cnfrm	•	901	2	0.00	0.2%	67	X
Northern Flicker	901	88	0.10	8.7%	28	Cnfrm		901	1	0.00	0.1%	68	Pssbl
Hairy Woodpecker	901	94	0.10	9.9%	29	Cnfrm		901	4	0.00	0.4%	69 <b>-</b> 0	X
American Crow	901	79	0.09	5.9%	30	Prbbl		841	3	0.00	0.1%	70	Cnfrm
American Goldfinch	377	31	0.08	6.4%	31	Prbbl		841	3	0.00	0.4%	71	Prbbl
Golden-crowned Kinglet	901	66	0.07	6.2%	32	Pssbl		601	1	0.00	0.1%	72	Prbbl
Common Grackle	901		0.06	3.3%	33	Cnfrm	_	601	1	0.00	0.1%	73	Prbbl
Common Raven	601	54	0.06	4.4%	34	Prbbl	· ·	601	2	0.00	0.2%	74	Prbbl
Nashville Warbler	901	43	0.05	4.4%	35	Prbbl		601	1	0.00	0.1%	75 <b>7</b> 6	X
Olive-sided Flycatcher	841	30	0.04	3.6%	36	Cnfrm		601	2	0.00	0.1%	76	X
Yellow-bellied Flycatcher	621	27	0.04	4.2%	37	Pssbl		601	1	0.00	0.1%	77 70	Prbbl
Gray Jay	901	34	0.04	2.2%	38	Cofen		601	3	0.00	0.3%	78 70	Prbbl
Swamp Sparrow	901	36	0.04	2.8%	39	Cnfrm		601	2	0.00	0.2%	79	Pssbl
Boreal Chickadee	901	29	0.03	3.0%	40	Prbbl	Pine Grosbeak	601	1	0.00	0.1%	80	Pssbl

Population changes as demonstrated by a statistical analysis of point counts at all distances help to illuminate the changes found at less than 50 metres. These can be seen in Table 13. Black-throated Green Warbler and Yellow-rumped Warbler declined in the Project Area in both analyses while Alder Flycatcher and Mourning Warbler no longer pass all the statistical tests for significance at the 95% level. This is likely due to the fact that the latter two species are readily detected at longer distances. However, this tendency

Table 13: Statistically Significant Changes in Peak Breeding Bird Abundance for Point Counts at All Distances by Area and Project Phase, 2008-2012 (95% Confidence Level)

					P	re/Post (	Construc	tion				
			Projec	ct Area					Contr	ol Area		
	M	ean		p-Va	lue		Me	ean	p-Value			
Species	Pre	Post	ANOVA	W	BF	WMW	Pre	Post	ANOVA	W	BF	WMW
<b>Black-throated Green Warbler</b>	0.93	0.53	0.000	0.000	0.000	0.000						
Hermit Thrush	0.36	0.54	0.032	0.022	0.022							
Dark-eyed Junco							0.30	0.46	0.021	0.011	0.011	0.029
<b>Ruby-crowned Kinglet</b>							0.22	0.43	0.000	0.000	0.000	0.001
Mourning Warbler	0.30	0.17	0.043	0.048	0.048		0.18	0.25				0.046
Yellow-bellied Sapsucker	0.28	0.13	0.003	0.008	0.008	0.011	0.27	0.12	0.001	0.006	0.006	0.020
Yellow-rumped Warbler	0.19	0.07	0.005	0.015	0.015	0.010						
Hairy Woodpecker	0.21	0.08	0.001	0.002	0.002	0.000	0.14	0.07	0.008	0.024	0.024	0.012
Golden-crowned Kinglet	0.20	0.03	0.000	0.000	0.000	0.000	0.16	0.02	0.000	0.000	0.000	0.000
Olive-sided Flycatcher	0.11	0.02	0.000	0.002	0.002	0.000						
Pileated Woodpecker							0.00	0.04	0.011			0.011
Evening Grosbeak							0.09	0.03	0.028			0.018
Black-throated Blue Warbler							0.04	0.01	0.009			0.009
Eastern Wood-Pewee							0.04	0.00	0.002	0.040	0.040	0.002
Tree Swallow							0.01	0.00	0.024			0.024
Brown Creeper	0.02	0.00	0.022			0.022				•	'	
Canada Warbler	'			'			0.01	0.00	0.021			0.021
Pre=Pre-Construction Mean; Pos	Pre=Pre-Construction Mean; Post=Post-Construction Mean; ANOVA=Analysis of Variance Test; W=Walsh Test; BF=Brow											

Pre=Pre-Construction Mean; Post=Post-Construction Mean; ANOVA=Analysis of Variance Test; W=Walsh Test; BF=Brow Forsythe Test; WMW=Wilcoxen-Mann-Whitney Test; green colour=increase; red colour=decrease

to be easily detected at longer distances added the Olive-sided Flycatcher to the list of species that declined in the Project Area after wind farm construction.

Yellow-bellied Sapsucker, Hairy Woodpecker, and Golden-crowned Kinglet declined significantly in the all distances analysis in both the Project Area and the Control Area. Eastern Wood-Pewee was added to the list of significantly declining species in the all distances analysis in the Control Area. Ruby-crowned Kinglet continued to demonstrate a significant increase in the Control Area in the all distances analysis while Dark-eyed Junco was added to those species showing an increase.

Table 14: Summary of Statistically Significant Changes in Abundance (95% Confidence Level)

Decrease in Project Area Only	Black-throated Green Warbler		
	Yellow-rumped Warbler		
	Olive-sided Flycatcher		
Increase in Project Area Only	None		
<b>Decrease in Control Area Only</b>	Eastern Wood-Pewee		
Increase in Control Area Only	Ruby-crowned Kinglet		
	Dark-eyed Junco		
Decrease in Both Areas	Yellow-bellied Sapsucker		
	Hairy Woodpecker		
	Golden-crowned Kinglet		
Increase in Both Areas	None		

The statistically significant changes in abundance are summarized in Table 14. The decrease in the Black-throated Green Warbler and Yellow-rumped Warbler may be due to the fact that wind farm construction, unlike the standard forestry practices, results in the clearing of significant areas of mixed forest. These two species have a fairly high preference for this habitat as shown in Table 10.

Normally, the clearing of forest

creates habitat for Olive-sided Flycatchers. In the case of a wind farm, the cleared areas are also cleared, for the most part, of the snags and brush that make up the preferred habitat of these flycatchers. However, the presence of a wind turbine did not appear to discourage the breeding of Olive-sided Flycatchers in suitable habitat since in one area, 225 metres from a turbine, one pair successfully fledged three young in 2011. This species is listed as "Threatened" under the Species at Risk Act.

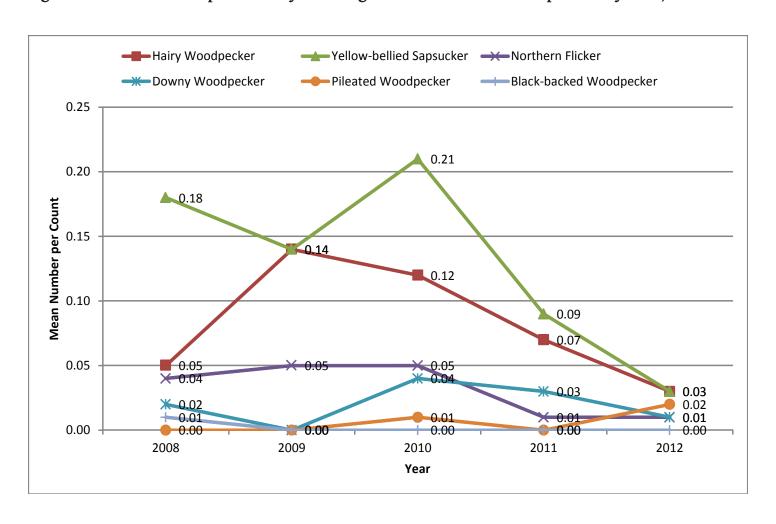
The decrease in the Control Area of Eastern Wood-Pewee may be part of a general decline in this insectivore. It is listed as of "Special Concern" by the Committee on the Status of Endangered Wildlife in Canada.

The increase in Ruby-crowned Kinglet and Dark-eyed Junco in the Control Area may be the result of a shift of forestry practices way from the cutting of softwood for pulp toward the cutting of mature deciduous for lumber and firewood. This would result in more softwood habitat, a preferred habitat of these two species.

The decline in the Golden-crowned Kinglet in both areas is very steep. This decline may be part of a more general trend in the status of this species as it is listed as "sensitive" (yellow category) species by the Province of Nova Scotia.

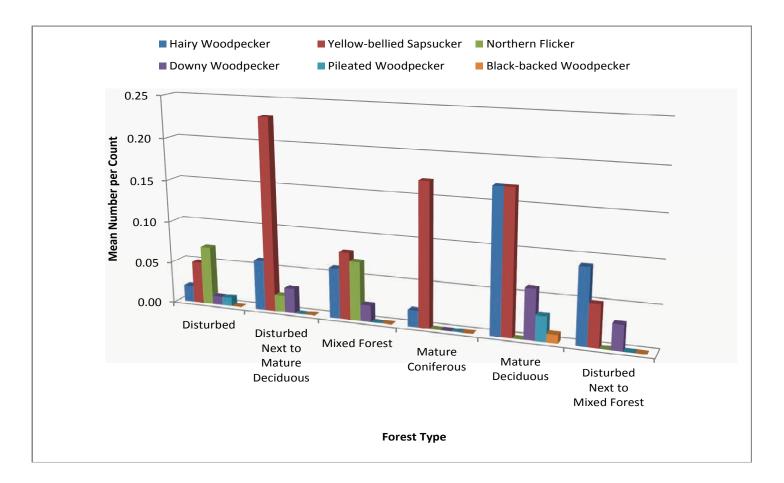
It is difficult to assess the decline of the Yellow-bellied Sapsucker and Hairy Woodpecker based on

Figure 3: Trends in Woodpecker Early Breeding Counts at <50 M of Woodpeckers by Year, 2008-2012



peak breeding data since they are early breeding species. In the early breeding analysis, there was some statistical evidence for decline in the Yellow-bellied Sapsucker and for increase in the Hairy Woodpecker (see Table 8). Graphing the early breeding mean number per count for all the woodpecker species in Figure 3, one notices an overall declining trend although there is no clear statistical support for this tendency. However, Figure 4 shows the importance of mature deciduous habitat for all woodpecker species except the Northern Flicker. As this deciduous forest may be under pressure as indicated by Table 5, these trends in woodpecker abundance may point to a situation that requires further examination and monitoring

Figure 4: Mean Numbers of Early Breeding Woodpecker Counts at < 50 M by Habitat, 2008-2012



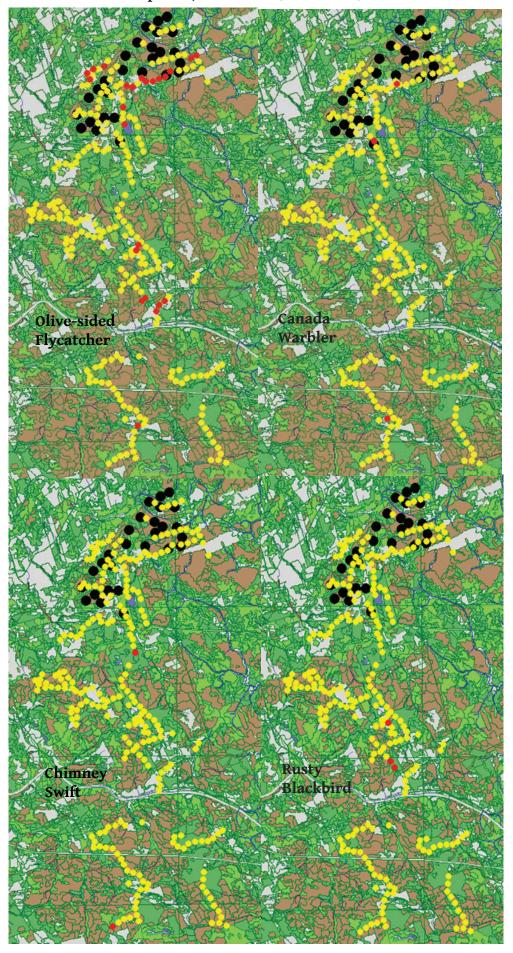
in term of the combined effects of forestry and wind energy development. Woodpeckers are a keystone species in the Sugar Maple-Yellow Birch-American Beech forest of the Pictou-Antigonish Highlands as they create nesting cavities for birds and mammals, provide foraging opportunities for other bird species, and accelerate decay processes and nutrient cycling.

Table 15 provides a list of the species of conservation concern in the study area, giving their status as determined by different government agencies and an annotation on their breeding occurrence in the study area. The status rankings come from 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). A map showing the location of the SARA listed species observed during the breeding season in the study area from 2007-2012 is presented in Figure 5.

Table 15: Annotated List of Species of Conservation Concern

	NSDNR	SARA	COSEWIC	COSEWIC	Breeding
Species	D	Cobadat	Lintard	Priority	Status in
Species Common Loon	Rank May be	Schedule 1	Listed	Candidates	Study Area  1 flying over
American Kestrel	at Risk			Mid	1 record
Wilson's Snipe	Sensitive				5 birds, mean of 0.1, frequency 0.4% of point counts
Black-billed Cuckoo	May be at Risk				1 incidental observation
Chimney Swift	At Risk	Threatened	Threatened		7 birds, mean of 0.01, 0.5% of point counts; see map
Belted Kingfisher				High	14 birds, mean of 0.02, 1.6% of point counts
Black-backed Woodpecker	Sensitive				1 record
Olive-sided Flycatcher	At Risk	Threatened	Threatened		30 birds, mean of 0.04, 3.6% of point counts; see map
Eastern Wood-Pewee	Sensitive		Special Concern		10 birds, mean of 0.01, 1.2% of point counts
Yellow-bellied Flycatcher	Sensitive				27 birds, mean of 0.04, 4.2% of point counts
Eastern Kingbird	Sensitive			Low	1 record, mean of 0.00, 0.1% of point counts
Gray Jay	Sensitive				34 birds, mean of 0.04, 2.2% of point counts
Tree Swallow	Sensitive				11 birds, mean of 0.01, 0.8% of point counts
Boreal Chickadee	Sensitive				29 birds, mean of 0.03, 3.0% of point counts
Golden-crowned Kinglet	Sensitive				66 birds, mean of 0.07, 6.2% of point counts
Ruby-crowned Kinglet	Sensitive				354 birds, mean of 0.39, 31.2% of point counts
Cape May Warbler	Sensitive				3 birds, mean of 0.00, 0.1% of point counts
Bay-breasted Warbler	Sensitive				6 birds, mean of 0.01, 0.7% of point counts
Canada Warbler	At Risk	Threatened	Threatened		3 birds, mean of 0.00, 0.4% of point counts, 0.4% of point counts
Rose-breasted Grosbeak	Sensitive				11 birds, mean of 0.01, 0.8% of point counts, 1.2% of point counts
Rusty Blackbird	May be at Risk	Special Concern	Special Concern		5 birds, mean of 0.01, 0.3% of point counts; see map
Pine Grosbeak	May be at Risk				1 record, mean of 0.00, 0.1% of point counts
Pine Siskin	Sensitive				23 birds, mean of 0.03, 1.4% of point counts
Evening Grosbeak				High	18 birds, mean of 0.03, 2.1% of point counts

Figure 5: Location of SARA Listed Species, 2007-2012 (Red Points)



## **Conclusion**

With six years of data and nearly 1,500 stop/point counts, this study provides a stronger basis of analysis than would normally be the case in pre-and-post-construction studies of wind energy facilities. The study suggests that forestry and wind farm construction together contribute to what appears to be a high rate of forest fragmentation. This effect may not only be cumulative but synergistic in that the wide access roads of wind farms help to facilitate the movement of forestry equipment and products.

There is evidence that the cutting of mixed wood forest in wind farm construction contributed to a decline in two species of birds preferring coniferous and mixed wood habitat, specifically, the Blackthroated Green Warbler and the Yellow-rumped Warbler. The decline of the Olive-sided Flycatcher may be the result of the lack of dead standing wood after the clearing of a site for turbine pads and access roads.

The study data suggest there may be a problem emerging in woodpecker populations, especially for those species most dependent on mature deciduous habitats. Further research is needed on the effects of forest fragmentation on woodpeckers and on the requirements of these birds relative to the size and connectedness of mature deciduous forest patches.