The Flight Behaviour of Soaring Birds at the Scarp Face

Glen Dhu Wind Farm Site

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Abstract

The baseline avian study for the Glen Dhu Wind Farm site recommended that turbines be set back from the edge of the cliff (scarp face) until further research could be conducted. It had noted that soaring birds, such as Bald Eagles, hawks, and ravens were frequently seen flying near the edge of the scarp as they "rode" warm air updrafts that were enhanced by the orographic effects of the cliffs. In response, Shear Wind Inc., the proponent, moved the placement of the proposed turbines at least one hundred metres back from the edge of the scarp. From August 19 to October 17, 2009, a study was conducted of the flight behaviour of soaring birds at the Glen Dhu Wind Farm site.

Using a variation on a risk collision model, the study involved the observation of soaring birds at four proposed turbine sites from a number of observation points for a total of 62 hours during the autumn season.

It was found that a relatively small number of soaring birds was at risk of collision with wind turbines, 20 birds out of total of 210 or 9.52%. No species of soaring bird appeared to be more at risk but the number of Bald Eagles at risk was considerably lower than for other species (4.50%).

Statistical analysis indicated that factors affecting collision risk were wind speed and the soaring pattern of the bird. Soaring birds were 3.5 times more at risk of collision in wind speeds at 30 km/hour or greater. Birds circling in an area for a certain period were 1.6 times more at risk than those flying in a distinct direction. The study also suggests that the risk of collision decreases with increasing distance of the turbine from the scarp face.

Combining the findings of this study with known avoidance rates for raptors at existing wind farms, it is estimated that the combined potential mortality at the four turbine sites would range between 0 and 1.5 birds per autumn season. When combined with the mortality data to be obtained during post-construction monitoring, this study can make a significant contribution to assessing the risk of collision for soaring birds at proposed wind farm sites.

Background and Rationale

The baseline avian study for the Glen Dhu Wind Farm site (Kearney 2008) (http://www.gov.ns.ca/nse/ea/glen.dhu.wind.farm.asp, Appendix D) raised a concern about the frequent occurrence of soaring birds like Bald Eagles and Common Ravens along ridge lines as they rode thermals rising on the coastal plain and were further lifted by orographic flows at the scarp face. The study recommended that turbines be set back from scarp face until further research could be conducted.

In response to these recommendations, Shear Wind Inc, the proponent, moved the proposed placement of wind turbines at least one hundred metres back from scarp face, and in the Registration Document made a commitment to further study of this issue (http://www.gov.ns.ca/nse/ea/glen.dhu.wind.farm.asp Registration Document, Part 2).

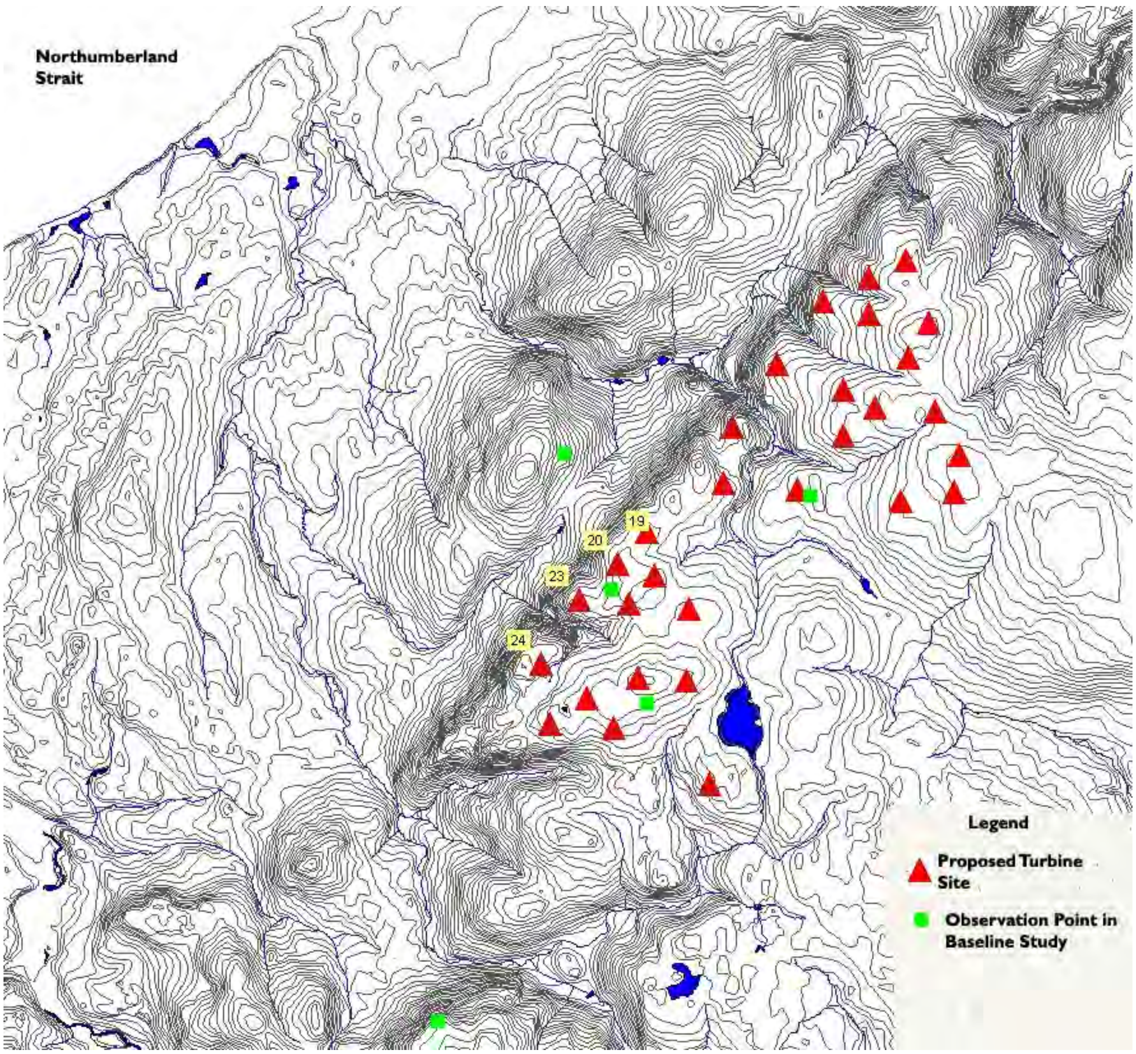
This document reports the results of the follow-up study about the behaviour of soaring birds such as hawks, eagles, and ravens at the scarp face of the Glen Dhu Wind Farm during the autumn of 2009.

Methods

Four proposed turbine sites were chosen for study. Selection was based on those closest to the observation points during the baseline study and where the orographic effects are likely to be the strongest, i.e., steep inclines alongside broad sections of the coastal plain over which soaring birds initially pick up the rising warm air thermals. These turbine sites are #19, #20, #23, and #24. These sites are shown in Figure 1 along with the location of the observation points in the baseline study. The turbine sites are shown in their proposed location at the time of the study, August to October 2009. The location at which the turbines are finally constructed may differ slightly.

The observation methods were adapted from those used during the diurnal passage migration surveys in the baseline study. Observations at each of the proposed turbine sites under study were recorded in 0.5 hour blocks of time. All birds seen or heard flying near the site were noted according to their species, altitude, location relative to the wind turbine site, flight direction, and number of individuals in a flock. Since the blade sweep of the proposed turbines, the Enercon E82 extends from 37 to 119 metres above the ground, bird observations as to altitude were divided into fours categories, <0 (birds below the scarp edge and turbine base), 0-40 metres, 40-120 metres, and >120 metres[1]. Observation times were concentrated during those hours for which the observations of Bald Eagles, Red-tailed Hawks, and Common Ravens, the most common soaring birds in the baseline study, were most frequently noted, that is, from 0900 to 1200 hours. However, all types of birds were noted and observations were conducted at other times of the day. These observation methods are similar to those described by Madders and Whitfield (2006) for using the "Band Collision Risk Model" at proposed wind farm sites.

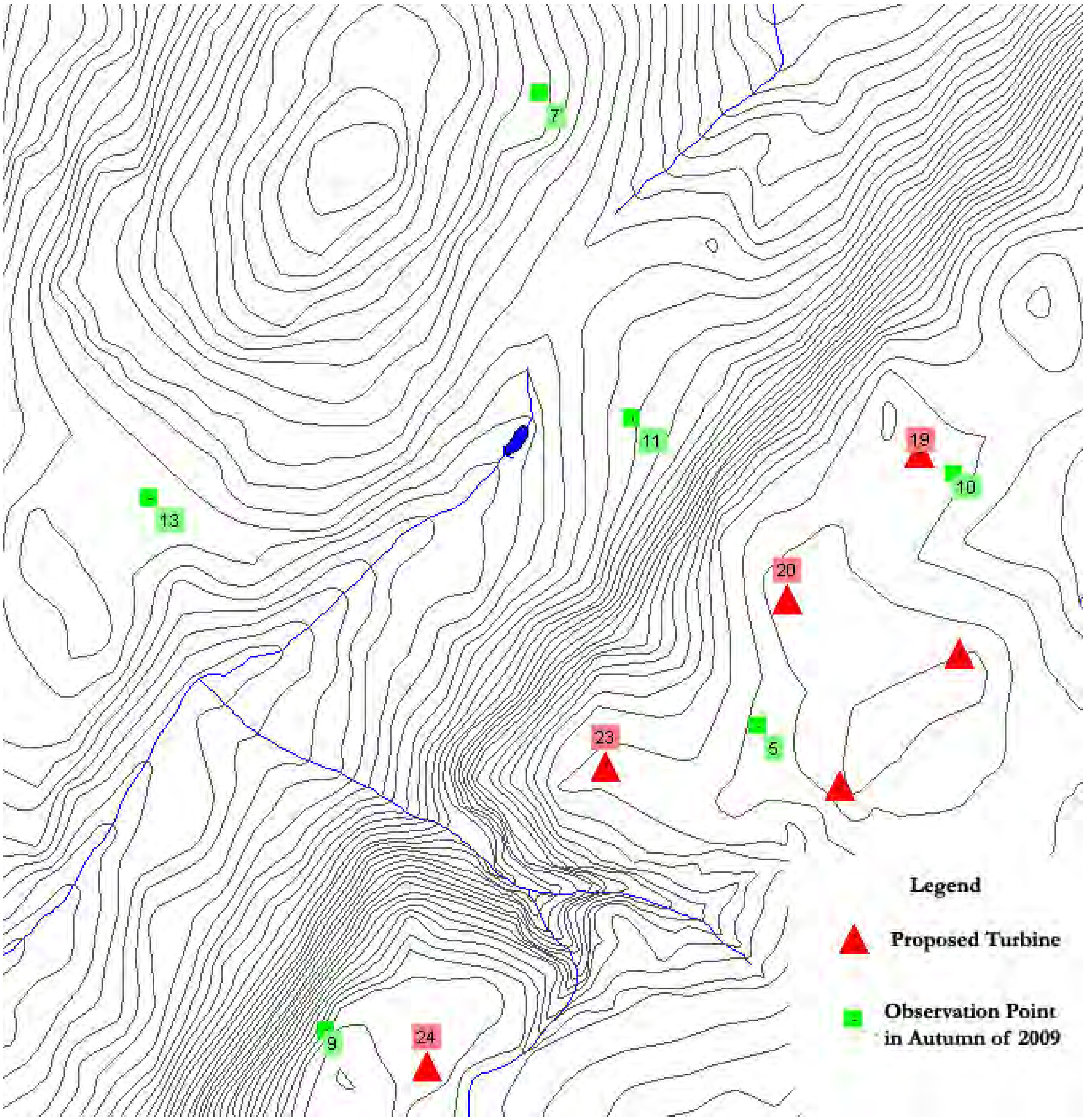
Figure 1. Map of Turbine Locations with Baseline Study Observation Points



[1] Although the lowest sweep of the blade of the E82 Turbine reaches to within 37 metres of the ground and 119 metres above the ground, it is not possible to estimate precisely the flying altitude of a bird within a few metres. Thus, the altitude category of 40-120 metres was used to define the blade sweep in this study.

The observation points used in this study are shown in Figure 2.

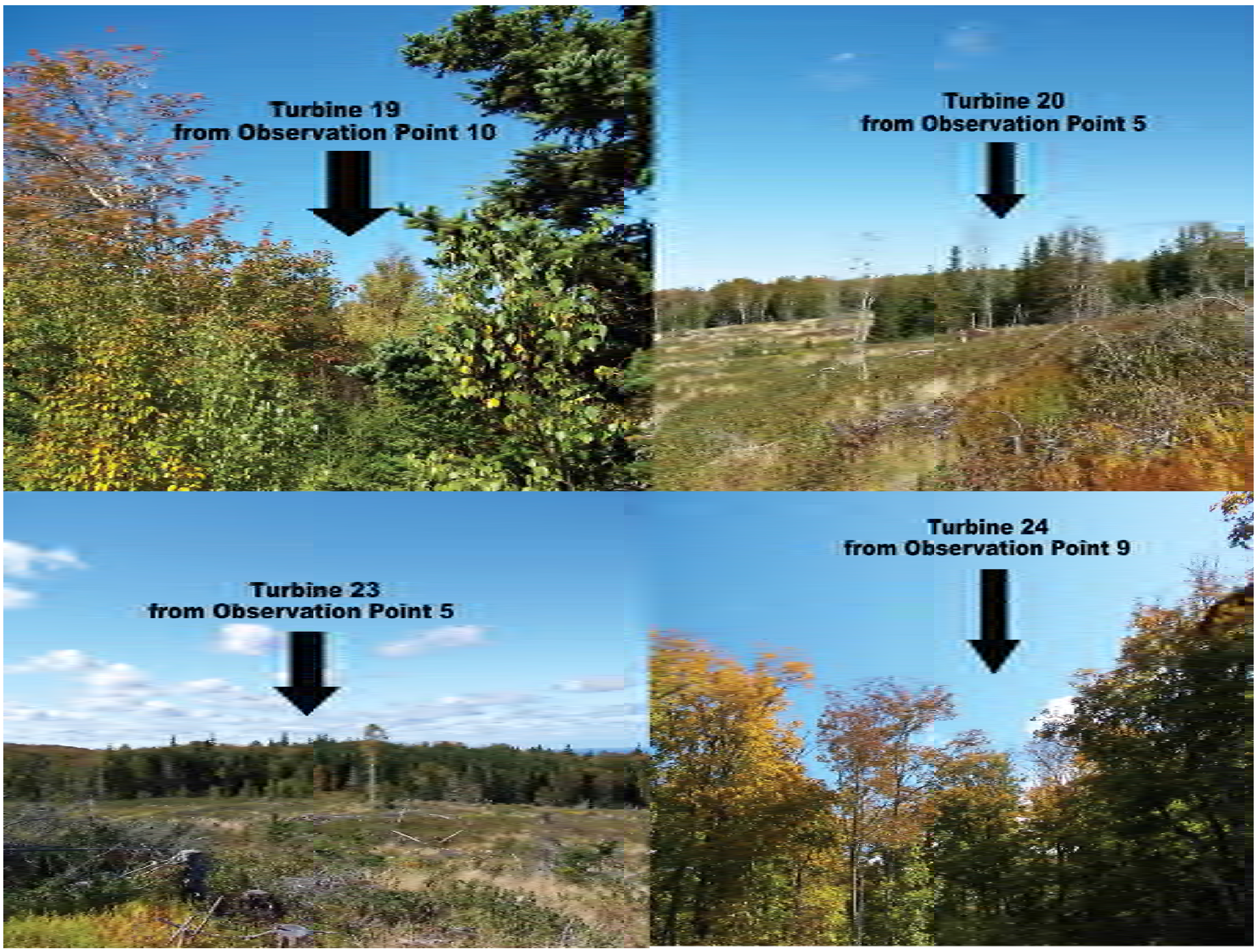
Figure 2. Observation Points for the Soaring Bird Study in 2009.



Observations for Turbine 19 were viewed primarily from Observation Point 10 (75 metre distance), for Turbine 20 from Point 5 (240 metres), for Turbine 23 also from Point 5

(290 metres), and for Turbine 24 from Point 9 (200 metres). Additional observations from another angle for Turbine 19 were from Observation Point 7 (985 metres), for Turbines 19, 20, and 23 from Point 11 (545 metres, 450 metres, and 655 metres), and for Turbines 23 and 24 from Point 13 (995 metres and 1200 metres). Photographs of the view from each of the primary observation points are shown in Figure 3.

Figure 3. View of Proposed Turbine Locations from Primary Observation Points



From August 19 to October 17, 2009, a total of 62 hours of observations were made in 124 one-half hour blocks of time.

Results

In analyzing the data from this study, a bird or flock of birds flying with 50 metres of the location of a proposed wind turbine and at altitude that would bring it within the blade sweep of that turbine (40-120 metres) was classified as "at risk of collision". This is the term used in the literature in studies assessing the potential impact of a proposed wind farm on birds and the risk of collisions with wind turbines. "Avoidance rates" refers to the percentage of birds that are at risk but avoid a collision. These are derived from actual mortality rates at existing wind energy facilities. Although the number of such studies are relatively few, data suggest that in the case of soaring birds such as raptors (eagles and hawks) the avoidance rate is very high at 98-100 per cent (Whitfield and Madders 2006).

The altitude of all flying birds and their closest distance from one of the four proposed turbines under study is shown in Table 1. Out of 401 observations, 23 birds or a flock of birds or 5.74% flew within 50 metres of a proposed turbine at an altitude of 40 to 120 metres. These are the birds "at risk of collision" and are highlighted by the orange colour in Table 1.

Table 1. Altitude of Flying Birds at Closest Distance to Proposed Turbines

			Altitude					
			<0 m	<40 m	40-120 m	>120 m	Unknown	Total
Distance	<50 m	Count	0	45	23	3	1	72
		% of Total	0.00	11.22	5.74	0.75	0.25	17.96
	50-100 m	Count	0	44	17	2	0	63
		% of Total	0.00	10.97	4.24	0.50	0.00	15.71
	>100 m	Count	35	165	58	6	2	266
		% of Total	8.73	41.15	14.46	1.50	0.50	66.33
	Total	Count	35	254	98	11	3	401
		% of Total	8.73	63.34	24.44	2.74	0.75	100.00
		=at risk of collision						

Table 2 shows the altitude of soaring birds at their closest distance to a proposed turbine. These are all single birds (not in a flock).

Table 2. Altitude of Soaring Birds at Closest Distance to Proposed Turbines

			Altitude					
			<0 m	<40 m	40-120 m	>120 m	Unknown	Total
Distance	<50 m	Count	0	13	20	3	0	36
		% of Total	0.00	6.19	9.52	1.43	0.00	17.14
	50-100 m	Count	0	16	14	2	0	32
		% of Total	0.00	7.62	6.67	0.95	0.00	15.24
	>100 m	Count	14	74	47	6	1	142
		% of Total	6.67	35.24	22.38	2.86	0.48	67.62
	Total	Count	14	103	81	11	1	210
		% of Total	6.67	49.05	38.57	5.24	0.48	100.00
		=at risk of collision						

Of the 210 soaring birds observed during the study, 67 or 32% were noted as flying along the scarp face and not drifting over the plateau where the wind turbines would be located. A few birds remained over the coastal plain, while others encroached upon the plateau area to some degree. Among the latter, a total of 20 soaring birds (9.52%) were in the "at risk of collision" category.

As shown in Table 3, no particular species of soaring bird stood out as more at risk than others although the number of Bald Eagles at risk was about half of all the other soaring species.

Table 3. Count and % of Soaring Birds at Risk of Collision by Species

Species	Total	At Risk	%
American Kestrel	14	1	7.10
Bald Eagle	44	2	4.50
Common Raven	95	9	9.50
Goshawk	1	1	100.00
Northern Harrier	5	1	20.00
Osprey	1	1	100.00
Red-tailed Hawk	40	4	10.00
Sharp-shinned Hawk	10	1	10.00
Total	210	20	9.52%

Table 4 presents the number of soaring birds at risk by turbine site.

Table 4. Count and % of Soaring Birds at Risk of Collision by Turbine

Turbine	Total	At Risk	%	Distance from Scarp Face (m)
19	26	2	7.70	184
20	44	6	13.60	130
23	66	9	13.60	105
24	74	3	4.10	154
Total	210	20	9.52	

More soaring birds were at risk at Turbines #20 and #23. However, the number of birds at risk is too small to use statistical methods to determine if these results are statistically significant. It is worth noting, however, that the number of birds at risk is highest at the two sites closest to the scarp face. Here the scarp face is defined as the 10-metre contour line in elevation which is less than 50 metres in distance from the previous lower 10-metre contour line but greater than 50 metres from the next higher 10-metre contour line (see Figure 2 for contour lines at the turbine sites).

An analysis of the number of birds at risk per hour of observation at each turbine site provides additional evidence that the distance from the scarp face reduces risk. As shown in Table 5, the number of birds at risk per hour of observation was progressively lower with distance from the scarp face.

A number of weather and behavioural factors were analyzed relative to their effect on the risk of collision. In the case of weather, Pearson Chi-Square Tests indicated that the only condition that affected the risk of soaring birds was wind speed. As can be derived from the data in Table 6, soaring birds were 3.5 times more at risk of collision when winds were 30 km/hr. or greater. These strong winds came out of the west, northwest, and north.

It thus appears that, under these conditions, it was more likely for the soaring birds to be "pushed" from the scarp face over the plateau area.

Table 5. Number of Birds at Risk per Hour of Observation by Turbine

Turbine	Birds at Risk/Hour	Distance from Scarp Face (m)
19	0.11	184
20	0.24	130
23	0.39	105
24	0.15	154

Table 6. Number of Soaring Birds at Risk Relative to Wind Speed

		Wind		
		Less than 30 km/hr	30 km/hr or Greater	Total
At Risk	No	147	43	190
	Yes	9	11	20
	Total	156	54	210

Another factor, according to the Pearson Chi-Square Test, that seemed to put soaring birds more at risk was flight pattern. Birds with a distinct flight direction, e.g., heading west, were less likely to be at risk than birds for which no clear flight direction could be determined. These latter birds were recorded as being "local" and tended to soar around in circles before alighting somewhere nearby. As can be seen in Table 7, these "local" soaring birds were 1.6 times more at risk of collision. The explanation for these different behaviours in flight direction is beyond the scope of this study but may be due to differences in food searching patterns.

Table 7. Number of Soaring Birds at Risk Relative to Flight Direction

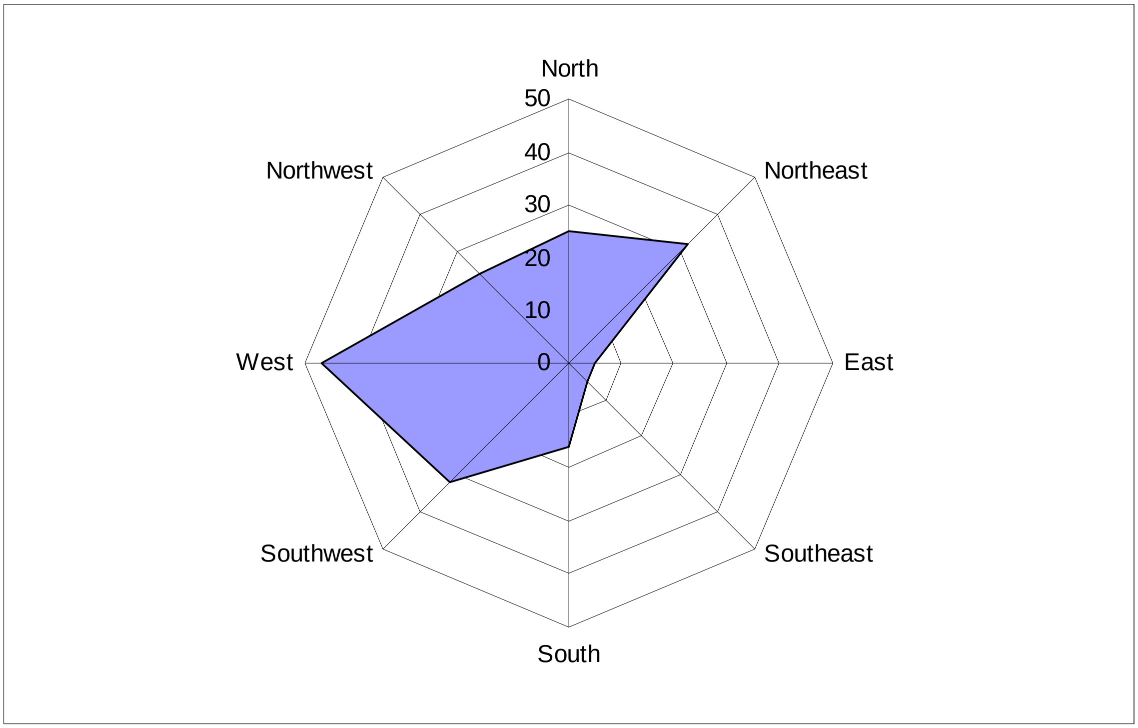
		Flight Direction		
		With Direction	Local	Total
At Risk	No	127	63	190
	Yes	11	9	20
	Total	138	72	210

Some Notes on Non-Soaring Birds

Observations of non-soaring birds were also recorded during the study. With the exception of two flocks of Double-crested Cormorants, these birds were woodpecker and passerine (songbird) species. Observations of migrating passerine species would normally begin earlier in the morning than for soaring birds. Nonetheless the study reveals two interesting aspects of diurnal passage migration for woodpeckers and passerines.

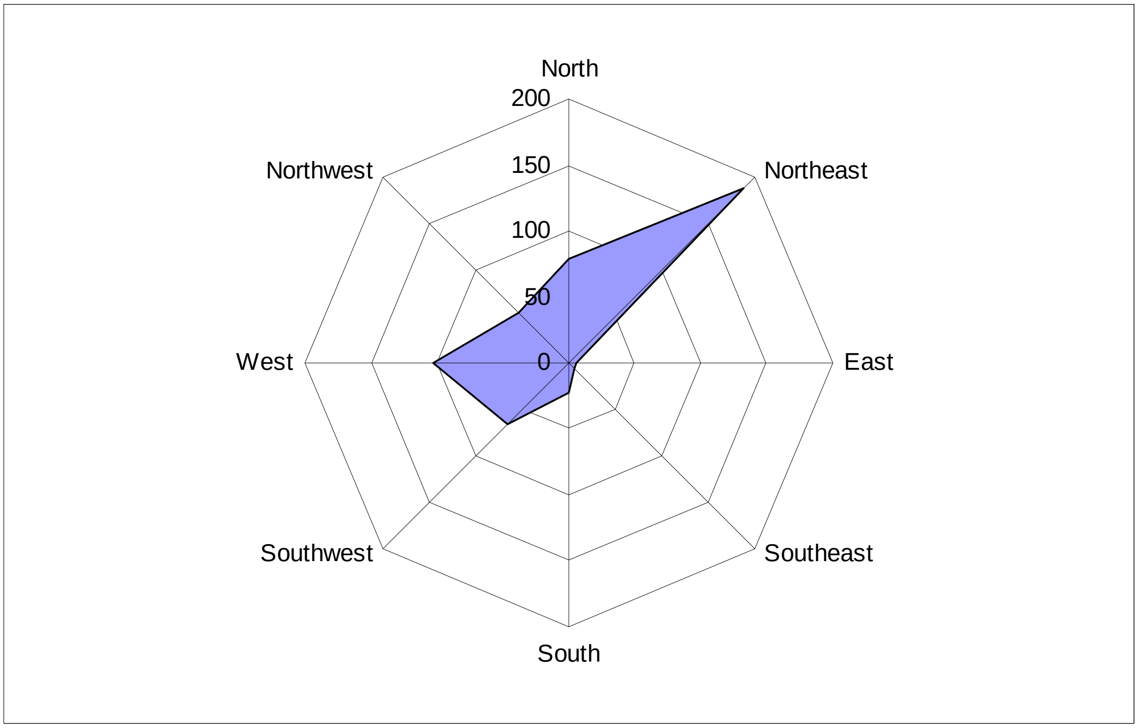
First, the tendency of diurnal passage migrants in the study area to be heading more west than southwest during the autumn migration, as noted in the baseline study (Kearney 2008), was further documented. Normally, one would expect most woodpecker and passerine species to have more of a southwesterly orientation (Richardson 1972). This tendency is shown in the radar chart in Figure 4 which presents the flight direction recorded for each observation. An observation is either a single bird or a flock of birds of the same species. West is clearly a dominant flight direction. What is unexpected in this chart is the large number of observations of birds with a northeasterly heading.

Figure 4. Flight Direction of Woodpeckers and Passerines by Number of Observations (flock of same species or an individual)



This tendency is highlighted further in Figure 5 which shows the flight direction of the total number of individual woodpeckers and passerines observed during the study. The dominance of birds flying in a northeasterly direction is accounted for by the diurnal reverse migration of the American Robin over the area during certain days of the study. The reason for this reverse migration is not known. However, the coastal areas along the Northumberland Strait are believed by local observers to be important stop-over feeding area for migrating American Robins due to the abundance of fruit-bearing trees such as Mountain Ash (*Sorbus aucuparia*). This might thus indicate that the robins had over-shot this feeding area during their nocturnal migration and were returning by reverse migration during the day. This hypothesis is consistent with one proposed by Richardson (1982) as to the various causes of reverse migration in Nova Scotia.

Figure 5. Flight Direction of Woodpeckers and Passerines by Total Individuals



Discussion

The methods developed for this study parallel those used for the "Band Collision Risk Model" (Band, Madders, and Whitfield 2005) as cited and described by Madders and Whitfield (2006). This method differs from the "circular plot model" developed for Australian wind farms where an observer located in the centre of an 800 metre radius circle records all the birds flying over the circle. The latter method would not be workable in a forested area as was the case of the Glen Dhu Wind Farm at the time of the study.

The Band Collision Risk Model follows two stages: 1) field observation at a proposed wind farm site to determine the number and kind of birds at risk of collision and under what conditions and 2) the application of avoidance rates derived from operating wind farms to determine possible levels of mortality at the proposed site.

It must be emphasized that these models are in early stages of development and suffer from a lack of data, especially as it pertains to avoidance rates. However, in the case of raptors, the subject of this study (along with the Common Raven), it is clear that avoidance rates are very high even if the data are still being debated (Madders and Whitfield 2006).

In this study, relatively few soaring birds were at risk of collision (20), especially considering the number of hours of observations. If one extrapolates from the 20 birds at risk from 62 hours of observation to the 59 days of the study period during the hours of 0900 to 1300 (when most soaring takes places), then a total of 76 birds would be at risk during the autumn season. This represents a potential mortality of 0 to 1.5 soaring birds per season using avoidance rates of 98 to 100%. For Turbine #23 which had the highest number of birds at risk per hours of observation, the potential mortality is similar, from 0-1.8 birds per season.

When combined with the mortality data to be obtained during post-construction monitoring, this study can make a significant contribution to assessing the risk of collision for soaring birds at proposed wind farm sites.

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Figure 3: Glen Dhu Wind Farm Viewscapes by John Kearney