

Appendix A
Avian Survey Data:
2005 Baseline Report
And
One Year Post Construction Monitoring Report

Bird issues for an environmental assessment of a wind energy project at Lingan, Cape Breton Island, Nova Scotia

D.B. McCorquodale, PhD
41 Holywood Rd., Georges River, NS B1Y 3H9

Prepared for Dillon Consulting Limited
137 Chain Lake Drive, Halifax, NS B3S 1B3

December 2005

Table of Contents	1
Summary	2
Methods	3
Point Counts	3
Spring migration surveys	4
Breeding season surveys	4
Autumn migration surveys	5
Anemometer Tower Checks	5
Species of conservation concern	5
Consultation	6
Questions from Canadian Wildlife Service draft guidelines	6
Results	7
Overview	7
Birds of Spring Migration	9
Annotated list of spring migration birds	9
Questions and answers for spring migration	11
Birds of the Breeding Season	12
Annotated list of breeding season birds	13
Questions and answers for breeding season	15
Birds of Autumn Migration	18
Annotated list of autumn migration birds	18
Questions and answers for autumn migration	20
Tower Surveys	22
Habitats within 1 km, potential bird use and habitat loss	23
Potential species of conservation concern (within 5km)	23
Consultation with Canadian Wildlife Service	24
Winter	25
Final comment	25
References	26
Figures 2-9 Photographs of habitats	27

SUMMARY:

Birds and a proposed wind energy project at Lingan, Cape Breton Island

Bird use of the peninsula at Lingan was assessed by on the ground surveys during the spring and autumn migrations and breeding season in 2005. This information, combined with published sources, consultation with government biologists and local birders, and my experience birding in the industrial Cape Breton region for the past 15 years, was used to address questions on the impact of wind turbines on birds at the Lingan site. The assessment is based on the questions in the draft version of 'Wind Turbines and Birds: A Guidance Document for Environmental Assessment' prepared by the Canadian Wildlife Service in December 2003 (Kingsley and Whittam 2003). This project is a small project (fewer than 10 turbines) according to the CWS draft guidelines.

No species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), nor species listed as Red or Yellow in the General Status of Wild Species in Nova Scotia, were detected during spring or autumn surveys. No large concentrations of migrant birds were noted or expected.

Also, no species listed by COSEWIC were detected during the breeding season surveys. One species listed as Yellow in the General Status of Wild Species in Nova Scotia, Common Tern, was seen during breeding season surveys. The most significant bird issue during the breeding season is avoidance of the colony of Great Cormorants on the cliff overlooking Laffins Cove. Keeping turbines away from the Great Cormorant colony would minimize risk. I recommend placing them so that they are closer to the Lingan Power Plant than the Great Cormorant colony.

The birds observed to fly through the airspace of the proposed turbines included Herring Gull, American Crow, Double-crested Cormorant and Great Black-backed Gull. These are all large birds that are capable of avoiding tall objects by changing their flight paths.

Some nocturnal migrants such as sparrows and warblers do use this site during migration. Kills at wind turbines are associated with lights that attract them. Use of minimal lighting, including strobes with long OFF periods, would minimize mortality.

METHODS

Point Counts: On 16 and 22 May 2005 the site (Figure 1) was traversed from the old Lingan Colliery to the World War II gun emplacement and along the Nova Scotia Power fence line. Several forays into the woods of White Spruce, Trembling Aspen and White Birch were made. From this reconnaissance, seven locations, representing all terrestrial habitats on the site (see Figures 3-7, 10) were selected for five minute point counts for the spring, breeding season and autumn surveys (Figures 1; Table 1). From three locations (Figure 1 points A, C and F and Figures 5, 8, 9) scans could be made of the surrounding waters. All birds detected while walking (and birding) between the point count locations were also recorded. Therefore each survey includes 7 five-minute point counts and all birds detected during the 2-3 hours taken to traverse the whole area. Throughout the surveys attention was paid to any birds flying overland at the height of the wind turbines and whether there were flight paths that would potentially intersect with the locations of the turbines.

Figure 1: Map showing proposed site of Lingan wind energy project and the associated anemometer tower in the context of Indian Bay and Lingan Bay on Cape Breton Island. A through G are the representative points selected for point counts of birds during spring and autumn migration and breeding season bird surveys. A to E is about 1.5 km.



Table 1: Latitude and longitude (dd° mm.000') of the locations A through G for point counts at the Lingan site (see map in Figure 1).

Point	Description	Latitude	Longitude
A	End of grassy road just west of ventilation shaft for old Lingan Colliery	46° 14.931'	60° 02.850'
B	Along cut line in woods	46° 14.795'	60° 02.560'
C	Along coast	46° 14.725'	60° 02.750'
D	Along track to gun emplacement from anemometer tower	46° 14.555'	60° 01.885'
E	Overlooking power plant and cormorant nesting cliff	46° 14.471'	60° 01.921'
F	Near northeast corner of Nova Scotia Power fence	46° 14.556'	60° 02.038'
G	Along Nova Scotia Power fence in mixed woods	46° 14.555'	60° 02.207'

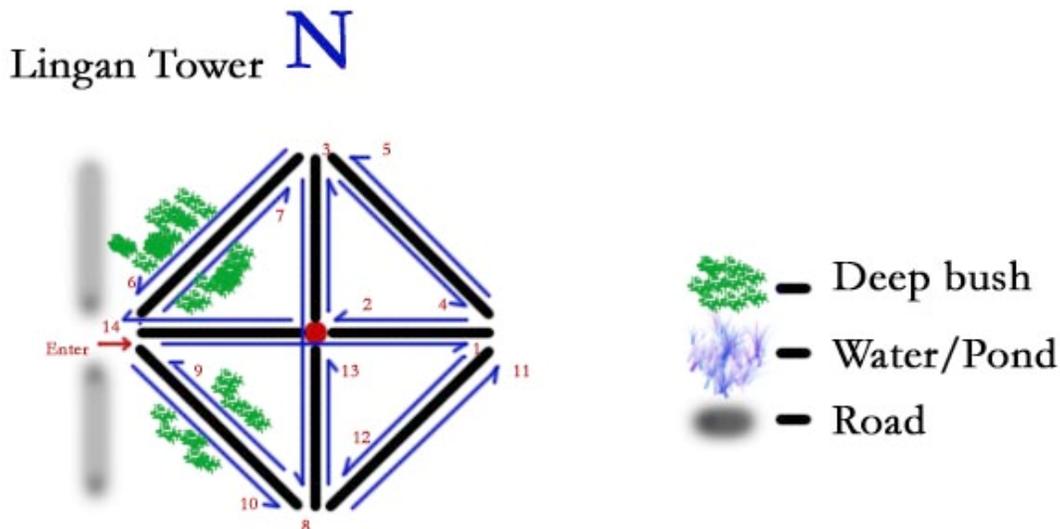
Spring Migration Surveys: On 22 and 28 May 2005 five-minute point counts were done at each of the seven locations. All birds heard or seen were recorded. In addition all other species seen or heard while walking to and between the seven locations were recorded. Surveys started early in the morning (before 7:00) to coincide with maximum bird activity.

Breeding Season Surveys: On 08 and 28 June 2005 five minute point counts were done at each of the seven locations. All birds heard or seen were recorded. In addition all other species seen or heard while walking to and between the seven locations were recorded. Surveys started early in the morning (before 5:30) to overlap with maximum bird activity.

Autumn Migration Surveys: On 17 September and 25 October 2005 five-minute point counts were done at each of the seven locations. All birds heard or seen were recorded. In addition all other species seen or heard while walking to and between the seven locations were recorded. Surveys started after 8:00 since fall migrants are more active mid-morning than just after dawn.

Anemometer Tower Checks: The location of the anemometer tower with guy wires is shown between points D, E and F in Figure 1. Each of the guy wires and the perimeter was walked twice to survey for birds killed by colliding with the wires (Figure 2). Eight surveys were done, at least a week apart, during the breeding season, 08 June to 30 July 2005, and another seven during fall migration, 24 September and 29 October 2005.

Figure 2: Sketch of protocol to check for bird carcasses under the anemometer tower at the proposed Lingan wind energy facility.



Species of conservation concern: Lists of species of special conservation concern maintained by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC www.speciesatrisk.gc.ca), the Nova Scotia Department of Natural Resources (The General Status Ranks of Wild Species in Nova Scotia www.gov.ns.ca/natr/wildlife/genstatus) and the Atlantic Canada Conservation Data Centre (ACCDC) (www.accdc.com/products/lists) were reviewed and compared with sightings on site and the habitats available. All species listed as Threatened or Special Concern by COSEWIC, those listed as Red or Yellow in the General Status Ranks of Wild Species in Nova Scotia and all those ranked as S4 or lower in Nova Scotia by the ACCDC are noted. S5 species are considered ‘demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions’. S4 species are considered ‘Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences)’. S3 species are considered ‘Uncommon throughout its range in the province, or found only in a restricted range,

even if abundant in at some locations. (21 to 100 occurrences)'. S2 and S1 species are rarer than any of these, but none were found on this site.

Consultation: Limited consultations with residents, private individuals and groups near the site have been undertaken. Terry Power, wildlife biologist with the NS Department of Natural Resources, Coxheath, Becky Whittam of Bird Studies Canada, Sackville, New Brunswick and coauthor of the draft guidelines for assessing the impact of wind projects on birds and Dan Busby, research scientist, Canadian Wildlife Service, Sackville, New Brunswick were consulted about the project.

Questions from 'Wind Turbines and Birds: A guidance document for environmental assessment' (Kingsley and Whittam 2003):

This document outlines protocols for assessing the impact of wind energy installations on birds in Canada. Presently it is under review. As the most recent version the questions in this version will be addressed. Here are the questions, from pages 46-48, that will be addressed for this project:

Breeding Birds:

What avian species breed at the site? What is the relative abundance of species breeding at the site?

What avian species breed in the surrounding area? Are any of the breeding birds found on or off-site considered Species at Risk? Do bird colonies occur in the area? If so how close, and what species? Do raptor nests occur in the area? If so what species? Do breeding birds commute through or near the area and if so in what direction is the movement? Do any species present have aerial courtship displays?

What is the expected amount and type of human presence during the breeding season?

What habitat occurs in the surrounding area? What types of habitat will be lost or altered? How much of each habitat type will be lost or altered?

Migrating Birds:

What is the species composition of birds that migrate through the area? Are any of the migrating birds found on or off-site considered species at risk? What is the approximate number of migrants that use the area? How does this number compare to other nearby sites?

Questions about altitude of migrants not required because of the small size of the project. Are there significant staging areas nearby?

If significant numbers of birds stage in the area of the proposed wind project, what activities taking place nearby could increase potential risk of bird collision with turbines and associated structures?

RESULTS

Overview:

Fifty-three species of birds were found during the 6 surveys between 22 May and 25 October 2005 (Table 2). No species listed by the Committee on the Status of Endangered Species in Canada (COSEWIC) were found. One species listed as Yellow in the General Status of Wild Species in Nova Scotia, Common Tern, was seen during breeding season surveys. The most significant bird issue identified was avoidance of the colony of Great Cormorants on the cliff overlooking Laffins Cove. More details on the species found and their status in Nova Scotia are given under the summaries for Spring and Autumn migration and breeding season.

Table 2: Summary of birds of the Lingan site during the spring migration, breeding and autumn migration periods in 2005. The maximum number of individuals (or nests as noted) detected during one survey is reported.

	Spring	Breeding season	Autumn
Common Loon			1
Northern Gannet	20+		8
Great Cormorant	50+ nests	50+ nests	43
Double-crested Cormorant	20	50	15
Great Blue Heron		1	
American Black Duck	2	1	
Long-tailed Duck			1
Common Eider		6	5
White-winged Scoter		3	
Red-breasted Merganser			1
Bald Eagle			1
Merlin	1	1	
Ruffed Grouse	1		
Greater Yellowlegs	1		
Herring Gull	300+	100+	130
Iceland Gull	6	1	
Great Black-backed Gull	100	40	39
Ring-billed Gull			30
Bonaparte's Gull			30
Common Tern		2	
Black Guillemot	78	70	
Rock Pigeon	1		
Belted Kingfisher	2	1	

Table 2 Cont'd:	Spring	Breeding season	Autumn
Northern Flicker	1		2
Alder Flycatcher		10	
Bank Swallow		70	
Blue Jay	2	1	7
American Crow	5	15	20
Common Raven	1	4	2
Black-capped Chickadee	2	2	7
Veery		1	
American Robin	3	4	1
Cedar Waxwing		1	
European Starling	3	1	12
Blue-headed Vireo	1	2	
Red-eyed Vireo		3	
Yellow Warbler		7	1
Magnolia Warbler		4	1
Yellow-rumped Warbler	24	4	4
Palm Warbler	6		
American Redstart		1	1
Northern Waterthrush		1	
Common Yellowthroat		6	8
Savannah Sparrow	5	3	4
Song Sparrow	8	15	40+
Lincoln's Sparrow	4		2
Swamp Sparrow			3
White-throated Sparrow	7	10+	60
Dark-eyed Junco	2		3
Common Grackle	8	4	
Purple Finch	1	1	
White-winged Crossbill		65+	
American Goldfinch	10	12+	

Birds of spring migration:

Thirty-one species of birds were recorded during surveys on 22 and 28 May 2005. Numbers are included in the following annotated list. No species listed by COSEWIC as endangered, threatened or of special concern were detected. No species listed Red or Yellow in General Status Ranks of Wild Species in Nova Scotia were detected.

Four species, Great Cormorant, Merlin, Black Guillemot and Greater Yellowlegs are ranked as S4 (widespread and fairly common but of long term concern) or S3 (uncommon throughout province) by the AC CDC. All other species are ranked in the most common, widespread category, S5.

Great Cormorant, S4, Merlin S3S4, and Black Guillemot S3 all breed on the site. Therefore discussion of these is in the breeding season section.

Greater Yellowlegs is ranked as S2B as a breeding bird and S5M as a migrant. A few breed in bogs on the Cape Breton Highlands Plateau at the extreme southern edge of its breeding range, hence the S2 rank. Undoubtedly the individuals detected at Lingan are part of the much larger population that migrates through, which is ranked S5.

Annotated list of 31 species of birds recorded during spring migration surveys 22 and 29 May 2005 at Lingan, Nova Scotia. ACCDC rankings for those ranked S3 and S4 are noted. All other species are S5.

Northern Gannet, more than 20 fishing offshore on 22 May, fewer offshore on the 29th.

Great Cormorant, at least 50 nests east of E on the cliffs along Laffins Cove. This area is called the nesting cliffs hereafter. Also 6 roosting at point beyond gun emplacement. ACCDC S4B.

Double-crested Cormorant, up to 20 around nesting cliff, a similar number either roosting along coast on north side or flying along the north coast. There will be a few nests on the edges of the Great Cormorant colony.

American Black Duck, two flying along coast at A on 29 May.

Merlin, one flying towards paved road near A. S3S4B.

Ruffed Grouse, one drumming between road and A on 29 May.

Greater Yellowlegs, one foraging in small pond between A and B and another calling near D on 29 May. S2B, S5M.

Herring Gull, a few hundred both 22 and 29 May. Most were associated with fishing boats offshore. More than 100 roosting either at the end of the point or along north shore. Each day 5-15 sighted flying overland through area where turbines could be erected.

Iceland Gull, six flying or foraging offshore on 22 May.

Great Black-backed Gull, about 100 both 22 and 29 May. Many were associated with fishing boats offshore. More than 40 roosting either at the end of the point or along

north shore. Each day a few sighted flying overland through area where turbines could be erected.

Black Guillemot, 78 adults on the 22nd and 75 on the 29th. They were concentrated between C and the tip of the point and off E in Laffins Cove. S3.

Rock Pigeon, 1 flying in to nesting cliff on 22 May. They probably nest on these cliffs.

Belted Kingfisher, two flying over near G on 29 May.

Northern Flicker, heard near B on 22 May and near G on 29 May.

Blue Jay, two heard, one at E, one at F on 29 May.

American Crow, up to five heard and seen during surveys.

Common Raven, one seen at E on 29 May.

Black-capped Chickadee, two calling near B on 22 May, another calling near F on 29 May.

American Robin, only one heard on 22 May and three on 29 May.

European Starling, one flying in to cliff near E on 22 May. Probably nest in crevices along this cliff. Three seen between D and E on 29 May.

Blue-headed Vireo, one singing between road and A on 29 May.

Yellow-rumped Warbler, two singing on 22 May, near A and G. Eight singing and another 16 seen in a variety of places on 29 May. Many of these were probably late migrants delayed by the weather of the past two weeks.

Palm Warbler, one singing on 22 May near E, six seen between D, F and G on 29 May. These were probably late migrants delayed by the weather over the past couple of weeks.

Savannah Sparrow, two singing each day. Males holding territories in the low heathy vegetation along the coast from A all the way to the tip of the point.

Lincoln's Sparrow, four along track from road to A on 29 May.

Song Sparrow, three singing on 22 May and 11 on 29 May. Males holding territory in the shrubby vegetation all the way from A to the anemometer tower.

White-throated Sparrow, only two singing on 22 May, at least seven on 29 May. Males holding territory along the edges of the spruce woods.

Dark-eyed Junco, two singing at B on 22 May.

Common Grackle, eight flew over low at E on 29 May and six flew over F on 22 May.

Purple Finch, one singing near B on 22 May 2005.

American Goldfinch, about 10 seen or heard each day. Most near D and F.

Questions and answers from the Canadian Wildlife Service draft guidelines, December 2003, for spring migration:

What is the species composition of birds that migrate through the area?

The small flocks of warblers (Yellow-rumped and Palm) found on 29 May were migrating through, as were the Lincoln's Sparrows on 22 May. Certainly the Northern Gannets fishing offshore were migrating north to their nesting colonies on Bonaventure Island, Quebec and Cape St. Marys Newfoundland. The gull concentrations were likely taking advantage of the food provided by waste bait from lobster fishers rather than migrating.

Many (most) of the birds detected in May nest in the area (e.g. Great Cormorant, Black Guillemot, Herring Gull, Merlin, Black-capped Chickadee, Song Sparrow, Savannah Sparrow, American Goldfinch).

In the two days of surveys I did not detect any large concentrations of migrants. Concentrations would be weather related and I suspect that in some years there would be small concentrations of kinglets, warblers, vireos and sparrows. This is similar to virtually all locations along the coast of eastern Cape Breton Island. This location is not known for concentrations of migrants.

Are any of the migrating birds found on or off-site considered species at risk?

No species listed by COSEWIC or on the Red or Yellow lists for Nova Scotia were detected. Comments on species ranked S3 and S4 by ACCDC are included in the breeding season section.

What is the approximate number of migrants that use the area?

Very few migrants (fewer than 50 passerines) were detected during two days of surveys at a time of year when many passerines (flycatchers, warblers, vireos) would be expected to pass through.

How does this number compare to other nearby sites?

I would expect to see more migrants under similar weather conditions at locations such as Schooner Pond, about 15 km east. Similar numbers would be expected in inland locations such as Petersfield Provincial Park, Tower Road Sewage Lagoon and at other headlands such as Point Aconi. All of these locations are within 25 km.

Questions about altitude of migrants not required because of the small size of the project.

Are there significant staging areas nearby?

Yes. Lingan Bay (2.5-5km away) hosts a few hundred Canada Geese, several hundred Greater Scaup, and dozens of Ring-necked Ducks, Common Goldeneye and Red-breasted Mergansers from late March until early May. As well, a hundred or more Double-crested Cormorants and a few hundred gulls (Herring, Great Black-backed, Ring-billed, Bonaparte's) forage over Lingan Bay and roost on the exposed sand flats at low tides.

If significant numbers of birds stage in the area of the proposed wind project, what activities taking place nearby could increase potential risk of bird collision with turbines and associated structures?

There appears to be little movement of ducks and geese between Lingan Bay and the north shore of the proposed site. The waterfowl tend to exit the bay following the channel by the wharf at Lingan and then roost on the ocean beyond the Power Plant. Gulls do fly over the Power Plant and then overland to the ocean on the north shore. Double-crested Cormorants do as well, but much less frequently than gulls. There is little evidence suggesting that these species are susceptible to colliding with turbines (see Kerlinger 2005). Gulls and cormorants should be able to notice the turbines and use alternate routes. Birds have become accustomed to the two tall smoke stacks at the Nova Scotia Power Plant, between the staging areas and the open water in which gulls and cormorants forage.

The mudflats of Lingan Bay and Dominion Beach are not significant staging areas for shorebirds in the spring, but they are in the autumn migration. This is considered in the autumn migration section.

Birds of the breeding season:

Thirty-eight species of birds were recorded during the surveys on 08 and 28 June 2005. Numbers are included in the following annotated list. No species listed by COSEWIC as Endangered, Threatened or Special Concern were detected.

One species, Common Tern, is listed as Yellow in the Nova Scotia general status ranks and S3 by the ACCDC. Yellow are 'species that are not believed to be at risk of immediate extirpation or extinction, but which may require special attention or protection to prevent them from becoming at risk'. There is a small (<10 nests) colony about 2.5 to 3 km away near the parking areas in Dominion Beach Provincial Park. Adults forage offshore and it is unlikely they will fly close to the proposed wind turbines.

Great Cormorant is ranked as S4. There is a significant nesting colony along the cliffs on the south side facing Lingan Bay. About 30% of the North American population nests around Cape Breton Island (McCorquodale et al. 2004). The Lingan colony is an average sized colony and has been reasonably stable in numbers at least over the past 15 years (Bredin et al. 1997). Adults forage at sea and rarely fly over land. All cormorants seen flying over the peninsula were Double-crested Cormorants. Keeping turbines away from the cliff directly above the colony on Laffins Cove would reduce the small risk of interactions with turbines.

Merlin is ranked as between S3 and S4 as a breeding bird. They regularly breed on coastal headlands between Point Aconi and Schooner Pond. My estimate is that 6-10 pairs nest between Point Aconi and Schooner Pond (about 40 km of coast). The site between the old Lingan Colliery and the Lingan Power Plant is a typical breeding site.

Black Guillemot is ranked as S3. There are at least 50 pairs that nest along the rocky coast at Lingan. Rocky shorelines from Gabarus through to Louisbourg, Scaterie Island, Cape Perce and west to the Bird Islands all support numerous nesting pairs. The Bird Islands probably support a few hundred nesting pairs (McCorquodale et al. 2004). The recent estimates from Bird Islands (McCorquodale et al. 2004) and the numbers found here would be half the Nova Scotia population estimated by Erskine (1992). This suggests that the population is higher than previously thought, likely because the remoter rocky coastlines of Cape Breton have been relatively poorly surveyed for birds. These birds forage at sea and are never seen flying over the peninsula. Therefore risk of collision with turbines is negligible.

The other 34 species were ranked in the most common and widespread category, S5.

Annotated list of 38 species of birds recorded during breeding season surveys 08 and 28 June 2005 at Lingan, Nova Scotia. ACCDC rankings for those ranked S3 and S4 are noted. All other species are S5.

Great Cormorant, at least 50 nests (probably closer to 100 along whole cliff near E). A few flying in and out of nests. None seen flying over land. S4B.

Double-crested Cormorant, 30 to 50 on the surveys. Most flying to and from nesting cliff near E. Others roosting on headlands along the coast or flying along coast. Each morning a couple flew inland through potential wind turbine sites.

Great Blue Heron, one being chased by gulls near nesting cliff 08 June.

American Black Duck, one in ocean near C on 28 June.

Common Eider, six flying about 100 m offshore from A on 08 June.

White-winged Scoter, three flying more than 100 m offshore from C on 08 June

Merlin, one calling inland from C on 08 June. S3S4B

Herring Gull, more than 100 each day. Concentrations around nesting cliff, around lobster boats offshore and roosting on headlands. Each day 5-10 flew inland through potential wind turbine sites. Many of those roosting or following boats were young birds (1-3 years old).

Iceland Gull, one immature flying along coast between B and C on 08 June.

Great Black-backed Gull, 30-40 each day with concentrations roosting on headlands, flying over nesting cliffs and offshore following lobster boats. The vast majority were young birds (1-3 years old).

Common Tern, 2 flying along coast near C on 08 June and foraging between nesting cliff and power plant on 28 June. A few have nested along lagoon in Dominion Beach Provincial Park. S3B. Yellow.

Black Guillemot, 50-70 seen on water from C and E both days. At this time of year many would be either away foraging or at the nests, suggesting at least 75 -100 pairs nesting along this stretch of coast. They nest in crevices in jumbled rock at bases of cliffs. S3.

Belted Kingfisher, one flying over water between E and power plant.

Alder Flycatcher, 10 singing males on 08 June and five on 28 June. Nest in the scrubby alders between the coast and the spruce woods.

Bank Swallow, more than 70 flying around the upper parts of the cormorant nesting cliff on 08 June. They nest in the softer soil at the tops of such cliffs along this coast. None seen on 28 June, therefore not likely nesting there this year. It is likely they will nest nearby most years.

Blue Jay, one stop F on 08 June.

American Crow, 10-15 seen and heard both days. Each day a few (2-4) flying through potential sweep of turbine blades. Nest nearby and forage widely over the site, seen at all of the point counts over the two days. The higher numbers compared to spring counts are likely due to recently fledged young.

Common Raven, a pair seen near power plant both days and likely another pair near anemometer tower and gun emplacement 08 June.

Black-capped Chickadee, two seen between F and G on 08 June. Likely nest here.

Veery, one singing between main road and A on 08 June. The alder swale here is similar to nesting habitat in the Alder Point and Frenchvale areas of Cape Breton.

American Robin, up to four singing each morning. Several pairs nest along edge of woods.

Cedar Waxwing, one seen at F on 08 June.

European Starling, one along coast near B on 28 June and another flew low over G the same day. A few likely nest both in cavities at the power plant and in crevices along the cliffs near the power plant.

Blue-headed Vireo, two singing at B on 08 June. A couple of pairs nest near B and inland from C.

Red-eyed Vireo, three singing at A and B on 28 June. A few pairs nest in the birch near B and likely G.

Yellow Warbler, 5 to 7 heard singing or seen both days. Likely about 10 pairs nesting, especially in alders and willows.

Magnolia Warbler, four heard singing or seen both days. A few pairs nest near B and the woods between C and G and near F.

Yellow-rumped Warbler, up to 4 heard singing or seen between F and G. A couple of pairs nest here.

American Redstart, a couple of pairs in deciduous shrubs between F and G.

Northern Waterthrush, one singing between road and A on 08 June.

Common Yellowthroat, a half dozen heard singing or seen both days. Nest in alders between coast and spruce woods.

Savannah Sparrow, three singing on heath between A and C.

Song Sparrow, up to 15 heard singing or seen both days. Recorded at all points except G.

White-throated Sparrow, 10 on 08 June and six on 28 June. At least one at each point count over the two days.

Common Grackle, four flew over low near B.

Purple Finch, one singing at B on 28 June.

White-winged Crossbill, more than 65 flying low over tops of stunted Spruce near F on 08 June.

American Goldfinch, more than 12 on 08 June along the edge of the woods, only two on 28 June. Several pairs undoubtedly nest here in July.

Questions from Draft Guidelines, December 2003 on breeding birds:

What avian species breed at the site?

All of the species in the above annotated list, except Great Blue Heron, Common Eider, White-winged Scoter, Iceland Gull and Common Tern, nest either on the site or within a hundred metres. White-winged Crossbill only nest when there is a large crop of spruce cones, hence would not nest in 2005. The large number seen were migrants moving through, not nesting birds. Common Terns nest about 2.5-3 km away. Great Blue Herons nest within 10 kms.

What is the relative abundance of species breeding at the site?

The two most common species nesting on the site are Great Cormorant and Black Guillemot (more than 50 pairs each). Next, with an estimated 10-20 pairs, would be Double-crested Cormorant, Herring Gull, Song Sparrow, White-throated Sparrow, Yellow Warbler, Common Yellowthroat roughly in decreasing order of abundance. All other species would have fewer than ten pairs, most only one or two pairs, nesting on or within a hundred metres of the site.

What avian species breed in the surrounding area?

Are any of the breeding birds found on or off-site considered Species at Risk?

Piping Plover (COSEWIC Endangered) have nested along Dominion Beach. The tip of the beach is about 2 km from the closest part of the site. Efforts to stabilize the beach by embedding old Christmas trees in the sand in the late 1980s and early 1990s were reasonably successful. This reduced sand movement by waves and therefore reduced its quality for Piping Plovers. They have not nested there in the past 15 years (since the late 1980s).

Short-eared Owls (COSEWIC Special Concern) have nested on the more extensive grassy areas behind the dunes at Glace Bay, about 10km east (Erskine 1992). Occasionally Short-eared Owls are seen at Dominion, more frequently in the autumn than the breeding season (Bredin et al. 1997). The relatively small area of beach grass and the number of people who walk the beach daily, throughout the year, make this beach less suitable for these owls.

Do bird colonies occur in the area? If so how close, and what species?

There is a Great Cormorant colony with at least 50 nests, probably closer to 75 nests, on the site. Associated with this colony are about 20 nests of Double-crested Cormorant and about 20 nests of Herring Gulls. The rocky cliffs surrounding the peninsula support a loose colony of at least 50, probably closer to 100, nests of Black Guillemot.

Do raptor nests occur in the area? If so what species?

No nests were found. A Merlin was seen on half the visits and undoubtedly nests in the thicker spruce woods in the southwest or across the road near the Lingan Power Plant ash dump. The size of the site and location suggest that larger raptors such as Red-tailed hawks and Northern Goshawks would not have enough room for a territory.

Do breeding birds commute through or near the area and if so in what direction is the movement?

Most of the commuting I saw was of young gulls between Lingan Bay and the ocean on the north shore. Each of the four mornings I saw a few (10-20 birds in total) Herring Gulls, Great Black-backed Gulls, Double-crested Cormorants and American Crows (in decreasing order of abundance) fly across the peninsula at the height that turbine blades would be turning. These birds flew both from Lingan Bay towards the ocean and from the ocean to Lingan Bay.

Do any species present have aerial courtship displays?

None were detected. The two most likely species would be American Woodcock and Wilson's Snipe. It is possible that a couple of pairs of woodcock breed in the alders close to the old ventilation shaft of the Lingan Colliery. However the wooded habitat they prefer is very limited on the site. There is not sufficient wetland habitat for Wilson's Snipe to nest on the site.

What is the expected amount and type of human presence during the breeding season?

There is significant evidence of All Terrain Vehicle (ATV) use of the heathy areas along the coast from the old Lingan Colliery to the World War II gun emplacement. I expect that people occasionally (fewer than 20 per week) walk and drive ATVs along the coast. Significant disruption of breeding birds will only occur if people spend time directly over the nests on the cliffs. Based on where the ATV trails are, this does not appear to have been a problem in the past.

What habitat occurs in the surrounding area? What types of habitat will be lost or altered? How much of each habitat type will be lost or altered?

The area surrounding the site has had significant industrial use (coal mine, power plant and ash dump for power plant) in the past 50 years. Most of the area is forested with a mix of White Spruce, White Birch and Trembling Aspen. Many areas have soil poor enough that tree growth is limited and often restricted to alders.

The wind turbines and associated infrastructure (access routes) will remove some breeding habitat, primarily young forest of alder, White Birch, White Spruce and Red

Maple. A few pairs of common species such as White-throated Sparrow, Magnolia Warbler, Yellow Warbler and Alder Flycatcher will be displaced.

Recommendation: Nesting birds are concentrated along the cliffs of Laffins Cove (Figure 1). The major species, Great Cormorant, has its major North American population on Cape Breton Island. The birds nest on the cliffs and forage offshore, minimizing likelihood of colliding with wind turbines. However I still suggest keeping wind turbines away from this cliff. If turbines are kept west of the anemometer tower and in line with the Lingan Power Plant, there should be minimal impact on the nesting Great Cormorants. Putting turbines between the cormorant nests and the north shore would significantly increase the risk of collisions during extreme winds or fog.

Birds of autumn migration:

Thirty species of birds were recorded during surveys on 17 September and 25 October 2005. Estimates for each species are included in the following annotated list.

No species listed by COSEWIC as Endangered, Threatened or Special Concern were detected. No species on the Red or Yellow lists from the General Status Ranks of Wild Species in Nova Scotia were detected.

One species, Great Cormorant, ranked S4 by ACCDC, was found. This species was considered in the breeding season section.

Annotated list of 30 species of birds recorded during spring migration surveys 17 September and 25 October 2005 at Lingan, Nova Scotia. ACCDC rankings for those ranked S3 and S4 are noted. All other species are S5.

Common Loon, one offshore from A on 25 October

Northern Gannet, 8 fishing offshore from E and F on 25 October.

Great Cormorant, only 1 immature on cliffs on 17 September, 43 roosting on cliffs 25 October. ACCDC S4B.

Double-crested Cormorant, 5-10 flying along shore between A and C on both 17 September and 25 October. Two roosting on nesting cliff on 17 September and 5 there on 25 October. Both days 2 or 3 were flying across peninsula at the height of wind turbine blades.

Long-tailed Duck, 13 offshore between A and C on 25 October.

Common Eider, three offshore near C and 2 near F on 25 October.

Red-breasted Merganser, 1 offshore at F on 17 September.

Bald Eagle, 1 adult perched at shoreline near C on 25 October.

Herring Gull, a few (<15) between A and E on both 17 September and 25 October. A couple of these flew over peninsula at height of wind turbine blades. About 120 foraging in water towards power plant from F on 17 September.

Great Black-backed Gull, fewer than 20 flying along coast and offshore between A and E on 17 September and 25 October. About 39 foraging offshore from F on 17 September with other gulls.

Ring-billed Gull, 19 fishing just offshore from C and at least 30 foraging near power plant (offshore from F) on 17 September.

Bonaparte's Gull, 30 foraging near power plant (offshore from F) on 17 September and 5 offshore at A on 25 October.

Black Guillemot, surprisingly none detected on either autumn survey.

Northern Flicker, 2 near anemometer tower on 17 September.

Blue Jay, 7 near anemometer tower on 17 September and 1 near A on 25 October.

American Crow, 20 in various locations on 17 September and 5 on 25 October. A few flew over peninsula at height of wind turbine blades.

Common Raven, 1 on 17 September and 2 on 25 October all near A.

Black-capped Chickadee, 3 on 17 September and 7 on 25 October in various locations with spruce trees.

American Robin, 1 near anemometer tower on 25 October.

European Starling, 10-12 on both 17 September and 25 October including one roosting on guy wires of anemometer tower.

Yellow Warbler, 1 on 17 September near the anemometer tower.

Magnolia Warbler, 1 near G on 17 September.

Yellow-rumped Warbler, 4 on 17 September between E and G.

Common Yellowthroat, 8 on 17 September between D and G.

American Redstart, 1 near A on 17 September.

Savannah Sparrow, 4 near A on 17 September.

Song Sparrow, more than 40 on 17 September including 1 singing near A and more than 20 at E.

Lincoln's Sparrow, 2 at E on 17 September.

Swamp Sparrow, 3 near E on 17 September.

White-throated Sparrow, about 60 on 17 September including more than 35 at E and 14 in shrubbery near A.

Dark-eyed Junco, 3 on 25 October.

Questions and answers from the draft guidelines, December 2003, for autumn migration:

What is the species composition of birds that migrate through the area?

Small mixed flocks of warblers (e.g. Yellow-rumped, Magnolia, Common Yellowthroat and American Redstart) move through in September.

Larger mixed flocks of sparrows (e.g. White-throated, Swamp, Song and Lincoln's) also move through from mid-September into October.

Few migrating seabirds (e.g. Northern Gannet, Common Eider, Long-tailed Duck) were detected. By mid-November migrants returning from northern nesting grounds (e.g. Long-tailed Duck, Common Goldeneye, Iceland Gull) would be more numerous than the numbers detected on these surveys.

In the two days of surveys I did not detect any large concentrations of migrants or any raptors. Concentrations would be weather related and I suspect that in some years there would be small concentrations of kinglets, warblers, vireos and sparrows. Cold fronts stimulate passerines to leave northern areas and then southerly winds will ground the migrants. If the two coincide during a peak migration time a fallout of migrants can occur. There is little about this site to suggest it will have more frequent fallouts or more birds than any other stretch of eastern Cape Breton Island. This location is not known as a place that concentrations are frequent.

In late October of 2005 Hurricane Wilma displaced many birds from the Caribbean and the southeastern United States to coastal Cape Breton (e.g. Caspian Tern, Laughing Gull, Chimney Swift, Barn Swallow). Although I did not see any at Lingan, many coastal locations from Cape North to Ingonish to Sydney to Donkin to River Bourgeois, harboured storm blown birds. Undoubtedly some Chimney Swifts and swallows spent time foraging along the headlands and shoreline at Lingan. Foraging was undoubtedly tough for these displaced Chimney Swifts and swallows because their prime food, flying insects, are not plentiful in October or early November. That is why they live here in July and August and not usually in October and November. As well they were stressed from a day or two of unplanned flying in stormy weather before they arrived. Some survived for more than three weeks despite the harsh conditions. Displaced, stressed individuals such as these, have a higher probability of colliding with wind turbines and being killed than individuals of regular migrant species such as White-throated Sparrows and Common Yellowthroats. They take more risks when foraging because of their stressed condition. Interestingly the populations consequences would be minimal because these stressed individuals are unlikely to find their way back to the normal wintering grounds in the Caribbean or northern South America.

Are any of the migrating birds found on or off-site considered species at risk?

No species listed by COSEWIC or on the Red or Yellow lists for Nova Scotia were detected. Comments on the species ranked S4 by ACCDC, Great Cormorant, are included in the previous section.

What is the approximate number of migrants that use the area?

The survey of 17 September detected almost 100 sparrows and a dozen warblers. With appropriate weather conditions these numbers could be double for sparrows and five times higher for warblers. The number of days each autumn with appropriate weather conditions during the peak periods of migration would be 0 to 3 or 4. For most days of fall migration fewer than 25 sparrows and 10 warblers would be moving through.

How does this number compare to other nearby sites?

I would expect to see more migrants under similar weather conditions at locations such as Schooner Pond, about 15 km east. Similar numbers would be expected in inland locations such as Petersfield Provincial Park, Tower Road Sewage Lagoon and at other headlands such as Point Aconi. All of these locations are within 25 km.

Questions about altitude of migrants not required because of the small size of the wind project.

Are there significant staging areas nearby?

Yes. Lingan Bay (2.5-5km away) hosts a few hundred Canada Geese, several hundred Greater Scaup, and dozens of Ring-necked Ducks, Common Goldeneye and Red-breasted Mergansers from mid-November. As well a hundred or more Double-crested Cormorant and a few hundred gulls (Herring, Great Black-backed, Ring-billed, Iceland, Bonaparte's, Black-headed) forage over Lingan Bay and roost on the exposed sand flats at low tides through the fall.

The mudflats of Lingan Bay are an important staging area for shorebirds from mid-July through September. The most common species (up to 100 individuals a day) are Black-bellied Plover and Semipalmated Plover. Other frequently occurring species, with maximum daily counts of a few to dozens, include Greater Yellowlegs, Lesser Yellowlegs, White-rumped Sandpiper, Least Sandpiper, Sanderling, Willet, Ruddy Turnstone, Pectoral Sandpiper, Dunlin and Semipalmated Sandpiper. Rarer species such as Curlew Sandpiper and Marbled Godwit have been seen in the past ten years.

If significant numbers of birds stage in the area of the proposed wind project, what activities taking place nearby could increase potential risk of bird collision with turbines and associated structures?

There appears to be little movement of ducks and geese between Lingan Bay and the north shore of the proposed site. Waterfowl (especially Canada Goose, Greater Scaup and Red-breasted Merganser) tend to exit the bay following the channel by the wharf at Lingan and then roost on the ocean beyond the Power Plant. Gulls do fly over the Power Plant and then overland to the ocean on the north shore. Double-crested Cormorants do as well, but much less frequently than gulls. There is little evidence suggesting that these species are susceptible to colliding with turbines (see Kerlinger 2005). Gulls and cormorants should be able to notice the turbines and use alternate routes. The birds are used to the presence of two tall smoke stacks at the Nova Scotia Power Plant between the staging areas and the open water where gulls and cormorants forage.

The mudflats in Lingan Bay are significant for staging shorebirds during the autumn migration. The flight paths into and out of the area are not well understood. Shorebirds have not had a history of colliding with wind turbines. There are no obvious reasons to suggest that their flight paths would intersect with the two proposed wind turbines. As with waterfowl, they have coexisted with two tall smoke stacks at the Nova Scotia Power Plant for decades.

During both spring and fall migrations there will be a few days, because of weather conditions, when concentrations of warblers, vireos, kinglets and sparrows are on the Lingan site. The mixed woods and shrubby vegetation will shelter most of these birds. There are no obvious reasons to suggest that their flight paths would intersect with the two proposed wind turbines. As with waterfowl, they have coexisted with two tall smoke stacks at the Nova Scotia Power Plant for decades with no obvious problems.

Tower Surveys:

The guy wires of the anemometer tower (Figure 7) were walked 8 times in June and July and 6 times in September and October (Figure 2) to check for bird carcasses that were potentially killed by collision with the tower or the wires. No carcasses were found during these surveys (Table 3). Clayton D’Orsay conducted the tower surveys.

Table 3: Summary of carcasses found during ground checks for carcasses under the anemometer tower at Lingan, Cape Breton Island.

Tower check survey date	Carcasses found
08 June 2005	0
23 June 2005	0
28 June 2005	0
02 July 2005	0
08 July 2005	0
16 July 2005	0
23 July 2005	0
30 July 2005	0
17 September 2005	0
24 September 2005	0
02 October 2005	0
07 October 2005	0
14 October 2005	0
22 October 2005	0
29 October 2005	0

These surveys were initiated because towers with guy wires are known to kill birds. The rationale was that if one anemometer tower was killing birds this would indicate that wind turbines could pose a significant threat. No bird carcasses were found.

The anemometer tower had no lighting. Lights contribute to bird mortality at man-made structures. Similar ground checks were undertaken through the summer and fall of 2005 at three communications towers with lights on the coast at Port Caledonia about 6 km east of Lingan. At these towers two carcasses were found, one Leach's Storm-petrel and one Yellow-rumped Warbler. The first was undoubtedly a storm blown bird, since this species spends all their time at sea. Since only the fleshless skull was found it is likely that the mortality happened months earlier. The warbler was found in October during fall migration.

Habitats within 1 km, potential bird use and habitat loss:

Much of the area within 1 km of the Lingan site is regrowth of alder, White Birch, White Spruce and Red Maple (Figure 12). This is similar to what covers much of the proposed wind facility site as well. This area was subject to significant disturbance during the past 100 hundred years as it is between the old Phalen colliery and the Lingan Power Plant. A railway that brings coal to the power plant and the ash dump associated with the power plant contribute to the landscape. Garbage from households is omnipresent in the vegetation close to the road and adjacent to ATV tracks further from the paved road.

Birds typical of such habitat (e.g. Blue-headed Vireo, Magnolia Warbler, Yellow Warbler, White-throated Sparrow) nest in small numbers. Removal of a few hectares for a wind project will remove some nesting habitat. The species affected are all common and widespread on Cape Breton Island.

Industrial activities at Lingan provide two sites frequently used by birds. Ash dump lake (Figure 11) is a freshwater roosting site for gulls (e.g. Herring and Great Black-backed) from mid-April through December. Wind turbines could present a small risk to those individuals who fly from the coast across the peninsula to the lake. However based on observations in North America and from offshore wind farms in Europe, gulls are not very susceptible to colliding with turbines (see Kerlinger 2005). It is likely that flight paths would be modified and therefore risks minimized.

Birds concentrate at the warm water outflow from the Lingan Power Plant (Figure 9) in the winter. Through the winter 500-1000 Greater Scaup, several hundred gulls (a few 100 Herring, plus dozens of Iceland, Great Black-backed and Black-headed) and a few other ducks (Bredin et al. 1997) forage here. Wind turbines on the headlands are not likely to influence these birds other than some gulls that commute to the ocean across the peninsula. As noted above these are likely to alter their flight paths and avoid the turbines.

Potential of other species of conservation concern (within 5 km):

Two ducks listed as Special Concern by COSEWIC, Harlequin Duck and Barrow's Goldeneye (listed Red and Yellow respectively by General Status Ranks of Wild Species in Nova Scotia), do occur along the eastern coast of Cape Breton. The former occurs largely at rocky points such as Point Michaud and the latter in Sydney Harbour (off North

Sydney, Sydney River and Wentworth Park in Sydney). Three winters of bird surveys of ducks at the Lingan Power Plant did not detect these species (Bredin et al. 1997) nor am I aware of birders seeing them in the past 15 years in this location. Therefore they are not likely to be affected by this project.

Piping Plovers (COSEWIC Endangered) nested on Dominion Beach in the 1980s. A beach stabilization program likely altered the character of the beach and they have not nested since before 1990. This beach is checked annually by birders and frequently by government agencies involved in the international Piping Plover nesting survey. Even if they did still nest on this beach, 1-3 km from the proposed towers, there would be little chance of a negative impact.

A Short-eared Owl (COSEWIC Special Concern) was seen on one of more than 30 surveys at Lingan Power Plant in the mid-1990s. They do occur in extensive grassy dunes as close as Glace Bay and Port Morien, 15 and 30 km away. There was special attention to potential nesting habitat for Short-eared Owls. No suitable habitat was detected. The grassed dunes at Dominion Beach, 1-3 km distant, are unlikely to be used for nesting because of the daily traffic of a few dozen walkers, dogs and joggers.

Peregrine Falcon (COSEWIC Threatened for *anatum*) may forage in the area. They are most frequently seen during fall migration in eastern Cape Breton. The concentrations of shorebirds and ducks appear to provide suitable prey. However, there are more sightings (still not annually) at Schooner Pond, 20 km to the east, and Point Michaud 80 km to the southwest.

The wind blown spruce-fir habitat favoured by Bicknell's Thrush (COSEWIC Special Concern) is not found in this section of Cape Breton. Ipswich Sparrow (*princeps* subspecies of Savannah Sparrow) (COSEWIC Special Concern) occurs in very small numbers in both spring and fall in eastern Cape Breton. They frequent sandy beaches and accompanying dunes on their way to and from nesting grounds on Sable Island. Wind turbines in unsuitable habitat are unlikely to have any influence on the stray individuals that may end up a km or two away along Dominion Beach.

Consultation with Canadian Wildlife Service:

Advice on the protocol I was using for pre-construction monitoring was sought from Dan Busby, Senior Wildlife Biologist, Canadian Wildlife Service, Sackville, NB.

He made three important points

- i) point counts are not sufficient on their own
- ii) attention must be paid to species that fly through turbine height air space and
- iii) turbine lighting is critical for nocturnal migrants.

During my surveys I emphasized five minute point counts for spring migration, breeding season and autumn migration surveys. However they were not the only source of bird data during the surveys. Searching particular habitats is essential to find species with particular habitat requirements. I walked the entire site in mid-May to select locations for

point counts that I felt were representative of all terrestrial habitats (Figures 3-10). In addition, the seven were situated so that I walked within 200 m of more than 90% of the site during each survey. I kept track of all birds heard or seen while walking between the point counts. Therefore I feel this approach had a very good chance of detecting most species that nested on the site.

I counted all birds seen or heard at the point counts, therefore these are considered unlimited distance point counts. The limitation is that these data cannot be used to estimate density. The advantage is more birds are recorded.

A suggestion was made to do longer point counts, e.g. 30 minutes, of birds that traveled through the airspace of the proposed turbines. This was not done, but special attention while walking between points and while at point counts was paid to birds flying at these heights. Five species were seen flying at these heights. In order of abundance (most to least) the species were Herring Gull, Double-crested Cormorant, American Crow, Great Black-backed Gull and Blue Jay. Most were Herring Gulls in May and early June when lobster fishers provided food on the ocean and the gulls traveled to either the ash dump lake or Lingan Bay to roost.

I did not detect concentrations of migrants at the site, during either spring and fall migration. Undoubtedly there are larger numbers of migrants for a few days in both spring and fall. Nocturnal migrants do collide with turbines (see compilation by Kerlinger 2005). Lighting on towers can attract nocturnal migrants and increase the risk of collision. No carcasses were found under the unlit anemometer tower. Using minimal lighting, maximizing OFF time and using white strobes will all assist in keeping mortality of nocturnal migrants to a minimum.

Winter:

In winter Greater Scaup, American Black Ducks and gulls concentrate at the warm water outflow from the Lingan Power Plant. A few Black-capped Chickadees, Red-breasted Nuthatches and Downy Woodpeckers will use the birch-spruce woods. Long-tailed Ducks, Common Eider, Red-breasted Merganser and Common Goldeneye will forage offshore when ice conditions permit. Little interaction between these woodland and sea birds and the turbines is expected.

Final comment:

Bird mortality can be minimized by careful site selection and minimizing lighting on wind turbines. Recent peer reviewed publications (e.g. Osburn et al. 2000; Johnson et al. 2002; Barrios and Rodriguez 2004), reviews for government agencies (e.g. Kingsley and Whittam 2003), environmental consulting firms (e.g. Kerlinger 2005) and environmental assessments (e.g. Kerlinger 2003; Anemos Energy Corporation 2004) support this view. Minimal lighting on the towers and avoidance of the Great Cormorant colony are two sensible approaches to minimize bird mortality at this location.

References:

- Anemos Energy Corporation. 2004. Environmental Assessment Registration St John's (NF) Wind Farm. Environmental Assessment Division, Newfoundland Department of Environment and Conservation. 20 pp.
- Barrios, L. and Rodriguez, A. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41: 72-81.
- Bredin, K.A., Burgess, N.M., McCorquodale, D.B. and Harris, D.L. 1997. Volunteer Surveys of Waterbirds of the Sydney, Nova Scotia Area, including the Sydney Tar Ponds, 1993-1996. Canadian Wildlife Service, Environment Conservation Branch, Technical Report Series Number 273. 40pp.
- Erskine, A.J. 1992. Atlas of the Breeding Birds of the Maritime Provinces. Nimbus Publishing and Nova Scotia Museum, Halifax, NS. 270pp.
- Johnson, G.D., Erickson, W.I.P., Strickland, M.D., Shepherd, M.F., Shepherd, D.A. and Sarappo, S.A. 2002. Collision mortality of local and migrant birds at a large scale wind-power development on Buffalo Ridge, Minnesota. *Wildlife Society Bulletin* 30: 879-887.
- Kerlinger, P. 2005. Summary of Bird Studies and Collision Rates at Wind Power Projects (revised February 9, 2005). www.easthavenwindfarm.com/flining/feb/ehwf-pk-rebl.pdf (accessed 10 July 2005).
- Kerlinger, P. and Dowdell, J. 2003. Breeding bird survey for the East Haven Windfarm, East Mountain Demonstration Project, Essex County, Vermont. Curry and Kerlinger LLC, Cape May, NJ. 13 pp.
- Kingsley, A. and Whittam, B. 2003 (December DRAFT). Wind turbines and birds: A Guidance document for environmental assessment. Prepared under contract by Bird Studies Canada for Canadian Wildlife Service., Gatineau, Quebec. 87pp.
- Knapton, R.W. and McCorquodale, D.B. 2001. Seasonal Checklist of the Birds of Cape Breton Island, Nova Scotia. UCCB Special Publication. 21pp.
- McCorquodale, D.B., Banks, D.B., Kerr, M.I., Knapton, R.W. and Harris, D.L. 2004. Nesting seabirds on the Bird Islands, Cape Breton, Nova Scotia. *Proceedings of the Nova Scotia Institute of Science*. 42: 241-252.
- Osburn, R.G., Higgins, K.F., Usgaard, R.E., Dieter, C.D. and Neiger, R.D. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge Wind Resource Area, Minnesota. *American Midland Naturalist* 143: 41-52.

Figure 3: Looking southeast from A towards Lingan Power Plant. Notice shrubby alders with interspersed White Spruce.



Figure 4: Looking southwest from B into the denser woodland of White Birch, White Spruce and Red Maple.



Figure 5: Open heathy vegetation along coast near C. Notice extensive rutting from All Terrain Vehicles.



Figure 6: Looking from D towards the anemometer tower, E and the end of the peninsula. Notice the shrubby White Spruce and alders.



Figure 7: The base of the anemometer tower showing guy wires and looking towards E and the end of the peninsula.



Figure 8: Looking from F to nesting cliffs along the shores of Laffins Cove.



Figure 9: Looking from top of nesting cliff towards Lingan Power Plant. A low ceiling results in the tops of the stacks being shrouded in fog.



Figure 10: Looking toward G along the path from D showing White Spruce, Red Maple and White Birch woods.



Figure 11: A view from the lake at the ash dump back towards the Lingan Power Plant. Gulls roost on this freshwater lake.



Figure 12: A view from road toward lake at the ash dump, alders and lots of garbage.



Post-construction bird monitoring at
wind turbines near
Lingan, NS:
June 2008 through March 2009

D.B. McCorquodale
41 Holywood Dr., Georges River, NS B1Y 3H9
902-794-2172, david_mccorquodale@cbu.ca

Summary

Government approval of the wind energy facility at Lingan, Nova Scotia required one year of post-construction bird monitoring at the seven large wind turbines installed in 2007. The monitoring documented i) bird use around the turbines, ii) bird mortality due to the turbines, and iii) which species were most at risk of collision because of their behaviour. Protocols for collecting bird use data were reviewed and approved by Environment Canada. Bird use of areas around the turbines were compared with bird use of control areas from June 2008 through May 2009. In addition, the 2008-2009 surveys were compared qualitatively to pre-construction surveys. Bird mortality from the turbines was estimated by comparing carcass density under the turbines with a control area. The persistence of carcasses and the efficiency of searchers were quantified and considered in estimates of bird mortality. Observations of which species flew at the height of the turbine blades, 'Through the turbine' observations, were done to assess which species might be at increased mortality risk.

A similar assemblage of birds foraged and roosted around the wind turbines at Lingan, NS from June 2008 through May 2009 to those observed during surveys in 2005 prior to construction. Some woodland habitat was cleared for access roads and for turbine construction. The cleared areas harboured few birds, especially those species that require trees and shrubs for breeding or foraging. Several species of birds were less frequent within 50 m of the turbines compared to control points (e.g. Red-eyed Vireo, Magnolia Warbler, Black-capped Chickadee), suggesting that changes in habitat reduced the number of birds using the disturbed areas adjacent to turbines.

The most objective estimate of bird mortality due to the 7 wind turbines at Lingan from June 2008 through May 2009 is zero. This low estimate of mortality suggests that further monitoring at the Lingan wind turbines is not necessary. The remains of 11 birds were found in the 5.5 ha search area under the turbines during 50 carcass searches. Remains of 8 birds were found in the smaller (2 ha) control search area. Searchers found more than two thirds (48/70) of the carcasses planted to test their efficiency in finding carcasses. About 60% of carcasses (43/70) persisted for more than 2 weeks, suggesting that if they were missed on one survey they were available to be found on the next one. The density of bird remains in the control area was twice as high as that under the turbines.

Few species were observed flying at the height of the turbine blades. The most frequently observed species were Herring Gull, Double-crested Cormorant and Great Black-backed Gull. Only one carcass of these species was found. This was a recently fledged (<1 week) Herring Gull found near T1 that likely died of causes other than collision with the turbine.

Contents

SUMMARY	2
POST-CONSTRUCTION BIRD MONITORING AT LINGAN, NS	4
BIRD OBSERVATION AND CARCASS SEARCH PROTOCOLS	4
BIRD USE OF AREAS AROUND TURBINES: POINT COUNTS	4
CARCASS SEARCHES	6
<i>Searching efficiency and carcass persistence</i>	6
<i>Limited visibility carcass searches</i>	7
SPECIES POTENTIALLY AT INCREASE RISK OF COLLISION WITH TURBINES	7
SPECIES COMPOSITION AND RELATIVE ABUNDANCE OF BIRDS	8
BIRDS OF SUMMER: JUNE THROUGH AUGUST 2008.....	8
<i>Summer species potentially at increased risk through collision</i>	9
BIRDS OF AUTUMN: SEPTEMBER THROUGH NOVEMBER 2008	10
<i>Autumn species potentially at increased risk through collision</i>	11
BIRDS OF WINTER: DECEMBER 2008 THROUGH MARCH 2009	11
BIRDS OF SPRING: APRIL AND MAY 2009	12
<i>Spring species potentially at increased risk through collision</i>	12
BIRD MORTALITY	12
CARCASS SEARCHES	13
BATS.....	13
SEARCHER EFFICIENCY.....	13
<i>Carcass persistence</i>	13
ESTIMATES OF NUMBER OF BIRDS KILLED BY THE TURBINES	14
CONCLUSIONS	15
REFERENCES	15
TABLES AND FIGURES	16
<i>Figure 1: Aerial view of the Lingan site</i>	16
<i>Table 1: Point count locations</i>	17
<i>Table 2: Hours with low visibility</i>	18
<i>Table 3: The 25 most frequently recorded species of birds</i>	18
<i>Table 4: Use of the area within 50 m</i>	19
<i>Table 5: The 25 most frequent species in Summer</i>	20
<i>Table 6: The 25 most frequent species in Autumn</i>	21
<i>Table 7: The 22 species in Winter</i>	22
<i>Table 8: The 25 most frequent species in Spring</i>	23
<i>Table 9: Bird remains found under the turbines</i>	24
<i>Table 10: Bird remains found in the 2 ha control area</i>	25
<i>Table 11: The 'planted' carcasses</i>	26
<i>Appendix A: Dates of the 50 surveys</i>	27
<i>Appendix B: Numbers of all species of birds</i>	29

Post-construction bird monitoring at Lingan, NS

Seven EnerconE70 wind turbines have been producing power since March 2007 at Lingan, Nova Scotia. The site is between the old Phalen Colliery on the New Waterford (north west) side and the Lingan coal-fired generating station operated by Nova Scotia Power towards Lingan Bay to the southeast (Figure 1). The project was developed by Glace Bay Lingan Wind Power Limited and is currently operated by Confederation Power (Confederation Power 2009).

An assessment of potential bird issues was conducted as part of the environmental assessment for this project (McCorquodale 2005: Appendix A in 'Lingan 10 MW Wind Power Project', Nova Scotia Department of Environment and Labour 2006). The major influence on bird populations predicted was a small reduction of populations of species that use shrubby and wooded habitats that would be cleared during the construction of the turbines. A caution was also sounded about Great Cormorants. During pre-construction monitoring Herring Gulls and Double-crested Cormorants were the birds that flew across the peninsula at the height of the turbines most frequently, and therefore were the species most likely at risk of colliding with the turbines. However this was deemed to be of minimal risk. Direct collisions of birds with the turbines were considered to be a minimal risk.

A condition of the environmental assessment approval of the Lingan wind energy project was one year of post-construction bird monitoring (Nova Scotia Department of Environment and Labour 2006). The monitoring had three goals, linked to the pre-construction assessment:

- 1) Assess whether the species composition, number and relative abundance of the various species of birds that nest and regularly use the area has changed since turbine construction.
- 2) Determine if birds are killed as a result of colliding with the turbines.
- 3) Determine which species flew close to the turbines at the height of the blades and therefore were potentially at increased risk of collision.

Bird observation and carcass search protocols

Observation protocols were based on 'Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds' (Canadian Wildlife Service 2007). Protocols were submitted to Dillon Consulting, Halifax, NS by D.B. McCorquodale and then modified to reflect comments received from Environment Canada, Canadian Wildlife Service, and Nova Scotia Department of Natural Resources. The final version was signed 28 May 2008. The protocols are summarized here.

Bird use of areas around turbines: Point Counts

Point counts (10 minutes at 7 turbines and 5 controls) were done once a week from June through August (N=13 Summer), twice weekly from September through late October, weekly in November (N=20 Autumn), monthly from December 2008 through March 2009 (N=4 Winter) and weekly in late April and twice weekly in May (N=13 Spring) (Total 50 surveys). Each of the 7 turbines was the centre of a turbine point count. The short distance between turbines, 200-400 m, precluded setting up matched controls between the turbines. Therefore 5 control points were selected at least 300 m away, far enough ways so the same birds were not counted, and within 600 m, to maximize similarity of the coastal environment. The most important criterion in selection of specific points was to match as closely as possible the habitat before the construction

of the turbines (See Table 1 for location and brief description of vegetation, Appendix A for list of survey dates).

All counts were done within 4 hours of sunrise to increase the probability of high levels of bird activity. The starting point of the surveys alternated between the east and west ends and each survey proceeded towards the opposite end. Occasionally (<10% of surveys) individual points were done out of order because of people working on the turbines. A few surveys were done over two days if weather deteriorated and the survey could not be completed within 4 hours of sunrise. Appendix A lists the dates of all surveys. D.B. McCorquodale conducted all observations from June 2008 through May 2009.

All birds seen and heard over land were recorded. The height of each bird, below turbine blades (<30 m), at the height of the turbine blades (30-100m) and above the turbine blades (<100 m), the distance from the turbine or control point (< 50 metres, 50-100 metres and > 100 metres) and its behaviour (Maritime Breeding Bird Atlas breeding codes, plus foraging, roosting and flying by) were recorded. If a bird flew at the height of the turbine blades at any time during the observation it was recorded as flying at the height of the blades. The recorded distance from the point was the closest a bird came to the turbine or control point during the 10 minute point count. Therefore there is a slight bias towards birds flying at the height of the blades and using the area closest to the point. Within each season, the numbers of each species recorded at the turbines and control points, within 50 m and from 50-100 m were summed and then divided by the number of turbines (n=7) or the number of control points (n=5) respectively. This allows the numbers for each species to be compared at turbines versus control points within each season. They are not comparable among seasons because of differing numbers of surveys by season.

Birds flying over the ocean were not included on point counts. These were mostly gulls, cormorants, and ducks. Of these, only gulls and cormorants flew over land regularly and those that did were recorded on the point counts. Numbers during the point counts provide a quantitative assessment of potential risk for the gulls and cormorants.

Birds seen and heard while walking between points were noted, but are not explicitly used here. These observations corroborate the patterns from the point counts. A few species of autumn vagrants were only recorded during these casual observations. During the winter and summer it was exceptional to record a species between the point counts that was not found on at least one point count the same day.

Use of the area within 50 m, compared to from 50-100 m from the turbine points versus the control points was compared for the most common land birds. The proportion of individuals counted within 50 m among all individuals counted within 100 m of the point was calculated for both turbine and control points. Then a ratio of the proportion within 50 m of the turbines to the proportion within 50 m at the controls was calculated. A ratio of 1 indicates similar use close to the points. A low ratio, for example <0.6, indicates less use of the area within 50 m of the turbine compared to within 50 m of control points. A ratio of more than 1 indicates more use of the area within 50 m of the turbines compared to the control points. This comparison is based on the assumptions that more habitat was lost within 50 m of the turbines than further away during construction. The ratio is used within species to control for differential detectability of birds and the difference in area within 50 m versus from 50-100 m from the points. It is easier to hear and see some species further from the points than others. Since we are interested only in comparing use of the areas close to the points within species the ratio provides some control for these factors.

These ratios were calculated for all species of land birds with more than 50 individuals recorded from June 2008 through May 2009. Water birds (e.g. Herring Gull, Double-crested Cormorant, American Black Duck) were not included because they were flying through the site and not using terrestrial habitat. Because proportions and a ratio were calculated, species with fewer than 50 individuals were considered to have too sparse data to provide a meaningful comparison.

Carcass Searches

The area within a 50 metre radius around the base of each of the 7 turbines was searched for carcasses on the same schedule as point counts (N=13 in Summer, N=20 in Autumn, N=4 in Winter, N=13 in Spring, Total 50 searches). During the first week of June 2008, the searchers established trails through the thickest vegetation based on 12 radii from each turbine. The perimeter of each 50 m radius circle was marked. Searchers walked neighbouring radii and crisscrossed between the radii as the radii diverged. A stick was used to part vegetation, especially tall grass, roses and bayberry. The types of vegetation determined how difficult it was to see carcasses. A map of the vegetation around each turbine was drawn to give an indication of the proportion of the circle that was relatively easy to search (open gravel, short grass), of moderate difficulty (forest floor under dense conifers, tall grass) and of extreme difficulty (dense thigh-high roses, dense alders and dense young Trembling Aspen mixed with herbaceous plants). Jana Aker and Meghan Taylor did the vast majority of the carcass searches, 49 and 50 respectively. In the late summer and early autumn Eric McCorquodale assisted on 12 and Martin MacInnis on 3 searches. Searching was most difficult in the summer and early autumn because of the increased quantity and density of the vegetation, so a third searcher was used. As vegetation (grass, leaves on deciduous shrubs) died back in October, it became easier to see. Coincidentally the searchers were also becoming more familiar with the site. Carcass search dates are listed in Appendix B.

A control area was also searched. The control area consisted of the transect from the edge of the 50 m search area under each turbine to the edge of the search area under the next turbine, and the transects from the nearest turbine search area to the 5 control points used for point counts. The area covered during the turbine searches was about 5.5 ha ($7 \times 3.14 \times 50\text{m} \times 50\text{m}$) while the control area was 2 ha, based on a 10 m wide transect between search areas under the turbines and to the control points.

All carcasses found were flagged with a unique identifier, photographed and UTM location recorded with a handheld Garmin GPS. The data (including photographs) were emailed to D.B. McCorquodale at the end of the weekly search, who corroborated or updated identifications.

Searching efficiency and carcass persistence

Seventy four bird carcasses were 'planted' in the search area under the turbines and in the control area between turbines to test searcher efficiency. Bird carcasses were obtained from NS Department of Natural Resources, Coxheath or scavenged (road kills, window kills) through a Salvage Permit from CWS, Sackville, NB to D.B. McCorquodale. Carcasses were placed in the field either the evening before a search or on the morning of a search. The species of bird, a categorical assessment of 'search difficulty' (Easy, Moderate, Challenging) and UTM were recorded for each carcass along with whether the searchers found it or not. Immediately following a search, the searchers were given the UTM coordinates of carcasses they missed. They then checked that those carcasses were still in place and added them to the list of carcasses.

Most carcasses placed out to test searchers were monitored for persistence. Persistence was not assessed during the winter because of infrequent surveys and accumulated snow. Some carcasses were moved to a different location for a second test of searcher efficiency and are not included in

persistence estimates. Also, those deployed in the last two weeks of the monitoring (May 2009) were not assessed for persistence. Bird remains found under the turbines and in the control area, which were not placed out to test searchers, were monitored for persistence as well.

Limited visibility carcass searches

Extra carcass searches were required if there were significant fog events, which functionally means reduced visibility. The protocol was to have an additional carcass search within 48 hours of a reduced visibility event. The main concern was during migration periods when reduced visibility might increase risk of collisions with the turbines of nocturnal migrants.

Visibility, fog and wind speed data were monitored from the nearby Sydney Airport (<5 km southeast) (http://www.climate.weatheroffice.ec.gc.ca/climateData/hourlydata_e.html). The initial operational definition of reduced visibility event was 22 hours of fog within a 24 hour period. Through monitoring the weather data it was noticed that many hours of fog had visibility of more than 1 km which did not fit the intent of the definition. As well snow could also cause reduced visibility. Therefore a modified operational definition for a significant reduced visibility event was more than 15 hours of reduced visibility (0.6 km or less). No additional carcass searches were required based on these criteria (See Table 2 for visibility summary). There were 10 periods of 3 or more hours with visibility of 0.6 km or less. Five of these had 3 hours (19 June 2008, 13 August 2008, 19 November 2008, 7 April 2009, 6 May 2009). Another three had four hours (7 June 2008, 12 February 2009, 13 February 2009) and the longest was 10 hours through the night of 29 to 30 August 2008. None of these was long enough to trigger an extra carcass search. After the longest reduced visibility event 29-30 August a regular point count survey was conducted on 30 August and a regular carcass search on 01 September (within 48 hours). The contingency of extra carcass searches after reduced visibility events was a requirement of the protocol, but since it did not trigger extra searches, it is not considered further.

Species potentially at increase risk of collision with turbines

Four 15 minute observations were used to count the number of birds flying between the turbines, with particular attention to those at the height of the turbine blades ('Through the turbine' observations). The approved protocol called for 30 minute observations from just west of the westernmost turbine (T7) and just east of the easternmost turbine (T1) weekly during the summer and twice during the autumn and spring migration periods. After two weeks in June 2008 it became obvious that birds were not being detected at the middle turbines. Therefore the protocol was modified from 2 points at either end for 30 minutes each to four 15 minute observations, from four points that offered a view of all turbines. The four points were: T5-7 (UTM 726946 5125818), T4-5 (727686 5125889), T1-3 (728574 5125484) and T1-2 (728742 5 125270). These points provided more complete coverage of birds flying between all of the turbines. At each of the four points the height, below level of blades (<30 m), through the height of the blades (30-100m), above the height of the blades (>100 m) of all birds that flew between the turbines or between the observer and the turbines was recorded. All of these observations from June 2008 through May 2009 were done by D.B. McCorquodale.

Species composition and relative abundance of birds

The assemblage of birds found at the turbines was similar to those expected at coastal sites in eastern Cape Breton where there are no houses or bird feeders. The 25 most frequently recorded species are common in eastern Cape Breton (Table 3).

Several species that forage and nest in shrubby deciduous vegetation and young spruce woodland were less frequently recorded within 50 m of the turbines than they were within 50 m of control points (Table 4). The removal of shrubby deciduous vegetation and spruce woodland during construction, and conversion of these areas to open gravel and sparse grass was expected to reduce the numbers of birds using such vegetation in the immediate vicinity (<50 m) of the turbines (McCorquodale 2005). This habitat conversion was concentrated, although not limited to, the area within 50 m of the turbines.

One way to assess the effect of habitat conversion was to compare the ratio of individuals recorded within 50 m and between 50 and 100 m from the point counts at the turbines and control points (as proportions). If habitat change reduced use by a particular species around the turbines you would expect the proportion of observations within 50 m be lower ($\ll 1.0$) for the turbines than the control points. Analogously if the ratio is close to 1, this indicates similar use of the area within 50 m of the turbines and the controls, and a ratio of $\gg 1$ indicates more use of the area close to the turbines than the control points.

Only 3 of nineteen species with more 50 individuals tallied had ratios close to 1, between 0.98 and 1.2. All three species, American Crow, American Robin and Savannah Sparrow, forage frequently in open areas and generally shun wooded areas. The other 16 species all had ratios less than 0.80.

Eleven species had ratios less than 0.6 suggesting much less use of the area within 50 m of turbines than within 50 m of control points. Many of these, for example Red-eyed Vireo, Magnolia Warbler, Yellow-rumped Warbler, Black-capped Chickadee, rely on wooded habitats. For other species why there was less use close to the turbines was not obvious. European Starlings regularly forage on and along roads and in open gravelly areas. Bank Swallows forage in flight over many different habitats, but often open areas. The high counts of Common Redpoll and Bohemian Waxwing both were based on one or two large flocks that happened not to be close to the turbines. On balance the ratios indicate that for some of the common nesting species and autumn migrants that use shrubby deciduous vegetation and young spruce woodlands, the conversion of these habitats to grass and open gravel reduced use of the area close to the turbines.

This section considered the assemblage of birds and use of area near the turbines through the whole year, June 2008 through May 2009. The next four sections consider each of the four seasons in more detail, Summer (June through August 2008), Autumn (September through November 2008), Winter (December 2008 through March 2009) and Spring (April and May 2009).

Birds of Summer: June through August 2008

The 25 most common species during the breeding season (Table 5) are among the most common birds in shrubby and young woodlands in eastern Cape Breton (Tufts 1985, Erskine 1993,

Maritime Breeding Bird Atlas 2009). The same species that nested commonly at the site in 2005 (McCorquodale 2005) were the most common nesting birds in 2008. The twelve most common nesting species in 2005 were also in most the most frequently recorded species in 2008 (American Crow, Alder Flycatcher, American Goldfinch, American Robin, Bank Swallow, Common Yellowthroat, Magnolia Warbler, Red-eyed Vireo, Song Sparrow, White-throated Sparrow, Yellow Warbler, Yellow-rumped Warbler). Three raptors were seen regularly, Merlin (a nest successfully fledged young along Hinchey Ave., about 400 m from T7), Northern Harrier and Bald Eagle.

The biggest change due to construction was that the cleared areas around the turbines, that are now grass, goldenrod and clover, did not support the birds that nested in the spruce woods, willow/alder shrubs and poplar woods that were there before construction of the turbines. It is difficult to present quantitative comparisons because of the small dataset from the 2005 surveys and because the control points reflect overall habitat similarity and not paired controls. However comparing ratios of the proportion found within 50 m of turbines, where most of the habitat loss occurred during construction, with the proportion between 50 and 100 m with the same ratio at control points provides a useful indicator (see previous section). The nesting species with low ratios (<0.6) of use within 50 m of the turbines compared to the controls included Red-eyed Vireo, Black-capped Chickadee, Magnolia Warbler, and White-throated Sparrow (Table 4). All use shrubby deciduous vegetation and/or young spruce woods, the habitats that were converted to open gravel or grass with the construction of the turbines. This suggests reduced nesting density because of habitat loss through the construction of the turbines.

A few species did forage in the grass, particularly American Crow, Savannah Sparrow and American Robin, and had similar ratios around the turbines and the control points.

Birds regularly seen offshore from early June until just after the lobster fishing season ended in mid-July included Herring and Great Black-backed Gulls (a few hundred), Black Guillemots (several dozen) and cormorants (several dozen, mostly Double-crested Cormorant). By early August gull numbers had dropped to a few dozen. Cormorant numbers offshore dropped but not to the same degree. Once the young Double-crested Cormorants fledged the numbers declined.

In June 2009 nesting gulls, cormorants and guillemots were counted during a boat trip from Lingan wharf out around the headland. More Double-crested Cormorants nested along the cliffs (101 nests, on both north and south faces) than Great Cormorants (48 all along south face). All nests were in steep places that made access by terrestrial predators such as Red Fox and Coyote next to impossible. A few Herring Gull nests (13) were scattered along the margins of the cormorant colonies on the north side of the headland. No Great Black-backed Gull nests were found. Black Guillemot nests are difficult to find because they are just crevices amid boulders or in cracks in cliffs. Only 75 adults were found in early June. However I estimate about 110 pairs nest from the Lingan Power Plant around the headland to the old Phalen Colliery based on counts of pairs in late April through May 2008. These numbers are similar to those reported in McCorquodale (2005) suggesting the installation of the turbines has had no effect on the population of nesting seabirds.

Summer species potentially at increased risk through collision

The vast majority of observations of birds flying between the turbines at the height of the blades were in early summer 2008, during lobster season which ends in mid-July. Herring Gull (166), Double-crested Cormorant (110) and Great Black-backed Gull (50) contributed 216 observations. Those flying between the ocean and the estuary tended to fly at the height of the blades, more often than those flying near the headland near T1 and T2. The only other species with more than

5 observations was Bank Swallow (20). They nest under the overhang at the top of the cliff near T1 and occasionally forage in this area. The only other species recorded flying at the height of the blades, American Crow, American Black Duck, American Goldfinch and Glaucous Gull (unusual in June in Cape Breton) contributed a combined 6 observations.

McCorquodale (2005) cautioned against constructing turbines too close to the Great Cormorant nests because of the potential risk of flights at the height of the turbines. One year of monitoring showed that Great Cormorants rarely flew over the peninsula near the turbines and no carcasses were found at the turbines. The number of Great Cormorant nests has not changed since construction of the turbines. Even though Double-crested Cormorants flew at the height of the blades frequently, no carcasses were found near the turbines and the number of nests on the cliffs appears stable through two nesting seasons after construction.

Birds of Autumn: September through November 2008

The 25 most frequently observed species during the autumn migration surveys were among the most common species in coastal Cape Breton (Table 6). It is difficult to compare the 20 autumn surveys in 2008 with the 2 in 2005. All of the species observed in 2005 were among the common species in 2008. As expected many more species, 58, were found due to the increased effort in 2008.

There was little difference in the suite of species and their relative abundances at the turbines compared to the control points. Of the 7 species seen at the control points and not the turbines, 6 had 2 or fewer observations (Blue-gray Gnatcatcher, Black-and-White Warbler, White-crowned Sparrow, American Tree Sparrow, Yellow-breasted Chat, Wilson's Snipe, White-winged Crossbill see Appendix B). The gnatcatcher, White-crowned Sparrow and chat are rare but regular autumn vagrants in eastern Cape Breton. The seventh species, White-winged Crossbill, is irruptive, with flocks tracking the varying abundance of spruce cones across the coniferous forests of North America. The cone crop was light in 2008 and therefore large numbers were not expected. A Prairie Warbler was seen only at T4. Prairie Warbler is a rare but regular fall vagrant on coastal headlands in eastern Cape Breton. Two autumn vagrants were seen only while walking between points, Yellow-billed Cuckoo between C1 and C2 and a Lark Sparrow between T4 and T5.

The number of migrant sparrows, especially Savannah Sparrow and Swamp Sparrow was impressive. Both species used the area consistently for several weeks during autumn migration. It surprised me that both were more numerous through the autumn than White-throated Sparrow, often a more common migrant sparrow in coastal Cape Breton.

Even though there were some interesting vagrant warblers (Blue-winged Warbler, Prairie Warbler and Yellow-breasted Chat) there were low numbers of more regular migrant warblers. The number of Blackpoll Warblers seemed low for a coastal headland. Bay-breasted Warbler, Blackburnian Warbler, American Redstart, Ovenbird, Black-and-White Warbler and Northern Parula all seemed very low or were absent. With twice weekly surveys some major movements may have been missed. However it does suggest limited warbler migration through this site.

Merlin and Northern Harrier hunted in the area regularly. Merlins either patrolled the tops of the cliffs or the edges of woodlands. Several of the carcasses found both under the turbines and in the control area appeared to be plucked remains of Merlin kills.

The numbers of gulls and cormorants were much reduced after lobster season ended in July and young fledged from cormorant nests. The exception to this pattern was Great Cormorant. Only 3

Great Cormorants were noted on point counts even though they were regularly seen just offshore. They roosted on the cliffs overlooking Lingan Bay from September through until the end of November. In September and October, few birds other than a few gulls were seen offshore. Starting in early November small numbers of Red-breasted Mergansers, Common Goldeneye and Long-tailed Ducks were noted. Black Guillemots disappeared around the time the young fledged in late July and were not seen again until late November.

Autumn species potentially at increased risk through collision

Few birds were observed during the 'Through the Turbine' observations from September through November 2008. Twelve gulls, 7 Double-crested Cormorants and 14 American Black Ducks flew at the height of the blades near the turbines in the 12 hour long surveys. Land birds (e.g. Northern Flicker, Blue Jay, Northern Harrier) flew below the sweep of the blades of the turbines. The only exception was one American Crow that flew through at the height of the blades.

Eleven of the 24 watches at the middle turbines recorded no birds during the 15 minutes of observation. Most birds were seen at the watch near T7. Ducks, gulls and cormorants fly from the ocean to roosting areas around a settling pond and to the estuary behind Dominion Beach.

Fewer birds were seen in autumn than during the summer because there were fewer gulls and cormorants in the area in the autumn. Gulls followed the lobster boats for discarded bait in June and July. Their numbers plummeted after the end of lobster season in mid-July. Cormorant numbers dropped once young had fledged at the end of July. Great Cormorants were seen just offshore during most surveys through the autumn, however none were recorded overland near any of the turbines.

Birds of Winter: December 2008 through March 2009

Fewer species of birds were found on the four winter surveys compared to either the breeding season or autumn migration surveys. The 22 species listed in Table 7 were all of the species found within 100 m of the turbine and control points. Fewer surveys may have contributed to fewer observations, but the main reason is the dearth of insectivorous birds through the winter. All species found were those expected in coastal Cape Breton in the winter. The small number of species and no comparative pre-construction surveys in the winter make it difficult to assess effects of the turbines, yet as noted for other seasons, there were no striking differences in the assemblage between the turbines and control points.

Fruit eating birds were prominent through the winter. Two sizeable flocks of Bohemian Waxwings remained much of the winter and they were the most numerous species on the 4 winter surveys. American Robin and Yellow-rumped Warbler, both fruit eaters through the winter, were also regularly recorded. Interestingly there were more American Robins counted in the winter than summer or autumn despite only 4 winter surveys, compared to 13 and 20 surveys during the other 2 seasons respectively. American Robins overwinter in Cape Breton where there are sufficient fruit crops to support them. Wind-swept coastal headlands, with good supplies of mountain-ash, and bayberry and sheltered areas nearby for roosting while digesting, provide suitable wintering habitat for these species.

Few winter finches (e.g. Common Redpoll, American Goldfinch) were found. This was not expected to be a winter with large numbers of Common Redpolls, despite finding more than 100 on one late autumn survey. No White-winged Crossbills were seen, likely because there were few or no cones on most of the White Spruce.

Raptors hunted around the turbines on each survey day during the winter, but were infrequently recorded during point counts. Northern Harrier was expected because they often hunt over exposed coastal headlands through the year in Cape Breton. A Red-tailed Hawk also hunted at this site in December and January. Surprising was a first year Northern Goshawk hunting around C1 and T7 in March. I watched it cruising over the tops of the alders, shrubby poplar and spruce, probably searching for Snowshoe Hare or Ruffed Grouse. A Bald Eagle was also seen at the site several times, but not on one of the point counts.

The ocean was open in December and January, by February there was some drift ice, and in March there was drift ice to the northern horizon and much of Lingan Bay was filled with ice. Offshore there were Long-tailed Duck, Red-breasted Merganser, Common Goldeneye, Greater Scaup (Lingan Bay), Common Eider, Common Loon, Great Cormorant, Northern Gannet, Black Guillemot, Herring Gull, Iceland Gull and Great Black-backed Gull. The ice in February and March dramatically reduced their numbers, especially of Great Cormorants. In late March about 35 Black Guillemots had returned and pairs of gulls were inspecting potential nest sites along the cliffs.

Birds of Spring: April and May 2009

The suite of species found during the 13 surveys from mid-April until the end of May 2009 was typical of coastal sites in eastern Cape Breton (Table 8). The fifteen most frequently recorded species were those expected in coastal Cape Breton. There was little evidence of significant movements of passerine migrants. The exceptions were a few Ruby-crowned Kinglets, Yellow-rumped Warblers and White-throated Sparrows in early May. No significant movements of warblers or sparrows were recorded. The flycatchers, warblers and sparrows were largely those arriving to take up territories on the site (e.g. Alder Flycatcher, Yellow Warbler, Common Yellowthroat, Song Sparrow). In contrast to the autumn migration when interesting vagrants were seen regularly (e.g. Blue-winged Warbler, Prairie Warbler, Blue-gray Gnatcatcher), no unexpected passerines were found in the spring.

Offshore there were a few hundred Northern Gannets regularly in late April and early May. Before lobster season started in mid-May, Red-breasted Merganser, Common Eider and Black Guillemot were numerous offshore. Other sea ducks, White-winged Scoter, Long-tailed Duck and Common Goldeneye, were less frequent. With the onset of lobster season sea-duck and gannet numbers dropped while the number of gulls increased dramatically. A few Iceland Gulls lingered until the last week of May.

Spring species potentially at increased risk through collision

Only three species were seen flying through the turbines at the height of the blades during two, hour long (4 x 15 minutes) surveys in May 2009. Herring Gull (17) and Double-crested Cormorant (3) were the most frequent, with the only others being 2 Common Grackles. As in the summer of 2008, Double-crested Cormorants and Herring Gulls that flew between the ocean and the estuary at the west end of the site tended to fly more frequently at the height of the blades.

Bird mortality

Bird mortality was estimated based on the frequency of carcasses found underneath the turbines during the 50 carcass searches and the background density of carcasses found during searches of the control area. The estimate of birds killed by the 7 turbines from June 2008 through May 2009 based on this approach is 0. The logic and data to support this estimate are presented below.

Carcass Searches

The remains of 11 birds were found in the 50 m radius search areas under the 7 turbines (5.5 ha) from June 2008 through May 2009 (Table 9). Two were gulls (one Herring, one Iceland), the others a Leach's Storm-petrel, a Black Guillemot and 7 passerines of 5 species. The remains of 8 birds were found in the 2 ha control area (Table 10). Three of these were the same species as found under the turbines: Herring Gull, Black Guillemot and American Robin. Others were a Hairy Woodpecker, a scoter, a Blackpoll Warbler and a Swamp Sparrow. The remains found both under the turbines and in the control area were species seen at the same time of year they were found on the point counts. The only exception was the scoter. They were seen offshore, but not observed on point counts.

In addition, three carcasses were found on the first two carcass searches. All three were in an advanced state of decomposition, that is feathers and bones. Two were Leach's Storm-petrels and one was unknown, but quite likely the same species. From the state of decay and since they were found on the first two surveys, I conclude they died weeks or possibly months before this study started and therefore are not considered further.

Outside of the search areas under the turbines and in the control area, the remains of an adult Iceland Gull, a nestling Double-crested Cormorant and a Black Guillemot were found during surveys at Lingan. In the control, area carcasses of a Star-nosed Mole and a Snowshoe Hare were also found. These discoveries provide further support that few carcasses were missed by the searchers and there was a significant background density of carcasses.

Raptors hunted at Lingan throughout the year. Merlins often hunted along the tops of the cliff and edges of the woodlands during the summer and autumn. Several of the bird remains found appeared to be the plucked remains of Merlin kills. Specifically the Swamp Sparrow, American Robin and Black Guillemot were strongly suspected to be remains of Merlin kills based on their location where Merlins had been recently hunting. However it was not possible to unequivocally assign bird remains to a source of mortality. This applies to both those found under the turbines and in the control area.

Bats

No bat carcasses were found either under the turbines or in the control area.

Searcher Efficiency

More than two thirds of the bird carcasses (69%) deployed to test the efficiency of the searchers were found on the first attempt (Table 11). Four of 74 carcasses were scavenged before the searchers arrived at the site. All were scavenged in open areas, for example on gravel around the turbines or from the edge of the road, suggesting birds such as crows were responsible. Anecdotal observations support this conjecture. Searchers found one Ruffed Grouse carcass because they saw crows on the carcass. Forty eight of the remaining 70 carcasses (69%) were found. They ranged in size from a Brown Creeper to a Northern Gannet. Twenty four were passerines. Efficiency in finding planted carcasses ranged from 53% (10/19) in summer to 82% in winter (9/11). Seventeen of 21 carcasses (81%) classified as easy, 27 of 34 (79%) as moderate and 7 of 18 (34%) as challenging were found.

Carcass persistence

The four carcasses scavenged within hours of being placed on the site were the exception (Table 11). Forty three of 70 carcasses (61%) persisted for more than two weeks after discovery (Table 11).

Estimates of number of birds killed by the turbines

The most objective estimate of bird mortality at the 7 wind turbines at Lingan, NS from June 2008 through June 2009 is 0 (zero). This estimate considers the number of carcasses found, searcher efficiency and the background density of carcasses in the control area. This estimate is robust even if unrealistically restrictive assumptions are used.

Eleven carcasses were found in the 5.5 ha search area under the 7 turbines, or 2 per hectare. More than 2/3 of carcasses were found on the first search. Since 60% of carcasses persist for 2 weeks, 2/3 of those persisting would be found on the next survey. Therefore 82% of carcasses would be found in two surveys (0.685 on first survey plus an additional 0.61 (carcass persistence)*0.315 (proportion of carcasses missed on earlier search)*0.685 (probability of finding a carcass on any search) on the second). Therefore the 11 carcasses found indicate 13.4 carcasses, or 2.4/ha, from June 2008 through May 2009 at the 7 turbines at Lingan.

Eight carcasses were found in the 2 ha control area or 4/ha. This represents 9.8 carcasses (see rationale in previous paragraph), or 4.9/ha, in the control area from June 2008 through May 2009.

Carcass density was lower under the turbines than in the control area. Therefore the best estimate of bird mortality due to the turbines is 2.4/ha - 4.9/ha = -2.5/ha. This is less than 0, so I will use an estimate of 0.

The turbines did not increase bird mortality. Even if more restrictive assumptions are added the estimate of mortality remains below 0. For example if carcasses were twice as easy to find in the control area, the mortality estimate would be the same, 0 (zero). There is no reason to expect carcasses to be easier to find in the control area. Even if all bird remains found between 50 and 100 m of the turbines in the control area were excluded from the background carcass density, the mortality estimate would still be 0 (zero). There is some justification to extend the distance from the turbine because birds killed by the turbines could die more than 50 m from the turbine. However only about half the carcasses found in the control area were within 100 m of a turbine. The background carcass density excluding those is still about 2.5/ha, still greater than the density of carcasses near the turbines.

Some might argue that these figures suggest that the turbines reduce bird mortality. Undoubtedly the actual number of birds killed by the turbines is less than one bird per turbine per year and very likely less than 0.1 birds per year per turbine.

Three carcasses found under the turbines could have been killed by collisions with the turbines. However it was not possible to unequivocally assign a cause of death. Two recently fledged (<1 week) birds were found near T1 in July, a Herring Gull and a European Starling. Mortality of recent fledglings is much higher than for older birds and the turbines may have had no role in their deaths. The third was an intact Ruby-crowned Kinglet carcass found in the autumn. Another Ruby-crowned Kinglet was missing the tail when found, strongly suggestive of predation. Most of the other remains, both under the turbines and in the control area, were only feathers and bones suggesting a role for predation. The presence of raptors, especially Merlins, is consistent with this speculation.

The most objective estimate of bird mortality from the Lingan wind turbines from June 2008 through May 2009 is 0 (zero).

Conclusions

1. The assemblage of birds that used the Lingan site after the construction of 7 wind turbines was similar to that found during limited surveys prior to construction and to that expected in similar coastal sites in eastern Cape Breton.
2. Several species that forage and nest in shrubs and trees avoided the cleared ground immediately around the turbines. This loss of habitat was the primary influence of the turbines on the birds at the site.
3. The most objective estimate of mortality is zero birds killed due to the turbines.
4. Herring Gull, Double-crested Cormorant and Great Black-backed Gull were the three species that flew through the site at the height of the blades and hence potentially at greater risk of collision with the blades than other species. This activity was concentrated during lobster season, mid-May through late July.

References

- Canadian Wildlife Service 2007. Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds. http://www.cws-scf.ec.gc.ca/publications/eval/prot/index_e.cfm
- Confederation Power. 2009. <http://www.confedpower.com/projects/glanceBay.php>. (Viewed 18 July 2009).
- Erskine A.J. 1993. Atlas of the Breeding Birds of the Maritimes Provinces. Nimbus Publishing and Nova Scotia Museum, Halifax, NS.
- Maritime Breeding Bird Atlas. 2009. <http://www.mba-aom.ca/english/index.html> (viewed 18 July 2009).
- McCorquodale, D.B. 2005. Bird issues for an environmental assessment of a wind energy project at Lingan, Cape Breton Island, Nova Scotia. Submitted to Dillon Consulting, Halifax, NS. (Appendix A in Nova Scotia Department of Environment and Labour 2006).
- Nova Scotia Department of Environment and Labour. 2006. Lingan 10 MW Wind Power Project. <http://www.gov.ns.ca/nse/ea/linganwind10mw.asp> (Viewed 18 July 2009).
- Tufts, R. 1985. The Birds of Nova Scotia, 3rd ed., Nimbus Publishing and Nova Scotia Museum, Halifax, NS.

Tables and Figures

Figure 1: Aerial view of the Lingan site before turbine construction. Turbines 1, 4 and 7 (T1, T4 and T7 respectively) are shown to indicate the ends and middle of the line of turbines. Four of the five control points (C1, C3, C4, C5) are shown, C2 is on the opposite side of Hinchey Ave. from C1. C3 is 46.245°N 60.042°W. C1 to T1 is about 2.3 km. Source: Google Maps, 18



Table 1: Point count locations (UTM 20 T NAD 83) at the 7 wind turbines and 5 control points at Lingan, NS. The turbines are labelled 1 through 7 starting at the peninsula at the east end. Plants are listed starting with the species with the most areal coverage. Vegetation height was estimated.

Point	Easting	Northing	Vegetation
Turbine 1	729034	5125276	30% grass, gravel, goldenrod/aster, bayberry, White Spruce, rose, raspberry, 1- 7 m.
Turbine 2	728818	5125262	45% grass, gravel, White Spruce, White Birch, rose, raspberry, bayberry, aster, goldenrod, 1-6 m
Turbine 3	728653	5125381	50% grass, gravel, White Spruce, rose, alder, bayberry, White Birch, 1-9 m.
Turbine 4	728280	5125555	50% grass, gravel, White Spruce, White Birch, rose, Trembling Aspen, 1-12 m.
Turbine 5	728016	5125676	35% grass, gravel, White Spruce, White Birch, rose, alder, 1-12 m.
Turbine 6	727592	5125783	75% grass, gravel, White Spruce, rose, alder, 1-10 m
Turbine 7	727287	5125750	70% grass, gravel, alder, White Spruce, White Birch, 1-8 m.
Control 1	727037	5125862	Alder, willow, bayberry, goldenrod, 1-3 m
Control 2	726947	5125660	Alder, Pin Cherry, willow, Trembling Aspen, White Spruce, 1-7 m
Control 3	728013	5125476	Aspen, White Spruce, Pin Cherry, willow, aster, bracken, Wild Raisin, White Birch, Mountain-ash, 1-12 m
Control 4	728517	5125268	White Birch, White Spruce, Pin Cherry, Mountain-ash, alder, 1-12 m
Control 5	727687	5125895	Alder, cranberry, rose, Trembling Aspen, 1-4 m

Table 2: Hours with low visibility, less than 600 meters, and the maximum number of hours of continuous low visibility (<600 m) in each month from June 2008 to May 2009, obtained from Environment Canada weather data for Sydney Airport (http://www.weatheroffice.gc.ca/city/pages/ns-31_metric_e.html).

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Hrs Visibility <0.6 km	18	1	25	1	3	6	4	4	10	3	7	4
Max Continuous Hrs Visibility <0.6 km	4	1	10	1	2	3	2	2	6	2	2	3

Table 3: The 25 most frequently recorded species of birds at the 12 point counts (7 turbines, 5 controls) from June 2008 through May 2009 at Lingan, NS. All birds recorded within 100 m of the point during 50 surveys were tallied.

	Summer	Autumn	Winter	Spring	Total
Song Sparrow	275	397	20	312	1004
Herring Gull	323	35	8	111	477
Yellow-rumped Warbler	18	338	13	46	415
American Goldfinch	171	79	1	105	356
Black-capped Chickadee	63	199	26	41	329
American Crow	31	66	36	91	224
American Robin	27	42	46	95	210
Common Yellowthroat	72	87		26	185
Common Redpoll		177	4		181
Savannah Sparrow	33	117		12	162
Yellow Warbler	114	13		35	162
White-throated Sparrow	36	86		35	157
Swamp Sparrow	6	138		6	150
Double-crested Cormorant	66	24		42	132
Blue Jay	18	91	5	15	129
Bohemian Waxwing		28	90		118
American Black Duck	5	74	5	25	109
Great Black-backed Gull	48	10	2	12	72
Alder Flycatcher	67				67
European Starling	13	27	6	17	63
Red-eye Vireo	37	25			62
Magnolia Warbler	36	14		10	60
Bank Swallow	35			15	50
Common Raven	16	14	4	13	47
Common Grackle	8			37	45

Table 4: Use of the area within 50 m at the turbine points versus the control points for all species with more than 50 individuals recorded at Lingan, NS wind facility, June 2008 through May 2009. The number of individuals of each species recorded within 50 m of the point as a proportion of the total of all individuals recorded within 100 m is calculated for both turbines and controls. A ratio of turbine proportion to control proportion of 1 indicates similar use at turbines and controls, a ratio of <1.0 indicates less use of the area within 50 m of turbines compared to within 50 m of control points.

	Turbines			Controls			Turbine: Control
	<50 m	50-100m	Proportion	<50 m	50-100m	Proportion	
Song Sparrow	277	358	0.44	201	168	0.54	0.80
Yellow-rumped Warbler	61	131	0.32	163	60	0.73	0.43
American Goldfinch	46	94	0.33	94	122	0.44	0.76
Black-capped Chickadee	50	110	0.31	114	55	0.67	0.46
American Crow	51	63	0.45	42	68	0.38	1.17
American Robin	24	50	0.32	42	94	0.31	1.05
Common Yellowthroat	33	45	0.42	76	31	0.71	0.60
Common Redpoll		5	0.00	175	1	0.99	0.00
Savannah Sparrow	63	55	0.53	24	20	0.55	0.98
White-throated Sparrow	21	59	0.26	57	20	0.74	0.35
Swamp Sparrow	33	40	0.45	65	12	0.84	0.54
Blue Jay	19	52	0.27	31	27	0.53	0.50
Bohemian Waxwing		105	0.00	8	5	0.62	0.00
Yellow Warbler	32	39	0.45	55	36	0.60	0.75
Alder Flycatcher	8	27	0.23	11	21	0.34	0.66
Red-eye Vireo	6	15	0.29	25	18	0.58	0.49
European Starling	9	25	0.26	15	14	0.52	0.51
Magnolia Warbler	8	17	0.32	22	13	0.63	0.51
Bank Swallow	15	35	0.30			N/A	

Table 5: The 25 most frequent species in Summer on the 13 point count surveys from June through August 2008 at the Lingan, NS wind energy facility. The number is the average per point, turbine or control, over the 13 surveys. Therefore the numbers for each species are comparable between turbines and controls. They are not comparable across seasons because of differing numbers of surveys.

	Turbines		Controls	
	<50 m	50-100 m	<50 m	50-100 m
Herring Gull	5.6	24.1	6.4	16.6
Song Sparrow	12.6	13.1	11.2	7.8
American Goldfinch	5.4	6.9	7.8	9.2
Yellow Warbler	4.0	3.4	7.8	4.6
Common Yellowthroat	2.1	2.3	6.0	2.2
Alder Flycatcher	1.1	3.9	2.2	4.2
Double-crested Cormorant	1.1	4.1	2.8	3.0
Black-capped Chickadee	2.7	2.0	3.4	2.6
Great Black-backed Gull	0.4	5.6	0.4	0.8
Red-eye Vireo	0.3	1.3	2.6	2.6
White-throated Sparrow	1.1	2.4	1.0	1.2
Magnolia Warbler	0.9	1.0	2.6	2.0
Bank Swallow	2.1	2.9		
Savannah Sparrow	1.9	0.9	2.0	0.8
American Crow	1.1	1.4	0.8	1.8
American Robin	1.1	1.1	0.6	1.6
Yellow-rumped Warbler	0.6	1.1	0.8	0.4
Blue Jay		1.4	1.4	0.2
Common Raven	1.1	0.9		0.4
Whimbrel		1.1	1.2	0.2
European Starling	0.9	0.6	0.4	0.2
Northern Harrier	0.1	0.7	0.4	0.8
American Redstart	0.3	0.3	0.6	0.4
Common Grackle			0.2	1.4
Swamp Sparrow		0.1	0.4	0.6

Table 6: The 25 most frequent species in Autumn on the 20 point count surveys from September through November 2008 at the Lingan, NS wind energy facility. The number is the average per point, turbine or control, over the 20 surveys. Therefore the numbers for each species are comparable between turbines and controls. They are not comparable across seasons because of differing numbers of surveys.

	Turbines		Controls	
	<50 m	50-100 m	<50 m	50-100 m
Song Sparrow	17.0	21.9	16.0	9.0
Yellow-rumped Warbler	6.4	15.3	27.6	9.6
Black-capped Chickadee	3.7	10.7	14.0	5.6
Common Redpoll		0.7	34.4	
Swamp Sparrow	4.7	5.6	12.4	0.8
Savannah Sparrow	6.6	6.4	2.2	3.0
Blue Jay	2.6	4.7	3.8	4.2
Common Yellowthroat	2.1	2.4	8.4	2.6
White-throated Sparrow	1.7	4.1	7.0	2.0
American Goldfinch		2.0	7.4	5.6
American Black Duck		1.6	5.8	6.8
American Crow	0.7	1.9	4.2	5.4
American Robin	1.3	1.0	1.0	4.2
Herring Gull	1.0	1.9	0.8	2.2
Bohemian Waxwing		4.0		
European Starling		0.7	2.6	1.8
Northern Flicker	0.6	1.1	1.0	1.6
Red-eye Vireo	0.6	0.9	2.4	0.6
White-winged Crossbill			4.8	0.2
Double-crested Cormorant		1.3	1.0	2.0
Dark-eyed Junco	2.1	0.7	0.6	
Cedar Waxwing		1.3	1.6	0.8
Blackpoll Warbler		1.0	2.8	
Lincoln's Sparrow	0.7	0.7	1.0	
Common Raven	0.3	1.0		1.0
Magnolia Warbler	0.3	1.1	0.6	0.2

Table 7: The 22 species in Winter on point count surveys (n=4) from December 2008 through March 2009 at the Lingan, NS wind energy facility. The number is the average per point, turbine or control, over the 13 surveys. Therefore the numbers for each species are comparable between turbines and controls. They are not comparable across seasons because of differing numbers of surveys.

	Turbines		Controls	
	<50 m	50-100 m	<50 m	50-100 m
Bohemian Waxwing		11.0	1.6	1.0
American Robin		0.3	1.2	7.6
American Crow	1.9	0.9	1.4	2.0
Iceland Gull		1.0		4.2
Black-capped Chickadee		1.0	2.0	1.8
Song Sparrow	0.7	0.7	0.8	1.2
Yellow-rumped Warbler		1.0	0.6	0.6
Herring Gull		1.0	0.2	
Northern Flicker	0.1		0.4	0.6
European Starling		0.3		0.8
American Black Duck				1.0
Blue Jay				1.0
Common Redpoll			0.6	0.2
Common Raven	0.1	0.1		0.4
Northern Harrier			0.2	0.2
Rock Pigeon				0.4
Red-tailed Hawk				0.4
Great Black-backed Gull		0.3		
American Goldfinch				0.2
Boreal Chickadee			0.2	
Northern Goshawk			0.2	
American Tree Sparrow	0.1			

Table 8: The 25 most frequent species in Spring on the 13 point count surveys from April and May 2009 at the Lingan, NS wind energy facility. The number is the average per point, turbine or control, over the 13 surveys. Therefore the numbers for each species are comparable between turbines and controls. They are not comparable across seasons because of differing numbers of surveys.

	Turbines		Controls	
	<50 m	50-100 m	<50 m	50-100 m
Song Sparrow	9.3	15.4	12.2	15.6
Herring Gull	3.3	7.9	2.8	3.8
American Goldfinch	1.1	4.6	3.6	9.4
American Robin	1.0	4.7	5.6	5.4
American Crow	3.6	4.9	2.0	4.4
Yellow-rumped Warbler	1.7	1.3	3.6	1.4
Double-crested Cormorant	1.0	4.0	0.8	0.6
Black-capped Chickadee	0.7	2.0	3.4	1.0
Common Grackle	0.0	0.7	2.0	4.4
White-throated Sparrow	0.1	1.9	3.4	0.8
Yellow Warbler	0.4	1.3	2.2	2.4
Common Yellowthroat	0.4	1.7	0.8	1.4
American Black Duck	0.1	0.3	1.2	3.2
European Starling	0.4	2.0		
Blue Jay	0.1	1.3	1.0	
Bank Swallow		2.1		
Common Raven	0.3	0.7	0.8	0.4
Purple Finch		0.7	1.0	0.6
Savannah Sparrow	0.6	0.6	0.6	0.2
Great Black-backed Gull		1.0	0.2	0.8
Magnolia Warbler		0.3	1.2	0.4
Northern Flicker	0.1	0.3	0.4	0.6
Great Cormorant		1.0		
Merlin		0.6	0.4	0.2
Swamp Sparrow			0.2	1.0
Northern Harrier		0.4	0.6	

Table 9: Bird remains found under the turbines, in the 50 m radius search areas under the 7 wind turbines (5.5 ha) at Lingan, NS during 50 carcass searches from June 2008 through May 2009. * indicates a carcass that was not followed for at least 2 weeks, because it was either moved to another location, was still *in situ* at the beginning of winter or was removed at the end of the project. Since these were not on site for more than 2 weeks they are not used in calculations of persistence.

	Confidence in Identity	Date	Turbine	UTM	Condition	Vegetation, distance to turbine	# days
Summer							
American Crow	High	5-Jul-2008	T4	0728310 5125558	Black wing	Edge spruce woods, +25 metres	58
European Starling	High	18-Jul-2008	T1	0728979 5125067	Intact, hatch year	Grass, +5 metres	45
Herring Gull	High	1-Sep-2008	T3	0728863 5125290	Mostly intact, hatch year bird	Sparse grass, +40 metres	
Autumn							
Ruby-crowned Kinglet	High	25-Sep-08	T3	0728638 5125338	Intact	Grass, 30 m dense spruce, 40 m	26
Leach's Storm-petrel	High	7-Oct-08	T1	0729051 5125230	Wing Intact		69
Ruby-crowned Kinglet	High	11-Oct-08	T2	0728820 5125248	except for tail	Grass, 25 m	10
Winter							
Iceland Gull	high	19-Feb-09	T1	0729000 5125306	only feathers	snow and gravel	
Spring							
American Robin	high	4-May-09	T6	0727560 5125793 0727584	wings	edge spruce woods	25*
Black Guillemot	high	4-May-09	T6	5125837 0728651	wings	low grass	25*
American Robin	high	6-May-09	T3	5125394 0728650	wing a few body	open gravel grass and	3
Yellow-rumped Warbler	moderate	24-May-09	T3	5125346	feathers	gravel	5*

Table 10: Bird remains found in the 2 ha control area between the 7 turbines and the control points at the Lingan, NS wind facility during 50 carcass searches from June 2008 through May 2009. * indicates a carcass that was not followed for at least 2 weeks, because it was either moved to another location, was still *in situ* at the beginning of winter or was removed at the end of the project. Since these were not on site for more than 2 weeks they are not used in calculations of persistence.

	Confidence in Identity	Date	Place	UTM	Condition	Vegetation distance to turbine	#days
Summer							
Black Guillemot	High	21-Jun-08	T3 and T4	0728562 5125511	Fresh wing, feathers	Open heath, edge of cliff, >200m	5
Autumn							
American Robin	High	4-Sep-08	Path to C- 4	0728568 5125268	Head, feathers Tail, separately	Path through spruce, >200 m	52
Blackpoll Warbler	High	13-Sep-08	T2 and T3 on road	0728763 5125278	foot and thigh	Low grass and gravel, ±120 m In shrubs	2
Swamp Sparrow	High	21-Sep-08	Path to C5	0727627 5125851	Wings, tail, feathers Scattered	along crude path, >65 m Open heath	6
Herring Gull	High	15-Nov-08	T3 and T4	0728568 5125504	pieces, feathers	at top of cliff, >200 m	30
Winter							
American Robin	high	24-Jan-09	Path to C5	0727627 5125851	only feathers	on wet path, 70 m	
Hairy Woodpecker	moderate	21-Mar-09	T2 and T3	0718761 5125276	wings, pelvic girdle	on road, 75 m	
Spring							
Scoter sp.	moderate	17-May-09	T5 and T6	0727875 5125701	breast feathers	on road, 120 m	

Table 11: The ‘planted’ carcasses, location, degree of difficulty, success at finding and persistence of the 74 carcasses at the Lingan, NS wind facility from June 2008 through May 2009. * indicates a carcass that was not followed for at least 2 weeks, because it was either moved to another location, was still *in situ* at the beginning of winter or was removed at the end of the project. They are not used in calculations of persistence.

Species	Date	Turbine	Easting	Northing	Found	Difficulty	Description	Last seen	# days
Northern Harrier	4-Jul-08	T5	728056	5125698	No	Challenge	Hidden under dense shrubbery	1-Sep-08	59
Hairy Woodpecker	4-Jul-08	T7	727274	5125739	Yes	Easy	At edge of shrubbery	18-Jul-08	14
Sharp-shinned Hawk	4-Jul-08	T6	727624	5125796	Yes	Easy	Grass in cleared area	1-Sep-08	59
Sharp-shinned Hawk	4-Jul-08	T6	727600	5125753	No	Moderate	In dense grass	8-Jul-08	4
Chestnut-sided Warbler	4-Jul-08	T4	728317	5125559	Scavenge	Moderate	Coniferous woods		0
Sharp-shinned Hawk	8-Aug-08	T4	728259	5125533	No	Challenge	In woods under brush	1-Sep-08	24
Belted Kingfisher	8-Aug-08	T3	728826	5125292	No	Challenge	Under dense shrubbery, roses	1-Sep-08	24
Dovekie	8-Aug-08	T1	729048	5125285	No	Challenge	Under dense shrubbery, roses	1-Sep-08	24
Ruffed Grouse	8-Aug-08	T3	728622	5125367	Yes	Challenge	Under coniferous trees	1-Sep-08	24
Barred Owl	8-Aug-08	T4	728262	5125539	Yes	Easy	On slope in the open	1-Sep-08	24
Pine Siskin	8-Aug-08	T7	727274	5125739	Scavenge	Moderate	On rocks at edge of drain		0
Barred Owl	31-Aug-08	T5	728016	5125639	No	Challenge	In coniferous woods	15-Dec-08	106
European Starling	31-Aug-08	T4	728312	5125540	No	Challenge	Under dense coniferous trees	15-Dec-08	106
Alder Flycatcher	31-Aug-08	T4	728310	5125556	Yes	Challenge	Edge of coniferous woods	15-Dec-08	106
Ruffed Grouse	31-Aug-08	T2 to T1	728863	5125289	Yes	Easy	On side of road	1-Sep-08	1
Red-tailed Hawk	31-Aug-08	T7	727336	5125748	No	Moderate	Dense grass, beside coiled cable	15-Dec-08	106
Dark-eyed Junco	31-Aug-08	T4	728298	5125537	No	Moderate	Rock on the slope	15-Dec-08	106
Least Flycatcher	31-Aug-08	Path to T3	728349	5125585	Yes	Moderate	On path in the heath just past the trees	15-Dec-08	106
Northern Goshawk	31-Aug-08	Path to T3	728367	5125589	Yes	Moderate	On path in the heath	15-Dec-08	106
American Redstart	31-Aug-08	T6	727599	5125794	Yes	Moderate	In open beside roots	15-Dec-08	106
Great Horned Owl	31-Aug-08	T6	727563	5125777	Yes	Moderate	Edge of woods in dense herbaceous vegetation	15-Dec-08	106
Barred Owl	21-Sep-08	T6	727605	5125748	No	Moderate	In alder/poplar woods	15-Dec-08	85
Herring Gull	21-Sep-08	T6	727568	5125774	No	Moderate	In alder/poplar woods	15-Dec-08	85
Barred Owl	21-Sep-08	T6	727566	5125776	Yes	Moderate	In tall grass	15-Dec-08	85
Barred Owl	21-Sep-08	T6	727594	5125752	Yes	Moderate	Tall grass	15-Dec-08	85
Barred Owl	21-Sep-08	T6	727590	5125752	Yes	Moderate	Tall grass	15-Dec-08	85
Rock Pigeon	8-Nov-08	T4	727600	5125753	No	Easy	Gravel near edge of grass	12-Nov-08	4
Northern Flicker	8-Nov-08	T5	727624	5125796	Yes	Easy	Grass in cleared area	15-Dec-08	37
Northern Saw-whet Owl	8-Nov-08	Path to T3	727274	5125739	Yes	Moderate	At edge of shrubbery	30-Nov-08	22
Barred Owl	29-Nov-08	T4	728253	5125540	No	Challenge	Dense shrubs in poplar woods	30-Nov-08	1
American Crow	29-Nov-08	T5	728018	5125640	Yes	Challenge	In coniferous woods	15-Dec-08	17
Ruffed Grouse	29-Nov-08	T2	728781	5125289	Yes	Challenge	Under dense shrubbery, roses	30-Nov-08	1
American Crow	29-Nov-08	Path to T3	728555	5125505	Yes	Easy	In open heath, 3 m from path	30-Nov-08	1*
Ruffed Grouse	29-Nov-08	Path to T3	728559	5125505	Yes	Easy	In open heath, 3 m from path	30-Nov-08	1*
Northern Gannet	29-Nov-08	T6	727597	5125829	Yes	Easy	In short grass and gravel	14-Dec-08	16*
Whimbrel	29-Nov-08	T4	728274	5125578	Yes	Easy	On gravel	30-Nov-08	1
Great Black-backed Gull	29-Nov-08	T3	728617	5125413	No	Moderate	Amongst dead branches of brush pile	15-Dec-08	17
Common Eider	29-Nov-08	T6	727595	5125820	Yes	Moderate	In tall grass	14-Dec-08	16*
Common Eider	29-Nov-08	T6	727595	5125818	Yes	Moderate	In tall grass	14-Dec-08	16*
Common Eider	29-Nov-08	T5	728047	5125693	Yes	Moderate	Edge of alders and tall grass	30-Nov-08	1

Species	Date	Turbine	Easting	Northing	Found	Difficulty	Description	Last seen	# days
Common Eider	29-Nov-08	T5	728047	5125691	Yes	Moderate	Edge of alders and tall grass	14-Dec-08	16*
Barred Owl	15-Dec-08	T3	728266	5125528	No	Challenge	Under dense shrubbery, Spirea, young poplars		
Common Eider	15-Dec-08	T5	728029	5125637	Yes	Challenge	In coniferous woods		
Common Eider	15-Dec-08	T6	727624	5125807	Yes	Easy	In tall grass		
Common Eider	15-Dec-08	T6	727560	5125793	Yes	Moderate	In coniferous woods		
Northern Gannet	15-Dec-08	T6	727593	5125753	Yes	Moderate	In poplar woods		
Ruffed Grouse	21-Mar-09	T7	727280	5125725	No	Challenge	In poplar woods		
Dovekie	21-Mar-09	T5	728026	5125698	Yes	Easy	Grass		
Herring Gull	21-Mar-09	T4	728283	5125575	Yes	Easy	Grass		
Bohemian Waxwing	21-Mar-09	T7	727312	5125752	Yes	Moderate	Grass		
Great Black-backed Gull	21-Mar-09	T7	727261	5125781	Yes	Moderate	Edge of coniferous woods		
Great Black-backed Gull	21-Mar-09	T5	728015	5125659	Yes	Moderate	In coniferous woods		
American Robin	6-May-09	T4	728307	5125572	No	Challenge	under dense spruce	11-May-09	5
Yellow-billed Cuckoo	6-May-09	T4 and T3	728363	5125586	Yes	Challenge	in shrubbery	9-May-09	3
Chestnut-sided Warbler	6-May-09	T4	728317	5125571	Yes	Challenge	under dense spruce	29-May-09	23*
Sharp-shinned Hawk	6-May-09	T5 and T4	728124	5125614	No	Easy	on roadside gravel	6-May-09	1
Mourning Warbler	6-May-09	T6	727569	5125804	No	Easy	on dark gravel	29-May-09	23*
Whimbrel	6-May-09	T3	728694	5125368	No	Easy	on gravel	6-May-09	1
Dovekie	6-May-09	T3 and T2	728694	5125314	Yes	Easy	on roadside gravel in short grass and gravel	6-May-09	1
Purple Finch	6-May-09	T6	727584	5125817	Yes	Easy	gravel	29-May-09	23*
Ring-billed Gull	6-May-09	T7	727274	5125779	Yes	Moderate	in poplar grove	29-May-09	23*
Blue Jay	6-May-09	T3	728644	5125401	Yes	Moderate	in small dead spruce	6-May-09	1
American Robin	24-May-09	T5 and T4	728124	5125614	scavenge	Easy	edge of road		0
Yellow-bellied Flycatcher	27-May-09	T5	727954	5125772	No	Challenging	in mixed woods	29-May-09	2*
Ruffed Grouse	27-May-09	T6 and T5	727847	5125705	Yes	Easy	on roadside gravel	29-May-09	2*
Wilson's Snipe	27-May-09	T6	727597	5125790	Yes	Easy	gravel	29-May-09	2*
Dark-eyed Junco	27-May-09	T5	728015	5125680	Yes	Easy	gravel amidst dead spruce branches	29-May-09	2*
Brown Creeper	27-May-09	T4	728252	5125573	No	Moderate	branches	29-May-09	2*
Yellow-rumped Warbler	27-May-09	T7	727278	5125747	Yes	Moderate	amid rocks in shrubs edge of ditch	29-May-09	2*
American Goldfinch	27-May-09	T6	727570	5125780	Yes	Moderate	ditch	29-May-09	2*
Ring-necked Pheasant	27-May-09	T5	727986	5125661	Yes	Moderate	dense spruce woods	29-May-09	2*
Black-capped Chickadee	27-May-09	T4	728214	5125580	Yes	Moderate	grass near road	29-May-09	2*
American Robin	27-May-09	T3	728701	5125385	Yes	Moderate	edge of muddy puddle	29-May-09	2*
Wilson's Warbler	27-May-09	T7	727291	5125745	scavenge	Easy	open gravel		0

Appendix A: Dates of the 50 surveys, point count and carcass searches, at the Lingan, NS wind facility, June 2008 through May 2009.

	Counts	Start Point	Start Time	Two days	Search
Summer	04-Jun-08	C1	5:30		07-Jun-08
	10-Jun-09	T7	6:08		14-Jun-08
	17-Jun-08	C1	5:52		21-Jun-08
	26-Jun-09	T7	5:59		29-Jun-08
	05-Jul-09	C1	5:11		05-Jul-08
	10-Jul-08	T7	6:12		13-Jul-08
	19-Jul-08	C1	5:22		18-Jul-08
	28-Jul-08	T7	6:37		26-Jul-08
	03-Aug-08	C1	5:57		02-Aug-08
	07-Aug-08	T7	6:28	yes	09-Aug-08
	12-Aug-08	T7	7:34	yes	16-Aug-08
	16-Aug-08	C1	6:45		23-Aug-08
	30-Aug-08	C1	6:38		01-Sep-08
Autumn	04-Sep-08	T7	7:54	yes	06-Sep-08
	06-Sep-08	C1	6:58	yes	09-Sep-08
	13-Sep-08	C1	6:46		13-Sep-08
	14-Sep-08	T7	7:30	yes	16-Sep-08
	18-Sep-08	C1	7:01	yes	21-Sep-08
	21-Sep-08	T7	7:17		25-Sep-08
	26-Sep-08	C1	7:05		27-Sep-08
	27-Sep-08	T7	7:13		30-Sep-08
	30-Sep-08	C1	7:01		05-Oct-08
	04-Oct-08	T7	8:49	yes	07-Oct-08
	07-Oct-08	C1	7:13	yes	11-Oct-08
	10-Oct-08	T7	7:39	yes	14-Oct-08
	13-Oct-08	C1	7:37		18-Oct-08
	17-Oct-08	C1	7:37	yes	21-Oct-08
	26-Oct-08	T7	9:55	yes	25-Oct-08
	31-Oct-08	T7	8:10	yes	28-Oct-08
	02-Nov-08	C1	8:10		02-Nov-08
	08-Nov-08	T7	8:35		08-Nov-08
23-Nov-08	C1	7:50		15-Nov-08	
30-Nov-08	T7	8:15		30-Nov-08	
Winter	14-Dec-08	C1	8:34	yes	15-Dec-08
	24-Jan-09	T7	9:36		03-Jan-09
	22-Feb-09	C1	8:45		19-Feb-09
	29-Mar-09	C1	7:23		21-Mar-09
Spring	21-Apr-09	C1	7:23		21-Apr-09
	24-Apr-09	T7	6:17		25-Apr-09
	25-Apr-09	C1	6:10		28-Apr-09
	02-May-09	T7	6:10	yes	04-May-09
	03-May-09	C1	5:54		06-May-09
	05-May-09	T7	6:00		09-May-09
	14-May-09	C1	5:21		11-May-09
	16-May-09	T7	5:25		15-May-09
	18-May-09	C1	5:36		17-May-09
	21-May-09	T7	5:31		22-May-09
	23-May-09	C1	5:33		24-May-09
	24-May-09	T7	5:24		27-May-09
28-May-09	C1	5:35	yes	29-May-09	

Appendix B: Numbers of all species of birds (n=87) during 50 point count surveys from June 2008 through May 2009 at the Lingan, NS wind facility. The numbers are those recorded within 100 m of the turbine or control point. Those species recorded only beyond 100 m from a point are indicated with *.

	Summer		Autumn		Winter		Spring		Grand Total
	Turbine	Control	Turbine	Control	Turbine	Control	Turbine	Control	
Alder Flycatcher	35	32							67
American Bittern									*
American Black Duck	2	3	11	63		5	3	22	109
American Crow	18	13	18	48	19	17	59	32	224
American Goldfinch	86	85	14	65		1	40	65	356
American Pipit									*
American Redstart	4	5	3	3				1	16
American Robin	16	11	16	26	2	44	40	55	210
American Tree Sparrow				2	1				3
Bald Eagle			2						2
Baltimore Oriole			3	2					5
Bank Swallow	35						15		50
Bay-breasted Warbler			1						1
Belted Kingfisher							3		3
Black Guillemot	2								2
Black-and-White Warbler		2		1					3
Black-bellied Plover				3					3
Black-capped Chickadee	33	30	101	98	7	19	19	22	329
Black-throated Green Warbler			4	1					5
Blackpoll Warbler			7	14					21
Blue Jay	10	8	51	40		5	10	5	129
Blue-gray Gnatcatcher				1					1
Blue-headed Vireo							2	2	4
Blue-winged Warbler				1					1
Bohemian Waxwing			28		77	13			118
Boreal Chickadee			2			1			3
Cedar Waxwing	2		9	12					23
Common Grackle		8					5	32	45
Common Loon									*
Common Raven	14	2	9	5	2	2	7	6	47
Common Redpoll			5	172		4			181
Common Tern									*
Common Yellowthroat	31	41	32	55			15	11	185
Dark-eyed Junco			20	3				1	24
Double-crested Cormorant	37	29	9	15			35	7	132
Downy Woodpecker			3	7				1	11
Empidonax sp.			1						1
European Starling	10	3	5	22	2	4	17		63
Glaucous Gull							1		1
Golden-crowned Kinglet				4					4

	Summer		Autumn		Winter		Spring		Grand Total
	Turbine	Control	Turbine	Control	Turbine	Control	Turbine	Control	
Gray Catbird	1	2	1				1	1	6
Great Black-backed Gull	42	6	5	5	2		7	5	72
Great Blue Heron	1						3		4
Great Cormorant	1	4	2	1			7		15
Greater Yellowlegs				2					2
Hairy Woodpecker		5	1	1					7
Herring Gull	208	115	20	15	7	1	78	33	477
Iceland Gull	1			1	7	21	2	1	33
Lincoln's Sparrow			10	5					15
Magnolia Warbler	13	23	10	4			2	8	60
Mallard				3			2		5
Merlin		2	3	1			4	3	13
Nashville Warbler			2						2
Northern Flicker	1	3	12	13	1	5	3	5	43
Northern Harrier	6	6		4		2	3	3	24
Northern Parula			1	2					3
Northern Waterthrush				1					1
Ovenbird							1	1	2
Palm Warbler			7	5					12
Philadelphia Vireo				2					2
Pine Siskin				5					5
Prairie Warbler			1						1
Purple Finch				5			5	8	18
Red-breasted Nuthatch		3							3
Red-eye Vireo	11	26	10	15					62
Red-tailed Hawk						2		1	3
Rock Pigeon				3		2		1	6
Ruby-crowned Kinglet			6	5			1	4	16
Ruby-throated Hummingb	2								2
Ruffed Grouse				1					1
Savannah Sparrow	19	14	91	26			8	4	162
Semipalmated Plover		1		4					5
Sharp-shinned Hawk		1							1
Song Sparrow	180	95	272	125	10	10	173	139	1004
Swamp Sparrow	1	5	72	66				6	150
Whimbrel	8	7	3						18
White-crowned Sparrow				1					1
White-rumped Sandpiper				1					1
White-throated Sparrow	25	11	41	45			14	21	157
White-winged Crossbill				25					25
Wilson's Snipe				2					2
Wilson's Warbler		3							3
Yellow-breasted Chat				2					2
Yellow Warbler	52	62	7	6			12	23	162
Yellow-rumped Warbler	12	6	152	186	7	6	21	25	471
									5399