FINAL AVIAN RISK ASSESSMENT

Project Icebreaker in Lake Erie

Cuyahoga County, Ohio

Report Prepared for:

Lake Erie Energy Development Corporation (LEEDCo)

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Executive Summary

This report reexamines and updates potential risk to birds from the six-turbine Project Icebreaker, a demonstration wind-energy project proposed for the waters 11-16 kilometers (km) (7-10 miles) off of Cleveland, Ohio. Turbines would have an 87.5-meter (m) (287-foot) tubular steel tower on which a rotor of 120 m (394 feet) in diameter would be mounted. Rotors would sweep from a maximum height of 147.5 m (484 feet) to a minimum height of 27.5 m (90 feet) above the lake, making a rotor swept area of 11,310 m^2. Each turbine would generate a nameplate capacity of 3.0 megawatts (MW). Lighting on turbines has not yet been determined, but this analysis is based on L-864, red-strobe obstruction lights mounted on nacelles, as generally required by the Federal Aviation Administration (FAA) for wind turbines. A docking platform would be constructed at the base of each turbine to allow maintenance crews to access the turbines.

Potential avian risk from a demonstration wind farm in the waters off of Cleveland was considered previously in a document hereafter referred to as the 2008 risk assessment (Guarnaccia and Kerlinger 2008), which depended on research that had been conducted in Europe to date, where many of the same species as occurring in Lake Erie, or closely related species, were studied. The present report examines the 2008 risk assessment in light of recent site-specific studies, both on and offshore, and current project specifications. Those studies included aerial surveys of the offshore waters, boat surveys of the waters where the project would be constructed, a radar study during spring and fall migration periods, and avian acoustic studies. It also examines the collision risk that offshore turbines are likely to pose to Kirtland's Warbler and Piping Plover, two federally endangered species that migrate to some extent over Lake Erie.

Summarized below (Table 1), the 2008 risk assessment categorized impacts to seabirds from offshore wind farms as follows:

- **Habitat Loss:** Displacement due to disturbance by operating turbines and associated ship and helicopter traffic, or habitat alteration by artificial creation of hard-bottom substrate in soft-bottom areas (i.e., turbine foundations, monopoles, and scour protectors).
- **Barrier Effect:** A type of habitat fragmentation caused by avoidance reactions (detours) taken by migrating or locally moving seabirds, which, if flown regularly, would theoretically increase energy expenditure and reduce fitness.
- **Collision Risk:** Additional mortality at turbines resulting from collisions.
- **Population Effect:** The likelihood that habitat loss, barrier effect, and collision risk from Project Icebreaker will have a biologically significant impact on populations of any species..

The principal conclusion of the 2008 risk assessment was that no avian species was likely to suffer a population level impact from the construction and operation of a small, demonstration wind farm in the waters off Cleveland. If anything, such a pilot project is essential for confirming European findings with respect to avian interactions with offshore turbines, thereby helping to ensure responsible development of offshore wind energy on large inland lakes in North America.

Table 1. Summary of the 2008 avian risk assessment (Guarnaccia and Kerlinger 2008)

Species and species groups[a]	Particularly Sensitive[b]	Habitat Loss[c]	Barrier Effect[d]	Collision Risk[e]	Population Effect[f]
Common Merganser	No	Unlikely	Uncertain	Low	No
Red-breasted Merganser	No	Unlikely	No	Low	No
Common Loon	Yes	Probably	Probably	Low	No
Horned Grebe	No	Uncertain	Uncertain	Low	No
Double-crested Cormorant	No	Unlikely	Probably	Low	No
Bonaparte's Gull	No	Uncertain	No	Low	No
Ring-billed Gull	No	Uncertain	No	Low	No
Herring Gull	No	No	No	Moderate	No
Great Black-backed Gull	No	No	No	Moderate	No
Caspian Tern	No	Uncertain	Uncertain	Low	No
Common Tern (Ohio endangered)	Yes	Unlikely	No	Low	No
Songbird migrants (nocturnal)	No	No	No	Low	No
Waterbird migrants (mainly nocturnal)	No	No	Yes	Low	No
Raptor migrants (diurnal)	Yes	No	Yes	Low	No

[a] These are the most likely species to occur at the site; special-status species are indicated in boldface (see Tables 6.0-1 and 6.0-2 in Guarnaccia and Kerlinger 2008).
[b] Particularly Sensitive: Yes for loons and raptors because of European sensitivity indices (see Section 6.0 discussion in Guarnaccia and Kerlinger 2008), and yes for special-status species.
[c] Habitat Loss: See Table 6.1-1 in Guarnaccia and Kerlinger 2008, but habitat loss would be minimal at the Project because of its small size and offshore location.
[d] Barrier Effect: See Table 6.2-1 in Guarnaccia and Kerlinger 2008, but barrier effect would be minimal at the Project because of its small size and distance from the lakeshore, even though the orientation of the turbine string has changed from parallel to the lakeshore to perpendicular.
[e] Collision Risk: See Table 6.3.5-1 in Guarnaccia and Kerlinger 2008; categories are low, moderate, and high.
[f] See Section 6.0 discussion in Guarnaccia and Kerlinger 2008. For the federally endangered Piping Plover and Kirtland's Warbler, see below.

S studies conducted at the Icebreaker project site and surrounding waters since the 2008 risk assessment supported this conclusion. Aerial surveys of the offshore waters conducted by the Ohio Department of Natural Resources, Division of Wildlife (ODNR-DOW), and the U.S. Fish and Wildlife Service (Service) basically confirmed distribution patterns indicated in the literature and in studies covered in the 2008 risk assessment. At 11 km (7 miles) from the lakeshore, where Project Icebreaker would be located, the number of birds recorded per mile had already passed the asymptotic point and had leveled off at minimal values for most bird species. In other words, Project Icebreaker was located far enough from the lakeshore to be beyond where seabirds and other species tended to concentrate.

Boat surveys conducted by Tetra Tech of the waters 2.4-10.4 km (1.5-6.5 miles) offshore found a small number of species and low overall densities, in line both with the ODNR-DOW and Service estimates and with the literature. This further supported the conclusion that, at 11 km (7 miles) from the lakeshore, minimal densities of seabirds and other birds would be expected to occur.

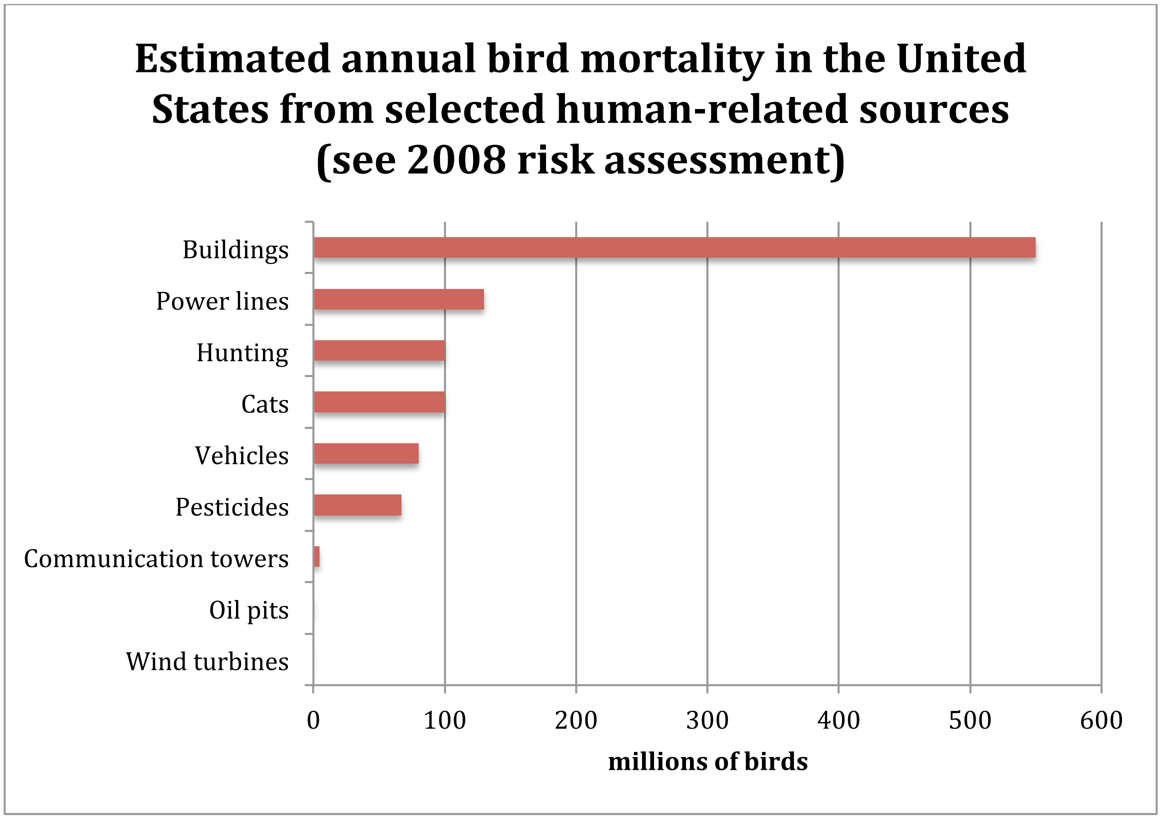
A marine surveillance (MERLIN) radar study conducted by Tetra Tech at the Cleveland Crib and along the lakeshore revealed large numbers of targets, although there is strong indication from the radar data that the large number of targets are, to an unknown degree insects. Also, a comparison of Merlin radar data from nine studies in eastern North America with 82 non-Merlin studies showed statistically greater target passage rates for the Merlin radar. The suggestion of insects in the dataset, explains the great target passage rate and suggests that Merlin radar is more sensitive than other radars making comparison of different radar technologies not possible. The literature on nocturnal bird migration in eastern North America, a site-specific NEXRAD study conducted as part of the 2008 risk assessment, and dozens of radar studies conducted at prospective wind energy facilities in the eastern U.S. support a conclusion that nocturnal migration above the waters off of Cleveland occurs mostly at altitudes above the height of wind turbines at densities similar to other sites studied at similar latitudes. Thus, collision risk to night-migrating songbirds would be minimal and unlikely to result in any population effects.

A model developed by the Service to assess the effects of the construction of 49 publicly owned communication towers (used by the Service) in neighboring Michigan on the federally endangered Kirtland's Warbler was used to evaluate Project Icebreaker. Based on conservatively estimated parameters, the model predicted that, over the 30-year lifespan of Project Icebreaker, the take of Kirtland's Warbler may be estimated at 0.06 Kirtland's Warblers, or 0.002 Kirtland's Warblers per year. This is one Kirtland's Warbler every 500 years at the six turbines, a negligible, non-measurable risk. For Piping Plover, estimated take was five times lower.

In conclusion, additional studies supported the basic conclusion of the 2008 risk assessment: that no population effect is likely in any avian species as a result of habitat loss, barrier effect, or collision mortality associated with the construction and operation of the six turbines proposed (Table 1). Cumulative effects are also not anticipated given the small size of the project and the negligible contribution that wind-energy development makes to human-related bird mortality (see figure below). In the figure below, note that the impacts from all wind turbines in the U.S. are neglible as compared to other human-related sources of mortality. This comparison is relevant for NEPA analyses.

With respect to likely impacts on the federally endangered Piping Plover and Kirtland's Warbler, a U.S. Fish and Wildlife Service model for assessing risk of collision mortality demonstrated no measurable risk for either species.

Given that Project Icebreaker is a pilot project, post-construction studies will provide a valuable opportunity to study bird interactions with offshore turbines, thereby helping to ensure responsible development of offshore wind energy on large inland lakes, and perhaps ocean-based sites, in North America.


Estimated annual bird mortality in the United States from selected human-related sources (see 2008 risk assessment)
Buildings
Power lines
Hunting
Cats
Vehicles
Pesticides
Communication towers
Oil pits
Wind turbines
0
100
200
300
400
500
600
millions of birds

Introduction

The potential for risk to birds from the construction and operation of a demonstration wind farm in the waters off of Cleveland, Ohio, was analyzed in detail by Guarnaccia and Kerlinger (2008). The present report examines that risk assessment (hereafter, the 2008 risk assessment) in light of recent site-specific studies and current project specifications. Those studies included aerial surveys of the offshore waters (Norris and Lott 2011), boat surveys of the waters where the project would be constructed (Tetra Tech 2012), a MERLIN radar study during spring and fall migration periods (Tetra Tech 2012), and avian acoustic studies (Tetra Tech 2012). We also examine the collision risk that offshore turbines are likely to pose to Kirtland's Warbler and Piping Plover, two federally endangered species that migrate to some extent over Lake Erie.

Offshore wind-energy development is still almost entirely a European phenomenon. The world's first offshore wind farm (a project of 11 turbines totaling nearly 5 MW) went on line in 1991 at Vindeby in Denmark. Presently, 96% of the world's 5,600 MW of installed generating capacity in offshore environments is located in ten European countries[1]. This is more than a 400% increase in European generating capacity since the 2008 risk assessment, which relied mainly on the findings of European studies to assess avian risk. In addition, many more offshore projects have been approved or are under consideration in Europe, Asia, and North America (notably, Cape Wind off of Cape Cod, Massachusetts).

The effects of offshore wind farms on birds have been well studied in Europe. As noted in the 2008 risk assessment, applying the findings of European research to Lake Erie poses an interesting challenge, given fundamental differences in the offshore environments (freshwater versus saltwater, large inland lake versus ocean-connected seas) and birdlife (Nearctic versus Palearctic). Nonetheless, many of the key offshore species in the European studies also occur on Lake Erie (e.g., Red-breasted Merganser, Herring Gull, and Common Tern) or have close relatives or ecological equivalents among Great Lakes species (e.g., Great Cormorant for Double-crested Cormorant, Black-headed Gull for Bonaparte's Gull, and Mew Gull for Ring-billed Gull). Thus, research in Europe has much to say about how birds on the Great Lakes are likely to react to offshore turbines.

Changes in project specifications

The 2008 risk assessment considered a project (then called the Great Lakes Wind Energy Center or GLWEC) that would be constructed approximately 4-8 km (2.5-5 miles) from the Cleveland lakefront in 10 m of water. At that time, two to ten turbines were planned, each with nameplate capacity in the range of 2.0-5.0 MW, and a total project capacity not to exceed 20 MW.

The project has been renamed Project Icebreaker. It would construct six turbines approximately 11-16 km (7-10 miles) from the lakeshore (Fig. 1). Turbines would be similar in size to those considered in the 2008 risk assessment. Hub height on tubular towers would be 87.5 m (80-100 m in the 2008 risk assessment) and the rotor diameter would be 120 m (90-126 m in the 2008 risk assessment). Thus, rotors would sweep from a maximum height of 147.5 m above the lake

[1] http://www.lorc.dk/offshore-wind-farms-map/statistics/installed-capacity/countries

surface to a minimum height of 27.5 m above the lake surface. The area swept by each rotor would be 11,310 m^2. Turbines would have a nameplate capacity of about 3.0 megawatts.

Figure 1. Proposed turbine locations

Each turbine would be equipped with aviation obstruction lighting in accordance with Federal Aviation Administration (FAA) guidance, which would likely be red-flashing, L-864 lights on the nacelle[2]. Lights on all turbine nacelles would likely flash synchronously. The new FAA advisory circular, to be issued in the near future, has eliminated steady-burning lights on structures in the height range of the turbines under consideration. This is an important consideration, because Gehring et al. (2011) demonstrated that steady-burning, L-810 lights attracted birds and that, when those lights were extinguished leaving only flashing lights, fatalities of night-migrating songbirds were reduced by 50-70%. Furthermore, Kerlinger et al.

[2] Chapter 13 of the FAA Advisory Circular AC 70/7460-1K, Obstruction Marking and Lighting, applies specifically to the marking and lighting of wind turbines.

(2010) demonstrated that the red, flashing L-864 lights (mostly strobes) on wind turbines do not attract night migrating birds and, therefore, are not a problem, because they do not result in elevated fatality rates.

A docking platform at the base of each turbine would provide access by boat for maintenance. We do not know if the U.S. Coast Guard will require navigation lighting on the turbines or other infrastructure. The Bureau of Offshore Energy Management (BOEM) is presently developing best practices for lighting at offshore wind plants. John Guarnaccia and Paul Kerlinger of Curry & Kerlinger, LLC, the authors of the BOEM report, conducted the literature search and lighting analyses that informed the section on best avian safety practices. Those practices should be evaluated for adoption for Project Icebreaker.

Summary of findings of the 2008 risk assessment

The 2008 risk assessment (Guarnaccia and Kerlinger 2008) analyzed published literature and Internet-accessible databases to profile the birdlife expected to occur in the waters off of Cleveland during the breeding, spring and fall migration, and wintering seasons. Nocturnal migration, however, was given special attention through a separate study commissioned for that report. That study (Livingston 2008) examined the most recent five years (2003-2008) of archived data from the nearby KCLE weather surveillance radar (WSR-88D, also known as "NEXRAD" [Next Generation Radar]). The 2008 risk assessment then summarized the European literature on avian interactions with offshore wind-energy development, adding appropriate research findings from onshore projects. By relating the local avian profile with the literature findings on avian effects, the avian risk assessment and recommendations for minimizing avian impacts were developed.

Summarized below (Table 1), the 2008 risk assessment depended on a comprehensive literature review that Dierschke and Garthe (2006) had conducted for the German Environment Ministry. Following the pre- and post-construction studies then available, they categorized impacts to seabirds from offshore wind farms as follows:

- **Habitat Loss:** Displacement due to disturbance by operating turbines and associated ship and helicopter traffic, or habitat alteration by artificial creation of hard-bottom substrate in soft-bottom areas (i.e., turbine foundations, monopoles, and scour protectors).
- **Barrier Effect:** A type of habitat fragmentation caused by avoidance reactions (detours) taken by migrating or locally moving seabirds, which, if flown regularly, would theoretically increase energy expenditure and reduce fitness.
- **Additional Mortality:** Collisions with turbines.

Reviews and studies since (e.g., Allison et al. 2008, Vanermen and Stienen 2009, Boehlert and Gill 2010, Langston 2010, Masden et al. 2010, Wilson et al. 2010, Burger et al. 2011, Schwemmer et al. 2011, Furness and Wade 2012, Petersen et al. 2012, Furness et al. 2013) have followed this framework for assessing avian risk, which underlines its practicality for analyzing avian risk at offshore wind farms.

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[e] Collision Risk: See Table 6.3.5-1 in Guarnaccia and Kerlinger 2008; categories are low, moderate, and high.
[f] See Section 6.0 discussion in Guarnaccia and Kerlinger 2008. For the federally endangered Piping Plover and Kirtland's Warbler, see below.

Specific references for the European and other findings below may be found in the 2008 risk assessment. Please refer to that document for more information.

Habitat loss

Based on the results of European studies for the same species and homologues (i.e., species that fill the same ecological niche/ecological equivalents, for example, Bonaparte's Gull may be considered the North American homologue of Black-headed Gull), the 2008 risk assessment found that habitat loss in the waters off Cleveland was only questionably indicated for Common Loon, but it was not indicated or is uncertain in other species likely to occur at the site (including Red-breasted Merganser, Double-crested Cormorant, Bonaparte's Gull, Ring-billed Gull, and the Ohio-endangered Common Tern). Two common gulls (Herring and Great Black-backed) were found to increase in numbers at offshore wind farms; the wind farms and activities at them (particularly increased boat traffic) had an apparent effect of increasing habitat for some gulls. Nonetheless, boat and helicopter traffic to service the wind farm may cause temporary habitat loss in some species (e.g., Red-breasted Merganser). The fact that the amount of habitat that potentially could be lost as a result of Project Icebreaker is such a small percentage of the available habitat in Lake Erie, and because it is so far offshore where bird abundance is low, biologically significant impacts to these species are highly unlikely, and no population effects are anticipated.

Barrier effect

The 2008 risk assessment concluded that barrier effect in the waters off Cleveland was not indicated for Red-breasted Merganser, gulls, and the Ohio-endangered Common Tern, which were found to commonly fly through European wind farms. It may be indicated for Common Loon, because strong avoidance was recorded for Red-throated and Arctic Loons. Double-crested Cormorant may detour around the Project's turbines, because its congener, the Great Cormorant, was recorded doing so in Europe.

It is highly unlikely that the Project Icebreaker will pose a significant barrier to bird migration or local flight paths at 11 km (7 miles) offshore in Lake Erie. Arrayed in a string perpendicular to prevailing bird movements, Project Icebreaker will stretch approximately 4.8 km (3 miles). Findings from European studies indicate that migrating waterfowl that would approach Project Icebreaker would make course adjustments many kilometers before they reach the turbines both day and night. Such course changes would add perhaps a few kilometers to their migration, resulting in a minimal additional expenditure of energy. For most species, this would increase their entire migration distance by perhaps 0.08% (assuming a 2,400-km migration and a 2-km detour). This increase would not result in a significant increase in migration time, distance, or energy expended. In any event, waterfowl are accustomed to flying longer distances than the straight-line distance between migration stops because of weather and existing topography.

Regarding local bird movements, Project Icebreaker is unlikely to be situated between a feeding and a roosting area because of the distance offshore. The closest feeding and roosting area is inshore, at the Cleveland Lakefront Important Bird Area (IBA). This IBA is judged to extend about 1.6 km (1 mile) into the lake. Project Icebreaker would not be situated closer than 11 km (7 miles) from the lakefront. Therefore, any birds flying from the east or west to feed or roost in the IBA would not likely intersect the wind farm. Instead, their flight paths would take them well inshore of the turbines.

Collision mortality

The 2008 risk assessment found that post-construction studies at onshore wind farms in the U.S. have demonstrated that collision mortality is relatively infrequent. In a recent review (National Research Council 2007), mortality estimates were similar among projects, averaging 2.51 birds per turbine per year and 3.19 birds per MW per year. Rates have been slightly higher in eastern North America than in western North America, presumably because of denser nocturnal migration of songbirds in the east. No federally listed endangered or threatened species of birds have been recorded in any of the studies undertaken, and relatively few raptor, waterfowl, or shorebird fatalities have been documented in eastern North America. In general, the documented level of fatalities has not been large in comparison with the source populations, nor have the fatalities been suggestive of biologically significant impacts to any species.

Except for seabirds, the following conclusions should hold for Project Icebreaker. Fatality numbers and species impacted at the offshore site are likely to be similar, on a per turbine per year basis, to those found at projects that have been studied in eastern North America (Table 2). These fatalities, when distributed among many species, are not likely to be biologically significant. When compared with the Altamont Pass Wind Resource Area, where raptor mortality has been particularly noteworthy (but not biologically significant), the sum of collision risk factors for raptors is minimal or nil, mostly because few raptors will be found over the Lake. Collision risk to day-migrating, nesting, and wintering songbirds is likely to be negligible, because few to none will be present at the site. Collisions of night-migrating songbirds are likely to be similar to other sites examined, because the altitude of migration is generally above the sweep of the wind turbine rotors. Nonetheless, the greater height of turbines (145 m above the lake surface) relative to the height of onshore turbines studied (Table 2) suggests that a slightly greater fatality rate among night migrants is possible. Nonetheless, given that Project Icebreaker will consist of six turbines, even if fatality rates are slightly elevated, there is a low probability that such rates would result in a biologically significant impact.

Regarding seabirds, a review of bird mortality at coastal wind farms in Europe (i.e., wind farms constructed either on the immediate coast or offshore in very close proximity to the coastline) has demonstrated that all groups of seabirds occurring on the Great Lakes are potentially vulnerable to turbine collisions offshore. But, collision frequency at those coastal wind farms was directly related to abundance and propensity to fly at rotor height, with common species of gulls (particularly Herring Gull) recorded most frequently. It should be noted that many of these coastal wind farms were located adjacent to nesting colonies and on flight routes between nesting sites and foraging areas.

Given that Project Icebreaker will be constructed more than 11 km (7 miles) offshore, bird abundance will be considerably less than along the Cleveland lakefront. The only common colonial nester in Cleveland is Ring-billed Gull, which nests on large rooftops, but Project Icebreaker would not be located between its nesting sites and prime foraging areas, which are primarily very close to shore or onshore.

In Europe, where wind farms have been constructed on heavily used waterfowl migration routes, low flying flocks usually detour around the turbines. The small number of flocks that fly through the wind farms between turbines, including at night, generally do so beneath the rotor-swept area. These and other behavioral adjustments are the reasons why collision risk among these species has been minimal.

The Project Icebreaker site does not appear to be on a heavily used migration path for waterfowl or seabirds. Large numbers of Red-breasted Merganser and Bonaparte's Gulls stage on Lake Erie in fall migration, but they are more likely to fly inshore of Project Icebreaker to roost or forage in the Cleveland Lakefront IBA where there is more food. Should migratory or local movements take seabirds in the vicinity of Project Icebreaker, it is expected that birds would detour around the turbines, or cross the wind farm below the rotor-swept zone. Therefore, collision risk to seabirds is judged to be low, and it is highly unlikely to rise to the level of biological significance.

Confirming these predictions at Project Icebreaker site will be problematic, because carcass searches at offshore wind farms are extremely difficult, if not impossible. Nonetheless, collision rates at offshore wind farms may be obtained by remote sensing methods, such as thermal imaging cameras. These methods have been used to varying degrees of success in Europe and should be evaluated for deployment post-construction.

Table 2. Avian mortality reported in available studies at wind farms in eastern North America (references available upon request)

Eastern U.S.	Radar study?	Turbine height	Months sampled	Number of searches	Number of carcasses in searches (incidental)	Adjusted mortality per turbine/yr[a]	Adjusted mortality per MW/yr[a]
MD, Criterion Year 1[b]		127 m	8	5,316	156 (105)	11.5	4.6
MD, Criterion Year 2		127 m	8	417	18 (14)	5.5	2.2
ME, Mars Hill	Yes	119 m	13	1,169	20 (23)	0.4-2.0	0.3-1.4
ME, Stetson Mountain	Yes	119 m	7	506	30 (8)	4.0	2.7
NJ, Atlantic County		116 m	24	1,500	31 (0)	NR[c]	NR
NY, Altona		119 m	7	966	14 (5)	0.5-1.0	0.4-0.7
NY, Bliss		119 m	16	3,703	45 (14)	0-4.5	0-3.0
NY, Chateaugay	Yes	119 m	7	607	19 (9)	2.5	1.7
NY, Clinton	Yes	119 m	15	2,944	30 (17)	1.4-3.3	1.0-2.2
NY, Cohocton		119 m	8	1,087	15 (3)	2.9-4.7	1.2-1.9
NY, Ellenburg	Yes	119 m	15	2,412	31 (12)	1.2-5.7	0.8-3.8
NY, Madison		100 m	7	98	4 (2)	NR	NR
NY, Maple Ridge	Yes	122 m	22	5,671	256 (48)	3.1-9.6	1.9-5.8
NY, Munnsville	Yes	119 m	8	320	5 (5)	2.2	1.5
NY, Wethersfield		119 m	7	691	11 (7)	2.6	1.7
PA, Allegheny Ridge		124 m	10	2,395	10 (0)	2.7-8.6	1.4-4.3
PA, Bear Creek		124 m	8	2,190	6 (3)	1.0-2.0	0.5-1.0
PA, Casselman	Yes	119 m	8	2,040	16 (5)	0.4-4.7	0.3-3.1
PA, Garrett		90 m	12	136	0 (0)	NR	NR
PA, Meyersdale		115 m	3	480	9 (4)	NR	NR
TN, Buffalo Mountain		88-120 m	37	1,329	55 (14)	1.8-7.3	1.0-11.0
VT, Searsburg		59 m	5	84	0 (0)	NR	NR
WV, Mount Storm	Yes	118 m	4	978	26 (11)	2.4-3.8	1.2-1.9
WV, Mountaineer		105 m	10	2,002	48 (36)	4.0	2.7
Eastern Canada							
ON, Erie Shores		119 m	12	2,391	59 (0)	2.0-2.5	1.3-1.7
ON, Exhibition Place		94 m	4	34	2 (0)	3.0-4.0	4.0-5.3
ON, Pickering		117 m	12	59	3 (0)	4.0	2.2
ON, Wolfe Island		117 m	24	12,900	250 (0)	10.0-13.4	4.3-5.8
				49,109	**1,084 (365)**		

[a] Ranges are given when more than one year of results were reported or when different search intervals (e.g., 1-day, 3-day, 7-day) were reported.
[b] Lights left on in nacelles at two (perhaps more) turbines in year 1 caused higher than average fatality rates involving night-migrating songbirds; the adjusted mortality reported excludes the 85 fatalities at those turbines, which are shown as incidental finds.
[c] NR = Not Reported.

Site-specific studies conducted since the 2008 risk assessment

The following site-specific studies, which examined the birdlife in the offshore waters where Project Icebreaker would be constructed, were conducted since the 2008 risk assessment:

- Aerial surveys of the offshore waters (Norris and Lott 2011),
- Boat surveys of the Project Icebreaker site (Tetra Tech 2012),
- MERLIN radar study of spring and fall migration (Tetra Tech 2012), and
- Avian acoustic survey (Tetra Tech 2012).

We summarize these studies below and examine whether they change the conclusions of the 2008 risk assessment.

Aerial surveys of the offshore waters

The Ohio Department of Natural Resources, Division of Wildlife (ODNR-DOW), and the U.S. Fish and Wildlife Service (Service) teamed to conduct aerial surveys of bird distribution and abundance in Ohio's offshore waters from Lucas County to Ashtabula County (Norris and Lott 2011). These surveys included the waters off Cuyahoga County, where Project Icebreaker is located. The purpose of this study was to collect baseline data on seabird activity for the purpose of assessing the potential for direct and indirect impacts from offshore wind turbines and to encourage the siting of wind-energy facilities within areas where potential impacts to birds would be minimized. A wind turbine placement analysis and mapping tool[3] (George and Watkins 2011) includes data from this study.

Over a two-year period (2009-2010 and 2010-2011), flights were undertaken weekly during fall (mid-October to mid-December) and spring (mid-March to mid-May). Flights were conducted in a sawtooth pattern from the lakeshore out to more than 16 to 51 km (10 to 32 miles) from shore, covering a distance of 1,070 km (664 miles). The sawtooth pattern included 29 transects from the lakeshore to offshore or vice versa.

In year 1, 12,047 miles were flown, along which 458,522 individuals of 44 species were recorded in 10,644 observations. In year 2, 12,348 miles were flown, along which 267,263 individuals of 46 species were recorded in 13,996 observations. Few species were abundant, averaging >1 bird/mile in any season (Table 3). Of those abundant species, only Ring-billed and Herring Gulls[4] were more or less equally abundant in fall and spring. The other common species were much more abundant in fall than spring (Table 3), confirming a finding of the 2008 risk assessment.

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[3] http://glc.org/energy/wind/pdf/conf2011presentations/George_Offshore_OH-Favorability-Mapping.pdf

[4] Ring-billed and Herring Gulls are reported together because they were difficult to tell apart at an altitude of 76 m (250 feet) from an airplane traveling at 120 knots (138 mph).

Table 3. Most abundant pelagic birds (mean birds per mile ± Standard Error) recorded in ODNR-DOW and Service surveys (Norris and Lott 2011)

	Year 1 (2009-2010)		Year 2 (2010-2011)	
Species (taxonomic order)	**Fall (N=10)**	**Spring (N = 11)**	**Fall (N=10)**	**Spring (N = 11)**
Greater and Lesser Scaup	32.9 ± 11.9	6.1 ± 3.6	19.1 ± 6.9	1.6 ± 0.8
Red-breasted Merganser	9.0 ± 4.3	1.5 ± 0.7	2.4 ± 1.7	1.4 ± 0.5
Double-crested Cormorant	4.2 ± 2.8	0.5 ± 0.1	1.0 ± 0.4	0.3 ± 0.1
Bonaparte's Gull	2.7 ± 0.4	0.4 ± 0.2	2.5 ± 0.5	0.3 ± 0.1
Ring-billed and Herring Gulls	4.4 ± 1.1	3.6 ± 1.4	5.8 ± 0.8	5.6 ±1.3

Based on distribution maps (see Norris and Lott 2011), only Bonaparte's Gull and Ring-billed and Herring Gulls were recorded in nearly all distance intervals from the lakeshore to the boundary waters offshore, including in the waters where Project Icebreaker would be located. In other words, they were relatively homogenous seasonally in their distribution in the Lake Erie waters of Ohio. Among relatively scarce species, only Common Loon and Horned Grebe shared this distribution pattern. Common Loon averaged 0.2-0.5 birds/mile, while Horned Grebe averaged 0.04-0.17 birds/mile, in the four seasons sampled.

Other species were either concentrated in the Western Basin of Lake Erie, beginning about 80 km (50 miles) west of the Project Icebreaker site, or along the immediate lakeshore, inshore of where Project Icebreaker would be located. Among abundant species, Scaup ducks and Double-crested Cormorant were examples of the former distribution pattern, while Red-breasted Merganser was an example of the latter.

The overall trend for species distribution was similar among years: the farther from the lakeshore, the fewer birds observed (Norris and Lott 2011). At 11 km (7 miles) from the lakeshore, where Project Icebreaker would be located, the number of birds recorded per mile had already passed an inflection point and had leveled off at minimum values. In other words, Project Icebreaker was located far enough from the lakeshore to be beyond where seabirds tended to concentrate.

Based on density maps[5] (see Norris and Lott 2011), 90% or more of the Lake Erie waters of Ohio, including the Project Icebreaker site, had the lowest avian density of 0 to 77 birds/km^2 (0 to 200 birds/mi^2). In the vicinity of Project Icebreaker, the highest avian densities – >770 birds/km^2 (>2,000 birds/mi^2) – were shown, as expected, close to the lakeshore at the warm-water outlets within the Cleveland Lakefront IBA.

[5] In Norris and Lott 2011, density is reported in 0.65 km^2 (0.25 mi^2) grids. We have converted the values reported to birds/km^2 and birds/mi^2 to facilitate comparison with other data sources

Boat surveys of Project Icebreaker site[6]

In 2010, Tetra Tech (2012) conducted 10 boat surveys of the waters within 4 km (2.5 miles) north and south of the Cleveland Crib, which was located about 6.4 km (4 miles) from the lakeshore. Thus, these boat surveys did not specifically cover the waters where Project Icebreaker would be located (which were slightly farther offshore), but they do provide data on the birdlife likely to be present there.

Four surveys were conducted during 5-24 May 2010 (spring surveys) and six surveys were conducted during 13 September-25 October 2010 (fall surveys). Each survey attempted to sample 21 points distributed in a sawtooth pattern, with points located about one nautical mile apart. Each point was sampled for about six minutes, during which observers counted birds within 300 m of the boat, or in an area of 0.28 km^2 (0.11 mi^2). In spring 2010, 68 point counts were conducted, and in fall 2010, 126 point counts were conducted.

During spring surveys, Ring-billed and Herring Gulls accounted for 441 (97%) of the 456 birds recorded, yielding an average density of gulls of 23.2 birds/km^2 (59.0 birds/mi^2). There were also eight Double-crested Cormorants recorded, for an average density of 0.4 birds/km^2 (1.1 bird/mi^2). All but a handful of birds were recorded in flight, distributed as follows: 58% below the Rotor Swept Zone (RSZ), 31% at altitudes equivalent to the RSZ, and 2% above the RSZ.

During fall surveys, Herring and Ring-billed Gulls accounted for 1,720 (58%) of the 2,958 birds recorded, for an average density of 48.8 birds/km^2 (124.1 birds/mi^2), and Bonaparte's Gull accounted for 731 (25%) of the total, yielding an average density of 20.7 birds/km^2 (52.7 birds/mi^2). Double-crested Cormorant accounted for 503 (17%) of birds recorded, for an overall density of 14.3 birds/km^2 (36.3 birds/mi^2), but most of the cormorants were perched on the Crib. Except for the 400 cormorants perched on the Crib, all birds were recorded in fight at an altitude distribution as follows: 96% below the RSZ, 1% at altitudes equivalent to the RSZ, and 3% above the RSZ.

The small number of species and the relatively low overall densities recorded (23.9 birds/km^2 [61.0 birds/mi^2] in spring and 83.8 birds/km^2 [213.4 birds/mi^2] in fall) agree with the avian profile developed in the 2008 risk assessment, as well as with the results of the study by Norris and Lott (2011), summarized in the previous section. At 11 km (7 miles) from the lakeshore, Project Icebreaker is located where minimal densities of seabirds would be expected to occur.

It is worth commenting on the use of the Crib by cormorants as a resting place. As noted in the 2008 risk assessment, cormorants and gulls are likely to perch on docking platforms of turbines, as they have been recorded to do at European offshore projects. In addition, the introduction of foundations and scour protectors of turbines in areas of soft bottom creates a benthic habitat that attracts fish and other underwater life, on which birds may be attracted to feed. Percival (2001) argued that seabirds may benefit from an increase in prey species by a "reef effect" at offshore

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[6] Densities are reported in birds/km^2 and birds/mi^2, to allow comparison with the results of the aerial survey. Note that Tetra Tech (2012) did not present density estimates, but we have calculated them from the data reported. If Tetra Tech had reported densities, it probably would have accounted for the effects of distance on detectability. Nonetheless, those data were not available to us.

turbines, but Dierschke and Garthe (2006) considered that "reef effect" had not yet been proven. Nonetheless, habituation and attraction to offshore turbines by some avian species is within the realm of possibility.

MERLIN Radar Study

The 2008 risk assessment found that, in migration, large numbers of birds use the airspace over Lake Erie, with most songbirds, waterfowl, and shorebirds migrating at night. Marine surveillance radar studies conducted in the eastern U.S. indicated that most nocturnal migration occurs at altitudes above the height of wind turbines, but a small percentage of songbirds migrate at altitudes equivalent to the rotor-swept zone (RSZ) of wind turbines. The density of nocturnal migration at Cleveland was considered to be similar to other sites studied at similar latitudes. An analysis of five recent years (2003-2008) of archived NEXRAD data from the nearby KCLE weather surveillance radar confirmed this pattern. Thus, it was concluded that collisions of night-migrating songbirds at offshore turbines would be similar to other sites at the same latitude, provided that turbines were equipped with flashing aviation obstruction lighting and not the type of lights that attract birds to the tall structures.

To provide further confirmation of this pattern, Tetra Tech (2012) was contracted to conduct a marine surveillance radar study that examined the use of airspace as close to the proposed offshore site as possible. Tetra Tech used a MERLIN Avian Radar System (hereafter, MERLIN radar) to study spring and fall migration from the lakeshore at Cleveland Lakefront State Park and from the Crib approximately 6.4 km (4 miles) offshore (Table 4). The radar unit operated both day and night. For the analyses that follow, we focus on data from night radar operations, because night-migrating songbirds make up the majority of collision fatalities at wind plants in eastern North America (see Guarnaccia and Kerlinger 2008).

Table 4. Results of MERLIN radar study during night period (Source: Tetra Tech 2012)

Date range	31 March-21 April 2010	1-26 May 2010	16 August-12 October 2010
Location	Onshore (lakeshore)	Offshore (Crib)	Offshore (Crib)
Hours analyzed	129 hours	229 hours	285 hours
Avg. passage rate (targets/km/hour)	32.1	840.7	1694.1
% above RSZ	95.3%	1.4%	54.9%
% in RSZ	4.7%	4.0%	37.7%
% below RSZ	0.1%	94.3%	7.5%
Mean altitude	383-433 m	17.3 m	466.4 m

The MERLIN radar used horizontal-beam, S-band radar and vertical-beam X-band radar to quantify the movements of "targets," such as birds, bats, and insects. Proprietary software was employed to filter out insects, atmospheric phenomena, and wave clutter that could increase the number of targets, sometimes substantially, but it should be noted that the success of filtering is rarely, if ever, substantiated (see Schmaljohann et al. 2008), and some radar operators have been known to shut their radar down when there are large numbers of insects (P. Kerlinger, personal observation). Data collected by the MERLIN radar allowed determination of the passage rate of targets, as well as their direction and altitude above a site.

There were large discrepancies between onshore and offshore radar results, particularly in the passage rate (expressed as targets/km/hour), mean altitude, and percentages in altitude zones (Table 4)[7]. The low mean passage rate recorded onshore in spring may have been the result of the date range sampled, which was before peak spring migration.

With respect to the offshore results, two things stand out: (1) traffic rates were much greater than almost any other prospective wind energy site where radar has been used to study bird activity (Table 5), and (2) targets were recorded at lower altitudes than in almost any previous study (Table 5). When available MERLIN radar studies (N = 9) were compared with available radar studies using other radar systems (N = 82), it was evident that MERLIN radar consistently showed greater passage rates and lower mean altitudes than other radar systems (Table 5). Spring passage rates were 69% greater with MERLIN radar than with other radars, while those in fall were 112% greater. Mean altitude was 30% less in spring with MERLIN radar and 32% less in fall. These differences were statistically significant (Table 5).

The high offshore passage rates that the MERLIN radar recorded could be interpreted as suggesting that the waters off of Cleveland are in a major migration corridor, even though there is nothing in the literature to suggest that such corridors exist near the middle of any of the Great Lakes. No NEXRAD radar studies anywhere in the Great Lakes (e.g., Diehl et al. 2003), at least away from peninsulas or lake ends (e.g., Whitefish Point), have shown this pattern, and the Cleveland area lacks topographic features that would funnel migration, such as happens at peninsulas and at the end of lakes (Kerlinger 1995). It is worth noting that the waters off of Cleveland are fundamentally different than the waters of the Western Basin of Lake Erie in that the waters off of Cleveland lack a peninsula such as Point Pelee and a series of islands across the lake that may concentrate some migrants.

This suggests that the results of the MERLIN radar study were confounded. Tetra Tech (2012) suggested that the lights on the Crib may have attracted birds, bats, and insects. However, an avian acoustic study conducted at the Crib in spring found little evidence of night-migrating songbirds (see below), and an acoustic study of bats at the Crib found relatively low abundances of bats in comparison with onshore sites (Tetra Tech 2012). Thus, it is reasonable to conclude that large numbers of insects were likely the cause, possibly attracted by lights on the Crib. Note that even without the lights there are often massive swarms of insects over Lake Erie.

Flight direction and altitude of targets support this conclusion. The MERLIN average was toward 7º in spring and toward 209º in fall, which only differed slightly from those measured in the NEXRAD study reported in the 2008 risk assessment. The variability of the MERLIN directional data, however, was striking in comparison with that of the NEXRAD, which was unequivocally oriented in the appropriate direction for migration. Spring MERLIN data, on the other hand, showed a bimodal circular distribution of radar tracks, with peaks toward the NW and SE, about 40º different from the mean direction. Fall data showed what appeared to be a

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[7] The percentages reported in Table 4 were derived from data reported by Tetra Tech (2012) and differ slightly from the percentages that Tetra Tech reported in its summary of results.

random directional tendency. This variability may be best explained by insect contamination, which is suggested by the fact that insects tend to be blown with the wind and show much less of directional tendency than do birds. With respect to altitude of flight, the very low altitude of flight for birds in the radar data is also suggestive of insect contamination.

It is worth noting that entomologists use X-band radar, the same wavelength as the MERLIN radar, for studying insect movements. In the case of Lake Erie, hatches of midges (*Chironomus plumosus*) are famous for their invasions of the lakeshore. They have even been credited for beating the New York Yankees in the playoffs, when a Yankee pitcher was distracted enough by midges to throw two wild pitches in the deciding game[8]. They are among many insects that emerge from the lake during different seasons.

Other factors may be at play. For example, radar is difficult to calibrate. In a study that aimed to present a procedure that would quantify bird migration reliably using radar, Schmaljohann et al. (2008) concluded that radar is often used in an inappropriate manner in environmental impact studies. They believed that density estimates based on radar could differ by as much as 400% from actual densities, in part because the detection probabilities of different targets (e.g., birds, insects, and unidentified echoes) were ignored. In radar studies at offshore sites in Europe (discussed in the 2008 risk assessment), wave clutter was identified as a particular problem (Blew et al. 2006, 2007). In some studies, virga (rain that does not reach the ground) and wave clutter were suggested as factors affecting radar data (S. Gauthreaux, personal communication).

The MERLIN radar data appear to indicate that the Crib with its lighting, insect swarms, waves, and other factors is a difficult place to conduct a radar study. Taken together, the literature on nocturnal bird migration in eastern North America, a site-specific NEXRAD study conducted as part of the 2008 risk assessment, and dozens of radar studies conducted at prospective wind energy facilities in the eastern U.S. (Table 5) support a conclusion that nocturnal migration above the waters off of Cleveland may be expected to occur mostly at altitudes above the height of wind turbines at densities similar to other sites studied at similar latitudes. Thus, collision risk to night-migrating songbirds would be low and unlikely to result in any population effect (Table 1).

[8] http://cleveland.about.com/od/livingincleveland/f/midges.htm.

Table 5. Comparison of metrics reported in available MERLIN and non-MERLIN radar studies conducted in the eastern U.S. (references available upon request)

	mean targets/km/hour		mean altitude of targets (m)	
MERLIN radar studies	**spring**	**fall**	**spring**	**fall**
ME, Canton 1	628	292	217	158
ME, Canton 2	304	181	197	178
ME, Colonel Holman		162		249
ME, Saddleback	708	624	354	290
ME, Spruce Mountain	409	480	367	316
NY, Ripley-Westfield	1062	774	340	332
OH, Cleveland offshore	841	1694	17	466
OH, Cleveland onshore	32		383	
VT, East Haven		1732		
Sample (N)	7	8	7	7
Mean	569	742	268	284
Standard Error	131	225	50	39

	mean targets/km/hour		mean altitude of targets (m)	
Non-MERLIN radar studies	**spring**	**fall**	**spring**	**fall**
MD, Dans Mountain	493	188	541	542
ME, Bingham		803		377
ME, Bowers	289	344	315	315
ME, Bull Hill 1	387	431	217	279
ME, Bull Hill 2	519	614	371	357
ME, Highland, Somerset	511		314	
ME, Highland, Somerset	496	549	287	348
ME, Kibby 1	443	201	334	352
ME, Kibby 2	456	585	368	370
ME, Kibby 3	197	452	412	391
ME, Kibby 4	512	201	378	352
ME, Mars Hill	342	512	332	424
ME, Oakfield/PenobscotCity	498	501	276	309
ME, Rollins Lincoln	247	368	316	343
ME, Roxbury	539	420	312	365
ME, Sisk, Kibby	207	458	293	287
ME, Stetson Mountain 1	147	476	210	378
ME, Stetson Mountain 2		457		420
NH, Errol		366		343
NH, Granite	342	469	332	310
NH, Lempster	542	620	358	387
NH, Tenney	234	470	321	342
NY, Alabama	112	67	413	489
NY, Allegheny	268	451	316	382
NY, Arkwright	175	112	450	458
NY, Ball Hill	419	189	493	353
NY, Blenberg		197		333
NY, Bliss		440		411
NY, Cape Vincent	166	346	441	490

NY, Centerville	290	259	351	350
NY, Chateaugay	360	843	409	431
NY, Chautauqua	395	238	528	532
NY, Chrubusco	254	152	422	438
NY, Clayton	460	418	443	475
NY, Clinton	110	197	338	333
NY, Copenhagen	192	225		
NY, Dairy Hills	117	94	397	466
NY, Dutch Hill	535	535	358	358
NY, Flat Rock		158		415
NY, High Sheldon	112	197	418	422
NY, Horse Creek	450	418	443	475
NY, Hounsville	624	281	319	298
NY, Howard	440	481	426	491
NY, Jordanville	409	380	371	440
NY, Marble River	254	152	422	438
NY, Martinsburg		230		
NY, Moresville 1	210	315	431	494
NY, Moresville 2	230		314	
NY, Munnsville	160	732	291	644
NY, New Grange 1		112		458
NY, New Grange 2	175		450	
NY, Perry		64		466
NY, Prattsburgh 1	170	200	319	365
NY, Prattsburgh 2	277	193	370	516
NY, Stamford		315		494
NY, Top Notch	509	691	419	516
NY, Villenova	419	189	493	353
NY, West Hill	160	732	291	664
NY, Wethersfield 1	324	256	355	344
NY, Wethersfield 2	324	256	355	344
PA, Bedford City		438		379
PA, Casselman		174		448
PA, Fayette City		297		426
PA, Martindale	271	187	416	436
PA, Somerset		316		374
PA, South Chestnut			382	426
PA, Swallow Farm	146	166	401	402
VA, Highland		385		492
VT, Deerfield 1	404	178	523	556
VT, Deerfield 2	263	559	435	395
VT, Kingdom Community Wind	223	356	298	350
VT, Milton		326		371
VT, Sheffield	199	109	552	566
VT, Vermont Community Wind	435	443	320	330
WV, Franklin		229		583
WV, Laurel Mountain	277	321	533	533
WV, Liberty Gap	457	229	492	583
WV, Mount Storm 1		241		410
WV, Mount Storm 2		199		410
WV, New Creek	1031	811	354	360

WV, North Briery				420
WV, Preston		379		420
Sample (N)	60	77	60	77
Mean	337	350	381	418
Standard Error	21	21	10	9
% difference	69%	112%	-30%	-32%
p in two-tailed t-test	0.0029	0.0001	0.0013	0.0001

Avian acoustic survey

Using a specially designed recording unit known as a Song Meter SM-1, Tetra Tech (2012) recorded flight calls of night-migrating songbirds during the spring and fall migration periods in 2010 where the MERLIN avian radar study was conducted. Spring sampling was conducted during 31 March-20 April 2010 at the Cleveland Lakefront State Park and during 29 April-26 May 2010 at the Crib. Recording was continuous from 45 minutes before sunset to 45 minutes after sunrise on 49 nights. The flight-call rate at the onshore location was 1.0 flight calls/night, and at the offshore location it was 2.6 flight calls/night. Of the 95 flight calls recorded, 49 were attributable to blackbirds, 17 to warblers, 11 to finches, 10 to thrushes, 5 to mimic thrushes, and 3 to swallows.

Fall sampling was conducted on 44 nights during 16 August-12 October 2010, but no flight calls were recorded because power could not be maintained between the radar unit and the acoustic sampling unit.

The spring results at the Crib are noteworthy because they do not support a conclusion that the nearly 800 targets/km/hour indicated by radar within and below the RSZ were night-migrating songbirds.

Collision risk to the federally endangered Kirtland's Warbler and Piping Plover

In 2007, the U.S. Fish and Wildlife Service (Service) issued a Biological Opinion (Dingledine and Czarnecki 2007) on the effects on Kirtland's Warbler of 49 of the 179 towers that had already been constructed for the Michigan Public Safety Communications System (MPSCS), a statewide communications system that facilitates national and statewide security and emergency services. Many public agencies use the MPSCS, including the Service and Michigan Department of Natural Resources.

This opinion is relevant to assessing collision risk of Kirtland's Warbler at Project Icebreaker because of the proximity of the MPSCS system in adjacent Michigan and because the towers constructed for the MPSCS are similar in height to the turbines proposed for the waters off of Cleveland. Gehring et al. (2009, 2011) studied avian collision mortality at 20 of the MPSCS towers, and their findings were the basis for the decision of the Federal Aviation Administration (FAA) to no longer require steady-burning, aviation obstruction lighting (rather, to require only flashing lights) at tall structures. Gehring et al. (2009) demonstrated that avian mortality at such communication towers could be reduced by 50%-70% by extinguishing steady-burning lights and using only flashing lights of the same type used on wind turbines.

The Service limited its opinion to the 49 towers in counties that contained known breeding sites, current management units, and/or records of Kirtland's Warbler. Curiously, none of the other ~125 towers were considered, even though they posed a collision risk in migration.

In its opinion, the Service anticipated incidental take of Kirtland's Warblers in the form of death or injury from collisions with the structures of the 49 towers. Take was calculated by using data on tower collisions in Michigan of a surrogate species, Blackpoll Warbler, an abundant warbler with a continental population of 21 million birds (Kirtland's at the time had a population estimated at 5,000 birds). The Service estimated that 10% of the Blackpoll population (2.1 million birds) had the potential to migrate across Michigan in the vicinity of the 49 towers. In a two-year mortality study, 11 Blackpoll Warblers were found dead at 12 Michigan towers. Thus, the annual mortality of Blackpoll Warblers was found to be 0.458 birds per tower (11 carcasses divided by 12 towers divided by 2 years). In other words, risk exposure of Blackpoll Warblers to tower collisions was 0.00000022 (0.458 Blackpoll Warblers killed per tower divided by 2.1 million at risk).

Risk exposure to Kirtland's Warbler was increased by a factor of 9 to 0.0000099 to account for carcasses that were not found during the mortality study and other factors. The Service then calculated take by multiplying risk exposure by population size (5,000 birds), number of towers (49), and project lifespan (30 years). The result was a take of 73 Kirtland's Warblers at the 49 towers over a 30-year period, or 2.4 Kirtland's Warblers at all 49 towers each year, or 0.05 Kirtland's Warbler at each tower each year (one Kirtland's Warbler every 20 years).

The Service's method may be used to estimate Kirtland's Warbler mortality at the six turbines of Project Icebreaker. To do so, risk exposure would need to be reduced by a factor of 20, because research (Gehring et al. 2009, 2011, Kerlinger et al. 2010) has shown that communications towers of the size class, support system, and lighting under consideration in Michigan kill 20 times more birds per structure than the wind turbines proposed for Project Icebreaker. Furthermore, only a small percentage of the current population of ~7,000 Kirtland's Warblers migrate across Lake Erie at Cleveland on their way to wintering habitat in the Bahamas. We use a conservative estimate of 10%, but it could be as low as one percent or less.

Thus, over the 30-year lifespan of Project Icebreaker, the take of Kirtland's Warbler may be estimated at 0.06 Kirtland's Warblers, or 0.002 Kirtland's Warblers per year[9]. This is one Kirtland's Warbler every 500 years at the six turbines, a negligible, non-measurable risk.

As pointed out by the Service in its Biological Opinion for Kirtland's Warbler and the MPSCS, there was uncertainty associated with several of the factors the model used to determine risk. To address this, the Service ran a sensitivity analysis that adjusted the values of various parameters, some by an order of magnitude. Results of the sensitivity analysis were not specified, but the Service reported that the annual estimate did not vary by much.

[9] The calculation is as follows: risk exposure of 0.000000495 * population of 7,000 birds * 10% of population likely to fly in the vicinity of Project Icebreaker * 6 turbines * 30-year project lifespan.

In the case of our estimates, adjusting the parameters also had little practical effect on the annual estimate. Furthermore, the level of mortality forecast is unlikely to have a population effect, even if our estimate is an order or more of magnitude too low.

Piping Plover mortality was not considered in the above Biological Opinion, but the same method could be used to calculate take of Piping Plover at Project Icebreaker. To begin with, risk exposure for Piping Plover would be less than that for Kirtland's Warbler because research demonstrates that, in comparison with raptors and night-migrating songbirds, shorebirds rarely collide with communication towers (Shire et al. 2000) or wind turbines (National Research Council 2007). In the calculation below, we use a risk exposure of 0.00000005, which is an order of magnitude lower that that for Kirtland's Warbler. The Great Lakes population of Piping Plover is very small (400 birds), and only a small percentage of that population (probably 10% or less) is likely to migrate in the vicinity of Cleveland. Thus, over the 30-year lifespan of Project Icebreaker, take of Piping Plover would be on the order of 0.0036 Piping Plovers, or one Piping Plover every 2,500 years, again a negligible, non-measurable risk

Conclusions and recommendations

Since the 2008 risk assessment was issued, a number of site-specific studies have been conducted to improve forecasts of avian impacts. Discussed above, those studies included aerial and boat surveys of the waters off of Cleveland, a MERLIN radar study from locations as close to Project Icebreaker site as possible, and an avian acoustic study. Those studies support the basic conclusion of the 2008 risk assessment: that no population effect is likely in any avian species as a result of habitat loss, barrier effect, or collision mortality associated with the construction and operation of the six turbines proposed (Table 1). Cumulative effects are also not anticipated given the small size of the project. With respect to likely impacts on the federally endangered Piping Plover and Kirtland's Warbler, a U.S. Fish and Wildlife Service model for assessing risk of collision mortality demonstrates no measurable risk for either species.

Given that it is a pilot project, Project Icebreaker provides a valuable opportunity to study avian interactions with offshore turbines, thereby helping to ensure responsible development of offshore wind energy on large inland lakes in North America.

Recommendations are as follows:

Pre-construction

- Summarized above, the site-specific studies conducted provide much useful information, but they do not change the basic conclusion of the 2008 risk assessment. No further studies are needed for assessing potential risk at this demonstration project.

Construction

- Lighting of construction equipment (including work vessels), with exception of safety and FAA obstruction lights, should be kept to a minimum and extinguished at night to avoid attracting night-migrating birds. If FAA lights are needed for turbines or cranes, they should be limited to red-flashing lights (strobe or LED). Other safety lights should be used judiciously.

- Other lighting on turbines and other infrastructure should be minimal. Safety lights on turbines, the substation, and other infrastructure should be extinguished at night and only used when human safety is in question. U.S. Coast Guard navigation lights should be minimal and down-shielded to avoid attracting night migrants flying over Project Icebreaker site. If work lights are needed on turbines or the substation, some consideration should be given to green or blue lights rather than white lighting.

- Turbine infrastructure should be designed to preclude perching by gulls, terns, cormorants, and raptors.

Post-construction

- A post-construction fatality study is recommended for Project Icebreaker that would consist of use of Thermal Animal Detection System (TADS) types of cameras that would use infrared videography to monitor turbine rotors for collisions. One variant of this methodology has been developed for offshore wind facilities in Europe, but that methodology needs to be improved on. The demonstration Project Icebreaker provides an opportunity to develop and test such improved technologies.

- As noted, Project Icebreaker provides a valuable opportunity to study avian interactions with offshore turbines, advancing knowledge to assess cumulative impacts. In this regard, disturbance/displacement and fatality studies may be implemented to determine the type and significance of impacts to birds.

Literature cited

Allison, T., E. Jedrey, and S. Perkins. 2008. Avian issues for offshore wind development. Marine Technology Society Journal 42:28-38.

Blew, J., A. Diederichs, T. Grünkorn, M. Hoffmann, and G. Nehls. 2006. Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark (draft version of 2005 progress report). BioConsult SH, Hunsum, Germany.

Blew, J., M. Hoffmann, and G. Nehls. 2007. Collision risk at sea: Species composition and altitude distribution of birds in Danish offshore wind farms, in Conference Proceedings of the 2nd Scientific Conference on the Use of Offshore Wind Energy by the Federal Ministry for the Environment, 20 and 21 February 2007 in Berlin, L. Morkel, A. Toland, W. Wende, and J. Köppel, Editors. Institute for Landscape Architecture and Environmental Planning, Berlin, Germany.

Boehlert, G.W., and A.B. Gill. 2010. Environmental and ecological effects of ocean renewable energy development, a current synthesis. Oceanography 23(2): 68-81.

Burger, J., C. Gordon, J. Lawrence, J. Newman, G. Forcey, and L. Vlietstra. 2011. Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. Renewable Energy 36: 338-351.

Diehl, R.H., R.P. Larkin, and J.E. Black. 2003. Radar observations of bird migration over the Great Lakes. Auk 120:278-290.

Dierschke, V., and S. Garthe. 2006. Literature Review of Offshore Wind Farms with Regard to Seabirds, in Ecological Research on Offshore Wind Farms: International Exchange of Experiences (Project No.: 804 46 001), Part B: Literature Review of the Ecological Impacts of Offshore Wind Farms, C. Zucco, W. Wende, T. Merck, I. Köchling, and J. Köppel, Editors. BfN-Skripten, Bonn, Germany.

Dingleline, J., and C. Czarnecki. 2007. Biological opinion on the effects of the 49 towers that are part of the Michigan Public Safety Communications System in Michigan on Kirtland's Warbler (Dendroica kirtlandii). U.S. Fish and Wildlife Service, East Lansing, Michigan.

Furness, B., and H. Wade. 2012. Vulnerability of Scottish seabirds to offshore wind. Prepared for the Scottish Government by MacArthur Green, Ltd., Glasgow, Scotland.

Furness, R.W., H.M. Wade, and E.A. Masden. 2013. Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119: 56-66

Gehring, J. Kerlinger, P. and A.M. Manville II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications, 19(2):505-514.

Gehring, J., P. Kerlinger, and A. M. Manville, II. 2011. The role of tower height and guy wires on avian collisions with communication towers. Journal of Wildlife Management 75: 848-855.

George, B.D., and J. Watkins. 2011. Ohio offshore wind: Wind turbine placement analysis and mapping. Ohio Department of Natiral Resources, Office of Coastal Management, Sandusky, Ohio.

Guarnaccia, J. and P. Kerlinger. 2008. Avian Risk Assessment – Great Lakes Wind Energy Center, Cuyahoga County, Ohio. Report to Juwi GmbH/JW Great Lakes Wind, LLC.

Kerlinger, P. 1995. How birds migrate. Stackpole Books, Mechanicsburg, PA.

Kerlinger, P., J. Gehring, W.P. Erickson, R. Curry, A. Jain, and J. Guarnaccia. 2010. Night migrant fatalities and obstruction lighting at wind turbines in North America. Wilson Journal of Ornithology 122: 744-754.

Langston, R.H.W. 2010. Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters. RSPB Research Report No. 39: February 2010.

Livingston, J.W. 2008. Analysis of WSR-88D Data to Assess Nocturnal Bird Migration Offshore of Cleveland, Ohio. Report to Curry & Kerlinger, LLC. Geo-Marine, Inc., Plano, TX.

Masden, E.A., D.T. Haydon, A.D. Fox, and R.W. Furness. 2010. Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. Marine Pollution Bulletin 60: 1085-1091.

National Research Council, Committee on Environmental Impacts of Wind Energy Projects. 2007. Environmental Impacts of Wind-Energy Projects. The National Academies Press, Washington, D.C.

Norris, J., and K. Lott. 2011. Investigating annual variability in pelagic bird distribution and abundance in Ohio's boundaries of Lake Erie, final report for funding award number NA10NOS4190182. Available at http://www.dnr.state.oh.us/LinkClick.aspx?fileticket=YWikoCsjEe0%3d&tabid=21467. Accessed 5 October 2013.

Percival, S.M. 2001. Assessment of the effects of offshore wind farms on birds. ETSU Report W/13/00565/REP, DTI/PubURN01/1434.

Petersen, I.K., A.D. Fox, M. Desholm, J. Kahlert, and T.K. Christensen. 2012. Effects of offshore wind farms on birds. Department of Bioscience, Aarhus University, Denmark. Available at: http://www.noordzeewind.nl/wpcontent/uploads/2012/11/pdf/OWE%202012%20Petersen%20Overview%20of%20effects%20on%20birds.pdf

Schmaljohann, H., F. Liechti, E. Bächler, T. Steuri, and B. Bruderer. 2008. Quantification of bird migration by radar – a detection probability problem. Ibis 150: 342-355.

Schwemmer, P., B. Mendel, N. Sonntag, V. Dierschke, and S. Garthe. 2011. Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. Ecological Applications 21: 1851-1860.

Shire, G.G., K. Brown, and G. Winegrad. 2000. Communication towers: a deadly hazard to birds. American Bird Conservancy, Washington, DC.

Tetra Tech. 2012. Spring-Fall 2010 avian and bat studies report, Lake Erie Wind Power study. Prepared for the Cuyahoga County Department of Development, Cleveland, OH.

Vanermen, N., and E. Stienen. 2009. Seabirds & offshore wind farms: Monitoring results 2008. Study commissioned by the Royal Belgian Institute for Natural Sciences, Brussels, Belgium.

Wilson, J.C., M. Elliott, N.D. Cutts, L. Mander, V. Mendao, R. Perez-Dominguez, and A. Phelps. 2010. Coastal and offshore wind energy generation: Is it environmentally benign. Energies 3: 1383-1422.