Appendix L-1
WEST Summary of Risks to Birds and Bats

ICEBREAKER WIND:
SUMMARY OF RISKS
TO BIRDS AND BATS

Prepared for

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EXECUTIVE SUMMARY

The Lake Erie Energy Development Corporation (LEEDCo) has proposed the Icebreaker Wind project, a small, demonstration 6-turbine, 20.7-megawatt (MW) offshore wind energy facility eight to 10 miles (13 to 21 kilometers [km]) from the shore of Cleveland, Ohio. WEST has completed a review and summary of baseline data and other publicly available data on bird and bat use and other information of the Project's environment for the purpose or evaluating the level of risk posed by the proposed project to birds and bats. The overall conclusion of this analysis is that the Project poses low risk of adverse impacts to birds and bats. This conclusion stems largely from two principal observations: 1) the Project is small in scale, consisting of six turbines; 2) the level of use of this area by birds and bats is low compared to bird and bat use of terrestrial or nearshore environments.

The potential for *displacement* effects, defined as the transformation of the Project area from suitable habitat to less suitable habitat by virtue of Project construction or operation, was evaluated by examining data on the use of the Project site and other offshore environments in the central Lake Erie basin by birds and bats for activities other than transit, in the context of technical literature on the subject. Our analysis indicated that the risk of displacement effects is likely low for Icebreaker Wind. This is because baseline data have shown that the use of the Project area as a habitat for anything other than migratory transit by any bird species is minimal or negligible. In a baseline aerial survey effort conducted by the Ohio Department of Natural Resources over a large portion of Lake Erie, including the Project site, between 2009 and 2011, only six species of waterbirds were documented within the vicinity of the Project area at densities that can be considered above negligible or occasional. Three of these species were gulls (Bonaparte's Gull, Ring-billed/Herring Gull), with averages roughly between one and five individual birds observed in the Project area and vicinity per survey during the baseline survey effort. For the other three species, (Horned Grebe, Common Loon, and Red-breasted Merganser), averages of roughly one individual or fewer were observed within the Project area and vicinity per survey during the baseline survey effort. At such low densities, statistically significant displacement effects would not likely be detectable with a realistic survey effort. For the same reason, there is not a reasonable likelihood that any such effects could be biologically significant for any species.

The potential for behavioral *avoidance or attraction* effects was evaluated by examining post-construction monitoring results of other offshore wind energy facilities, and by reviewing technical literature on this subject. Behavioral avoidance is defined as the avoidance of the Project by bird or bat species that would otherwise use the Project area strictly for transit. Behavioral attraction is defined as attraction to the Project area by bird or bat species that would otherwise utilize the area less frequently or not at all. The conclusion of our analysis is that Icebreaker Wind does have the potential to generate both behavioral avoidance and attraction effects in some groups of birds or bats. Although the passage rates of migrating birds through the Project area are expected to be lower than on land, along the shore of Lake Erie, or in near-shore waters, some migrating birds and bats from a variety of taxa are likely to migrate through the Project area on a regular basis. After construction some migrating birds and bats may detect the presence of the facility and fly around it. In such cases, the additional energy expenditure of

this avoidance behavior is expected to be negligible, as has been demonstrated at offshore wind projects in Europe. Therefore, the potential for adverse effects from this behavior is likely negligible. Other birds and bats flying in the vicinity of the Project area may be attracted to the facility. This is not likely to occur in nocturnal migrant birds, as the Project will utilize flashing red aviation obstruction lights, which do not attract nocturnal migrants or other birds. Attraction effects are more likely to occur with some diurnal waterbirds such as gulls and cormorants, as has been demonstrated in Europe, and may also occur with additional taxa, including bats.

The potential for *collision* effects was evaluated by examining data on the use of the Project site and other offshore environments in the central Lake Erie basin by birds and bats, including merely for transit, contextualized with information on taxon-specific wind-turbine collision susceptibility patterns from technical literature and publicly available post-construction monitoring reports from other wind energy facilities. The overall conclusion of our analysis was that total fatality levels of birds and bats are expected to be lower for Icebreaker Wind than for land-based wind energy facilities in the region. Previous risk analyses and correspondence with the US Fish and Wildlife Service has indicated that no federally listed bird or bat species are likely to be affected. The Project is not likely to generate population-level effects for any species. These conclusions are based primarily on the low use of offshore environments within the central Lake Erie basin by birds and bats, as well as the small size of the Project, and are also influenced by known patterns of taxon-specific collision susceptibility and species' geographic ranges.

No eagles or other raptors regularly forage 8-10 miles offshore, minimizing exposure to collision risk in this group of birds. A small number of eagles and other raptors may be exposed to collision risk if they encounter the Project while migrating across Lake Erie; however, eagles and other raptors tend to avoid migrating over large water bodies such as Lake Erie, and no raptors were documented within 10 miles of the Project area during a 2-year baseline survey effort. Therefore, we conclude that collision risk is low for eagles and other raptors.

For waterfowl and other waterbirds, baseline aerial survey data have shown that the spatial utilization pattern of such birds is largely restricted to the first three to six miles (five to 10 km) from shore in the central/southern Lake Erie basin, with minimal or negligible density of waterfowl and other waterbirds in the vicinity of the proposed Project area. Furthermore, available evidence from both offshore and onshore wind energy facilities indicates that wind turbine collision susceptibility is generally low for these bird types. Certain waterbird species, notably Double-crested Cormorants and several species of gulls, may experience higher levels of exposure to potential collision risk if they are attracted to the Project subsequent to construction, but collision susceptibility is generally regarded to be low for these bird types, hence overall risk is low. Additional insight into the potential for such effects can only be gained from post-construction observations.

For bats, the likely per megawatt bat fatality rate at Icebreaker Wind must be predicted with caution due to the well-known complexity of the relationship between pre-construction bat acoustic activity rates and post-construction bat fatality rates at land-based wind energy facilities in the Midwest and nation-wide. Although bats are primarily terrestrial animals, some species are likely to cross Lake Erie and the Project area on a regular basis, particularly as they are migrating, and the extent to which bats may be attracted to the Project's turbines as they are migrating across the Lake is not well-known and cannot be determined through additional baseline data gathering. The overall bat collision risk is low for Icebreaker Wind, nonetheless, because even if the Project results in fatality rates that are toward the upper end of the distribution of per megawatt bat fatality rates at regional land-based wind projects, the small size of the Project limits the total (facility-wide) bat fatality rate to one that would be moderate, at worst, in relation to land-based wind energy projects in the Great Lakes region.

Nocturnally migrating songbirds and similar birds may be exposed to collisions with Icebreaker Wind's turbines as they migrate across Lake Erie in spring and fall, though the terrestrial habitats of bird species in this category naturally restricts potential collision exposure to migratory flights. As a group, nocturnally migrating songbirds and similar birds exhibit low general susceptibility to collisions with wind turbines. Furthermore, a region-wide analysis of NEXRAD radar data performed by an independent research team of government and academic scientists demonstrated that the density of songbird migration over the central Lake Erie basin was less than one half of what it was over terrestrial environments within the region. Several recent studies employing marine radars in shoreline environments have demonstrated relatively high densities of nocturnal migrant birds along the shorelines of Lake Erie and Lake Ontario, reinforcing our understanding of the tendency of such migrants to concentrate along coastlines and avoid flying over large water bodies, such as Lake Erie, if possible. On the basis of this information, and also in light of the small size of the Project, we conclude that the collision risk for nocturnally migrating songbirds and similar birds is low.

The relationship between pre-construction bird and bat use, or "exposure" data and post-construction collision fatality at wind energy facilities is known to be complex. However, the baseline information on bird and bat abundance in the offshore environment of the central Lake Erie basin can be compared with publicly available, bias-corrected bird and bat fatality rates for land-based wind energy facilities in the Great Lakes region. We applied such comparisons to make rough, quantitative predictions of the collision fatality rates that Icebreaker Wind is likely to generate for bats and birds. Such comparisons indicate that bat fatality rates are most likely to be on the order of one to four bats/MW/year, which would lead to roughly 21 to 83 total bat fatalities/year for the facility. We note that bat fatality rates could be as high as 20-30 bats/MW/year if there is a substantial behavioral attraction effect, but the small size of the Project limits the magnitude of this risk to a moderate level in relation to other regional wind energy facilities even under this worst case scenario. For birds, fatality rates are most likely to be on the order of one or two birds/MW/year, or 21 to 42 total birds/year for the facility. At these levels, the collision fatalities caused by Project Icebreaker do not have a reasonable likelihood of generating a population-level impact for any species of bird or bat, particularly as these fatalities are not likely to affect any listed species, and will be distributed among many species, further lessening the impact on any one species.

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INTRODUCTION

This document presents an analysis of the nature, intensity, and likelihood of risks to birds and bats posed by the development of Icebreaker Wind (also known as the "Project" or "Icebreaker"). Icebreaker is a small-scale wind demonstration project (a six-turbine 20.7-megawatt [MW] facility) that would be located in Lake Erie eight to 10 miles (13 to 21 kilometers [km]) offshore of Cleveland, Ohio. The Project is being developed by the Lake Erie Energy Development Corporation (LEEDCo) and Icebreaker Windpower Inc., a subsidiary of Fred. Olsen Renewables USA. One of the key advantages of developing commercial wind energy facilities in the offshore environment is that bird and bat risks are generally regarded to be lower than on land, as all bats and most birds are generally terrestrial animals (Schuster et al. 2015). Nonetheless, there is still a great deal of uncertainty regarding the potential for offshore wind energy to create adverse impacts on birds and bats, owing partially to the newness of offshore wind energy relative to land-based wind energy development, particularly in the US, and also to the inherent difficulties in gathering data on wildlife risks and impacts in the offshore environment. This uncertainty is one of the primary reasons for constructing a small demonstration project such as Icebreaker Wind as the first offshore wind energy development in the Great Lakes. As such, Icebreaker will be able to serve as a platform for gathering information that will be useful for decision-making regarding future development in the region.

Beginning in 2008, LEEDCo conducted a variety of Project-specific bird and bat baseline studies for the purpose of providing information on the risks posed to birds and bats by the proposed Project to support the risk determinations and permitting processes required by state and federal authorities (Geo-Marine, Inc 2008; Svedlow et al. 2012). These baseline studies have been supplemented by several systematic expert reviews of bird and bat risk issues associated with the Project, in which Project-specific data have been interpreted in the context of available data from independently performed field studies, publicly available databases, and technical literature (Kerlinger and Guarnaccia 2013, Kerlinger 2016). The need for this additional summary stems from the availability of new information germane to bird and bat risk considerations that has arisen or been identified subsequent to the Project's most recent application for a Certificate of Environmental Compatibility and Public Need to the Ohio Power Siting Board in 2014.

The intent of the current analysis is to present an updated synthesis of available information relevant to the consideration of bird and bat risks posed by the Project. All of the information presented in the baseline studies and previous risk analyses for Icebreaker is not fully recapitulated in this document, but all of the available information germane to each risk-related topic has been incorporated into the current analysis, with particular sources of information weighted according to their relevance with regard to addressing the risk-related questions. The analysis is organized by effect type, and then by taxon (for collision effects).

DISPLACEMENT EFFECTS

The potential for generating a displacement effect, defined as the transformation of an area from being suitable habitat to being unsuitable habitat for one or more wildlife species, is an important wildlife risk consideration for some land-based and offshore wind energy facilities (Drewitt and Langston 2006, Strickland et al. 2011). In wind-wildlife literature, such effects are most often associated with wildlife species that are known or hypothesized to avoid occupying areas in which tall structures, or significant anthropogenic activity/disturbance is present. For land-based wind farms in the US, displacement effects have received the most attention in relation to grassland and shrub-steppe obligate species (e.g., Greater and Lesser Prairie-Chickens [*Tympanuchus cupido* and *T. pallidicinctus*], Sage Grouse [*Centrocercus urophasianus*], Grasshopper Sparrow [*Ammodramus savannarrm*]; Strickland et al. 2011, LeBeau et al .2016). In the offshore realm, displacement effects have been hypothesized or examined primarily in certain species of waterfowl and other waterbirds (e.g., loons, alcids) that are known to forage regularly in marine areas where offshore wind facilities have been proposed or installed (Petersen and Fox 2007, Walls et al. 2013). Displacement effects are considered herein in the sense most commonly applied in wind-wildlife literature, referring only to use or avoidance of foraging, roosting, breeding, or wintering habitats. The use or avoidance of areas that are occupied by wildlife species strictly for transit is considered separately below under "behavioral avoidance."

In the case of Icebreaker Wind, there is minimal potential for displacement effects, as there is minimal to negligible utilization of the Project area by any bird or bat species for anything other than transit. This pattern was documented through an aerial baseline survey effort conducted over a two year period (2009-2010 and 2010-2011) by the Ohio Department of Natural Resources (ODNR) over a large portion of the south-central Lake Erie basin, including the Project area (Norris and Lott 2011). This survey effort consisted of weekly, low-altitude (ca. 76 meter [m; 248 foot (ft)]) flights during fall (mid-October through mid-December) and spring (mid-March through mid-May) seasons, with expert observers gathering bird observations from aboard a small twin-engine fixed-wing aircraft flying at a speed of roughly 120 knots (138 miles [222 km] per hour). The 2-year survey effort resulted in a total of 24,395 miles of flight along the transect pattern shown in Figure 1, during which a total of 725,785 individual bird observations was collected, representing at least 51 bird species.

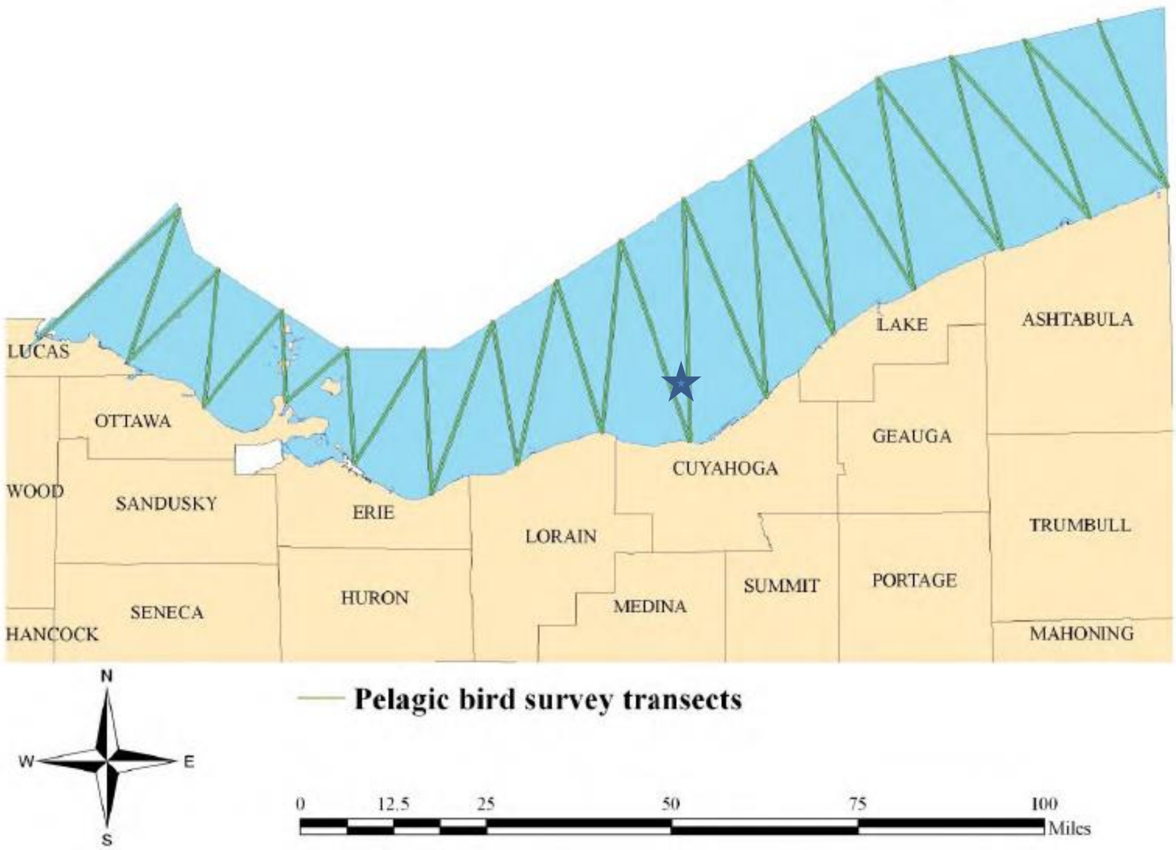

Figure 1. Aerial flight transect pattern flown during the Norris and Lott (2011) pelagic bird surveys in Lake Erie during 2009-2011. The approximate proposed location of Icebreaker Wind is shown by the blue star (Figure reproduced from Norris and Lott 2011).

In order for Icebreaker Wind to have the potential to generate a displacement effect, the Project area must be utilized by wildlife species prior to the construction of the facility. Data from both years of the ODNR survey effort indicate that the abundance of birds was negligible (Year 1) or minimal (Year 2) at distances between eight and 10 miles from shore, corresponding to the zone in which the Project has been proposed (Figures 2 and 3). Examination of species-specific and spatially-explicit patterns in the ODNR survey data (Norris and Lott 2011 appendix C) indicated that the only species that may occur in the vicinity of the Project area on a somewhat consistent basis are Red-breasted Merganser (*Mergus serrator*), Common Loon (*Gavia immer*), Horned Grebe (*Podiceps auritus*), Bonaparte's Gull (*Chroicocephalus philadelphia*), and Ring-billed/Herring Gull (*Larus delawarensis*/*L. argentatus*; Norris and Lott 2011). For the merganser, loon, and grebe, the density of birds in the vicinity of the Project area documented by Norris and Lott (2011) was roughly one bird per survey or lower. For the gulls, the density may have been as high as five birds per survey. At such low densities, a statistically significant displacement effect resulting from the presence of the Project would be difficult to detect. For the same reason, there is no reasonable likelihood that such an effect would be biologically significant for any species.

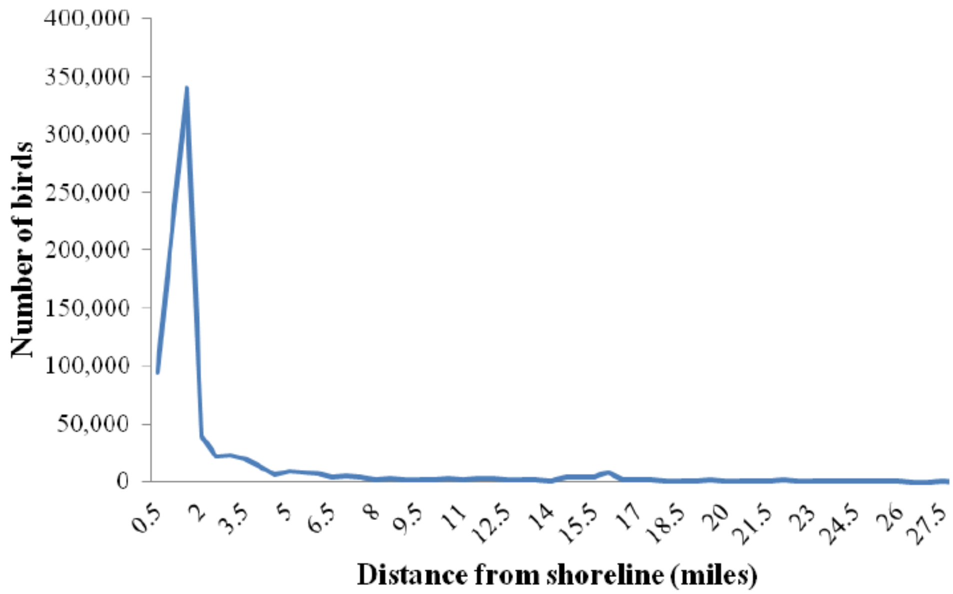

Figure 2. Total bird observations in relation to distance from shoreline along the southern shore of Lake Erie as recorded in Year one (fall 2009 – spring 2010) of the aerial pelagic bird survey effort conducted by the Ohio Department of Natural Resources. (Figure reproduced from Norris and Lott 2011).

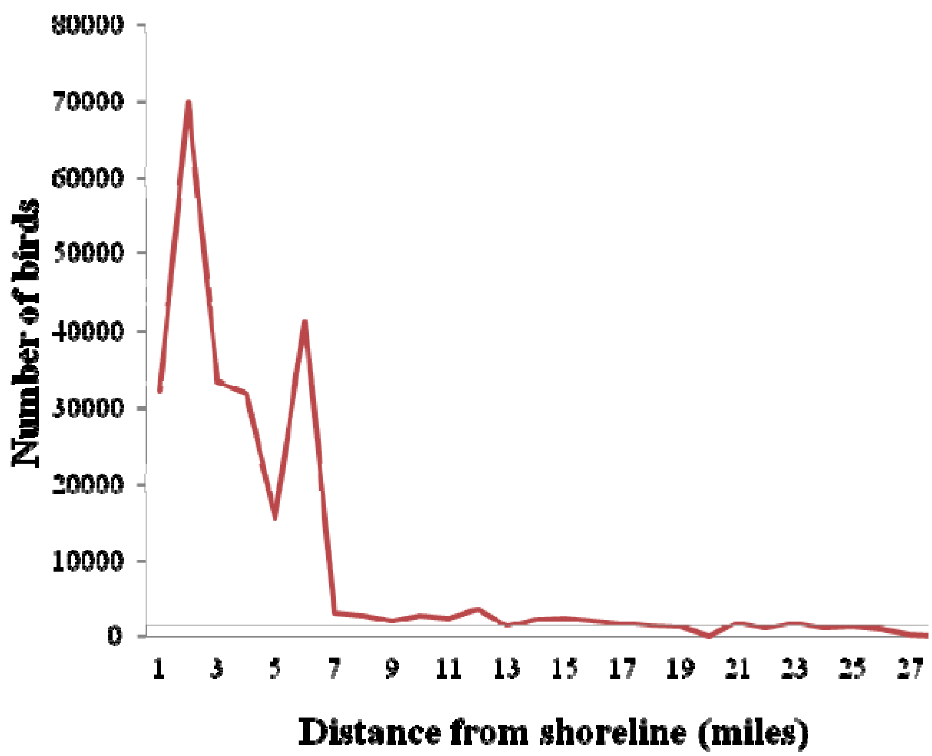

Figure 3. Total bird observations in relation to distance from shoreline along the southern shore of Lake Erie as recorded in Year two (fall 2010 – spring 2011) of the aerial pelagic bird survey effort conducted by the Ohio Department of Natural Resources (Figure reproduced from Norris and Lott 2011).

BEHAVIORAL AVOIDANCE/ATTRACTION EFFECTS

Behavioral avoidance effects are defined herein as the avoidance of a constructed facility by wildlife species whose only utilization of the Project area would be strictly for transit (i.e. passing through on migratory or “commuting” flights). Avoidance of the Project area by species that might otherwise use the area as foraging or roosting habitat is considered separately in this analysis as a displacement effect (see previous section). Behavioral avoidance of a wind facility by a bird or bat may have a beneficial effect, as it will generally reduce collision risk, but it may also generate an adverse effect in the form of increased energy expenditure required to fly around a turbine or the facility.

In the case of Icebreaker Wind, the potential for adverse effects on wildlife from behavioral avoidance is negligible, as the additional energetic expenditure required for migrating birds or bats to fly around the Project will be negligible. This conclusion is based on the findings of Masden et al. (2009), who found that the additional energetic expenditure required for migrating birds to circumvent the Nysted Offshore Wind Energy Facility in the Danish Baltic Sea was negligible in relation to the overall energetic cost of their migratory journey. The Project will occupy a relatively small above-water footprint, consisting of a linear array of six turbines and measuring roughly two miles (three km) in length, substantially smaller than the dimensions of the facility studied by Masden et al. (2009). In addition, the Project’s turbines would be spaced at approximately 600 meter intervals, providing space for birds to fly between turbines.

Icebreaker Wind has a high likelihood of generating attraction effects in some species of birds and/or bats, as above water structures in general, and offshore wind turbines in particular, are known to attract certain species for whom such structures may represent places to perch and roost. The phenomenon of bats’ potential attraction to wind turbines is still poorly understood, but recent studies have indicated that some bats may be attracted to wind turbines under some circumstances (McAlexander 2013, Cryan et al. 2014). Krijgsveld et al. (2011) demonstrated attraction of cormorants and gulls to the structures of the Egmond aan Zee Offshore Wind Energy Facility in the Netherlands. Several species of gulls and one species of cormorant occur regularly on Lake Erie, and may be similarly attracted to the structures of Icebreaker. Similar to behavioral avoidance, behavioral attraction to offshore wind turbines may have both beneficial and adverse effects on flying wildlife. Beneficial effects may include increased availability of roosting and/or foraging sites in an otherwise inhospitable or unfavorable environment. Adverse effects may include increased exposure to collision risk. One feature relevant to the likelihood of attracting flying wildlife is that flashing red aviation obstruction lighting will be installed on the nacelles of the turbines for Project Icebreaker. Such lighting does not appear to attract nocturnally migrating birds (Kerlinger et al. 2010, Gehring et al. 2012); hence, the Project is not likely to attract substantial numbers of such birds.

COLLISION EFFECTS

It is well-known that some birds and bats can experience mortality or injury due to collisions or near-collisions with wind turbines (Strickland et al. 2011, Schuster et al. 2015). Bird and bat collision fatality rates at land-based wind energy facilities have been particularly well-studied in North America, where intensive and systematic carcass searching studies have been accompanied by sophisticated methods for adjusting the raw data to account for biases caused by limited carcass detectability and carcass removal by scavengers. For birds, recent reviews of bias-corrected fatality rate estimates have indicated a fairly consistent pattern, with an overall average US rate of roughly four to five birds killed per MW of installed wind capacity per year (4.11 birds/MW/year reported by Loss et al. 2013). For bats, there is a greater degree of variation in fatality rates across land-based wind energy facilities, and overall fatality rates are generally higher than they are for birds (Arnett et al. 2013).

Beyond simple rates, one of the most important patterns that has emerged from bird and bat collision fatality studies at land-based wind energy studies to date is that collision susceptibility is highly taxon- or guild-specific for both birds and bats (Strickland et al. 2011, Arnett et al. 2013, Schuster et al. 2015). For many bird species, susceptibility appears to be most closely related to species' overall abundance, and the amount of time a species spends flying within rotor swept altitudes, with an additional influence of behavioral and morphological factors (Strickland et al. 2011). The majority of bird fatalities at land-based wind energy facilities in North America are nocturnal migrants (many songbirds and similar species), and some of the fatalities presumably occur during their high-altitude nocturnal migratory flights, particularly when storms or ascent/descent bring the birds below their normal migratory cruising altitudes (300-500 m [984-1,640 ft]) and into the rotor swept altitudes of commercial wind turbine rotors (Strickland et al. 2011). Certain common birds of agricultural habitats that exhibit tendencies to engage in high altitude flights, and certain widespread and abundant vulture and raptor species, are also commonly found among bird fatalities at land-based wind energy facilities (Strickland et al. 2011). Other birds, particularly species with a high degree of aerial maneuverability, such as swallows and swifts, are rarely encountered as fatalities at wind energy facilities even though they may be very abundant, and may spend a substantial amount of time flying within rotor-swept altitudes (Strickland et al. 2011). Birds that are rare, or that rarely fly within rotor swept altitudes, tend to be rarely encountered as wind-turbine fatalities (Strickland et al. 2011).

For bats, the pattern of collision susceptibility at land-based wind energy facilities in North America is also highly species-specific, but the underlying reasons that drive the pattern are less well-understood than they are for birds. Three species of migratory, tree-roosting insectivorous bats in the family Vespertilionidae (Eastern Red Bat [*Lasiurus borealis*], Silver-haired Bat [*Lasionycteris noctivagans*], and Hoary Bat [*Lasiurus cinereus*]) are among the most commonly found bats in North American wind farm fatality studies, comprising 78% of bat fatalities at US wind energy facilities (Arnett and Baerwald 2013). In these species, most fatalities occur during late summer and fall, typically late July through late September, a period that corresponds to fall migration and initiation of mating activities (Fleming and Eby 2003, Cryan and Barclay 2009). By contrast, many other species, particularly bats in the genus *Myotis*, are found as wind turbine collision fatalities much more rarely, for reasons not yet fully understood (Arnett et al. 2008, 2010, 2013).

In the offshore realm, the carcass-searching field study methodologies that have advanced our scientific understanding of bird and bat fatality rates at land-based wind energy facilities are generally unavailable. Direct monitoring of bird and bat fatalities has rarely been attempted at European offshore wind energy facilities to date. In one of the first and best known attempts, Mark Desholm and colleagues developed the Thermal Animal Detection System (TADS), and deployed it at the Nysted Offshore Wind Energy Facility in the Danish Baltic Sea. In vertical (collision) viewing mode, the system's infrared monitoring field of view covered roughly one third of the rotor of a single turbine, and it was deployed in this way for intensive monitoring periods during the peak period of spring and fall sea duck migration over a three year period (2004-2006; Desholm 2006). In spite of the fact that this facility is located within a major flight corridor for migrating sea ducks, with an estimated 235,136 Common Eiders (*Somateria mollissima*) passing by in the vicinity of the wind farm each autumn, no sea duck collisions were recorded during this monitoring effort in 1,086 hours of direct observation in collision-viewing mode (Desholm 2006). Only one collision event of any kind was recorded during this monitoring effort, a collision of a single small bird or bat (Desholm 2006). Perhaps influenced by this result, avian impact studies at European offshore wind energy facilities in recent years have focused on collision risk modeling efforts, in which bird passage rates are combined with collision avoidance rates to "predict" collision fatality rates (Cook et al. 2014). To date, no offshore wind energy facilities in Europe or elsewhere have reported bird or bat fatality rates generated from direct observations of bird or bat collisions with operating offshore wind turbines, though there are a variety of emerging remote sensing systems that show varying degrees of potential for producing such data in the future (see reviews by Collier et al. 2011, Sinclair et al. 2015).

Although empirical validation of predicted collision fatality rates has not yet been attained for an offshore wind energy facility, information on the turbine collision/avoidance probabilities for various bird taxa from European offshore wind studies, combined with known bird and bat fatality patterns from land-based wind energy facilities in North America, provides a reasonable foundation for assessing the levels of collision risk likely to be experienced by various bird and bat taxa from Icebreaker Wind. In the sections that follow, collision risk is reviewed for four separate categories of birds and bats, representing the bird and bat types of the highest potential interest with regard to potential collision risk from Icebreaker. In these discussions, the overall risk evaluations (e.g. "high" "moderate" "low") refer to how the range of potential fatality rates likely to be generated by Icebreaker Wind compares to fatality rates that have been documented at typical land-based wind energy facilities in the region.

We note that low collision risk for any ESA-listed species of birds or bats was established in earlier risk analyses for the Project (Guarnaccia and Kerlinger 2013, Kerlinger and Guarnaccia 2013), and was acknowledged by the USFWS (2014). For this reason, the discussion of risk to ESA-listed species is not repeated in the present analysis.

Eagles and Other Raptors

The level of collision risk for eagles or any other species of raptor at Icebreaker Wind is low, primarily because no species of eagle or other raptor regularly utilizes offshore environments eight to 10 miles from shore. Although Bald Eagles (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*) regularly forage over water for fish, both of these species are typically restricted to areas within several miles of shore (Buehler 2000, Poole et al. 2016). This general pattern was evidenced specifically for the Project site and vicinity by the boat-based avian baseline surveys conducted in nearshore waters near the Project site during 2010 (Svedlow et al. 2012) and the aerial avian baseline surveys conducted in 2009-2011 by the ODNR (Norris and Lott 2011), neither of which resulted in any observations of any raptors within 10 miles of the Project area.

The potential for Bald Eagles or other raptors to be exposed to any risk of collision with Icebreaker's turbines is therefore almost exclusively limited to migratory transits of these species across Lake Erie (but see also waterfowl and ice discussion in the next section). Bald Eagles and a variety of other migratory raptor species may occasionally cross the open water of Lake Erie during migration. Nonetheless, such crossings are expected to be uncommon in the vicinity of Icebreaker Wind, as raptor migration in general (Kuvlesky et al. 2007), and specifically within the Great Lakes region (Hawk Migration Association of North America [HMANA] 2016) tends to be heavily concentrated along shorelines and at narrows and peninsulas due to the tendency of raptors to avoid migrating over large water bodies (Kerlinger 1989).

To the extent that a small amount of exposure of Bald Eagles and other raptors to potential collision risk at Project Icebreaker does exist, given the small project size, and offshore location, risk is anticipated to be low. In a recent review, Pagel et al. (2013) reported that a total of six Bald Eagle fatalities are known to have occurred over a 16-year period from 1997-2012 for all land-based wind energy facilities within the contiguous United States. To date, there are far fewer publicly available records of Bald Eagle fatalities or injuries at wind energy facilities than there are for Golden Eagles, which are rare in the Great Lakes region. According to Pagel et al. (2013), there were 85 eagle fatalities at wind energy facilities throughout the U.S. between 1997 and 2012 (excluding eagle fatalities at the Altamont Pass Wind Resource Area in California). Of these 85 mortalities, 79 were Golden Eagles and 6 were Bald Eagles (Pagel et al. 2013).

Waterfowl and Other Waterbirds

The level of collision risk for waterfowl, or other water-affiliated bird species at Icebreaker Wind is low, overall, with some variation among waterbird taxa. Several species of gulls (Ring-billed Gull, Herring Gull, Bonaparte's Gull) are the only bird species shown by baseline studies to utilize the Project area and vicinity at densities generally greater than one bird observed per survey (Norris and Lott 2011). Several additional gull species (e.g. Glaucous Gull [*Larus hyperboreus*], Iceland Gull [*L. glaucoides*], Great Black-backed Gull [*L. marinus*]) likely use the Project area, albeit on an occasional basis (Norris and Lott 2011, eBird 2016). The general behavioral patterns of gulls can lead to higher exposure to potential wind turbine collision risk, as gulls tend to spend a large fraction of time flying, and a substantial fraction of their flight activity may occur within the rotor swept altitudes of wind turbines (Winiarksi et al. 2012). However, gulls are very agile and acrobatic flyers, and possess a high degree of visual acuity, giving them a relatively high degree of aerial maneuverability and a relatively low level of susceptibility to collisions with wind turbines (Cook et al. 2014). For this reason, current practice in avian collision risk modeling for offshore wind facilities in Europe is to assign very high collision avoidance probabilities to gull species (e.g., 0.995 total avoidance probability recommended for Herring Gull and Great Black-backed Gull, Cook et al. 2014). Therefore, although some gull collisions with Icebreaker's turbines may be expected, particularly if gull species exhibit behavioral attraction to the Project (see Behavioral Avoidance/Attraction section), the general level of collision risk for this group is low, and there is no reasonable likelihood that it could affect the populations of any gull species.

In the case of waterfowl and similar species (loons, grebes, coots, cormorants), collision risk is low, both because of low levels of exposure, and also because of low wind-turbine collision susceptibility. Baseline data have shown that only a small number of species in this category utilize the Project area on a regular basis, and in all cases the density of such birds was generally below one bird observed in the vicinity of the Project area per survey (Norris and Lott 2011; and Displacement section). One possible exception to this pattern is Double-crested Cormorant (*Phalacrocorax auritus*), which may experience somewhat higher exposure to collision risk at Icebreaker if it is attracted to the Project's turbines once built, as was observed for Great Cormorants (*P. carbo*) at the Egmond aan Zee Offshore Wind Energy Facility in the Netherlands (Krijgsveld et al. 2011; see Behavioral Avoidance/Attraction section). Although protected by the Migratory Bird Treaty Act, it should be noted that Double-crested Cormorants have been actively managed as a pest species in recent years in the Great Lakes region, as this species' recent population growth is believed to have negatively impacted fish populations (USFWS 2003); hence some collision risk for this species from Icebreaker Wind does not represent a significant concern from a biological or conservation perspective.

Another possible exception to the overall pattern of low exposure could occur if high concentrations of waterfowl and/or similar waterbirds are attracted to ice-free refuges around the Project's turbines. It was recently hypothesized that such refuges could form during extreme ice-over events on Lake Erie by the US Fish and Wildlife Service (USFWS 2016). The USFWS (2016) extended this hypothesized effect to possibly include Bald Eagles as well, noting that eagles could also be attracted to ice free refuges in order to prey on waterfowl, fish, or carrion. In order to examine this possibility, we conducted a systematic analysis of Lake Erie ice formation patterns and movement dynamics, focused on identifying the likelihood that the Project's turbine towers could generate ice-free refuges that would attract concentrations of birds, potentially exposing them to increased collision risk. This analysis was facilitated by the effort that LEEDCo has dedicated to understanding the dynamics of ice formation and movement on Lake Erie as they relate to engineering aspects of the Project.

The overall finding of the analysis of ice-related bird risk is that this risk is low, since open areas will still exist closer to shore even during extreme ice cover events, while at other times when the ice is more open and mobile, there will be a predominance of alternative open areas closer to shore and scattered throughout the offshore ice cover. One factor that influences this conclusion is that extreme ice-over events capable of causing a general scarcity of open water as far as eight to 10 miles offshore in Lake Erie are rare. Table 1 shows the number of days during which ice cover on Lake Erie exceeded 96% dating back to 1973. There were a total of 41 such days over this 44-year period (Table 1).

Table 1. Number of days per year that ice cover exceeded 96% on Lake Erie from 1973 to 2016, according to the US National Oceanographic and Atmospheric Administration's (NOAA) Great Lakes Environmental Research Laboratory (J. Wang, NOAA Great Lakes ice climatologist, pers. comm., November 7, 2016).

	Decade				
Year	1970	1980	1990	2000	2010
0		0	0	0	0
1		0	0	0	0
2		5	0	0	0
3	0	0	0	0	0
4	0	0	5	0	1
5	0	0	0	0	10
6	0	0	6	0	0
7	5	0	1	0	
8	6	0	0	0	
9	2	0	0	0	

Figure 4 shows the mean winter-time ice cover percentage in Lake Erie over the same period. These ice cover patterns indicate that extreme ice-over events, where open water areas may become relatively scarce, are generally rare in Lake Erie.

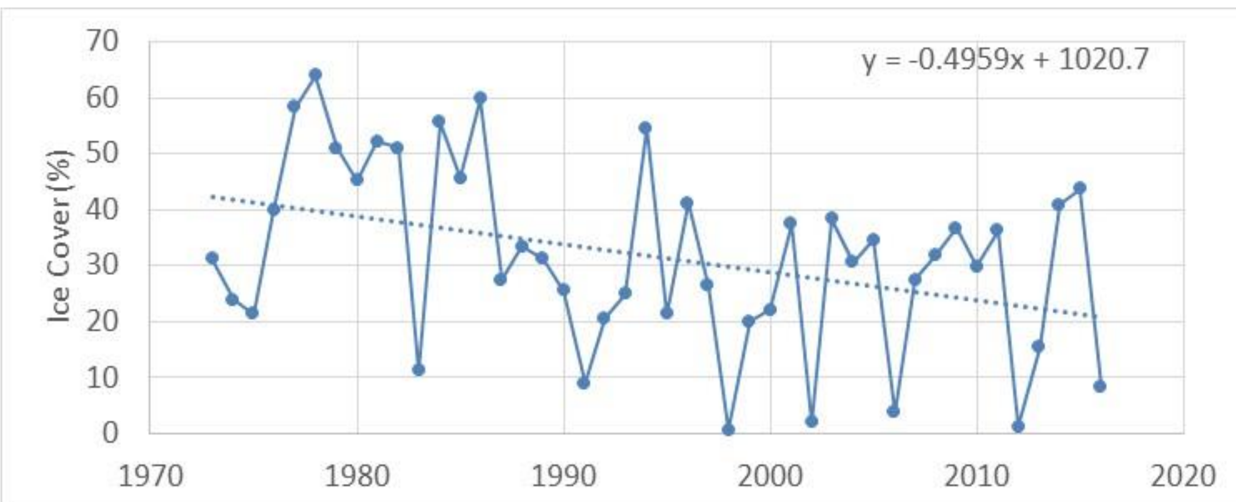

Figure 4. Mean annual winter ice cover on Lake Erie from 1973 to 2016, according to the US National Oceanographic and Atmospheric Administration (NOAA)/Great Lakes Environmental Research Laboratory (GLER; adapted from Wang et al. 2012, and J. Wang, NOAA Great Lakes ice climatologist, pers. comm., November 7, 2016).

The other factor indicating that the risk of bird-attracting ice-free refuges forming exclusively around Icebreaker Wind's turbines is low derives from the ice dynamics of Lake Erie and the Project. Icebreaker's turbine towers will measure seven m (23 ft) in diameter at the ice cone-surface interface. When ice moves past these turbine tower cones, it will fill in rapidly, since the design will cause broken ice chunks to flow around the towers and float in the wake, rather than pile up at the leading edges where the moving ice is contacting the towers (D. Dickins, pers. comm.). Ice pile-ups at the leading edge that could leave the wake relatively clear would only occur with much broader structures in shallower water where the ice could ground on the Lake bottom, such as is known to occur at the Cleveland water intake crib, which is 110' wide and does not have an ice cone (D. Dickins, pers. comm.). Therefore, ice-free wakes that may be created by the Project's turbines under rare circumstances are small, and will fill in rapidly, indicating that there is a minimal chance that they will attract birds.

There is a further fundamental physical consideration that supports the conclusion of low ice-related bird risk. Wakes can only form when ice is moving, and ice can only move when there is open water into which for it to move. Therefore, Icebreaker's turbine towers can only generate broken ice wakes under conditions in which other, larger areas of open water are available nearby; hence, the wakes are not likely to attract substantial numbers of birds. If ice is not moving, for example when extreme cold conditions are combined with calm winds, then Icebreaker's turbine towers will not generate wakes (D. Dickins, pers. comm.).

The image shown in Figure 5 illustrates the availability of ice-free areas on March 6, 2014, which was the day with the maximum ice coverage on Lake Erie that winter, which was the coldest in four decades. Even in this extreme case, large areas of open water are visible throughout most portions of the Lake. Areas of open water during such events may include areas where ice has been blown away from shore by the prevailing winds, cracks, leads, and polynyas created by the movement of ice, and open areas created by warm water outfalls, such as the Avon Lake Power Plant, located roughly 12 miles west of Cleveland (Figure 5). At least five additional outfalls are located along the Cleveland lakefront.

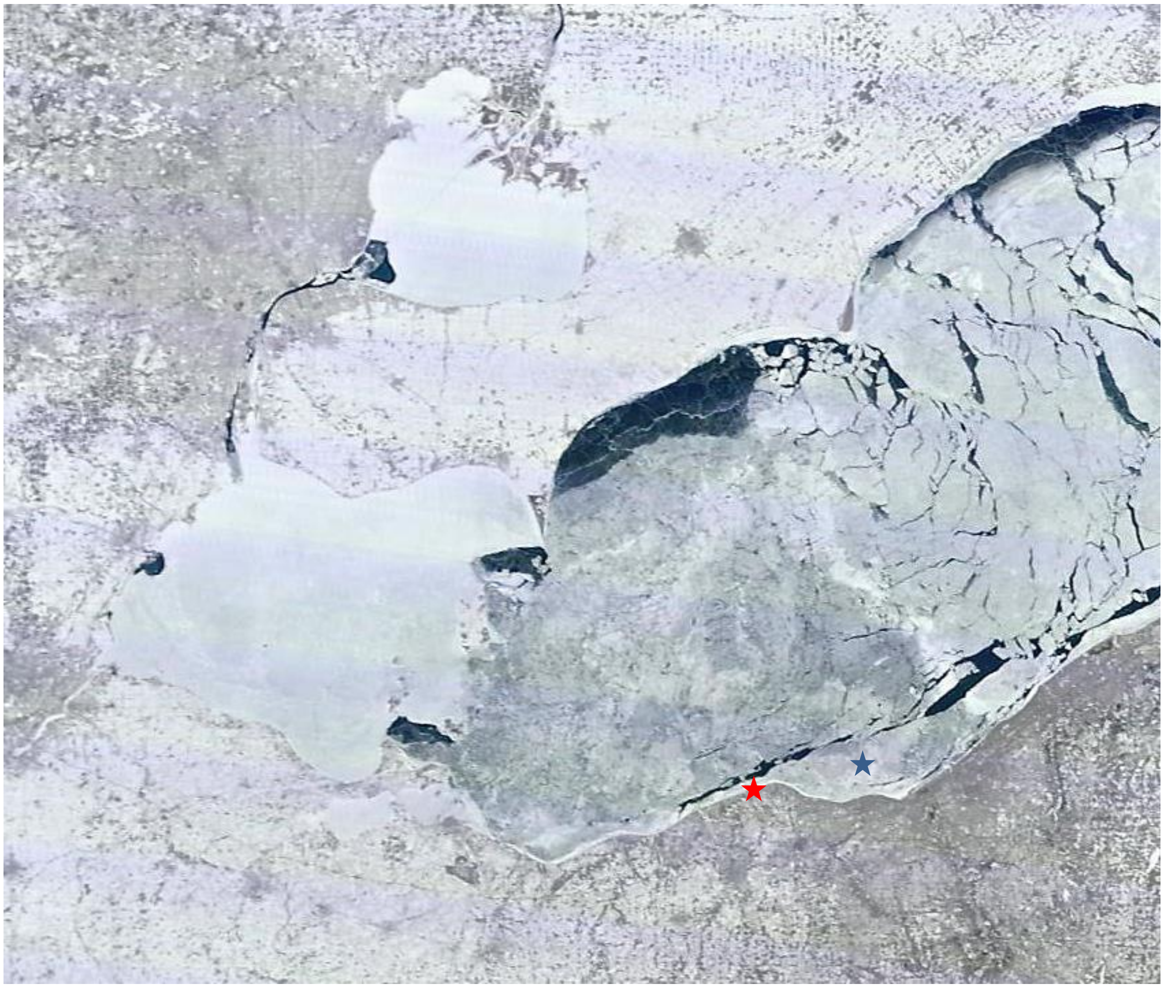

Figure 5. MODIS Terra true color image of western and central Lake Erie, on March 6, 2014, corresponding to the day with maximum ice coverage recorded in 2014 of 96.5% (Source: J. Wang - NOAA/GLERL). 2014 was an exceptionally severe winter, ranked as the coldest on record for the Great Lakes region since 1978/79 (Source: M. Herring - NOAA Boulder). In spite of the extensive ice cover in the central part of the Lake, there are numerous openings and fractures (dark blue areas) scattered throughout the offshore ice sheet as well as extensive shore-following leads with open water between Cleveland and the proposed location of Icebreaker Wind (approximate location shown with a blue star). The location of the Avon Power Plant, a coal-fired power plant that normally produces an ice-free refuge along the Lake Erie shore due to warm water outfall, is shown by the red star. Image courtesy of NASA, processed by the Space and Engineering Center, University of Wisconsin-Madison.

As a final consideration regarding waterfowl collision risk, it is important to note that European studies have demonstrated a strong tendency for flying ducks to avoid offshore wind facilities and turbines (Desholm and Kahlert 2005, Pettersson 2005, Desholm 2006, Larsen and Guillemette 2007, Masden et al. 2009). Furthermore, a variety of studies at land-based wind energy facilities in the US sited near waterfowl concentration areas have also demonstrated low wind-turbine collision susceptibility in waterfowl (Derby et al. 2009, 2010b, Jain 2005, Niemuth et al. 2013). For these reasons, waterfowl are expected to have a low probability of colliding with Icebreaker's turbines, even on the rare occasions when they may be exposed to such risk.

Bats

The level of collision risk for bats at Icebreaker Wind is low. This conclusion stems largely from the small size of the Project, which confers a correspondingly low scale to the possible level of overall bat collision fatality that the Project may generate. Furthermore, the exposure of bats to potential collision risk at the Project is also low, as indicated by the level of acoustic bat activity recorded offshore in the central Lake Erie basin during the baseline study. We recognize that the relationship between exposure and fatality rate is complex and must be interpreted with caution. The relatively low level of bat acoustical activity recorded at offshore studies to date (Ahlén et al. 2009, Pelletier et al. 2013, Boezaart and Edmonson 2014) is consistent with the basic observation that bats are primarily terrestrial animals. In the case of Icebreaker, bats' use of the Project site is expected to be restricted to migratory transits. In contrast to other primarily terrestrial groups with somewhat parallel predictions, such as raptors and songbirds, there is a higher level of residual uncertainty in this prediction for bats, as bats' utilization of Great Lakes offshore environment, and the phenomena associated with potential bat attraction to turbines, are not well understood (McAlexander 2013, Cryan et al. 2014, Schuster et al. 2015). Because this residual uncertainty stems primarily from the possibility of a behavioral attraction effect, we note that it can only be resolved with post-construction observations.

The most informative source of information on the level of bat activity likely to occur at Icebreaker Wind is the bat acoustic study conducted by Tetra Tech in 2010, as part of Icebreaker's wildlife baseline data gathering effort (Svedlow et al. 2012). In this effort, Anabat™ SD-1 (Titley Scientific™, Columbia, Massachusetts) ultrasound detectors were deployed at four land-based locations along the central Lake Erie shore to gather data on land-based bat activity, and four identical detectors were deployed on the Cleveland water intake crib, located roughly three miles offshore of Cleveland in Lake Erie, to gather data on offshore compared with onshore bat acoustic activity in the central Lake Erie basin. Ultrasound acoustic recordings were gathered at these locations during the entire spring and summer/fall migratory periods, the two periods during which most bat collision fatality occurs at Midwestern wind energy facilities (Arnett et al. 2008). Two of the crib-based offshore detectors were located on the crib's crow's nest, roughly 35 m (115 ft) above the surface of the water, and two of the detectors were elevated to a height of approximately 50 m (164 ft) above the water's surface on the guy wires of the crib's meteorological tower. During the spring 2010 deployment (April 1 through May 31, 2010), a total of 244 detector-nights of data were gathered at the onshore locations, and a total of 232 detector-nights of offshore data were gathered at the crib. During the summer/fall 2010 deployment (June 1 through November 10, 2010), a total of 616 detector-nights of data were gathered at the onshore locations, and a total of 482 detector-nights of offshore data were gathered at the crib. The levels of bat acoustic activity recorded over the course of this effort are shown in Table 2.

Table 2. Bat call rates, expressed as the number of calls recorded per detector-night, at onshore versus offshore locations in the central Lake Erie basin, as recorded during the baseline bat acoustic study conducted for Icebreaker Wind (Svedlow et al. 2012, see text for additional explanation).

Location	Spring Call Rate	Summer/Fall Call Rate
Onshore	4.95	51.1
Offshore	0.353	5.28

The Icebreaker Wind bat baseline acoustic study demonstrated that the bat activity level was roughly 10 times greater on land than offshore during both the spring and summer/fall study periods. We note that this comparison may overestimate the level of bat activity likely to occur at the Project site, as the location used to represent the offshore environment in this case, the Cleveland water intake crib, is located roughly three miles from shore, whereas the Project site is located between eight and 10 miles from shore where the abundance of bats is likely to be lower. Boezaart and Edmonson (2014) documented bat acoustic activity at a Great Lakes offshore location even further from shore in Lake Michigan (roughly 30 miles [48 km] from shore). Their study resulted in the detection of some bat calls attributable to several of the most common and widespread migratory bats in the region; however, the study only reported data on bat calls that were unambiguously identified to the species level, and many bat calls cannot be unambiguously identified using state-of-the-art call classification methods; hence, bat acoustic activity rates reported by Boezaart and Edmonson (2014) are not directly comparable to those reported by Svedlow et al. (2012).

Further insight into how the offshore bat acoustic activity data gathered at the Cleveland water intake crib by Svedlow et al. (2012) compare to onshore bat acoustic activity patterns can be gained by comparing the overall rate recorded by Svedlow et al. (2012) to rates recorded during baseline bat acoustic studies conducted for land-based wind energy projects within the region. Figure 6 illustrates such a comparison, showing Svedlow et al.'s (2012) summer/fall offshore bat acoustic data in relation to comparable data from 14 studies conducted at land-based wind energy projects in the Great Lakes region, representing all such studies for which data comparable to the Icebreaker offshore bat acoustic data are publicly available. References and date ranges for the data gathering efforts of these studies are presented in Table 3.

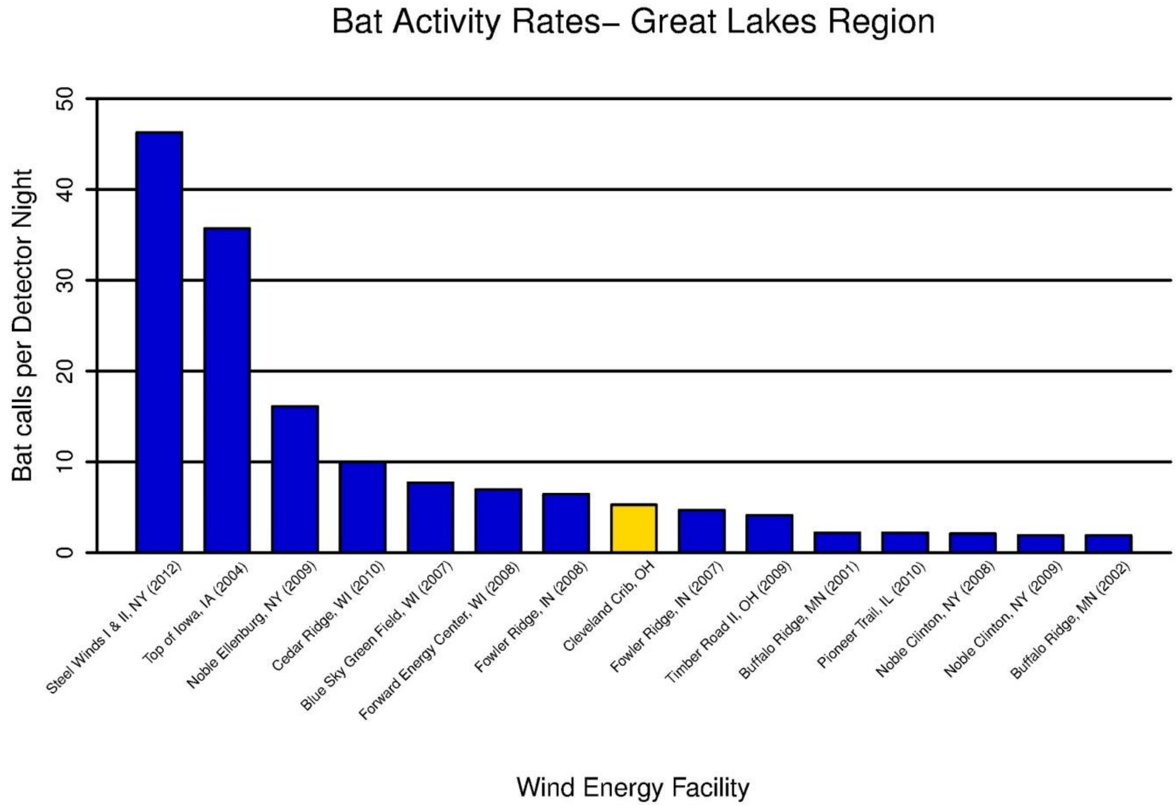

Figure 6. Bat acoustic data during the summer/fall season, expressed in terms of bat calls per detector-night, recorded three miles offshore of Cleveland in Lake Erie at the Cleveland water intake crib (yellow bar labeled "Cleveland Crib", data from Svedlow et al., 2012), in relation to comparable data gathered during 14 baseline studies conducted at land-based wind energy project areas in the Great Lakes region, representing all such projects for which comparable data are publicly available.

Table 3. Data sources and bat acoustic data recording date ranges for the bat acoustic studies whose data are illustrated in Figure 6.

Study	Reference	Date Range
Blue Sky Green Field (2007)	Gruver et al. 2009	7/24/07-10/29/07
Buffalo Ridge (Phase II; 2001/Lake Benton I)	Johnson et al. 2004	6/15/01-9/15/01
Buffalo Ridge (Phase II; 2002/Lake Benton I)	Johnson et al. 2004	6/15/02-9/15/02
Cedar Ridge (2010)	BHE Environmental 2011	7/16/07-9/30/07
Cleveland Crib (2010)	Svedlow et al. 2012	6/02/10-11/10/10
Forward Energy Center (2008)	Grodsky and Drake 2011	8/5/08-11/08/08
Fowler Wind Farm (2007)	Gruver et al. 2007	8/15/07-10/19/07
Fowler Wind Farm (2008)	Carder et. al. 2010	7/17/08-10/15/08
Noble Clinton (2008)	Jain et al. 2009a	8/8/08-09/31/08
Noble Clinton (2009)	Jain et al. 2010a	8/1/09-09/31/09
Noble Ellenburg (2009)	Jain et al. 2010b	8/16/09-09/15/09
Pioneer Trail (2011)	Stantec Ltd. 2011b	7/16/10-10/31/10
Steel Winds I & II (2012)	Stantec Ltd. 2013	5/10/12-11/5/12
Timber Road II (2009)	Good et al. 2010	3/19/09-11/16/09
Top of Iowa (2004)	Jain 2005	5/26/04-9/24/04

Bat acoustic activity is the most commonly gathered form of baseline bat data gathered during the development of wind energy facilities in North America, and is widely regarded as the best indicator of bat exposure to collision risk that can be gathered during the development phase of wind energy projects (Strickland et al. 2011, USFWS 2012). Nonetheless, it is important to note that bat acoustic activity is an imperfect predictor of bat collision risk, as bat acoustic activity is not equivalent to bat abundance (Strickland et al. 2011). Furthermore, the relationship between pre-construction bat acoustic activity levels and bat fatality levels recorded at wind energy facilities subsequent to construction is complex and variable (Hein et al. 2013). For this reason, it is also useful to examine bat fatality rates that have been documented at land-based wind energy facilities in the Great Lakes region in order to generate a more quantitative, if rough, prediction of the level of bat fatality likely to be caused by the operation of Icebreaker Wind. Figure 7 illustrates 55 bias-corrected bat fatality rates that have been produced at land-based wind energy facilities in the Great Lakes region, representing all such studies for which bias-corrected bat fatality rate estimates are publicly available. Reference information for these studies is presented in Table 4. Figure 7 illustrates a distribution of bat fatality rates similar to that presented in an earlier analysis for all of North America by Strickland et al. (2011), with bat fatality rates ranging from roughly 1 to over 30 bats/MW/year.

Given the observation that the bat acoustic activity levels recorded offshore in the central Lake Erie basin were on the low end of the range for land-based wind projects in the region with comparable data (Figure 6), the most parsimonious prediction that can be made regarding the level of bat fatality likely to be generated by Icebreaker is that it will be toward the lower end of the distribution of bat fatality rates recorded at land-based wind energy projects in the region, on the order of 1-4 bats/MW/year (Figure 7). However, given the complexity of the relationship between pre-construction bat activity and post-construction bat fatality rates at land-based wind energy facilities in the US (Hein et al. 2013), and the possibility that bats migrating over Lake Erie may be attracted to the Project's turbines, increasing collision risk, the most precise prediction that is warranted by existing information in this case is that the bat fatality rate at Icebreaker Wind is likely to fall somewhere within the distribution shown in Figure 7, ranging from one to 30 bats/MW/year. Within this range, the overall level of bat fatality likely to be generated by the Project is still moderate, at worst, in relation to land-based wind energy projects in the Great Lakes region, due to the Project's small size.

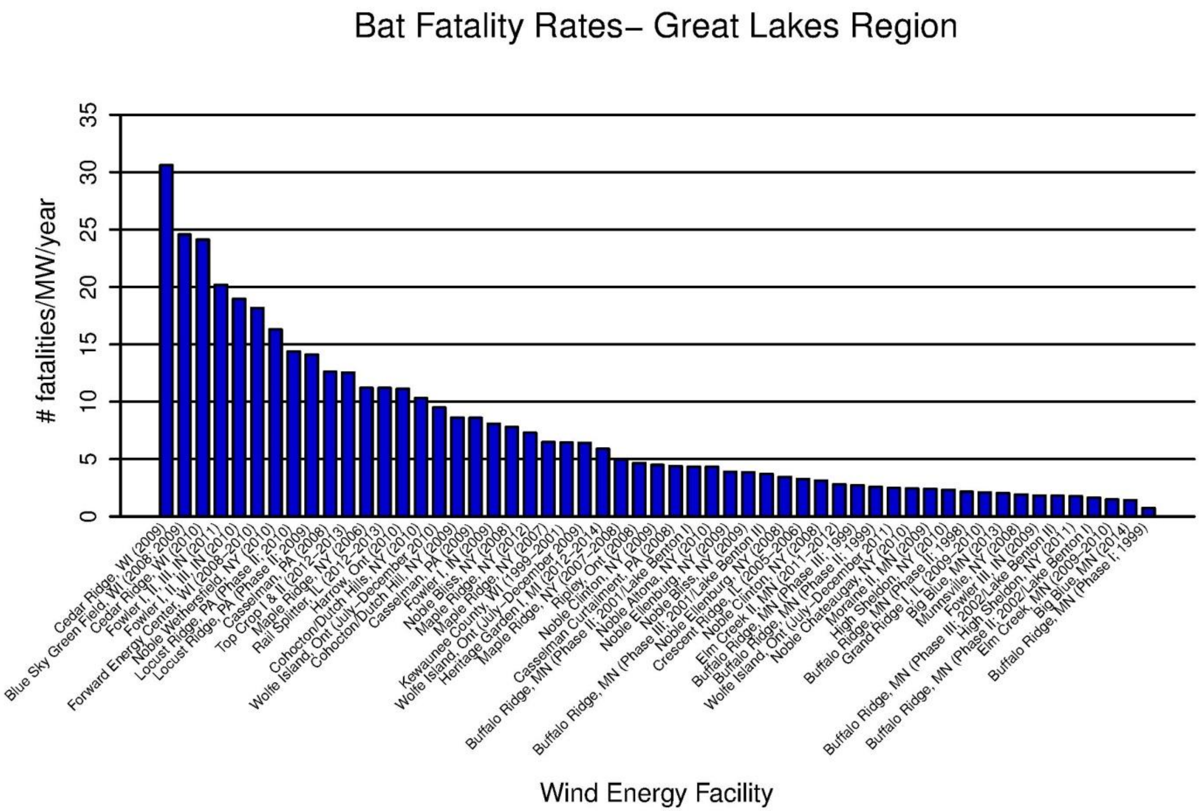

Figure 7. Bias-corrected bat fatality rates, expressed in terms of bat fatalities/megawatt of installed wind energy capacity/year, recorded in 55 studies from land-based wind energy projects in the Great Lakes region, representing all such projects for which comparable data are publicly available.

Table 4. Data sources for the bat fatality rate studies whose data are illustrated in Figure 7.

Facility and Study Year(s)	Report Reference
Big Blue, MN (2013)	Fagen Engineering 2014
Big Blue, MN (2014)	Fagen Engineering 2015
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	Johnson et al. 2004
Casselman, PA (2008)	Arnett et al. 2009a
Casselman, PA (2009)	Arnett et al. 2010
Casselman Curtailment, PA (2008)	Arnett et al. 2009b
Cedar Ridge, WI (2009)	BHE Environmental 2010
Cedar Ridge, WI (2010)	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	Stantec 2010a
Cohocton/Dutch Hills, NY (2010)	Stantec 2011c
Crescent Ridge, IL (2005-2006)	Kerlinger et al. 2007
Elm Creek, MN (2009-2010)	Derby et al. 2010a
Elm Creek II, MN (2011-2012)	Derby et al. 2012
Forward Energy Center, WI (2008-2010)	Grodsky and Drake 2011
Fowler I, IN (2009)	Johnson et al. 2010a
Fowler I, II, III, IN (2010)	Good et al. 2011
Fowler I, II, III, IN (2011)	Good et al. 2012
Fowler III, IN (2009)	Johnson et al. 2010b
Grand Ridge I, IL (2009-2010)	Derby et al. 2010b
Harrow, Ont (2010)	NRSI 2011
Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014
High Sheldon, NY (2010)	Tidhar et al. 2012a
High Sheldon, NY (2011)	Tidhar et al. 2012b
Kewaunee County, WI (1999-2001)	Howe et al. 2002
Locust Ridge, PA (Phase II; 2009)	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011
Maple Ridge, NY (2006)	Jain et al. 2007
Maple Ridge, NY (2007)	Jain et al. 2009b
Maple Ridge, NY (2007-2008)	Jain et al. 2009c
Maple Ridge, NY (2012)	Tidhar et al. 2013
Moraine II, MN (2009)	Derby et al. 2010c
Munnsville, NY (2008)	Stantec 2009
Noble Altona, NY (2010)	Jain et al. 2011a
Noble Bliss, NY (2008)	Jain et al.2009d
Noble Bliss, NY (2009)	Jain et al. 2010c
Noble Chateaugay, NY (2010)	Jain et al. 2011b
Noble Clinton, NY (2008)	Jain et al. 2009e
Noble Clinton, NY (2009)	Jain et al. 2010a
Noble Ellenburg, NY (2008)	Jain et al. 2009f
Noble Ellenburg, NY (2009)	Jain et al. 2010b
Noble Wethersfield, NY (2010)	Jain et al. 2011c
Rail Splitter, IL (2012-2013)	Good et al. 2013a
Ripley, Ont (2008)	Jacques Whitford 2009
Top Crop I & II (2012-2013)	Good et al. 2013b
Wolfe Island, Ont (July-December 2009)	Stantec Ltd. 2010b
Wolfe Island, Ont (July-December 2010)	Stantec Ltd. 2011a
Wolfe Island, Ont (July-December 2011)	Stantec Ltd. 2012

Nocturnally Migrating Songbirds and Similar Birds

The level of collision risk for nocturnally migrating birds (including various shorebirds, songbirds, and other small-bodied land birds) at Icebreaker Wind is low. This conclusion stems from three principal observations, as follows:

1) Nocturnally migrating birds are primarily terrestrial animals, and their expected level of activity at the Project site is expected to be low, and generally restricted to migratory transits.

2) Although substantial broad-front nocturnal migration activity occurs throughout the Great Lakes region, and extends to birds' passage directly over the Great Lakes, including Lake Erie, nocturnally migrating birds exhibit a well-known tendency to avoid flying over large bodies of water if possible, evidenced in the central Lake Erie basin by a radar study that demonstrated that the density of nocturnal migrant bird passage was more than twice as high over land than it was over the Lake during both spring and fall migration.

3) Numerous studies of bird fatality rates at land-based wind energy facilities have demonstrated that fatality rates of nocturnal migrant birds at wind energy facilities are sufficiently low that there is no reasonable likelihood of such fatalities causing population-level impacts to any nocturnal migrant bird species.

The most informative source of information on the passage rates of nocturnally migrating birds through the Icebreaker Wind site and vicinity is a study of nocturnal bird migration density over the Great Lakes vs. over terrestrial environments within the region, published by a team of independent academic ornithologists in *The Auk* (Diehl et al. 2003). This study relied on a region-wide analysis of NEXRAD (WSR-88D) radar data to study nocturnal bird migration patterns over large spatial scales for the entire spring and fall migration periods of a representative year (2000). The authors applied techniques that had been developed over the course of three previous decades of radar ornithology for separating the radar echoes of migrating birds from those of insects, ground clutter, and precipitation, and for controlling for known sources of signal variation, such as signal refraction as a function of distance to the antenna. These authors focused their research on direct comparisons of estimated migrant densities over land versus over water at four locations in the Great Lakes, taking advantage of the locations of four NEXRAD radar antennae with ample viewsheds of both land-based and water-based environments within suitable distance of the antennae, and with minimal or no terrain-related blockage of the portions of the radar beam needed for the comparisons.

One of the locations selected for this comparison was the central Lake Erie basin, using data from the KCLE WSR-88D radar antenna in Cleveland, Ohio. The beam of the KCLE radar is well-suited for detecting nocturnally migrating birds in the central Lake Erie basin out to at least 40 miles from the southern shore, including the Icebreaker site and vicinity. Diehl et al.'s (2003) analysis revealed that the density of nocturnally migrating birds was 2.72 times higher over land than it was over water in the central Lake Erie basin during the spring migration period, and 2.13 times higher over land than over the lake during the fall migration period. Diehl et al. (2003) were also able to document the signature of dawn ascent of migratory birds over water, as well as directional reorientation of migrating birds toward land, suggestive of these birds' tendency to avoid flying over water. These observations are consistent with recent studies by Rathbun et al. (2016) and Horton et al. (2016), who used marine surveillance radar systems deployed in shoreline environments in Lake Ontario and Lake Erie, respectively, to demonstrate high concentrations of nocturnal migrant birds in Great Lakes shoreline environments.

Similar to the case of bats, information on pre-construction patterns of nocturnal migratory bird activity must be interpreted with caution when generating collision risk predictions for wind energy facilities, as the relationship between pre-construction use data and post-construction fatality patterns in birds is complex. For this reason, radar-based studies of nocturnal migrant bird passage rates or nocturnal utilization of airspace within proposed wind facility areas are not included within typical baseline studies for land-based wind farms in the US (Strickland et al. 2011, USFWS 2012). In spite of the known limitations of pre-construction baseline data in general, and radar data specifically (USFWS 2012, Erickson et al. 2014, Kerlinger 2016), for predicting fatality levels of nocturnally migrating birds at wind energy facilities, such data, when considered alongside empirically-derived fatality rates generated from systematic, bias-corrected post-construction monitoring studies at land-based wind energy facilities within the Great Lakes region, can provide a reasonable basis for making a rough quantitative prediction regarding the level of nocturnal migrant songbird fatalities likely to be generated by Icebreaker Wind.

Figure 8 illustrates empirically-derived, bias-corrected bird fatality estimates from 42 studies conducted at operational, land-based wind energy facilities within the Great Lakes region, representing all such studies with publicly available data for the region. Reference information on the studies illustrated in Figure 8 is provided in Table 5. Figure 8 reveals a distribution of bird fatality rates similar to that reported in an earlier analysis of such rates for the entire US (Strickland et al. 2011), although there appears to be a tendency toward lower bird fatality rates at land-based wind energy facilities in the Great Lakes region than for the US as a whole. Commercial wind energy facilities in the Great Lakes region incur roughly two to three bird fatalities per MW of installed wind energy capacity per year on average (Figure 8). Before extrapolating from these data to a prediction of nocturnal songbird fatality rates at Icebreaker, it should also be noted that the rates shown in Figure 8 and considered in recent studies of bird fatalities at land-based wind energy facilities (Strickland et al. 2011, Loss et al. 2013) include a significant proportion of collisions by birds that are local, diurnally active residents in the environment of the wind energy facilities, and whose fatalities are not likely due to collisions during nocturnal migratory flights (e.g., Horned Larks [*Eremophila alpestris*], meadowlarks [*Sturnella spp.*], various doves, Killdeer [*Charadrius vociferus*], and others; Strickland et al. 2011). For this reason, using total bird fatality rates as a basis for predicting nocturnal migrant songbird fatality rates at Icebreaker would likely result in an overestimate of migrant songbird fatality. Nonetheless, it is well-known that nocturnal migrant songbirds comprise the majority of total bird fatality at land-based wind energy facilities in the US (NAS 2007, Strickland et al. 2011), and a recent study by Erickson et al. (2014) demonstrated that fatality rates are typically between 2.10 and 3.35 birds per MW of installed capacity per year for small passerines, most of which are nocturnal migrants. Therefore, total bird fatality rates can serve as a useful, if conservative, basis for predicting the likely fatality rates of nocturnally migrating land birds at Icebreaker, where no diurnal land bird activity is expected.

Given the observation that the nocturnal migrant bird passage density recorded in the offshore environment in the central Lake Erie basin was less than half of the level recorded at comparable sites over land during both spring and fall migrations (Diehl et al. 2003), it is reasonable to predict that nocturnal migrant bird fatality generated by Icebreaker Wind may be lower than typical land-based facilities in the region (Figure 8), assuming all other factors are equal. This would suggest that bird fatality rates at Icebreaker in the range of 1-2 birds per megawatt of installed capacity per year. Given that the Project will contain 20.7 megawatts of installed capacity, one estimate for Icebreaker is 21-42 total bird fatalities per year, most of which will likely be nocturnal migrant land birds. At this level, or even if rates were towards the higher end of U.S. estimates, there is no reasonable likelihood that the Project could have a population level impact on any species of nocturnal migrant bird (see Arnold and Zink 2011 and Erickson et al. 2014 for recent discussions of the likelihood of population level effects in nocturnal migrant songbirds resulting from collisions with wind turbines or other anthropogenic structures).

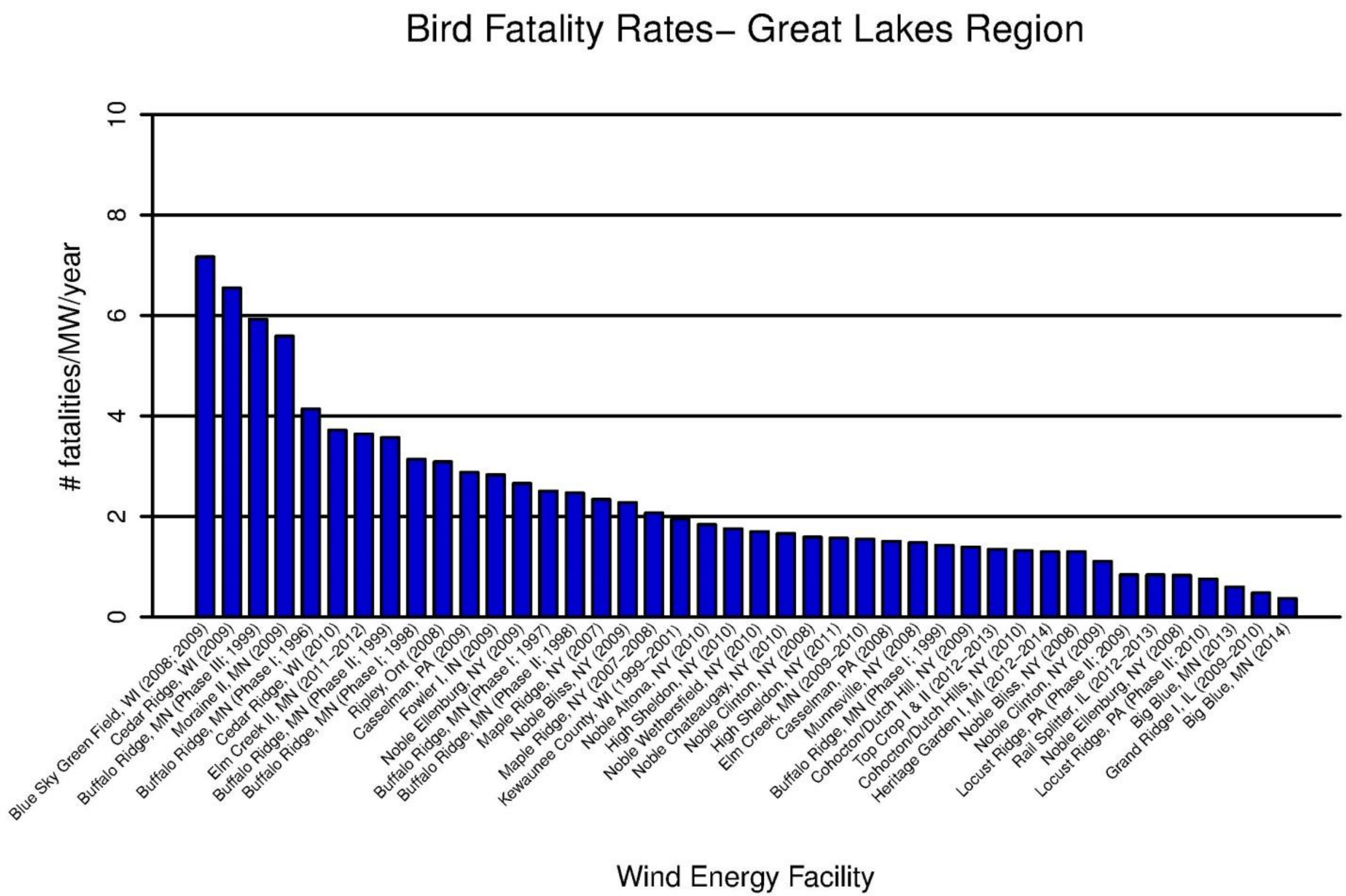

Figure 8. Bias-corrected bird fatality rates, expressed in terms of bird fatalities/megawatt of installed wind energy capacity/year, recorded in 42 studies from land-based wind energy projects in the Great Lakes region, representing all such projects for which comparable data are publicly available.

Table 5. Data sources for the bird fatality rate studies whose data are illustrated in Figure 8.

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Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000
Casselman, PA (2008)	Arnett et al. 2009a
Casselman, PA (2009)	Arnett et al. 2010
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Cedar Ridge, WI (2010)	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	Stantec 2010a
Cohocton/Dutch Hills, NY (2010)	Stantec 2011c
Elm Creek, MN (2009-2010)	Derby et al. 2010a
Elm Creek II, MN (2011-2012)	Derby et al. 2012
Fowler I, IN (2009)	Johnson et al. 2010a
Grand Ridge I, IL (2009-2010)	Derby et al. 2010b
Heritage Garden I, MI (2012-2014)	Kerlinger et al. 2014
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High Sheldon, NY (2011)	Tidhar et al. 2012b
Kewaunee County, WI (1999-2001)	Howe et al. 2002
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Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011
Maple Ridge, NY (2006)	Jain et al. 2007
Maple Ridge, NY (2007-2008)	Jain et al. 2009b
Moraine II, MN (2009)	Derby et al. 2010c
Munnsville, NY (2008)	Stantec 2009
Noble Altona, NY (2010)	Jain et al. 2011a
Noble Bliss, NY (2008)	Jain et al.2009c
Noble Bliss, NY (2009)	Jain et al. 2010a
Noble Chateaugay, NY (2010)	Jain et al. 2011b
Noble Clinton, NY (2008)	Jain et al. 2009d
Noble Clinton, NY (2009)	Jain et al. 2010b
Noble Ellenburg, NY (2008)	Jain et al. 2009e
Noble Ellenburg, NY (2009)	Jain et al. 2010c
Noble Wethersfield, NY (2010)	Jain et al. 2011c
Rail Splitter, IL (2012-2013)	Good et al. 2013a
Ripley, Ont (2008)	Jacques Whitford 2009
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