MINIMIZING THE IMPACT OF WIND TURBINES ON LAKE MICHIGAN'S WILDLIFE

A BCN Green Paper
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Written by Eleanora DiLiscia,with contributions from Libby Hill, Matt Cvetas, and Judy Pollock, on behalf of the Evanston North Shore Bird Club and the Bird Conservation Network.

The Bird Conservation Network (BCN) is aware of a number of off-shore wind farm proposals in Lake Michigan. One project, as described in the Evanston RoundTable, would consist of ten turbines, arrayed north to south, located three to four miles offshore opposite Northwestern's shoreline. Meteorological towers are being installed to study the feasibility of turbines off Chicago. The purpose of this paper is to provide insight into the issues that might impact the Lake's wildlife, particularly birds and bats.

BCN applauds efforts toward developing green energy sources, as climate change threatens people and wildlife alike. We hope, however, to ensure that wind energy development in the Great Lakes does not unduly impact the birds that use the lake.

Birds use Lake Michigan in several ways. Lake Michigan lies directly along one of North America's principle bird migration flyways. It is estimated that 5 to 7 million birds fly through Chicago during migration season. Radar studies show a blanket of migrating land birds over the length of the lake at night – birds such as tanagers, orioles, warblers, and hummingbirds. In the morning, these birds head for the shoreline, looking for a safe haven to rest and feed before continuing their journey. Many birds migrate from the tropics including dozens of rare, declining and endangered species. Strings of thousands of waterfowl, and smaller numbers of hawks, owls, herons, loons, shorebirds and other birds migrate above the lake in the daytime. Federally listed species that have been observed migrating along our portion of Lake Michigan include the Whooping Crane, Brown Pelican, Piping Plover, and Kirtland's Warbler. There is also some indication that bats may fly across the lake.

In the winter, many ducks live on the lake. Large flocks are visible from the shores of Chicago, northwestern Indiana, and many Illinois north shore communities. On most winter days**,** thousands of ducks such as goldeneyes, redheads**,** scaup and mergansers can be seen loafing and diving for food.

Almost every document about wind energy development today contains a special caution about avoiding migratory flyways when siting wind farms. Mistakes were made

in siting early wind farms. The wind farm at Altamont Pass, California kills over a thousand birds each year, mostly hawks, eagles and owls

Since the early days, the wind industry has developed turbines that are more visible to birds, has carefully researched locations and has considered mitigation strategies such as stopping the blades during hazardous conditions for migrants. All these welcome reforms should be adapted to the specific needs of any proposed site. A proposed policy is at the end of this document.

PRIOR RESEARCH:

Researchers have surveyed the impact of wind farms on land and in the North Sea and Gulf of Mexico. The Great Lakes have not been studied, and the exact nature of the hazards that wind turbines pose to their wildlife is yet to be determined. While a great deal of research is still needed, below is a partial summary of the surveys made to date:

Birds of Prey (Raptors): Researchers monitoring bird fatalities have found that turbine type, bird density and the siting of the individual turbines are the factors most likely to increase collisions. Birds strike newer turbines less than older designs. Greater numbers of raptors lead to greater likelihood of collision. Fatalities have also related to turbine site characteristics and the positions of turbines within a string. Higher strings near canyons and at the end of rows of turbines caused more raptor deaths. These studies indicate that where turbines are placed during construction of a facility can be critical.

Migrant Landbirds: Studies seem to show that the number of collisions between passerines (the perching birds which make up most of the migrant landbird population) and turbine blades at onshore facilities may not be significant at the population level, except possibly where migrating birds are concentrated or there are rare species. Not all flocks of migrants are equally affected: those that fly at high altitudes during good weather are able to avoid turbines. Radar shows that flight altitudes vary during the night and between nights.

Atmospheric conditions affect a migrant's choice of flight direction and altitude. One study estimated that as many as 51 of 55 collisions may have been associated with bad weather. Migrants have been shown to fly lower when cloud ceilings are low. Studies also show that while half of bird fatalities appear to be night flying migrants, the other half are resident birds. Night flying migrants in bad weather are of particular concern for Lake Michigan (Lighting has not been a factor since wind turbines tend to use red strobe or blinking lights, which research has shown to be less attractive to migrating birds. One facility had significant bird strikes on a foggy night when sodium vapor lights were used, but no further collisions occurred when the lights were turned off.)

Most studies show that passerines may be killed anywhere in a facility, and that site characteristics may not play as great a role as with raptors. However, wind farms located on eastern forested ridges have proved particularly deadly.

One research problem with passerines is that it may be difficult to determine exactly where the bird collided. Most studies assume the birds struck moving turbine blades, but they may have collided elsewhere on the structure.

Shorebirds: Very few fatalities appear to occur for shorebirds.

Bats: Recent studies suggest that bats are greatly at risk from turbines, even more so than from other structures. Some facilities kill thousands of bats each year. They appear to be attracted to the turbines, for reasons that are not well understood. The risk is particularly high when the turbine blades are rotating at maximum speed. Lighting does not appear to affect the risk. According to one study, bats are possibly less prone to death by collision with turbines than by hemorrhaging caused by rapid pressure change – an effect of wind turbines

Breeding Season Habitat: Little is known about the impact on habitat loss from wind farm development, and even less so concerning the Great Lakes. The greatest impact may be less from the construction and footprint of the site and more from the resulting disturbance and avoidance of habitat by birds that live in the affected habitat. Based on current research about the avoidance of tall structures by grouse and other grassland birds, the US Fish and Wildlife Service recommends that no wind turbines be sited within five miles of prairie grouse breeding ground. One Minnesota study did find that breeding bird densities were lower in those fields containing turbines than those without. The turbines may also be severely impacting local populations of the western burrowing owl. There are indications that disturbance and avoidance of habitat could affect the flocks of ducks that live in Lake Michigan in the winter (see next section).

Off Shore Facilities: North Atlantic studies indicate that the major risks to sea birds and resting birds are: 1) permanent loss of habitat, 2) collisions and 3) barrier effects such as fragmentation of the breeding or feeding areas. While sea birds may adapt better to turbines than land birds, collision and disturbance were considered the primary impacts on these birds. Large wind farms may diminish foraging (feeding) and resting conditions. Lake Michigan is an important winter feeding ground for waterfowl. Studies in the North Sea found that most birds avoided the wind farms, reducing the risk of collision, but also reducing the habitat available to them. Some species later began to use the habitat, while others didn't. An improperly sited wind farm in Lake Michigan could impact the survival of wintering birds that rely on the habitat. More study on the cumulative effects of this avoidance is still needed

The behavior, abundance and diversity of migrating birds may differ greatly over water from inland. Studies in the Gulf of Mexico show that migration tends to be an all or nothing phenomena. When strong cold fronts come in, migration halts. Local radar studies show significant migration over Lake Michigan. Before projecting the impact of

a Great Lakes wind farm, we must study the specific timing, routes and altitudes in movement between migrating and resting areas.

Birds were found to collide less often with the middle row of wind turbines indicating that a cluster formation might be better than a line formation. Lighting on the turbines was believed to be harmful, particularly in bad weather conditions. More birds collided with the rotors at night and twilight than during the day. One study near the Dutch coast estimated that 1 out of every 76 birds passing the towers at night were expected to collide with turbines. The Wildlife Society's 2007 technical review concluded that further studies are needed to better define offshore risks, and in the meantime, wind farms should be sited away from migratory paths, bird habitat and large concentrations of species at higher risk.

ISSUES:

The above research, while not specific to the Great Lakes, shows that the location of a wind farm can be critical. Therefore, risk evaluations and pre-construction monitoring are vital to learning which steps are needed to minimize potential impacts. Several questions concerning the particular nature of wildlife on Lake Michigan must be addressed before planning the wind farm. These questions are as follows:

1) How do birds use the Great Lakes in winter, during migration or at night? What are the differences in use according to species, for example raptors vs. ducks or songbirds? Are there zones in which different species operate? Would the freezing of areas near the shore force birds into the zone occupied by the wind turbines? How far offshore do birds use the lake for any purpose at any season? How far offshore should the turbines be?

2) What constitutes good habitat for the birds that rest on and feed in the lake during winter and migration? Do they congregate in water of a certain depth, or around reefs? Would the wind turbines create habitat loss or fragment habitat for wintering or breeding birds?

3) How many birds and bats use the lake?

4) How can the impact of the turbines on wildlife be documented? Birds that are killed over water may not be found. Some method for determining cause of death must be used. It is also important to determine how the turbine caused the bird's death. Did the bird fly into the blades or somewhere else?

5) What is the effect of low ceilings and/or cloud cover on nocturnal migrants? Does the resulting poor visibility cause more collisions? What effect do the air currents caused by the low ceiling have on flight patterns? There is good evidence that on certain nights of lowering

cloud cover, thousands of birds are killed at lighted buildings in urban centers, because the weather pattern brings them down to the height of the buildings. It is a fair assumption that these conditions over the lake would bring the birds down to the height of the wind turbines. What is an estimate of the frequency and mortality levels of such events?

6) Is there a danger of wind currents blowing birds or bats into the turbines? Can this be addressed?

7) How should the turbines be configured in terms of speed, size, length of the blade and placement vis a vis other turbines to avoid impact on wildlife? For example, studies indicate that newer models of wind turbines pose less threat to wildlife. Towers in salt water do not need to withstand the impact of frozen water and punishing gales. A new type of tower will need to be engineered for the Great Lakes. Care must be taken to ensure that the features of this new tower use the best practices for reducing bird strikes.

8) To what extent can data concerning wind farms on land be adapted to wind farms over water?

9) Will the transmission cable be buried in lake bed? What will be the impact on the birds' food sources? Should certain areas of lake bed be avoided?

SUMMARY:

BCN recommends that the above questions first be addressed before designing any wind farm for Lake Michigan. Review of radar data and literature may go a long way to answering some of the questions, but the question of how diving ducks and other water birds use the habitat in the lake during winter and migration is one that will require new research. Such research should be initiated well before any plans are drawn up. We recommend that no wind farm be placed in areas that are consistently used for winter habitat. Areas that show dense migration patterns should be avoided as well. Alternatively, turbines might be turned off on nights with high migration or adverse weather conditions. Any wind farm design should include features that mitigate the farm's impact on birds, for example, by using strobe lights instead of steady ones.

In summary, decisions made in siting turbines during construction can be critical to a wind farm's impact on our Lake's wildlife. Turbines are more dangerous where birds are abundant or where they are migrating through in large concentrations. Both of these conditions may be found on Lake Michigan. The cumulative effects of the wind farm on birds as well as bats must be thoroughly researched and monitored.

Wind power is going to come. BCN simply wishes to insure that it will be as benign to birds, bats and other wildlife as possible.

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Appendix 1

TURBINE TYPE: Considerations when choosing turbine type/characteristics to minimize potential for bird impacts:

a. Building-integrated turbines are preferable to self standing.

b. Open lattice supports (towers) are strongly discouraged because they serve as perching points for birds.

c. Slower blade movement is preferable to faster blade movement.

d. Visible blades are preferable to invisible (when blades are moving).

e. Lighting tower structures increases bird takes. Steady red lighting and a combination of red steady and flashing lights have been shown to pose the most threat to bird safety; flashing white light is preferred in terms of birds. However, please check on FAA requirements.

f. Guy wires, used to stabilize the poles for both turbines and anemometers, are notorious for bird takes. Where possible, guy wires should be avoided. Anemometers should be placed as low as possible (ideally under 150 feet), and ideally only up during non-migration periods (summer and winter).

Appendix 2

Excerpted from American Bird Conservancy's Wind Energy Policy, Siting Review Section:

1)… surveys should be conducted before wind turbines are approved or constructed that would entail both on-site observations of birds on a seasonal basis (e.g., bird passage during spring and fall migration), as well as more detailed evaluation of the use of the site by birds, particularly of species of concern. Surveys for nocturnal migrants where migratory corridors exist, especially for wind projects along mountain ridgelines, should be conducted. If there are science-based concerns over avian mortality requiring more detailed surveys, two years of pre-construction surveys of migratory birds should be considered. As migration is highly variable in magnitude and temporal and spatial distribution, one year is considered a minimum for identifying potential problems, unless projects are very small or located in areas that have a very low risk to birds. The intensity and duration of preliminary studies can be reduced for projects in areas where risk to birds and bats is clearly low, such as small projects or projects in areas where existing data suggest little bird or bat use. Other research techniques and tools, such as Nexrad, may evolve that can provide an adequate level of confidence about migratory patterns and behavior and may be able to reduce the time required for such studies.

There are two basic steps that should be followed when reviewing sites for bird abundance and migration patterns:

1. Biologists should complete a site assessment by conducting a literature review, evaluating existing published and unpublished data, speaking with people knowledgeable about the area, and conducting reconnaissance surveys to document major vegetation types and likelihood of bird, bat and other wildlife impacts. These reconnaissance surveys should be used to identify potential issues related to site development and to eliminate

sites that have a likelihood of causing significant negative wildlife impacts following development.
2. After potentially suitable sites are located, a second level of more intensive surveys should be initiated, if warranted, that quantify bird and bat use of the proposed sites. These follow-up surveys may be necessary because reconnaissance surveys may not provide the level of understanding and detail needed for siting a wind farm, or for siting individual turbines. In other situations, such as for Golden Eagles at Altamont Pass in California, even more intensive studies are needed (i.e., population level studies).
Sites known to be used by birds and bats listed under the Endangered Species Act should be avoided if the construction and operation of wind plants might adversely affect these species. ABC also recommends that locating turbines in known local bird migration pathways, in areas where birds are highly concentrated, or in areas or landscape features known to attract large numbers of raptors should be avoided, unless mortality risk has been analyzed and the likelihood of significant mortality has been ruled out. ABC also recommends that locating turbines in known local bird migration pathways, in areas where birds are highly concentrated, or in areas or landscape features known to attract large numbers of raptors should be avoided, unless mortality risk has been analyzed and the likelihood of significant mortality has been ruled out.

Independent analysis is important to the process. The U.S. FWS Guidelines contain a site evaluation checklist process for pre-development site evaluations and a ranking system for comparison with different sites. These Guidelines recommend that pre-development evaluations should be conducted by a team that includes federal and/or state agency wildlife professionals with no vested interests (such as monetary or personal) in the sites selected. These pre-development evaluations may include academic and industry consultants on the team. ABC suggests that these site assessments, as well as all other studies related to the impact of wind energy on birds and bats, be conducted by qualified professionals without a vested interest in the outcome of the studies. ABC recommends that all studies be conducted in a collaborative manner involving stakeholders.
From Offshore Wind Turbines Section:

A. ABC WIND ENERGY POLICY APPLIES TO LAND-BASED PROJECTS.
While some of the siting, operational, and monitoring recommendations contained herein may be useful in reviewing offshore wind project proposals, the ABC Wind Energy Policy applies to land-based wind energy projects. ABC notes that offshore wind power in the U.S. is a nascent industry without statutory interpretation, case law, or administrative guidance. The U.S. Fish and Wildlife Service voluntary guidelines for siting and operating wind turbines cited above, as well as state guidelines for wind energy projects, all apply to land-based turbines. Efforts are underway to develop guidelines for offshore projects. ABC will update its wind energy policy and information at a later date to include offshore wind plants.

B. OFFSHORE WIND PROJECT STATUS.
There are no currently operating offshore wind turbines in the U.S. and none under construction. More than a dozen offshore wind energy plants are operating in Europe with over 200 turbines. Information is available on most of these European wind

projects. Seven applications for offshore wind energy projects have been filed with the U.S. Army Corps of Engineers for turbines off the coast of Massachusetts, New York, Virginia, and in the Great Lakes. Siting is expected to be a critical issue with potential problems for slower flying, larger seabirds and waterfowl.

Appendix 3

Excerpts from **US Fish and Wildlife Service INTERIM GUIDELINES TO AVOID AND MINIMIZE WILDLIFE IMPACTS FROM WIND TURBINES 2003**

(Italics ours)

Site Development Recommendations
The following recommendations apply to locating turbines and associated structures within WRAs selected for development of wind energy facilities:
1. Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act.
2. *Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated,* unless mortality risk is low (e.g., birds present rarely enter the rotor-swept area). Examples of high concentration areas for birds are wetlands, State or Federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.
5. Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. …
6. *Avoid fragmenting large, contiguous tracts of wildlife habitat.* Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.

Appendix 4

Excerpted from
http://www.abcbirds.org/newsandreports/releases/070430_testimony.html
The House Subcommittee on Fisheries, Wildlife and Oceans
Oversight Hearing on: "Gone with the Wind: Impacts of Wind Turbines on Birds and Bats."
Testimony of Donald Michael Fry, PhD
Director, Pesticides and Birds Program
American Bird Conservancy
May 1, 2007

As members of this subcommittee may know, the Department of Energy formed a consensus-based collaborative in 1994, the National Wind Coordinating Collaborative (NWCC), which is comprised of representatives from the utility, wind industry, environmental, consumer,

regulatory, power marketer, agricultural, tribal, economic development, and state and federal government sectors. The purpose of the collaborative was "to support the development of an environmentally, economically, and politically sustainable commercial market for wind power". The NWCC has been an active forum for discussion of environmental issues, and subcommittees of the NWCC have developed several fact sheets and methods and metrics documents in an effort to identify risks to wildlife from wind projects, and to recommend actions that could be taken by industry to prevent, reduce, or mitigate collision mortality and habitat destruction arising from the construction and operation of wind projects within the US.

My experience with NWCC, however, has been that there has been much discussion and almost no real action on the part of the wind industry to resolve bird collision issues at wind project areas.

The wind energy industry has been constructing and operating wind projects for almost 25 years with little state and federal oversight. They have rejected as either too costly or unproven techniques recommended by NWCC to reduce bird deaths. The wind industry ignores the expertise of state energy staff and the knowledgeable advice of Fish and Wildlife Service employees on ways to reduce or avoid bird and wildlife impacts.

Biological Significance of wind turbine mortality.

While the actual number of birds killed by wind turbines is unknown, estimates have been made in the range of 30,000 to 60,000 per year at the current level of wind development. The wind industry is prepared to increase the number of turbines 30 fold over the next 20 years, in order to fulfill the President's request that renewable energy projects supply 20% of the nation's energy needs by 2030.

At the current estimated mortality rate, the wind industry will be killing 900,000 to 1.8 million birds per year. While this number is a relatively small percentage of the total number of birds estimated to live in North America many of the bird species being killed are already declining for other reasons, and losses of more than a million birds per year would exacerbate these unexplained declines. Data from the FWS Migratory Bird Management and Breeding Bird Survey by the US Geological Service indicate that at least 223 species of our native bird species are in significant decline (about 1/4 of all species in US). The mortality at wind farms is significant, because many of the species most impacted are already in decline, and all sources of mortality contribute to the continuing decline.

A Proposal for Meaningful Federal Participation to solve wildlife problems:

…

Below several important research topics that have not been adequately addressed since their discovery shortly after operation of the wind projects at Altamont Pass began 25 years ago. When answers to these questions are available, they should be incorporated into the BMPs, and enforced by the appropriate authorities. The logical federal agency to have authority over promulgation and enforcement of BMPs. would be the FWS.

Require efforts to reduce habitat loss during construction and operation of wind projects.

Require adequate studies prior to siting wind projects to avoid important and sensitive bird areas.

Require modifications to locations or operation of turbines that kill a disproportionate number of birds.

Require real-time radar to be installed at wind projects that are located in regions with high numbers of migratory birds, and require project shut-downs when flocks of birds at risk from collisions are detected approaching the wind project.

Critical research needs to be done in the following areas:

…

Can automated technologies be developed that detect bird strikes to turbine blades?

If acoustic, photographic or other sensitive automatic detectors could be developed within rotor blades or turbine hubs to monitor bird strikes, the uncertainty and expense of carcass searches and repetitious monitoring of wind farms could be eliminated, and better information on problem turbines would be generated. The costs of incorporating sensitive detectors into rotor blades or hubs would be very small compared to the overall costs, and cost reductions from reduced monitoring and analysis would be significant.

How will bird strikes be evaluated at offshore wind projects?

Which bird species (ex Brown Pelicans and Gannets) are at risk from offshore wind projects?

Will offshore wind projects exclude wintering migratory sea ducks and other birds from traditional feeding habitats?

The last three questions deal primarily with offshore wind projects, and need to be addressed to the Minerals Management Service Environmental Studies Program, as they gear up for environmental studies in conjunction with leasing offshore areas for wind projects.

All of these unanswered questions have been posed to the National Renewable Energy Laboratory of the Department of Energy and to the Minerals Management Service. At the current time there is no adequate budget to answer these or other questions, but wind projects are going forward at an increasing rate without answers to these questions, and without adequate involvement of the Fish and Wildlife Service for development of enforceable guidelines for preventing or minimizing bird kills and habitat losses.

The Department of the Interior and U.S. Fish and Wildlife Service Interim Guidelines for Siting Wind Towers, 2003:

Site Development Recommendations

The following recommendations apply to locating turbines and associated structures within WRAs selected for development of wind energy facilities:

1. Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act.

2. Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low (e.g., birds present rarely enter the rotor-swept area). Examples of high concentration areas for birds are wetlands, State or Federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.

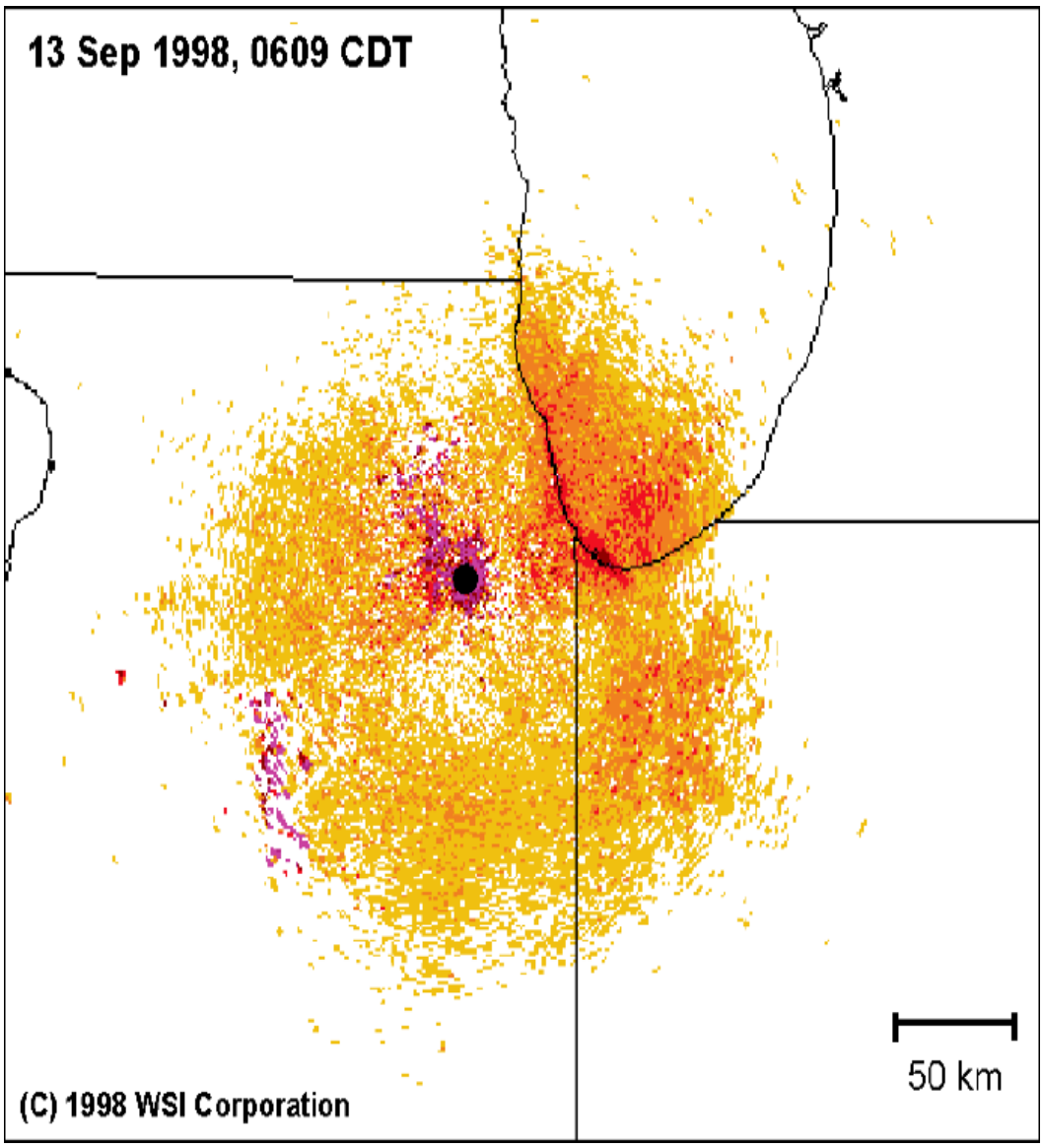
3. Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.

5. Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species (e.g., Sage Grouse).

6. Avoid fragmenting large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.

Appendix 5

Excerpted from
Migration in the Great Lakes Basin
Ronald P. Larkin, Wildlife Ecologist
Illinois Natural History Survey
http://www.fws.gov/midwest/greatlakes/windpowerpresentations/LarkinToledoGreatLakes.pdf



The red areas show higher concentrations of migrating landbirds in this early morning radar picture of fall migration over Lake Michigan.

Appendix 6

Lake Michigan Offshore Wind Power Policy Proposal

Wind farms should not be installed on or near the Great Lakes until their impact on wildlife is better understood. This includes bird and bat collisions with turbines and loss or fragmentation of the foraging and stopover habitat of populations of migrating, wintering, and breeding birds using the lakes and their airspace.

The Great Lakes region is widely acknowledged as one of the most important natural resources and migratory flyways for birds and bats in North America. More than 300 species of birds including – hawks, owls, falcons and other raptors; loons, ducks, gulls, terns, and shorebirds – migrate along its shorelines or fly directly over the Great Lakes each spring and fall. State and federally endangered species like the Piping Plover and Common Tern breed on or near its shores and significant numbers of waterfowl and gulls winter on the lakes. Because there has been so little research in many parts of the Great Lakes, the potential impact of wind farms on Great Lakes wildlife is virtually unknown.

It is recommended that a mandatory three years of potential site monitoring research be required of any developer seeking to construct a wind farm in the Great Lakes region. Monitoring should focus on areas where there are significant gaps in information regarding the specific migration and wintering habits of migrant songbirds, hawks and falcons, owls, waterfowl, loons and other waterbirds, gulls, terns, and bats on and over the Great Lakes. Research should attempt to correlate lake topology (e.g., depth, distance from shore, islands) with wildlife use in all seasons and conditions, and to identify areas heavily used by birds. Potential for collision and also effects of disruption of habitat such as habitat fragmentation, site avoidance, barrier effects, and creation of marginal / suboptimal habitats should be considered.

The results of any research should be made public for review prior to the approval of any construction. Based on the results, potential zones of exclusion and /or recommended seasonal or timed shutdowns to avoid peak migratory periods should be considered to preserve areas of special concern. It is also advised that monitoring should continue during and post construction to fully measure the impact of installed systems.

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