Guidance for Minimizing Impacts to Natural Resources from Terrestrial Commercial Wind Energy Development Wisconsin DNR

1. INTRODUCTION

The development of wind energy resources in Wisconsin is an important component of state energy policy (PSC 2010), and wind power plays a prominent role in a national strategy to achieve energy independence (USGAO 2005). Wisconsin's Renewable Portfolio Standard[1] requires the state to obtain 10% of its electricity from renewable energy sources by 2015, and 25% by 2025. Accordingly, wind generation is expected to play an important role in meeting Wisconsin's future electrical energy needs (PSC 2010). The Wisconsin Department of Natural Resources (WDNR) advocates the prudent and environmentally responsible development of wind energy in the state.

A U.S. Department of Energy wind resources map for Wisconsin (**Figure 1**) depicts the annual average wind speeds at 80 meters above the surface. Areas with annual average wind speeds at 6.5 m/s and greater are generally thought to have suitable wind resources for development (USDOE: http://www.windpoweringamerica.gov/wind_maps.asp).[2] The map shows that eastern, east-central, southeastern, and portions of northeastern, southwestern, and western Wisconsin have the greatest potential for wind power development, especially along the coast of Lake Michigan, where the wind resource potential is classified as "good" to "excellent" (U.S. DOE National Renewable Energy Laboratory, 3 March 2009). Based on these maps, the ecological landscapes most likely to be affected by wind farm development are (not ranked in order of importance): *Northern Lake Michigan Coastal, Central Lake Michigan Coastal, Southern Lake Michigan Coastal, Southeast Glacial Plains, Southwest Savanna, Central Sand Hills, Western Coulee & Ridges, and Western Prairie* (http://dnr.wi.gov/landscapes/).

Commercial wind projects[3] in Wisconsin will vary considerably from 1 to well over 100 turbines. Some portions of the state, most notably the Niagara Escarpment, already experience multiple wind projects in close proximity. Depending on topography and landowner participation, turbine layouts may be irregular rather than in clusters or rows.

Wind turbines most commonly used in Wisconsin wind projects have a rated capacity of 1.5 to 2.5 megawatts (MW), and they extend over 400 feet to the vertical tip of the blade (**Figure**

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[1] A target value set for the proportion of a state's electric power consumption to be met by renewable energy sources, such as wind, solar, biomass, geothermal, etc.

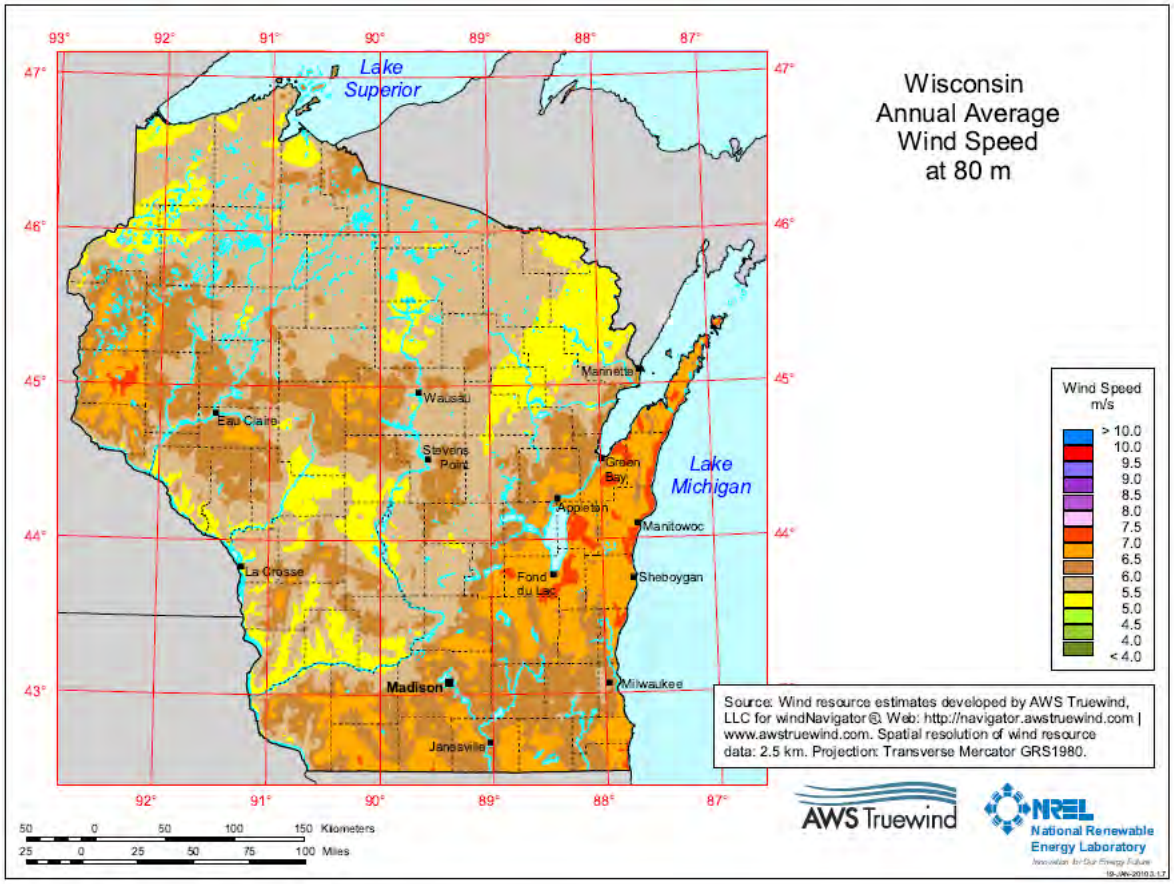
[2] A map of mean annual wind speeds in Wisconsin at 100 meters is unavailable for download to this document; however, it can be viewed at: http://www.focusonenergy.com/files/Document_Management_System/Marketing/windmeanannualwindspeed100m_map.pdf.

[3] Commercial is any wind energy system that exceeds the definition for small wind and has the primary objective of transmitting energy offsite. A small wind energy system is defined as a wind energy system that has a total installed nameplate capacity of 300 kilowatts or less and that consists of individual wind turbines that have an installed nameplate capacity of not more than 100 kilowatts.

2). Larger (3 MW) units approaching 600 feet are a possibility in the future. The blades on existing turbines can reach over 183 feet in length, yielding a rotor swept area of over 26,000 square feet. The tip of the blade moves at tip speeds up to 295 feet per second.

Despite its growing appeal as a renewable alternative energy source, wind power production can adversely impact wildlife through direct mortality or indirectly through habitat fragmentation and displacement. Especially vulnerable are bats (Keeley et al. 2001, Johnson et al. 2002, Johnson et al. 2003, Cryan and Brown 2007, Kunz et al. 2007b, Arnett et al. 2008, Cryan 2008) and birds (Leddy et al. 1999, Hunt 2002, Erickson et al. 2005, Everaert and Stienen 2006, FWS 2010), with variability in the types of birds and bird species impacted depending on location (Erickson et al. 2005, Everaert and Stienen 2006). The location, array, number, height, rotor swept area, and blade speed all determine how bats and birds are affected by wind turbines. Post-construction studies indicate that bats are generally at greater risk of mortality from wind turbines than birds. Mortality may also have a

Figure 1. *Wisconsin Annual Average Wind Speed at 80 Meters*

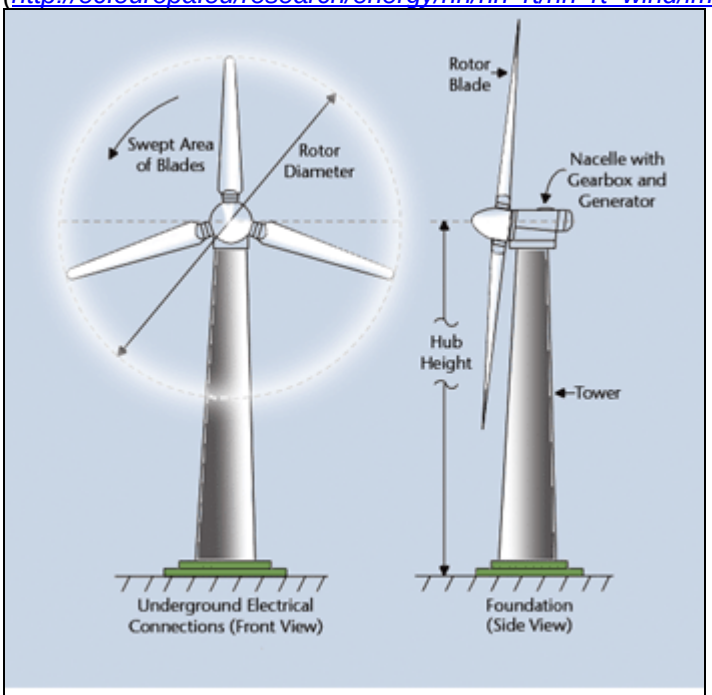


disproportionate effect on bird species that are listed under federal or state endangered species laws as threatened or endangered or whose populations are declining in numbers (Watts 2010). Loss or reduction in the quality of habitat and barriers to movement are only now being investigated on the heels of fatality studies, and are potentially important for both bats and birds (Pierce-Higgins et al., 2009; National Academy of Sciences 2007).

When consulted early in the development of a wind generating project, the WDNR will provide technical advice on how to avoid, minimize, and mitigate impacts to natural resources, especially bats, birds and their habitats.

This Guidance has been developed to help wind project reviewers, planners and owners address potential impacts and prevent unwanted and avoidable conflicts with area or site-specific natural resource management objectives. It is consistent with guidance published by the U.S. Fish & Wildlife Service and by state resource agencies within the Great Lakes region. The literature and resources cited in Section 8 provide the technical basis for this Guidance. We strongly urge potential developers to become familiar with this information and current developments pertaining to wildlife and wind turbine interactions. The Department will update this guidance periodically as more information becomes available on the impacts of wind turbines on wildlife.

Figure 2. *Operational Wind Turbine*
(http://ec.europa.eu/research/energy/nn/nn_rt/nn_rt_wind/images/wind_en_1370.gif)



Drawing of the rotor and blades of a wind turbine, courtesy of ESN

2. GUIDANCE APPLICABILITY

This guidance is applicable to all onshore commercial wind projects from the earliest phases of project siting through operation and should be used by all potential project developers as well as federal, state and local entities that participate in the evaluation, permitting or approval of wind projects. Consultation with the WDNR is strongly recommended at least two years prior to project construction.

This guidance has not been developed for private landowners with small wind turbines less than 100 kW or 175 feet tall, but the document may be useful to them when considering factors to consider in siting small turbines. This guidance will be used by WDNR staff charged with evaluating wind projects to comply with state and local requirements, WDNR permits, or other regulations.

Information compiled through this guidance may be applied to environmental analysis documents prepared under the National Environmental Policy Act (NEPA) or the Wisconsin Environmental Policy Act (WEPA), in support of state or federal permit applications, or for permits issued by other authorities, such as the Public Service Commission of Wisconsin's (PSC) issuance of a Certificate of Authority (CA) or Certificate of Public Convenience and Necessity (CPCN).

The first part of this Guidance addresses site characterization in considering the overall natural resource value of the site. The remainder of this Guidance stresses evaluation and study protocols for bats and birds. Reports of impacts to other wildlife groups are relatively few, and while other wildlife may be affected (Molvar 2008), there is too little information to address those impacts thoroughly in this document. Information gathered to address impacts to bats and birds, however, can also be used in a limited way to evaluate impacts to other wildlife.

This document replaces the WDNR's previous web-based guidance: "Considering Natural Resource Issues in Wind Farm Siting in Wisconsin, A Guidance." Bird and bat interactions with wind farm facilities is an area of active research and therefore this is a dynamic document that will identify knowledge gaps, recommend new research studies to address such gaps, and incorporate new information as it emerges.

3. GENERAL CONSIDERATIONS

3.1 Consultation and Contacts with WDNR

We recommend that wind project developers initiate consultation with WDNR, at a minimum, two field seasons before initiating project construction and before finalizing turbine location, to reach agreement on how to identify, avoid, minimize, and mitigate impacts on natural resources. When consulted early in the development of a wind project, the WDNR will provide technical advice on how to apply this Guidance. It is advisable to obtain concurrence from WDNR on all study and implementation methods and protocols. The Department believes that project development proceeds more smoothly and cost-effectively when this collaboration is achieved. In many cases, the PSC, local governments, and the FWS will also be part of the consultation.

The attached Decision Framework Diagram (Figure 3) outlines the process to avoid or minimize impacts to wildlife from land-based commercial wind projects. The Diagram highlights decisions that are made to identify whether a site presents a high, moderate, or low risk to wildlife, what studies are needed, and ultimately when actions should be taken to avoid or minimize impacts.

WDNR experts on energy facility impacts, regional wildlife ecology, endangered resources, and bat and bird biology can provide up-to-date and useful information on baseline conditions, help the project developer to plan and implement pre- and post-construction studies, and interpret and apply the results. Within the WDNR you may contact:

Shari Koslowsky
WDNR – Bureau of Endangered Resources
(608) 261-4382
shari.koslowsky@wisconsin.gov

for more information about wind project permitting, past studies, endangered resources reviews and other pertinent topics to wind project siting.

The FWS Ecological Services Office in Green Bay should also be consulted during project development because of their familiarity with national and regional wildlife issues associated with wind turbines, application and interpretation of federal wind siting guidelines, as well as reviews and permitting for eagles and other endangered resources. The Green Bay Office of the FWS can be contacted at (920) 866-1717.

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3.2 State Regulation of Land-Based Wind Energy Projects

The Department prepared a report in November 2010 regarding wind energy systems and the Department's authorities to protect wildlife and natural resources. The report in its entirety can be found at: http://dnr.wi.gov/org/es/science/energy/wind/MarchantFullerLetter.pdf.

The DNR does not regulate the siting of wind projects. Depending on size and ownership of the project, siting of wind energy systems is regulated at both the state and local levels. For

larger electric generation facilities, the Public Service Commission (PSC) is the main siting authority. PSC may approve the siting of wind facilities over 100 megawatts (MW) in output, and local governments permit smaller systems, including those proposed by individuals or non-utility developers. DNR regulates certain activities that may occur during construction of a wind system, as described below.

The PSC process requires full consideration of the environmental impacts of projects, and under an inter-agency cooperative agreement with PSC, the DNR participates in this review by providing its knowledge and expertise on issues based on its authorities over natural resources and environmental quality. The PSC and DNR have developed application filing requirements that include information and consultation requirements associated with DNR interests and authorities. The agencies cooperatively review developer applications for completeness, and develop joint environmental analysis documents required under Chapter 1.11, Stats, and Chapters PSC 4 and NR 150, Wis. Adm. Code. Based on review of the application materials, DNR provides technical testimony in PSC proceedings regarding its direct permitting authorities, potential impacts to species of concern: rare bird species, including state or federally listed endangered, threatened or special concern species, and state Species of Greatest Conservation Need (SGCN) (http://dnr.wi.gov/org/land/er/biodiversity/), impacts to state properties and unique habitats, potential operational impacts to bats and birds, and recommendations for pre- and post-construction bird and bat studies to increase our knowledge about these impacts and how to reduce them.

DNR has direct authority over waterway and wetland impacts associated with certain construction activities needed to install a wind system, such as placement of turbines, permanent access roads, collector lines, transmission lines, substations, and temporary access roads. The DNR is also responsible for Threatened and Endangered Species protection under s. 29.604, Stats, and administers general Wildlife Protection Laws under Chapters 23 and 29, Stats.

Collaboration between project developers and the WDNR to evaluate and address impacts to wildlife will also emphasize compliance with federal endangered species laws, the federal Migratory Bird Treaty Act (MBTA), and other applicable federal laws and regulations.

3.3 Information Sharing and Confidentiality

Currently, the WDNR does not have a public repository for sharing information from wind project-related wildlife studies. We believe, however, that this information should be available for use by the public and other wind project developers to make informed decisions about wind projects. For projects regulated by the PSC, study results may be posted on the Commission's electronic regulatory filing system (ERF). For other projects on which WDNR has been consulted, that information may be obtained by directly contacting the WDNR's Office of Energy at (608) 264-6048.

WDNR recognizes that the process of identifying and securing rights to lands suitable for wind project development is a confidential process. Project developers may hesitate to consult with the WDNR if the location of their project or individual turbines will not remain

confidential. To avoid a potential conflict, and to accommodate wildlife studies in a timely manner, there are informal and formal options for maintaining confidentiality during the early phases of a project. The most formal approach for establishing confidentiality is described in NR 2.19, Wisconsin Administrative Code.

The Department's Natural Heritage Inventory (NHI) information that includes the name and/or location of rare species is confidential and exempt from the State's open records laws (s. 23.27(3)(b), Wis. Stats.). Documents that include this information can be made available to the public in a redacted form. Confidential NHI information can be obtained through data sharing agreements or a certification process that is described at http://dnr.wi.gov/topic/ERReview/. Proponents of wind projects that are subject to PSC review should consult with the PSC regarding aspects of their project that can be filed confidentially.

3.4 Formation of Wind and Wildlife Study Team

Additional research is needed to improve scientifically based decision-making when siting wind energy facilities, evaluate impacts on wildlife and habitats during pre-construction and post-construction, decide buffer distances (setbacks) from the boundaries of an area that is not recommended for commercial wind development (see Section 4), and test the efficacy of mitigation measures. Research can provide data on operational factors (e.g. wind speed, weather conditions) that are likely to result in fatalities. And research could also include studies of cumulative impacts of multiple wind energy projects, or comparisons of different methods for assessing bird and bat activity relevant to predicting risks. It is in the interests of wind project developers and the WDNR to understand more fully wind project-wildlife dynamics to avoid or minimize the impacts of wind energy development on wildlife and their habitats.

The project developer is encouraged to form a *Wind and Wildlife Study Team* for their project as a source for consultation about natural resource impacts or to address needed studies or research. The Study Team may include ecologists representing the project developer, WDNR, FWS, local environmental experts, qualified consultants, and the PSC, if applicable. Local ornithologists and university researchers outside the agencies should also be consulted. A consultant chosen by a developer should have knowledge and understanding of wind turbine design and operation, as well as the literature on bat and bird interactions with wind turbines. It is also important that the consultant be knowledgeable of birds and bats that are at greatest risk at the project site.

3.5 Landowner Access

To complete site screening studies as well as pre- and post-construction studies, we recommend that the original option or lease agreement with a landowner include a condition for land access to undertake environmental studies. A provision to search the land area (radius of approximately 150 m to account for 495-foot-tall turbines) surrounding each turbine should be discussed with each landowner. Securing early agreements with the landowner will save planning and implementation time and improve the information obtained

from pre-construction studies, which is often limited due to lack of access to proposed turbine locations, and it will help in the implementation of post-construction studies if those are necessary.

4.0 PLACES NOT RECOMMENDED FOR COMMERCIAL WIND PROJECT DEVELOPMENT

The purpose of this Section is to list and describe places on the Wisconsin landscape where commercial wind power projects are not recommended based on their biological, scientific, land use, governmental or other public designations. Additional setback distances from the designated boundary are also recommended for these places. In a few cases the setbacks are already defined, but most rely on consultation with the WDNR, the Wind and Wildlife Study Team, if one is formed for the project, or additional studies.

The accompanying map of places not recommended for commercial wind development (Appendix A - Map) includes most of the places described in this Section. Places that are not represented on the map are noted in their description below. However, because some of these places include Natural Heritage Inventory data, the map does not distinguish among the different types of places or designations, i.e. all areas not recommended for commercial wind development have been lumped together. The map identifies the designated boundary of the place and does not include additional setbacks, if one is recommended. If a project overlaps or is near one of the places illustrated on the Map, we recommend that you contact the WDNR to assist you in identifying the natural resource designation(s) for that place, its boundary and additional setback distance, if one is recommended. The places, boundaries, recommended setbacks discussed in the following text and illustrated on the Map are summarized in the following table.

Table 1. *Summary of Places Not Recommended for Commercial Wind Development*

Place	Primary Designations or Value	Defined Boundary	Recommended Setback	Represented on Map
State Natural Areas (SNA)	educational, scientific, natural resource value	Yes	$\geq$ 1 mile	Yes, setback not included
State Wildlife Management Areas (WMA)	wildlife, restoration, recreational, natural resource value	Yes	Consult with WDNR or minimum 1 mile	Yes, setback not included
Bat Hibernacula	Bat concentration site	No, hibernacula are point locations	Consult with WDNR, generally 6.2 or 10 miles for largest hibernacula	Yes, setback
Lake Michigan and Lake Superior shorelines	Bird and possibly bat migration corridor	No	3 miles	Yes, with setback
Lake Winnebago shoreline	Bird and possibly bat migration corridor, bird concentration site	No	3 miles	Yes, with setback

Priority Migratory Bird Stopover Site	Bird concentration site	Only a few have been field verified and mapped as polygons, the remainder are identified as point locations	Consult with WDNR or 3 miles	Yes, primarily as point locations, setback not included
Important Bird Areas (IBA)	Bird concentration site	Yes	Consult with WDNR or 3 miles	Yes, setback not included
Great Wisconsin Birding and Nature Trail (GWBNT)	Bird, wildlife concentration, natural resource value	Yes	Consult with WDNR setbacks for other places or minimum 1 mile	No, approx. half are on the map under other designations, also check online GWBNT maps
Priority Conservation Opportunity Areas (COA)	Bird and wildlife concentration, concentration, natural resource value	Yes	Consult with WDNR, 2 miles from breeding areas of T/E species	Yes, setback not included
Land Legacy Places	Natural resource value	Some or with WDNR for sites w/o boundaries	Site/study dependent, or minimum 1 mile	No, but some are mapped as other places or check online LL maps
State Parks and Forests	Natural resource value	Yes	Site/study dependent, or minimum 1 mile	Yes, setback not included
Major Wisconsin Rivers	Bird and Bat migration, wildlife, natural resource value	Ordinary High or legal shoreline boundary of the waterway	5 miles	Yes, setback included
National Wilderness Areas	Natural resource value	Yes	Consult with federal and state resource agencies, site/study dependent, maximum 5 miles	Yes, setback not included
National Parks/National Wild and Scenic Rivers	Natural resource value	Yes	Consult with federal and state resource agencies, site/study dependent, maximum 5 miles	Yes, setback not included
National Wildlife Refuge	Natural resource value	Yes	Consult with federal and state resource agencies, site/study dependent, maximum 5 miles	Yes, setback not included

The tiered study approach described in Sections 5 and 6 of this Guidance are, in part, intended to determine if a project overlaps with one of these places or the setback distance, if one is recommended. If that is the case and project development still proceeds at the site, WDNR may recommend extensive studies or information-gathering to evaluate impacts to

natural resources along with a commitment to mitigation. The nature and scope of studies for projects that proceed at places not recommended for commercial wind development will be site-specific and may be beyond the scope of the Tier 1 and Tier 2 studies described in the Wind Siting Study Guidance.

4.1 State Natural Areas (SNA)

Wisconsin's SNAs are defined by State Statute s. 23.27(1)(e) as "an area of land or water which has educational or scientific value or is important as a reservoir of the state's genetic or biologic diversity and includes any buffer area necessary to protect the area's natural values." As of October 2011, there were 653 State Natural Areas in Wisconsin totaling 330,000 acres (D. Hinebaugh pers. comm.)(http://www.dnr.state.wi.us/org/land/er/sna).

Wisconsin Statutes Chapters 23.27, 23.28, and 23.29 are the authority for State Natural Areas. Rules governing their use are found in Wisconsin Administrative Code, Chapter NR 45. The Department holds designated SNAs in trust for the people of Wisconsin to ensure the protection and stewardship of the areas and their natural values. Most SNAs are owned by the Department or The Nature Conservancy (TNC). State Natural Areas are important to the preservation of the state's genetic and biological diversity and for providing some of the last refuges for rare plants and animals. They protect outstanding examples of native natural communities, significant geological formations, and archeological sites. More than 90 percent of the plants and 75 percent of animals listed as state endangered and threatened species are protected on SNAs. Among the State's Natural Areas, 139 are "dedicated," meaning that further restrictions of use are imposed. *Specific to the issue of wind turbine placement, any permanent or mobile building, structure, or facility cannot be constructed or placed on a dedicated SNA.* The SNA's "Articles of Dedication", which is unique type of conservation easement, legally protect the land in perpetuity. State Natural Area Dedication is the strongest form of land protection available in Wisconsin (Meyer 2003).

The Map includes SNA boundaries. A setback of at least 1 mile (1.6 km) is recommended from the proposed project boundary to an SNA (R. Hoffman pers. comm.). This recommended setback distance may be revised based on new information or consultation with the *Wind and Wildlife Study Team*.

4.2 State Wildlife Management Areas

Chapter 29 of the State Statutes and Chapter 10 of the Administrative Code govern the establishment and use of state wildlife management areas (WMAs). These areas provide quality hunting and fishing opportunities, as well as habitat and species restoration opportunities, and have been established using federal and state funds. The lands occupied by WMAs are owned by the Department. Wind power generation is incompatible with those wildlife management purposes because of the potential to degrade hunting and fishing experiences, fragment wildlife habitat, and to affect adversely some endangered and threatened species (e.g. Greater Prairie Chicken, Spruce Grouse, Henslow's Sparrow, Trumpeter Swan, Red-shouldered Hawk, Yellow Rail, Acadian Flycatcher, Hooded Warbler).

The Map includes WMA boundaries. A recommended setback distance from the proposed project boundary to the WMA will be determined based on study findings. Until studies occur, the wind project developer should consult with the *Wind and Wildlife Study Team* to determine setbacks for each relevant WMA or consider a minimum setback of one mile.

4.3 Bat Hibernacula

Of Wisconsin's eight bat species, silver-haired, red and hoary bats migrate south to warmer climates for the winter, while the little brown, big brown, northern myotis, eastern pipistrelle and Indiana bat pass the colder months hibernating in hibernacula, i.e., caves, abandoned mines and occasionally building attics. The hibernaculum itself is a point location, but the concentration of bats in the airspace around the hibernaculum increases with proximity to that point such that it is essential to establish appropriate setback distances. A setback distance from a hibernaculum will depend on the number of bats and the species using the site during winter months, as well as other more complex variables such as proximity to nearest hibernaculum, and proximity to other biological risks such as White Nose Syndrome. Moreover, our knowledge of bat migration and behavior in relation to fatalities at wind projects, however, is insufficient. Wisconsin's cave bats are listed as Threatened under the state's Endangered Species Law (Wis. Stats. § 29.601) and a broad incidental take permit exists for certain activities, including wind facilities, that comply with the conditions of that permit.

Six priority categories for setbacks from hibernacula have been defined currently based on the number of bats and species richness or diversity: P1 – 10 miles; P2 – 7 miles; P3 – 5 miles; P4 – 3 miles; P5 – 1.5 miles; P6 – 0.5 miles. There are currently three P1 category hibernacula in the state; the majority of hibernacula fall into categories P4 to P6. These setback distances will be updated as more information on bat behavior, population viability and WNS become available. The setbacks provided here have not been tested against fatality impacts at operating wind projects and are based on estimates from limited studies of bat activity away from hibernacula. A legally enforceable commitment of the project developer to operational curtailment may provide alternatives to these setbacks.

Not all hibernacula have been identified in the state. Also, available data may indicate that a proposed wind project is near a known or potential hibernaculum, but the numbers and species of bats using the site is unknown (e.g. a winter survey has not occurred within the past five years). Under such circumstances investigations beyond the Site Screening Evaluation (Tier 1 Study) may be needed. Only a qualified bat survey crew approved by the WDNR or FWS can conduct winter bat surveys during the months of January or February. Surveys outside of these two months are not considered valid for estimates of the number of bats within hibernacula. For caves and mines determined to be dangerous for personnel to enter, a suitable alternative survey consists of using a harp trap at each entrance/exit during periods of fall swarming and/or spring emergence.

The Map in Appendix A includes the locations of known hibernacula in the state and setbacks based on the six categories. The location of hibernacula is tracked by the WDNR's

NHI database. Due to the sensitivity of these sites this information is not published. The location of known hibernacula can be obtained through an Endangered Resources Review Request for the project area and by consulting the WDNR Bat Team in the Bureau of Endangered Resources.

4.4 Wildlife Concentration Sites: Great Lakes and Lake Winnebago Shorelines, Priority Migratory Bird Stopover Sites, Important Bird Areas, Great Wisconsin Birding and Nature Trail Sites

The Great Lakes and Lake Winnebago provide navigational cues for migrating bats and birds, which may concentrate along the shoreline (D. Redell pers. comm., D. Ewert in prep.). Rare species that migrate along the shoreline are at greater risk than common species because of the difference in the proportion of the species' population likely to be affected. Grveles and Matteson (2008) have conducted workshops to identify priority migratory bird stopover sites within the Lake Michigan and Lake Superior basins that are critical to conservation. Collectively, they provide significant refugia during both spring and fall migrations. Several of these sites may also be important to migrating bats.

Wisconsin's Important Bird Areas (IBA) Program began in 2003. There are 103 sites that "contain the top management and stewardship opportunities for Wisconsin's birds" (Steele, 2006). The location of Wisconsin's IBAs can be viewed at www.wisconsinbirds.org/IBA/. These sites, including state and federally owned lands, were selected by an IBA Technical Committee based on the following criteria: 1) Site is important to one or more species listed as endangered or threatened in Wisconsin. 2) Site is important to one or more species identified as high priority in Wisconsin. 3) Site harbors an assemblage of species associated with a habitat type that is representative, rare, or threatened in Wisconsin. 4) Site where significant numbers of birds concentrate for breeding, migration/staging, or wintering. 5) Site is important for long-term research and/or monitoring projects that contribute substantially to ornithology, bird conservation and/or education.

The Great Wisconsin Birding and Nature Trail (GWBNT), created by the Wisconsin DNR between 2004 and 2008, is a mapped auto tour and trails reaching into every corner of the state and is covered by five regional viewing guides that lead the nature traveler to warblers, shorebirds, eagles, loons, cranes and all manner of mammals found in some of the state's premier wildlife venues. Many of the places identified in the Great Wisconsin Birding and Nature Trail are also IBAs and/or overlap with SNAs, WMAs, State and County Parks and Forests. For more information refer to: www.wisconsinbirds.org/trail/.

By the very criteria used to define these areas, installation of wind generating facilities within IBAs and GWBNTs may affect their use by large concentrations of birds or rare species, increase the likelihood of collisions, and also raise conflicts with intended public uses of these sites.

Wind projects should be sited no closer than three miles (4.8 km) inland from the Lake Michigan and Lake Superior shorelines, from the shores of Lakes Winnebago, and from IBAs. The three-mile estimate is based on radar studies, ground surveys, and other studies

that describe where and how birds concentrate during migration (Able 1977, Barclay et al. 2007, Barrios and Rodriguez 2004, Bonter et al. 2007, Bonter et al. 2009, Bruderer et al. 1995, Cooper et al. 2004, Diehl et al. 2003, Dunn 2000, Dunn 2001, Erickson et al. 2001, Erickson et al. 2002, Ewert and Hamas 1996, Feucht 2003, Gauthreaux 1970, Gauthreaux 1971, Gauthreaux 1972, Grveles 1998, Hazzard 2001, Hebrard 1971, Howe et al. 2002, Hyde 1998, Johansen 1993, Johnson 2004, Kerlinger 1995, Kerlinger 2000, Klaassen et al. 2008, Kuvlesky et al. 2007, Mabee et al. 2006, Mabey and Paul 2007, MacDade 2009, National Wind Coordinating Collaborative 2010, Osborn et al. 1998, Petrie and Wilcox 2003, Rodewald 2007, Smith et al. 2007).

The Map in Appendix A includes the Great Lakes and Lake Winnebago Shorelines, Priority Migratory Bird Stopover Sites, and Important Bird Areas. Great Wisconsin Birding and Nature Trail sites are not included on the Map, although approximately half of these sites have other designations that are identified on the map. While a few Migratory Bird Stopover sites are mapped with boundaries, the majority remain as point locations on the map pending field verification. The Map includes the three mile setback for the Lake Michigan, Lake Superior and Lake Winnebago shorelines and the boundaries of IBAs. We recommend that developers proposing projects within three miles of migratory bird stopover site point locations or within one mile of other GWBNT sites consult further with the WDNR to assess appropriate setbacks.

4.5 Priority Conservation Opportunity Areas

In 2001, Congress created the State Wildlife Grants Program to prevent wildlife from becoming endangered. Wisconsin's Wildlife Action Plan (created in 2006) and Wisconsin's list of Priority Conservation Opportunities for Species of Greatest Conservation Need (created in 2008) identify species and sites where priority conservation actions will protect species and their habitats in perpetuity through the federally funded State Wildlife Grants Program. The development of wind projects in priority conservation opportunity areas (COA) is incompatible with their establishment and use, particularly in areas targeted for bat and bird conservation.

Of special concern specifically in relation to wind development projects are expansive grasslands, particularly patches larger than 250 acres (>101 ha). Grasslands with species of concern requiring or favoring large areas – e.g., Northern Harrier, Greater Prairie-Chicken, Sharp-tailed Grouse, Barn Owl, Short-eared Owl, Henslow's Sparrow – should be avoided. Conservation Reserve Program (CRP) lands should be avoided, too, since these likely comprise the last remaining grassland bird refugia on private lands (Ewert and Cole 2010). Leddy et al. (1999) found that densities of male songbirds were significantly lower in CRP grasslands containing turbines than in CRP grasslands without turbines.

The Map in Appendix A includes Priority COA boundaries. The recommended setback distance from the proposed project boundary to the COA will be determined based on study findings. Until studies occur, the wind project developer should consult with the *Wind and Wildlife Study Team*. For sites where there are known breeding areas for state and federally endangered and threatened animal species, a recommended setback distance from the

proposed project boundary to the COA should be a minimum of two miles (3.2 km) from the identified breeding areas, and a minimum of one mile (1.6 km) from sites with state or federally endangered/threatened plant species (Ewert and Cole 2010).

4.6 Wisconsin Land Legacy Places

The Wisconsin DNR (Pohlman et al. 2006) has identified 229 "Legacy Places" distributed throughout the State's 16 ecological landscapes that are believed to be critical to meet state conservation and recreation needs. Each Legacy Place typically has an important wildlife attribute that contributes to its unique status and to the preservation of biological diversity. The Land Legacy report can be viewed online at: http://www.dnr.state.wi.us/master_planning/land_legacy/. Approximately two-thirds of the Legacy Places feature rivers, lakes, or wetlands. The criteria used to identify Legacy Places are lands and/or waters that: 1) support natural areas; 2) contain unique or exceptional natural scenic beauty; 3) sustain an area's species, habitats, and ecological systems; 4) could be restored to support native plants and animals and their habitats; 5) support desired recreational uses; 6) improve access to, or use of, existing public lands and waters; 7) address high priority gaps or unfilled needs in outdoor recreation; 8) provide significant opportunities for fishing, hunting, and other outdoor activities; 9) allow the protection of large, minimally-fragmented ecologically functional landscapes; 10) a complete a statewide network of land and water-based recreational trails and provide linkages to population centers; 11) establish an interconnected network of corridors maximizing ecological benefits; 12) contribute to the protection and improvement of water used by municipal drinking water systems; and 13) significantly contribute to the quality and quantity of surface waters.

Legacy Places are not identified on the map. However, like GWBNT sites, many Legacy Places overlap with other places described in this text that are located on the Map. Some Legacy Places do not have defined boundaries.

A recommended additional setback from a Legacy Place will be determined based on study findings. The developer may also need to consult with WDNR to verify boundaries for some Legacy Places. Until studies occur, we recommend that the wind project developer in consultation with the *Wind and Wildlife Study Team* determine setbacks for each relevant Legacy Place or consider a minimum setback of one mile.

4.7 State Parks and State Forests

Wisconsin has 99 state parks, forests, trails, and recreation areas. These lands are important for nature education and recreation, but they are especially important as stopover habitats for migratory birds, where they can feed during their long migrations, or as breeding sites for many neotropical migrant birds, including state endangered, threatened, and special concern species (Cutright et al. 2006, Robbins 1991). Wind projects located within these state properties may also conflict with Department ecosystem management objectives, such as preventing or minimizing forest fragmentation, with the type of fragmentation of greatest concern the permanent and long-term conversion of forests to non-forest uses and development (WFSFAC 2007).

Chapter 45 of the Wisconsin Administrative Code governs the use of state parks and forests. Under Chapter 45 (3) (m): "Except as authorized by the department, no person may construct, place, occupy or use structures or store personal property on lands subject to this chapter" except for almost all tents or canopies.

State park and forest boundaries are located on the Map. A recommended setback distance from a state park or state forest boundary will be determined based on study findings. Until studies occur, we recommend that the wind project developer in consultation with the *Wind and Wildlife Study Team* determine setbacks for each relevant state park or state forest or consider a minimum setback of one mile.

4.8 Major Wisconsin Rivers

Wisconsin's diverse and numerous river resources stretch over 84,000 miles (134,400 km). The Mississippi River runs along about 200 miles (320 km) of Wisconsin and drains the third largest area of land in the world. Other major Wisconsin rivers include the Wisconsin River, St Croix, and Namekagon rivers, Red Cedar River, Apple River, Chippewa River, Flambeau River, Jump River, Eau Claire River, Wolf River, Peshtigo River, Fox River, Kickapoo River, Baraboo River, Black River, Yellow River, Menominee River, Rock River, and Milwaukee River (Martin 1932). These rivers provide commuting and foraging areas for birds as well as possible visual cues for orientation and navigation during migration (K. Grveles pers. comm.). Many of Wisconsin's bat hibernacula are likely located in or near these river corridors (D. Redell pers. comm.).

Except as noted above for bat hibernacula, wind projects should be sited no closer than 5 miles (8.0 km) from the ordinary high watermark (OHWM) or legally defined shoreline boundary of the major rivers listed above. The 5-mile estimate is based on radar studies, ground surveys, and other studies that describe where and how birds concentrate during migration (Able 1977, Barclay et al. 2007, Barrios and Rodriguez 2004, Bonter et al. 2007, Bonter et al. 2009, Bruderer et al. 1995, Cooper et al. 2004, Diehl et al. 2003, Dunn 2000, Dunn 2001, Erickson et al. 2001, Erickson et al. 2002, Ewert and Hamas 1996, Feucht 2003, Gauthreaux 1970, Gauthreaux 1971, Gauthreaux 1972, Grveles 1998, Hazzard 2001, Hebrard 1971, Howe et al. 2002, Hyde 1998, Johansen 1993, Johnson 2004, Kerlinger 1995, Kerlinger 2000, Klaassen et al. 2008, Kuvlesky et al. 2007, Mabee et al. 2006, Mabey and Paul 2007, MacDade 2009, National Wind Coordinating Collaborative 2010, Osborn et al. 1998, Petrie and Wilcox 2003, Rodewald 2007, Smith et al. 2007).

4.9 National Wilderness Areas

The Department has no jurisdiction over federal lands, but this guidance (statewide in scope) advances *recommendations* addressing all state and federal lands. Designated wilderness areas are part of the National Wilderness Preservation System as established by Congress in 1964. Wilderness is defined as an area "where the earth and its community of life are untrammeled by man, where man is a visitor who does not remain …. an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements

or human habitation, which is protected and managed so as to preserve its natural conditions and which 1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; 2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; 3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and 4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value". There are currently seven national wilderness areas in Wisconsin (see www.wildness.net for a state map and description of each area). A recent example is the Gaylord Nelson Wilderness Area in the Apostle Islands established in 2007. It is renowned for providing critically important bird stopover and breeding habits (S. Matteson pers. comm., J. V. Stappen pers. comm.).

The Department recommends that at minimum, tiered bird and bat studies occur in a wind project area whose boundaries fall within 5 miles of a national wilderness area. A recommended setback distance from a national wilderness area will be determined based on study findings and consultation with the federal and state resource agencies. Until such a study occurs, we recommend that the *Wind and Wildlife Study Team* recommend setbacks on a case-by-case basis for each relevant national wilderness area.

4.10 National Parks/National Wild and Scenic Rivers

The National Park Service administers both national parks and national wild and scenic rivers. There are two National Park System units in Wisconsin: The Apostle Islands National Lakeshore (AINL) and the St. Croix National Scenic Riverway. The 20-plus designations applied in adding areas to the National Park System are usually descriptive: seashore, lakeshore (e.g. AINL), historic site, recreation area, etc. Legislation authorizing national lakeshores, etc. sometimes allows a wider range of activities, such as hunting and trapping. Both NPS units in Wisconsin are important as bird breeding and migration stopover sites (Cutright 2006, Robbins 1991).

The Department recommends that at a minimum tiered bird and bat studies occur in a wind project area whose boundaries fall within 5 miles of a national park or national wild and scenic river. A recommended setback distance from a national parks and national wild and scenic rivers will be determined based on study findings and consultation with the federal and state resource agencies. Until such a study occurs, we recommend that the *Wind and Wildlife Study Team* recommend setbacks on a case-by-case basis for each relevant national wilderness area.

4.11 National Wildlife Refuges

There are nine federal refuges in the state: Fox River NWR, Gravel Island NWR, Green Bay NWR, Horicon NWR, Leopold Wetland Management District, Necedah NWR, St. Croix Wetland Management District, Trempealeau NWR, and Whittlesey Creek NWR. Each of these was established as refuges and breeding areas for migratory birds, fish, and other wildlife. The National Wildlife Refuge System is the only network of lands primarily dedicated to the preservation and management of fish and wildlife. Accordingly, the

installation of wind generating facilities within refuge boundaries would constitute a potential conflict with management objectives.

The Department recommends that at a minimum tiered bird and bat studies occur in a wind project area whose boundaries fall within 5 miles of a national wildlife refuge. A recommended setback distance from a national wildlife refuge will be determined based on study findings and consultation with the federal and state resource agencies. Until such a study occurs, we recommend that the *Wind and Wildlife Study Team* recommend setbacks on a case-by-case basis for each relevant national wilderness area.

4.12 Other Areas Not Recommended for Commercial Wind Power Development

The areas identified in this Chapter do not constitute all areas in the state that are not recommended for wind project development. We do not recommend, for example, that wind projects be sited within the Chequamegon-Nicolet National Forest (http://www.fs.fed.us), where several SGCN occur and where habitat fragmentation would likely become an issue through development of a wind project. The areas described above are state and federally owned lands. There are county, city and privately owned lands that have natural resource value, use designations, management objectives or funding restrictions similar to those described above. Wetlands larger than 1,000 acres and known to concentrate birds during migration should be evaluated on a case-by-case basis, with the *Wind and Wildlife Study Team* advancing recommendations. The Study Team should also address setbacks for inland wetlands important to reptiles and amphibians given their apparent sensitivity to change in both their aquatic and terrestrial habitats. Ewert and Cole (2010) recommended a buffer of ½ mile (0.8 km) from wetland complexes with either permanent bodies of water or vernal pools to minimize most negative interactions for most species even though some species, such as Blanding's Turtles, may disperse >4 km from water.

The wind project developer is responsible for properly investigating land uses and consulting with landowners and the WDNR to identify land areas of concern. In the northern part of the state, for example, there are large areas covered by county forest land as well as parks (e.g., http://dnr.wi.gov/org/land/parks/partners/coparks.html). Wisconsin is also home to more than 50 active land trusts that collectively protect and manage over 200,000 acres with significant ecological, scenic, recreational, agricultural, and historic value. Conservation of habitat for birds and bats is frequently among the objectives for creating a land trust. These land conservation organizations range from small groups operated solely by volunteers to large land trusts with multiple professional staff.

Land trusts in Wisconsin vary in the geographic scope of the conservation work they take on. Some, such as the Kinnickinnic River Land Trust, have identified a specific watershed within which they operate to protect the health and natural functioning of the rivers or lakes that watershed encompasses. Others, such as the Waukesha County Land Conservancy, use a political delineation for their service area. Still others operate within multiple counties or in areas which overlap political boundaries. For more information on land trusts in Wisconsin refer to the following website: http://www.gatheringwaters.org/wilandtrusts.php.

Setbacks from places mentioned in this document should be based on recommendations from the *Wind and Wildlife Study Team*. Tiered bird and bat studies may be needed before setbacks can be recommended.

5. SITE SCREENING EVALUATION (TIER 1 STUDY)

5.1 General Approach

This section introduces the first of three tiers corresponding to the process of decision-making illustrated in Figure 3. The tiered approach is adapted from FWS Land-Based Wind Energy Guidelines http://www.fws.gov/windenergy/docs/WEG_final.pdf.[4]

At each of the three tiers, developers are asked to answer a set of study objectives stated as questions, followed by recommended methods and metrics to use in answering the questions. Some questions are repeated at Tiers 1 and 2, with Tier 2 requiring a greater investment in data collection to answer certain questions. For example, while Tier 1 investigations may discover some existing information on bird species of concern [i.e., rare bird species, including state or federally listed endangered, threatened or special concern species, and state Species of Greatest Conservation Need (SGCN) http://dnr.wi.gov/org/land/er/biodiversity/)], it may be necessary to collect empirical data in Tier 2 studies to determine the presence, number, and density of these species.

The decision to proceed to Tier 2 or Tier 3 studies is made by the developer after consultation with the Wind and Wildlife Study Team. The developer's decision is based on whether all questions identified in the Tier have been adequately answered and whether the methods for arriving at the answers were appropriate for the site selected and the risk posed to species of concern and their habitats. If answers to Tier 1 questions indicate the site is unsuitable or conversely, that there is little or no risk to wildlife, the developer may end the studies without proceeding to Tier 2 or Tier 3. At the conclusion of Tier 2 studies again, the developer in consultation with the Wind and Wildlife Study Team, considers whether the site is unsuitable or whether to proceed with Tier 3 studies during the post-construction phase. The developer is encouraged to communicate early and often in the tiered approach with the WDNR as part of the Wind and Wildlife Study Team. Under some circumstances, the developer's decision may require review and approval by the PSC and/or WDNR (e.g. for projects greater than or equal to 100 MW or projects where the State's Endangered Species Law can be applied).

5.2 Tier 1 Site Screening Considerations

[4] Tier 1 in this Guidance is similar to Tier 1 in the FWS Land-Based Wind Energy Guidelines and addresses information gathered to complete a site screening. Tier 2 in this Guidance is similar to Tiers 2 and 3 in FWS Draft Guidelines and addresses pre-construction studies using more complex methods. Tier 3 in this Guidance is similar to Tiers 4 and 5 in the FWS Guidelines.

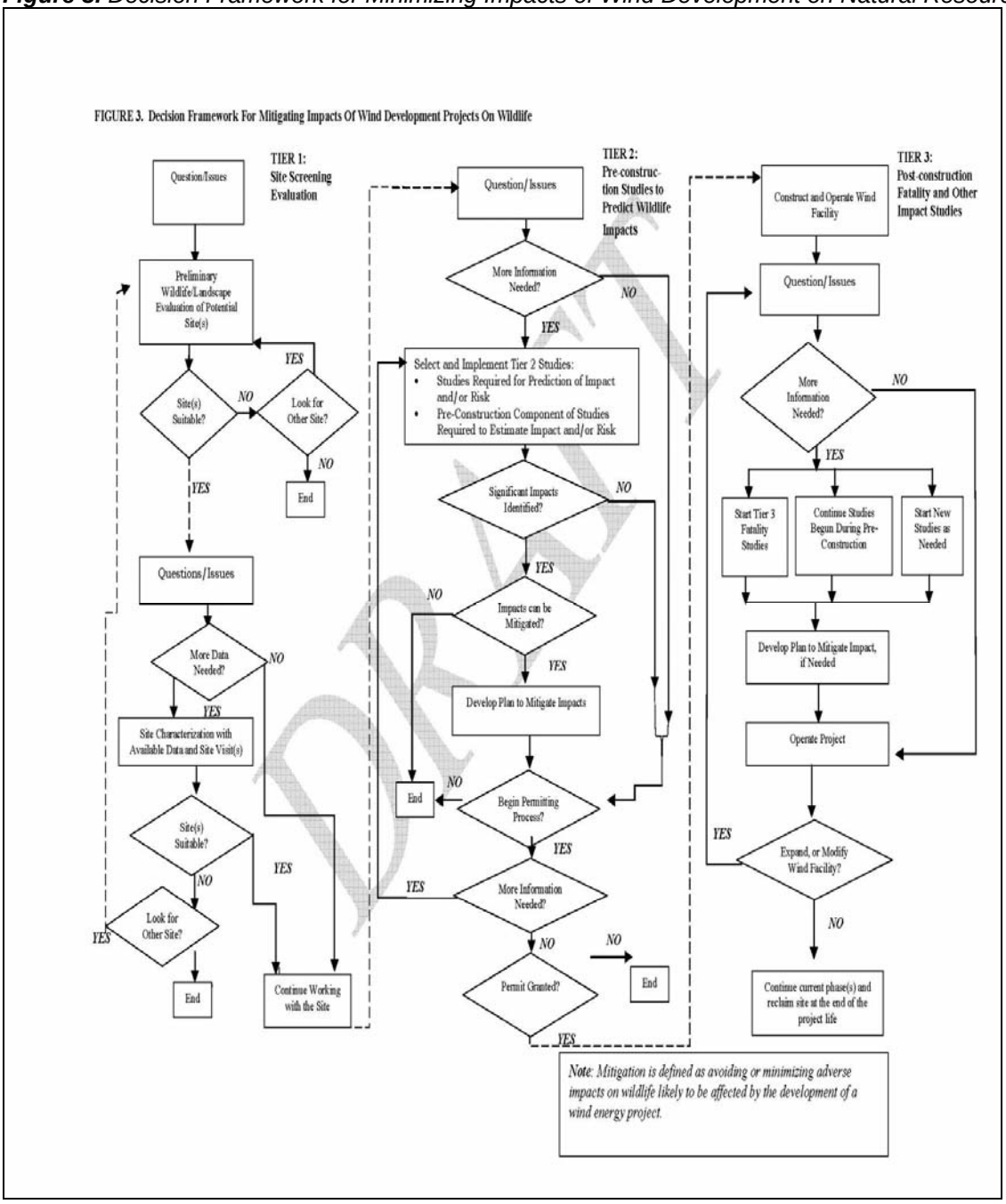
Collect relevant site screening information for the following:

- Projects with less than 10 turbines collect information and complete site screening within an area up to two miles from the proposed project boundary.
- Projects with more than 10 turbines collect information and complete site screening within an area up to five miles from the proposed project boundary.
- Projects, regardless of the number of turbines, that may lie within an area that is not recommended for wind project development as described in Section 4 within an area up to five miles from the proposed project boundary.

A Site Screening Evaluation is an important first step in the consideration of a potential wind project location. Site screening describes the natural resources at the site through the collection of existing information and limited field work. For developers taking a first look at a broad geographic area, a preliminary evaluation of the general ecological context of a potential site or sites can serve as useful preparation for coordination with the WDNR, federal agencies, and tribal and local governments. The developer can begin to identify areas of high sensitivity due to the presence of large blocks of intact native plant communities, locations with species of concern, and other important landscape-scale wildlife and other natural resource values, such as unique natural communities or priority migratory bird stopover sites.

A Site Screening Evaluation relies on existing information and reconnaissance-level field investigations to show generally where in the state to avoid or site wind turbines based on natural resource impacts. The evaluation is also useful because it can be used to compare the suitability of alternative sites or alternative project boundaries for wind project development.

Figure 3. *Decision Framework for Minimizing Impacts of Wind Development on Natural Resources*



Accordingly, Tier 1 may be used in any of the following three ways:

1) To "screen" a landscape or set of multiple potential sites to avoid those with the highest natural resource values that are not recommended for wind project development.
2) To identify regions where wind energy development poses substantial risks to species of concern or their habitats, including the fragmentation of large-scale habitats and threats to regional populations of state- or federally listed species.
3) To begin to determine if a single identified potential site poses serious risk to species of concern or their habitats.

Tier 1 can offer early guidance about the sensitivity of the site within a larger landscape context; it can help direct development away from sites that will be associated with higher mitigation costs and uncertainty; or it can identify those sensitive resources that will need to be studied further to determine if the site can be developed without adverse impacts to natural resource value, species of concern or local population(s). A Tier 1 evaluation could also reveal serious concerns indicating that a site should not be developed.

It should be noted that some areas may be inappropriate for large scale development due to a site's high wildlife value based on ecological rarity and intactness (e.g., State Natural Area, Land Legacy Places, Priority Conservation Areas, Wilderness Areas, as described in Section 4). It is important to identify such areas through the tiered approach, as reflected in Tier 1, Question 2 below.

State or federal law, or local laws and ordinances, may preclude development in some areas, and is separate from a determination through the tiered approach that an area is not appropriate for development. The WDNR's contact for wind energy projects can provide assistance in making this determination.

5.2.1 Tier 1 Questions to Be Considered in Site Screening

The following are questions to be considered in a Tier 1 Site Screening Evaluation. Question 1 is the primary question to be answered at this Tier.

1) Is the project located in an area not recommended for commercial wind development? Section 4 and Appendix A define areas that are already recognized in the State for their high natural resource value and that carry specific scientific, land use or public *designations*.
2) Are there known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?
3) Does the landscape contain areas where development is precluded by law or that are designated as sensitive by the WDNR or FWS? Examples of designated areas include, but are not limited to: State Natural Areas, federally-designated critical habitat; Priority Conservation Opportunity Areas as described and depicted in the State of Wisconsin Wildlife Action Plan (2005-2015).

(http://dnr.wi.gov/org/land/er/wwap/implementation/pdfs/statewide_report.pdf); and The Nature Conservancy high-priority conservation areas.

4) Are plant communities of concern present or likely to be present at the site(s)?
5) Are there known critical areas of wildlife congregation, including, but not limited to, hibernacula, staging areas, wintering roosts and areas, nesting sites, migration stopover sites or corridors, or other areas of seasonal importance?
6) Are there large areas of intact habitat with the potential for fragmentation affecting species of concern needing large contiguous blocks of habitat?
7) Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?

5.2.2 Tier 1 Methods and Metrics

Obtaining answers to Tier 1 questions will involve a thorough review of the existing site-specific information. Tier 1 site screenings will generally contain two elements:

A review of existing information, including existing published or available literature and databases and maps of topography, land use and land cover, potential wetlands, wildlife, habitat, and sensitive plant distribution. If agencies have documented potential habitat for SGCN/rare birds (http://dnr.wi.gov/org/land/er/biodiversity/) for which habitat fragmentation is a concern, this information can help with the analysis. It is recommended that developers conduct a review of the publicly available data and consult with WDNR's Office of Energy. The analysis of available sites in the state will be based in part on information available in published and unpublished reports, wildlife range distribution maps, and NGO reports. Currently available data sources useful for this analysis are listed in Appendix B. Information on wildlife present in a project area can be gathered (at least in part) through a WDNR Bureau of Endangered Resources Review. This Review includes a search of the WDNR Natural Heritage Inventory (NHI) database for occurrences of rare species, natural communities, and important habitat features such as bat hibernacula and bird rookeries. An Endangered Resources Review request form (Form 1700-047) can be downloaded at: http://www.dnr.state.wi.us/org/land/er/nhi/. The request form should be submitted to:

Ms. Shari Koslowsky
Conservation Biologist
WDNR – Bureau of Endangered Resources, ER/6
101 S. Webster St.
Madison, WI 53707-7921
shari.koslowsky@wisconsin.gov

The Endangered Resources Review will be able to identify areas described in Section 4 that are not suitable for wind project development (e.g., wildlife management area, state natural area). For additional resources, see Appendix B.

It is also recommended that the developer make contact with the FWS, tribal, and local

agencies that have jurisdiction or management authority over the project, or have information about the potentially affected resources. In addition, because key NGOs and interested local groups are often valuable sources of relevant local environmental information, it is recommended that developers contact key NGOs, even if confidentiality concerns preclude the developer from identifying specific project location information at this stage. These contacts also provide an opportunity to identify other potential issues and data not already identified by the developer.

Natural community and wildlife databases are incomplete because they reflect surveys done largely on properties with public access whereas wind projects are generally sited on private property. In many cases, land trusts and other private conservation easements may only be identified by consulting with willing landowners. It is very important that the project developer consult with landowners regarding their own wildlife observations and knowledge of habitat resources such as dens, raptor nests, rookeries or colonial nesting sites.

Utilizing Data from Midwestern Wind Projects

Pre- and post-construction data from other Midwestern wind projects may be applied generally during site screening, depending on the similarity between landscapes and habitat features. Since this information may not be available to the public, developers should contact WDNR, PSC, or the project owners for this information. In most cases, we should be able to provide a summary of results if we are knowledgeable about another applicable project or study.

Wind developers should not assume that data from nearby wind projects can substitute for the site screening evaluation (Tier 1) or pre-construction (Tier 2) studies.

An evaluation of current vegetation/habitat coverage and land management/use based on one or more site visits by a qualified wildlife biologist or ecologist. Current habitat and land use practices will serve as a baseline against which potential impacts from a proposed project can be evaluated. The vegetation/habitat analysis can be used for identifying potential bird and bat resources occurring at the site and the potential presence of, or suitable habitat for, species of concern. Any species of concern observed during the site visit should be noted, although lack of observation is not conclusive evidence of absence. If land access agreements are not in place, access to the site will be limited to public roads or properties.

Site visits by a qualified biologist or ecologist familiar with the habitats and wildlife of the region should occur during the breeding, wintering, and migration seasons at the proposed wind project area. The objectives of the site visit are to:

- Identify and map natural communities, vegetation types, and habitats (in and adjacent to the project area) as delineated by the Department's Bureau of Endangered Resources: http://www.dnr.state.wi.us/org/land/er/communities/, and list dominant plant species present at the proposed project site.
- Describe landscape and habitat features at the proposed project site that are relevant to wildlife taxonomic groups or may attract bats and birds.

- Consult with the Department's Bureau of Endangered Resources (BER) to determine if there is a bat hibernaculum within 10 miles of the project boundary.
- Identify other likely sources of mortality at the site (e.g.: communications towers, transmission, and distribution lines).
- Field verify reported dens, raptor nests, rookeries, maternal roosts or colonial nesting sites within the project boundary.
- Complete a reconnaissance-level[5] bird survey to help estimate occurrence, abundance and use by bird groups and species of concern.
- Map habitats and natural communities in the study area based on current aerial photography and field verification using the Department's standard geo-referencing system: Wisconsin Transverse Mercator based on the 1991 adjustment to the North American Datum of 1983 (WTM83/91).

5.2.3 Information Resources for Answering Tier 1 Questions

Specific resources and information that can help answer each Tier 1 question are summarized below.

1. *Is the project located in an area identified in Section 4 that is not recommended for commercial wind development because it has a scientific, land use or public designation as an area of high natural resource value?*

WDNR Information Review: The developer should review Section 4 and Appendix A relative to the project boundary. The WDNR will assist the developer in interpreting the areas identified on Appendix A.

Site Visit: The site visit completed by the developer should verify boundaries or setbacks on Appendix A relative to the proposed wind project boundary.

2. *Are there known species of concern present on the proposed site, or is habitat including designated critical habitat) present for these species?*

WDNR Information Review: Locations of state and federally listed, proposed and candidate species and species of concern are documented by the WDNR Natural Heritage Inventory Program (NHI) in the Bureau of Endangered Resources. Working with the WDNR, developers can request an Endangered Resource Review and arrange to view pertinent information, which is not accessible to the general public.

Site Visit: The site visit(s) should evaluate the suitability of habitat at the site for species of

[5] This type of survey considers short frequency and duration across the breeding/nesting season, may include spring and/or autumn migration, low density of count locations, coverage throughout the screening area, and unique or diverse habitats. Protocols and methodologies described in Appendix D should be considered.

concern identified by existing sources, and the likelihood of the project to affect adversely the species of concern that may be present.

3. *Does the landscape contain areas where development is precluded by law or is designated as sensitive by the WDNR or FWS? Examples of designated areas include, but are not limited to: State Natural Areas, federally designated critical habitat; Priority Conservation Opportunity Areas as described and depicted in the State of Wisconsin Wildlife Action Plan (2005-2015) (http://dnr.wi.gov/org/land/er/wwap/implementation/pdfs/statewide_report.pdf)*

WDNR Information Review: The WDNR will assist a developer in obtaining National Wetland Inventory data files; USGS National Land Cover data maps; state, federal and tribal agency data on areas that have been designated to preclude development, including wind energy development; State of Wisconsin Wildlife Action Plan, and other state and local resources; see the additional resources listed in Appendix C of this document.
Site Visit: To the extent practicable, the site visit(s) should characterize and evaluate the uniqueness of the site vegetation relative to surrounding areas.

4. *Are plant communities of concern present or likely to be present at the site(s)?*

WDNR Information Review: Consult with BER's NHI Program Botanist to determine state rankings (S1, S2, S3) or globally (G1, G2, G3) ranked rare plant communities.
Site Visit: To the extent practicable, the site visit should evaluate the topography, physiographic features, and uniqueness of the site vegetation in relation to the surrounding region.

5. *Are there known critical areas of wildlife congregation, including, but not limited to, hibernacula, staging areas, wintering roosts and areas, nesting sites, migration stopover sites or corridors, or other areas of seasonal importance?*

WDNR Information Review: BER ecologists and zoologists will be able to assist with an information review. Start with the BER NHI program to review existing databases, which will include information on priority migratory bird stopover sites, bat hibernacula, and Important Bird Areas (IBAs). The WDNR Office of Energy can also assist with information requests.

Site Visit: The site visit should evaluate the topography, physiographic features, and uniqueness of the site in relation to the surrounding region to assess the potential for the project area to concentrate resident or migratory birds and bats.

6. *Are there large areas of intact habitat with the potential for fragmentation from a proposed wind project affecting species of concern needing large contiguous blocks of habitat?*

WDNR Information Review: BER ecologists and zoologists can assist with a response to this question.

Site Visit: The site visit should evaluate the topography, physiographic features, and uniqueness of the site in relation to the surrounding region to assess the potential for habitat fragmentation.

Habitat fragmentation is defined as the partition of a block of habitat for a species into segments, such that the genetic or demographic viability of a species population is reduced; and risk, in this case, is defined as the probability that this fragmentation will occur as a result of the project. Site clearing, access roads, transmission lines and turbine tower arrays remove habitat and displace some species of wildlife, and may fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large areas of habitat for breeding, wintering, and foraging.

Consequences of isolating local populations of some species include decreased reproductive success, reduced genetic diversity, and increased susceptibility to chance events (e.g. disease and natural disasters), which may lead to extirpation or local extinctions. In addition to displacement, development of wind energy infrastructure may result in additional loss of habitat for some species due to "edge effects" resulting from the break-up of continuous stands of similar vegetation resulting in an interface (edge) between two or more types of vegetation. The extent of edge effects will vary by species and may result in adverse impacts from such effects as a greater susceptibility to colonization by invasive species, increased risk of predation, and competing species favoring landscapes with a mosaic of vegetation.

It is preferable to minimize fragmentation of large forest blocks (>10,000 acres) surrounded by agricultural or urban landscapes as these areas may be especially critical for breeding birds (e.g., Wood Thrush) (Robinson et al. 1995). Species whose range largely lies in these highly altered landscapes may be susceptible to forest loss or fragmentation where these forest blocks are less than approximately 10,000 acres (Mancke and Gavin 2000). Amphibians are vulnerable to fragmentation due to their low mobility and sensitivity to changes in abiotic (physical and chemical) conditions such as water chemistry and temperature. High mortality of juvenile forest amphibians has occurred when they were placed only 50 meters from the forest edge in open fields (Cushman 2006). Semlitsch and Bodie (2003) proposed criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles that addressed emigration of juveniles and movements between breeding areas and non-breeding areas. They recommended the following buffer distances for wetlands and streams: aquatic buffer (30-60 meters), core habitat (142-289 meters, includes aquatic buffer); terrestrial buffer 50 meters outside core habitat (thus 192-339 meters). These are mean values for many herptile species, and would differ species by species.

The impact of wind turbines and associated infrastructures on forests have led some scientists to the following conclusions:

1) Forest clearing resulting from road construction, transmission lines, and turbine placements represents perhaps the most significant potential change through habitat loss and fragmentation for forest-dependent species;

2) Changes in forest structure and the creation of openings may alter microclimate and increase the amount of forest edge; and

3) Plants and animals throughout forest ecosystems respond differently to these changes, and particular attention should be paid to species of concern that are known to have narrow habitat requirements and whose niches are disproportionately altered (King and DeGraaf 2002, Norris and Stutchbury 2002, Ortega and Capen 2002).

If the answer to Tier 1, Question 5 is yes, it is recommended the developer use the general framework for evaluating habitat fragmentation at a project site outlined below. WDNR or FWS offices can provide the available information on habitat types, quality, and intactness. Developers may use this information in combination with site-specific information to determine potential habitat impacts.

If the conclusion is reached that the potential for habitat fragmentation exists due to a wind project, avoid placing wind turbines or infrastructure in the following forest areas: 1) large intact forests (>5,000 acres) surrounded by agricultural or urban landscapes (e.g., Baraboo Hills); 2) in landscapes (based on areas 5 km^2 or more) with <20% natural cover, with no turbines in the remaining natural cover; and 3) in intact forest landscapes (e.g., much of northern Wisconsin) to ensure that turbine placement and infrastructure does not reduce forest cover to <70%. These recommendations are based on the following literature: Austen et al. (2001), Kaiser and Lindell (2007), Parker et al. (2005), Robinson et al. (1995), Stutchbury (2007), and Villard (1998).

7. *Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?*

WDNR Information Review: WDNR ornithologists and zoologists can assist with this question based on NHI data.

Site Visit: To the extent practicable, the site visit(s) should identify landscape features or habitats that could be important to bats and birds that may be at risk of adverse impacts, including nesting, wintering, migration, and foraging habitats, migration corridors, and features such as ridges that may concentrate raptors. It should include a reconnaissance-level bird survey. All bird species should be recorded during the survey.

At any time during field activities or surveys, if species of concern (i.e., SGCN species, state or federally listed endangered, threatened or special concern species) are observed, the WDNR should be notified as soon as possible. Reporting forms are available on the WDNR Bureau of Endangered Resources website: http://dnr.wi.gov/topic/ERReview/.

General Framework for Evaluating Habitat Fragmentation at a Project Site (Tier 1)

A. The developer should define the study area. The study area should include the wind project site for the proposed number of wind turbines. The extent of the study area should be based on the distribution of habitat for the local population of the species affected by habitat fragmentation.

B. The developer should analyze the current habitat quality and spatial configuration of the study area for the species affected by habitat fragmentation.

i. Use recent aerial and remote imagery to determine distinct habitat patches, or boundaries, within the study area, and the extent of existing habitat fragmenting features (e.g. roads).

ii. Assess the level of fragmentation of the existing habitat for species sensitive to habitat fragmentation and categorize into three classes: "High quality": little or no apparent fragmentation of intact habitat. "Medium quality": intact habitat exhibiting some recent disturbance activity (e.g., off-road vehicle (ORV) trails, roadways). "Low quality": extensive fragmentation of habitat (e.g., row-cropped agricultural lands, subdivisions and roads).

C. The wind project developer should determine potential changes in quality and spatial configuration of the habitat in the study area if development were to proceed as proposed using existing site information.

D. The developer should use the collective information from steps A-C to assess whether the habitat impacts, including habitat fragmentation, are likely to

5.2.4 Tier 1 Outcome, Conclusions and Reporting

The objective of the Tier 1 process is to help the developer identify a site or sites to consider further for wind energy development. Possible outcomes of this internal screening process include the following:

1) One or more sites are found within the area of investigation where the answer to each of the above Tier 1 questions is "No," indicating a low probability of significant adverse impacts to wildlife. The developer proceeds to Tier 2 investigations and characterization of the site or sites, answering the Tier 2 questions with site-specific data to confirm the validity of the preliminary indications of low potential for adverse impacts.

2) A "Yes" answer to one or more of the Tier 1 questions indicates a site is unsuitable or there is a high probability of significant adverse impacts to wildlife. The site may be abandoned, the project boundary may be adjusted or effort may be devoted to identifying means by which the project can be modified to avoid or minimize adverse

impacts.

3) The data available in the sources described above are insufficient to answer one or more of the Tier 1 questions. The developer proceeds to Tier 2, with a specific emphasis on collecting the data necessary to answer the Tier 2 questions, which are inclusive of those asked at Tier 1.

Raw survey data and a complete final report for Tier 1 Studies should be provided to the WDNR if the project proceeds. Depending on the type of data sharing agreement for obtaining and using NHI data that was established with the WDNR, the project developer may be required to share findings regarding the presence or absence of endangered resources regardless of the fate of the project. A copy of all submittals should also be provided to the PSC for wind projects subject to their review. Data should be recorded and entered into an Access or Excel database that can be imported into ArcGIS as appropriate. Each bird observation should have an individual record. Results of bat acoustic studies, if undertaken at this Tier, should be reported consistent with Appendix D. A map and GIS file of field information collected at this Tier should accompany the data.

6. PRE-CONSTRUCTION BAT AND BIRD STUDIES (TIER 2)

Once the Site Screening Evaluation process described in Section 5 has been completed, the developer (with assistance from resource agencies and the Study Team) should determine whether pre-construction studies are needed and what the scope of that effort should be. Pre-construction studies are used to:

1) site turbines and related facilities within the project area;
2) estimate direct and indirect impacts of turbine-related mortality, loss of habitat or reduction in habitat quality, and creation of barriers to movement
3) make pre- and post-construction comparisons of impacts on wildlife;
4) estimate the contribution of a project to cumulative impacts;
5) identify mitigation measures to avoid or minimize wildlife losses; and
6) to help design post-construction studies to measure wildlife impacts and/or test the effectiveness of mitigation measures.

6.1 Determining the Need for and Scope of the Pre-Construction Study

At this stage, the developer has narrowed consideration down to a project area and additional data may be necessary to characterize a potential site in terms of the risk wind energy development would pose to wildlife, especially species of concern and their habitats. The Checklist in Table 2 can be used to help determine whether pre-construction studies are needed. The Checklist summarizes important aspects of bat and bird use. Some “yes” answers in the Checklist may be further divided into “low”, “medium” and “high” importance. The answer to each question on the checklist may be based on limited information. Discussion with the Study Team may improve the breadth or accuracy of the answers.

The questions in the Checklist have been worded so that they are applicable to birds and bats; a separate Checklist, however, can be completed for each animal group.

Table 2. *Checklist to Help Determine if Pre-Construction Studies Are Needed*

Indicator of Bird and Bat Use	Unknown (U) or Not Applicable (NA)	No	Yes	Level of Importance		
				Low	Medium	High
1. Is the project located within any of the areas or setbacks prescribed for bats in Section 4 of this Guidance?						
2. Is the project located within any of the areas or setbacks prescribed for birds in Section 4 of this Guidance?						
3. SGCN[1] use the project area during the nesting season?						
4. SGCN use the project area during migration?						
5. Eagles nest within ten miles of the project area?						
6. Raptors nest within two miles of the proposed site?						
7. Staging or wintering areas for waterfowl, shorebirds or raptors within five miles of the site?						
7. Colonially nesting birds or bats occur within five miles of the site?						
8. A bat hibernaculum or maternal roost exists within 10 miles of the proposed site?						
9. The Great Lakes, Mississippi River, or Wisconsin River is within 10 miles of the proposed site?						
10. Birds or bats migrate through the proposed site?						
11. Priority bird migration stopover sites are within five miles of the proposed site?						
12. Birds or bats exhibit behaviors that place them at increased risk at the proposed site (e.g., flight displays, foraging)?						
13. Contiguous water/forest resources > 100 ac exist within one mile of the proposed site?						
14. Topographical features (e.g. ridges, shorelines) that could concentrate bat or bird movements exist at the proposed site?						

[1] SGCN = Species of Greatest Conservation Need.

No further study may be needed if:

- few or none of the indicators of bird and bat use in the Checklist are "unknown" and there is sufficient information to determine that the wind project or individual turbines at the site will not result in biologically significant[6] impacts to birds or bats;

[6] There is no definition of "biological significance" in Wisconsin statutes. The following definition was discussed at the 2003 meeting on Biological Significance coordinated by the NWCC and facilitated by Resolve: "A biologically significant outcome must have a measurable impact on the population and/or its habitat, which

- most of the indicators of bird and bat use in the Checklist are "not applicable," "no," or "low;"
- biologically significant impacts may occur, but there is sufficient information to implement measures to avoid or reduce impacts to less than significant levels;
- the project boundary is not located within any of the places not recommended for commercial wind development in Section 4.

Pre-construction studies (Tier 2) should occur if:

- there is insufficient information to determine that the wind project or individual turbines at the site will result in biologically significant impacts to birds or bats; or
- the developer has decided to proceed with a project located within a place not recommended for commercial wind development in Section 4;
- most or all of the indicators of bird and bat use in the Checklist are "unknown,"
- "yes," "medium," or "high;"
- the project may substantially contribute to cumulative impacts[7] to wildlife, and project-specific information is needed to complete an analysis to determine if impacts to wildlife are significant.

6.2 Tier 2 Pre-Construction Bat and Bird Studies

The pre-construction bat and bird study determines the nature and extent of bat and bird habitat and use based on the questions and information needs identified in Tier 1 and during completion of the Checklist. For the developer, Tier 2 is the first tier in which quantitative and scientifically rigorous studies are conducted to assess the potential risk of the proposed project. Specifically, these studies provide pre-construction information to:

- further evaluate a site for determining whether the wind energy project should go forward;
- design and operate a site to avoid or minimize significant adverse impacts if a decision is made to develop;
- help establish mitigation measures if significant adverse habitat impacts cannot acceptably be avoided or minimized;
- determine if post-construction studies are necessary; and
- to provide the pre-construction component of Tier 3 studies necessary to estimate impacts in a before-after context.

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could reasonably be expected to affect a population's finite rate of increase (lambda) or its stability, and as a result influence a population's viability." We suggest using it as the working definition.

[7] NR 150.22(2)(a)2: "The extent of cumulative effects of repeated actions of the same type, or related actions or other activities occurring locally that can be reasonably anticipated and that would compound impacts."

A distinguishing feature of Tier 2 studies is that they focus on site-specific information and multiple visits to the project area at different times of the year to collect data. Field studies are an essential part of Tier 2 studies, necessary to "ground-truth" available information and develop new information to answer the study questions. Tier 2 studies should include enough site visits during the appropriate times of the year to assess the risks to wildlife posed by the proposed wind project.

Risk is defined as the likelihood that adverse impacts will occur to species of concern as a result of wind energy development and operation (FWS 2010). It considers two components: the probability that the impact will occur and the severity of the outcome, if it does. The first component can be defined for individuals of a species or groups of species (such as raptors) as the estimated number of collision fatalities (impact) divided by the number of individuals in the zone of risk (exposure). The second component is species dependent, based on how the fatalities may affect population viability.

Estimating fatality risk may allow comparisons among projects, alternative development designs, and in the evaluation of risk to populations or species. Because there are relatively few methods available for direct estimation of risk, a weight-of-evidence approach is often used (Anderson et al. 1999). Until such time that reliable risk predictive models are developed, estimates of risk would typically be qualitative, but would be based upon quantitative site information.

Estimating the effect on populations, could involve complicated calculations to estimate the reduction in population viability as indicated by demographic metrics such as growth rate, size of the population, or survivorship, either for local populations, metapopulations, or entire species. For most populations, risk cannot easily be reduced to a strict metric, especially in the absence of population viability models for most species. Consequently, estimating the quantitative risk to populations is usually beyond the scope of project studies due to the difficulties in evaluating these metrics, and therefore risk assessment will be qualitative. Risk to habitat is a component of the evaluation of population risk. In this context, the estimated loss of habitat is evaluated in terms of the potential for population level effects (e.g., reduced survival or reproduction).

The assessment of risk should synthesize sufficient data collected at a project to estimate exposure and predict impact for individuals and their habitats for the species of concern, with what is known about the population status of these species, and in communication with the WDNR, FWS, and other wildlife experts. Predicted risk of these impacts could provide useful information for arriving at the most effective mitigation measures if they become necessary. In practice in the tiered approach, risk assessments conducted in Tier 1 and 2 require less information to reach a risk-based decision than those conducted in Tier 3.

Not all Tier 2 studies will continue into Tier 3. For example, surveys conducted in Tier 2 for species of concern may indicate one or more species are not present at the proposed project site; or siting decisions could be made in Tier 2 that remove identified concerns, thus removing the need for post-construction studies in Tier 3. Additional detail on the design of

Tier 3 studies that begin in Tier 2 is provided in the discussion of methods and metrics in Tier 2.

6.2.1 Tier 2 Questions to Be Considered in Pre-Construction Studies

The decision to conduct a Tier 2 study depends on whether additional data are necessary to answer the questions listed below. The following Questions should be considered in designing Tier 2 studies.

1) What additional studies are required to decide whether the proposed project can proceed to construction/operation or should be abandoned?
2) What data gaps were identified by the Checklist or other information gathered during the Tier 1 screening?
3) What additional data are necessary to design a project to avoid or minimize predicted risk; evaluate predictions of impact and risk through post-construction comparisons of estimated impacts (i.e., Tier 3 studies); and identify minimization and mitigation measures, if appropriate, to offset unavoidable significant adverse impacts.

Some of the specific questions that Tier 2 studies should be designed to answer the following questions may include the following:

1) Do field studies indicate that species of concern are present on, or likely to use, the proposed site?
2) Do field studies indicate the potential for habitat fragmentation, which could adversely impact a species of concern?
3) What is the distribution, relative abundance, behavior, and site use by species of concern identified in Tier 1, and to what extent do these factors expose these species to risk from the proposed project?
4) What are the potential risks of adverse impacts of the proposed project to species of concern? If significant adverse impacts are predicted to species of concern, can these impacts be mitigated?
5) Are there studies that should be initiated at this stage that would be continued in Tier 3?

These questions as posed in this Guidance remain fairly generic. This is because site sensitivity; the affected species of concern; the amount and quality of existing data from nearby comparable sites with similar species and their habitats; seasons of occupancy; and the variability within and between seasons and years where such variability is likely to affect substantially affect the duration, seasonality, and level of effort required to answer each Tier 2 question.

A reduced level of survey effort may be warranted for certain projects, such as projects with low potential risk for significant adverse impacts, some repowering projects, or projects

contiguous to existing low-impact wind energy facilities – provided these projects have sufficient credible information regarding impacts. More effort and longer duration may be needed for uncommon or rare species of concern, when there is little existing information, or when deviation from normal environmental conditions (e.g., drought years) or variability in the metric(s) of interest (e.g., bat activity) is considered so high that it is not otherwise possible to categorize risk as high, moderate or low. ***The greatest effort and duration of studies will be needed for those projects that are proposed in areas not recommended for commercial wind development.***

The problem formulation stage for Tier 2 also will include an assessment of which species identified in Tier 1 will be studied further in the site risk assessment. This determination is based on analysis of existing data from Tier 1 and existing site-specific data and site visit(s) in Tier 1, and on the likelihood of some degree of adverse impact to species or their habitats. Also, if a habitat is suitable for a species of concern needing further study, and the site occurs within the historical range of the species, or is near the existing range of the species but presence has not been documented, additional field studies may be appropriate. Additional analyses should not be necessary if a species of concern is unlikely to be present or is present but adverse impact is unlikely or of minor significance.

Tier 2 studies address many of the questions identified for Tier 1, but Tier 2 studies differ because they attempt to quantify the distribution, relative abundance, behavior, and site use of species of concern. Tier 2 data also attempt to estimate the extent that these factors expose these species to risk from the proposed wind energy facility. Therefore, data that are collected from Tier 2 studies must help to analyze and answer these questions.

6.2.2 Tier 2 Methods and Metrics

Standardized methods and metrics provide the greatest benefit over the long-term, allowing for comparisons among projects. In most instances, a single method will not be adequate for assessing potential wildlife impacts. For example, when there are moderate to high levels of concern about risk to nocturnally active species, such as migrating passerines and local and migrating bats, a combination of methods such as radar, acoustic monitoring for bats, and diurnal bird surveys during the migration period, may be necessary. Refer to Appendix D for suggested protocols and methods in conducting pre-construction bird and bat studies, including the use of radar.

6.2.3 Information Resources for Answering Tier 2 Questions

Specific resources and information that can help answer each Tier 2 question are summarized below. Some of these methods are explained in greater detail in Appendix D.

1. *Do field studies indicate that species of concern are present on, or likely to use, the proposed site?*

This question may be answered from information gathered in Tier 1. Specific

presence/absence studies may not be required, but it may be necessary to conduct field studies using methods such as those described in Appendix D when insufficient information is available for a particular site. The level of effort normally contemplated for Tier 2 studies should detect common species and species that are relatively rare. In the event a species of concern is very rare and only occasionally visits a site, a determination of "likely to occur" may be inferred from historical records of occurrence on or near the site. Normally, the methods and protocols by which surveys are applied also will include an estimate of relative abundance. Most presence/absence surveys should be done following a probabilistic sampling protocol to allow statistical extrapolation to the area and time of interest. Surveys should sample the wind turbine sites and applicable disturbance area during seasons when species are most likely present.

2. *Do field studies indicate the potential for habitat fragmentation, which could adversely impact a species of concern?*

If the answer to Tier 1 Question 5 was yes, but existing information did not allow for a complete analysis of potential impacts and decision-making, then additional studies and analyses should take place in Tier 2.

As in Tier 1, the particulars of the analysis will depend on the species sensitive to habitat fragmentation, the likelihood that the project will adversely affect a local population of the species, and the significance of these impacts to the viability of that population.

To assess habitat fragmentation in the project vicinity, developers should evaluate landscape characteristics of the proposed site prior to construction and determine the degree to which habitat will be significantly altered by the presence of a wind energy facility.

A general framework for evaluating habitat fragmentation that, while not necessarily quantitative, should consider all the major elements and processes inherent in habitat function to reach a comprehensive conclusion. Evaluating habitat fragmentation is warranted when other Tier 1 and Tier 2 studies, the WDNR, FWS or tribe demonstrate the likely presence of a population of a species of concern that may be impacted by habitat fragmentation. Otherwise, the developer need not assess the impacts of the proposed project on habitat fragmentation.

3. *What is the distribution, relative abundance, behavior, and site use of the species of concern identified in Tier 1, and to what extent do these factors expose these species to risk from the proposed project?*

The spatial distribution of species of concern at risk of collision can influence how a site is developed. This distribution should include the airspace for flying species with respect to the rotor-swept zone. The abundance of a species and the spatial distribution of its habitat can be used to determine the relative risk of impact to species using the sites, and the absolute risk when compared to existing projects where similar information exists. Species abundance and habitat distribution can also be used in modeling risk factors.

Surveys for spatial distribution and relative abundance require coverage of the wind turbine sites and applicable site disturbance area, or a sample of the area using observational methods for the species of concern during the seasons of interest. As with presence/absence (see Tier 2, Question 1, above and Appendix D) the methods used to determine distribution, abundance, and behavior may vary with the species and its ecology. Spatial distribution is determined by applying presence/absence or using surveys in a probabilistic manner over the entire area of interest.

a. Determine edge and interior habitat metrics of the study area: Describe habitat and identify existing fragmentation features affecting sensitive species: calculate area of intact patches of habitat, acres of edge, and compare to needs of species sensitive to habitat fragmentation.
b. Determine potential changes in quality and spatial configuration of the habitat in the study area if development proceeds as proposed using existing site information and the best available spatial data regarding placement of wind.

4. *What are the potential risks of adverse impacts of the proposed project to species of concern? If significant adverse impacts are predicted, can these impacts be mitigated?*

Methods used for estimating risk will vary with the species of concern. For example, estimating potential bird fatalities in Tier 2 may be accomplished by comparing exposure estimates at the proposed site with exposure estimates and fatalities at existing projects with similar characteristics (e.g., similar technology, landscape, and weather conditions). If models are used, they may provide an additional tool for estimating fatalities (Madders and Whitfield 2006). As with other prediction tools, model predictions should be evaluated and compared with post-construction fatality data to validate the models. Models should be used as a subcomponent of a risk assessment based on the best available empirical data.

Collision risk to individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, relative abundance, behavior, weather conditions (e.g., wind, temperature) and site characteristics. Collision risk for an individual may be low regardless of abundance if its behavior does not place it within the rotor-swept zone. If individuals frequently occupy the rotor-swept zone but effectively avoid collisions, they are also at low risk of collision with a turbine (e.g. ravens). Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher risk of collisions with turbines regardless of abundance. For a given species (e.g., red-tailed hawk), increased abundance increases the likelihood that individuals will be killed by turbine strikes, although the risk to individuals will remain about the same (FWS 2010). The risk to a population increases as the proportion of individuals in the population at risk to collision increases.

Approach to Evaluating Habitat Fragmentation

Define the study area. The study area for the site should include the "footprint" for the proposed facility plus an appropriate surrounding area. The extent of the study area should be based on the area where there is potential for significant adverse habitat impacts.

Determine the potential for occupancy of the study area by a species of concern.

Analyze current habitat quality and spatial configuration of the study area for a species sensitive to habitat fragmentation.

Use recent aerial or remote imagery to determine distinct habitat patches or boundaries within the study area, and the extent of existing habitat fragmenting features. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes: High quality: little or no apparent fragmentation of intact habitat; Medium quality: intact habitat exhibiting some recent disturbance activity (e.g., timber clearing, ORV trails, roadways); Low quality: extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

Determine edge and interior habitat metrics of the study area: Describe habitat and identify existing fragmentation features affecting sensitive species: calculate area of intact patches of habitat, acres of edge, and compare to needs of species sensitive to habitat fragmentation.

Determine potential changes in quality and spatial configuration of the habitat in the study area if development proceeds as proposed using existing site information and the best available spatial data regarding placement of wind turbines and ancillary infrastructure:

1. Identify and classify all additional features (e.g., roads, transmission lines, maintenance structures, etc.) added by the development that potentially fragment habitat for a species of concern.

2. Assess the expected future size and quality of habitat patches for the species of concern.

3. Determine expected future acreages of edge and interior habitats.

4. Calculate the area of the remaining patches of intact habitat.

5. Compare pre-construction and expected post-construction fragmentation metrics:

    a. Determine the area of intact habitat lost (to the displacement footprint or by an increase in edge).

    b. Identify habitat patches that are expected to be moved to a lower habitat quality classification as a result of the wind development project.

6. Assess the likelihood of a significant reduction in available habitat affecting a species of concern. If the developer finds the likelihood of a significant reduction, the developer should consider items a, b or c below:

    a. Consider alternative locations and development configurations to minimize fragmentation of habitat in communication with species experts, for all species sensitive to habitat fragmentation in the project area.

    b. Identify high quality habitat parcels that may be protected as part of a plan to limit future loss of habitat for the impacted population of the species of concern in the area.

    c. Identify areas of medium or low quality habitat that may be restored or improved to compensate for losses of habitat that result from the project (e.g., management of unpaved roads and ORV trails).

The estimation of displacement risk requires an understanding of animal behavior in response to a project and its infrastructure. A pre-construction estimate is needed of the species whose behavior would cause them to avoid areas in proximity to turbines, roads, and other components of the project. The amount of habitat that is lost to indirect impacts will be a function of the sensitivity of individuals to the project and to the activity levels associated with the project's operations. The population-level significance of this habitat loss will depend on the amount of habitat available to the affected population. If the loss of habitat results in habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased (FWS 2010).

Results of Tier 2 studies should provide a basis for identifying measures to mitigate significant adverse impacts predicted for species of concern. Information on wildlife use of the proposed area is most useful when designing a project to avoid or minimize significant adverse impacts. In cases of uncertainty with regard to impacts to species of concern, additional studies may be necessary to quantify significant adverse impacts and determine the need for mitigation of those impacts.

Recent research establishes that anthropogenic features (e.g., tall structures, buildings, roads, transmission lines, etc.) can adversely impact vital rates (e.g., nesting, nest success, leking behavior, etc.) of Lesser Prairie-Chickens (Pruett et al. 2009, Pitman et al. 2005, Hagen et al. 2009, Hagen et al. In press) and Greater Prairie-Chickens (Robel 2002) over long distances. Hagen et al. (In press) suggested that development within 1 to 1 ½ miles of active leks of prairie grouse may have significant adverse impacts on the affected grouse population. It is not unreasonable to infer that impacts from wind energy facilities may be similar to those from these other anthropogenic structures. Data accumulated through similar research may improve our understanding of the buffer distances necessary to avoid or minimize significant adverse impacts to Greater Prairie Chicken populations in Wisconsin.

When significant adverse impacts cannot be fully avoided or adequately minimized, some form of compensatory mitigation may be appropriate to address the loss of habitat value. For example, it may be possible to mitigate habitat loss or degradation for a species of concern by enhancing or restoring nearby habitat value comparable to that potentially influenced by the project. More detail is provided on this topic in Section Four.

5. *Are there studies that should be initiated at this stage that would be continued in Tier 3?*

The design of post-construction studies will depend on the specific questions addressed in Tier 2. Tier 2 predictions of fatalities will be evaluated using data from Tier 3 studies designed to estimate fatalities. Tier 2 studies may demonstrate the need for compensatory mitigation resulting from significant adverse habitat impacts or for measures to avoid or minimize fatalities. Where significant adverse habitat impacts are a major concern, Tier 3 studies will provide data that evaluate the predicted impacts and the effectiveness of avoidance and mitigation measures.

6.2.4 Tier 2 Outcome and Conclusions

At the end of Tier 2, the developer will make a decision regarding whether and how to

develop the project. There are three potential outcomes:

1) Development of the site has a high probability of an acceptable environmental impact based on existing and new information. There is little uncertainty regarding when and how development should proceed, and adequate information exists to satisfy any required permitting. The decision process proceeds to permitting, when required, and/or development, and pre-construction surveys are terminated.

2) Development of the site has a high probability of unacceptable adverse impacts without implementation of proper mitigation measures. This outcome may be subdivided into two possible scenarios:

    a. There is certainty regarding how to develop the site to adequately mitigate unacceptable adverse impacts. A decision to develop the site is made, conditional on adoption of the proper mitigation measures, with appropriate follow-up fatality studies and habitat studies (Tier 3).

    b. There is uncertainty regarding how to develop the site to adequately mitigate unacceptable adverse impacts; or the permitting process requires additional information on potentially unacceptable adverse wildlife impacts before permitting future phases of the project. A decision to develop the site is granted upon implementation of proper mitigation measures and appropriate post-construction studies (Tier 3).

3) Development of the site has a high probability of an unacceptable environmental impact that cannot be satisfactorily mitigated. Site development is delayed until plans can be developed that satisfactorily avoid, minimize, or provide compensatory mitigation for the foreseen unacceptable adverse impacts. Alternatively, the site is abandoned in favor of known sites with less potential for environmental impact, or the developer begins an evaluation of other sites to develop.

6.2.5 Reporting Tier 2 Studies

Raw survey data and a complete final report for Tier 2 Studies should be provided to the WDNR. A copy of all submittals should also be provided to the PSC for wind projects subject to their review. Data should be recorded and entered into an Access or Excel database that can be imported into ArcGIS as appropriate. Each bird observation should have an individual record. A map and GIS file of survey locations, bird and bat habitat resources, land cover, and proposed turbine sites or parcels should accompany the data.

The raw data sheets, electronic data tables, maps and summary report should be provided to the WDNR and PSC (if applicable) within 90 days following each season of study. **Occurrences of species of concern (including state-listed endangered or threatened species) should be reported to the WDNR within 1 week after the observation is made, using the NHI Rare Animal Field Report Form (1700-048) available on the WDNR**

Bureau of Endangered Resources website (http://dnr.wi.gov/topic/EndangeredResources/).

In addition to the survey results the final report should discuss/present the following in text, figures, and tables:

- Bat/bird species richness and abundance in the study area by season;
- Birds or bats that nest or may nest in the project area, and locations of nests, roosts, rookeries, and hibernacula;
- Description of bird and bat activity in the study area by season, including (if applicable) differences in use of topography (e.g.: ridgetops vs. valleys) by birds or bats.
- Use of the project area by species of concern (if any).
- Flight behavior of all species above, within, or below the rotor swept area by time, time of year, and weather conditions;
- Seasonal migration corridors as determined by acoustic and radar monitoring;

For birds, the data should be primarily organized for each season by date, species, and survey location. For bats, the report should include the data described for acoustic studies in Appendix D.

6.2.6 Planning Post-Construction Mortality Studies during Tier 2 Studies

Post-construction mortality studies should be discussed with participating landowners, the project developer, and the WDNR during the planning of pre-construction studies. Information on bird and bat activity collected during the pre-construction phase can be used to determine the scope and duration of the mortality study. Discussing post-construction studies during the planning of pre-construction studies also helps to set priorities for the assignation of resources as well as identify potential conflicts with project operation.

Project applicants are strongly encouraged to include post-construction mortality studies as an option in landowner agreements (secured at least 2 years in advance of wind project development) because landowner participation has proven to be a serious hurdle in the implementation of mortality studies. Time consuming efforts to redesign studies, serious delays in the start date, or inadequacies in the sample design have all resulted because landowner contacts were initiated only months prior to the start date for the study.

7. POST-CONSTRUCTION BAT AND BIRD STUDIES (TIER 3)

7.1 Purpose and Objectives

The purpose of this section is to provide guidance for completing bat and bird fatality studies once a facility has been built and is in operation. This portion of the Guidance has been

adapted primarily from the study protocols and study results for other mortality studies completed in Wisconsin with modifications based on FWS guidance.

The objectives of the fatality study are to:

- obtain accurate and precise estimates on bat and bird avoidance and mortality at a wind project;
- identify environmental, biological, turbine, and operational variables that correlate to mortality events;
- test mitigation measures intended to reduce bird or bat mortality

7.2 Post-Construction Fatality Studies (Tier 3)

Following the tiered decision process, the outcome of Tier 2 studies will determine the need for Tier 3 studies. Tier 3 studies focus specifically on post-construction fatality monitoring. Activities involve searching for bird and bat carcasses beneath turbines to estimate the number and species composition of fatalities. This information may be useful in answering other questions, such as relationships with site characteristics, comparison of fatalities among facilities, and comparison of actual and predicted fatality rates estimated in Tier 2.

Fatality studies should be considered for all wind energy projects. Fatality studies should occur over all seasons of occupancy for the species monitored, based on information produced in previous tiers. The number of seasons and total length of the study may be determined separately for bats and birds, depending on the pre-construction risk assessment, results of Tier 2 studies from comparable sites, and the results of first-year fatality studies**.** It may be appropriate to conduct studies using different durations and intervals depending on the species of concern. For example, if raptors occupy an area year-round, it may be appropriate to monitor for raptors throughout the year (12 months). It may be warranted to monitor for bats when they are active (spring, summer and fall or approximately eight months). It may be appropriate to increase the search frequency during the months bats are active and decrease the frequency during periods of inactivity. All fatality studies should include estimates of carcass removal and carcass detection bias likely to influence those rates.

The developer's decision about the number of years of study should follow discussions with the WDNR and the PSC. The decision should be based on the outcome of Tier 2 analyses.

For a discussion and description of Tier 3 recommended protocols, see Appendix E.

7.2.1 Tier 3 Questions to Be Considered in Planning Post-Construction Studies

Fatality monitoring results should be of sufficient statistical validity to answer Tier 3 questions, allow comparisons with pre-construction impact predictions and comparisons with other sites, and provide a basis for determining if corrective actions or mitigation measures at

the site are needed. Post-construction fatality monitoring activities are designed to answer the following questions.

1) What are the estimated bird and bat fatality rates and patterns for the project?
    a) Is there a tendency for fatalities to be skewed toward particular species, behavior or migratory status, sex or age classes?
    b) Is there a tendency for fatalities to be skewed higher or lower during a particular time period?
    c) If so, are there factors (e.g., weather events) that may be a trigger for the timing of these fatalities?
2) What are the fatality rates of species of concern?
3) How do the estimated fatality rates compare to the predicted fatality rates?
    a) Is there a correlation between measured bat activity In other words, if measured bat activity is high at a turbine location, will the number of fatalities at that turbine site be greater than if the activity level is low.
    b) Is there a correlation between measured pre- and post-construction activity and the number of fatalities? This information will provide additional data to attempt to determine if pre-construction acoustic data can be used to estimate future fatalities at a proposed wind park site.
4) How do the estimated fatality rates from existing projects in the Midwest in similar landscapes with similar species composition and use?
5) Do bird and bat fatalities vary within the project site in relation to site characteristics or times of year?
    a) Are fatalities significantly greater at a particular location (north/south/east/west) within the wind park, or at a particular turbine(s)?
    b) If fatalities are grouped in one or more areas, is it possible that the fatalities are correlated with migration activity patterns, habitat, or weather conditions?
    c) Is there a particular time period of significantly greater fatality for any or all bat or avian species?
6) What is the composition of fatalities in relation to migrating and resident birds and bats at the site?
7) Do fatality data suggest the need for mitigation measures to reduce impacts?
    a) Do the fatality patterns suggest that setbacks from certain habitat types or acreages should be further examined?

7.2.2 Tier 3 Methods and Metrics

In addition to the monitoring protocol (Appendix E), the metrics used to estimate fatality rates must be selected with the Tier 3 questions and objectives in mind. Metrics considerations for each of the Tier 3 questions are discussed briefly below. Not all questions

will be relevant for each project, and which questions apply would depend on Tier 2 outcomes.

1) *What are the bird and bat fatality rates and patterns for the project?*

The primary objective of fatality searches is to determine the overall estimated fatality rates for birds and bats for the project. These rates serve as the fundamental basis for all comparisons of fatalities, and if studies are designed appropriately they allow researchers to relate fatalities to site characteristics and environmental variables, and to evaluate mitigation measures. Several metrics are available for expressing fatality rates. Early studies reported fatality rates per turbine. This metric, however, is somewhat misleading as turbine sizes and their risks to birds vary significantly (NRC 2007). Fatalities are frequently reported per nameplate capacity (i.e. MW), a metric that is easily calculated and better for comparing fatality rates among different sized turbines. Even with turbines of the same name plate capacity, the size of the rotor swept area may vary among manufacturers, and turbines at various sites may operate for different lengths of time and during different times of the day and seasons. With these considerations in mind, it is recommended that fatality rates be expressed on a per turbine and per nameplate MW basis until a better metric becomes available (FWS 2010).

2) *What are the fatality rates of species of concern?*

This analysis simply involves calculating fatalities per turbine of all species of concern at a site when sample sizes are sufficient to do so. These fatalities should be expressed on a per nameplate MW basis if comparing species fatality rates among projects.

3) *How do the estimated fatality rates compare to the predicted fatality rates?*

There are a several ways that predictions can be assigned and later evaluated with actual fatality data. During the planning stages in Tier 1, predicted fatalities may be based on existing data at similar facilities in similar landscapes used by similar species. In this case, the assumption is that use is similar, and therefore that fatalities may be similar at the proposed facility. Alternatively, metrics derived from pre-construction assessments (Tier 2) for an individual species or group of species – usually an index of activity or abundance at a proposed project – could be used in conjunction with use and fatality estimates from existing projects to develop a model for predicting fatalities at the proposed project site. Finally, models can be used to predict the probability of a bird of a particular size striking a turbine, and this probability, in conjunction with estimates of use and avoidance behavior, can be used to predict fatalities.

Metrics derived from Tier 2 pre-construction assessments may be correlated with fatality rates, and in Tier 3 studies it should be possible to determine if different preconstruction metrics can in fact accurately predict fatalities and, thus, risk.

4) *How do the fatality rates compare to the fatality rates from existing facilities in similar landscapes with similar species composition and use?*

Comparing fatality rates among facilities with similar characteristics is useful to determine patterns and broader landscape relationships, as discussed above for predicting fatalities at a proposed project site. Fatality rates should be expressed on a per nameplate MW or some other standardized metric basis for comparison with other projects, and may be correlated with site characteristics – such as proximity to wetlands, riparian corridors, ridges, or other broader landscape features – using regression analysis. Comparing fatality rates from one project to fatality rates of other projects provides insight into whether a project has relatively high, moderate, or low fatalities.

5) *Do bird and bat fatalities vary within the project site in relation to site characteristics or times of year?*

Turbine-specific fatality rates may be related to site characteristics such as proximity to water, forest edge, staging and roosting sites, known stop-over sites, or other key resources, and this relationship may be estimated using regression analysis. This information is particularly useful for evaluating micro-siting options when planning a future facility or, on a broader scale, in determining the location of the entire project.

6) *What is the composition of fatalities in relation to migrating and resident birds and bats at the site?*

The simplest way to address this question is to separate fatalities per turbine of known resident species (e.g., Big Brown Bat, Blue Jay) and those known to migrate long distances (e.g. Hoary Bat, Red-eyed Vireo). These data are useful in determining patterns of species composition of fatalities and possible mitigation measures directed at residents, migrants, or perhaps both, and can be used in assessing potential population effects.

7) *Do fatality data suggest the need for mitigation measures to reduce impacts?*

It is recommended that the wind project operator and the WDNR and PSC discuss the results from Tier 3 studies to determine whether these impacts are significant. If fatalities are considered significant, the wind project operator and the WDNR should work closely to develop a plan to mitigate these impacts.

7.2.3 Operational Changes and Other Mitigation

Siting of wind projects and micrositing of turbines to avoid important bat and bird use areas, and adjusting turbine design and lighting, are measures that can be implemented prior to construction of a wind project to reduce bird and bat mortality and loss of habitat. Once a project is in operation, however, the most promising mitigation method that currently exists is curtailment: turbine blades are intentionally prevented from pitching into the wind at certain low wind speeds, thus lowering the risk to bats of collision or barotraumas (Redell 2009). Bat mortality is greatest during the summer and fall on nights with low wind speeds (<6.0 m s^{-1})(Arnett et al. 2008). Baerwald et al. (2009) and Arnett et al. (2010) found that by raising wind turbine cut-in speeds—the lowest wind speed at which turbines generate power to a utility—nightly reductions in bat mortality occurred ranging from nearly 60% and 44%-93%, respectively, with only marginal annual power loss ($\leq$1% of total annual output, Arnett

et al. 2010). Accordingly, increasing turbine cut-in speeds (from 3.5-4.0 m s^{-1} to 6.5 m s^{-1}) at wind facilities in areas of concern during periods when bats are most active and at greatest risk, may mitigate the impacts of wind-power generation (Arnett et al. 2010).

By adhering to the suggested guidance above and keeping abreast of the latest research on wind project impacts on wildlife, developers will have the opportunity to site projects in an environmentally responsible manner and work with the citizens of Wisconsin to ensure that the legacy of wildlife conservation endures.

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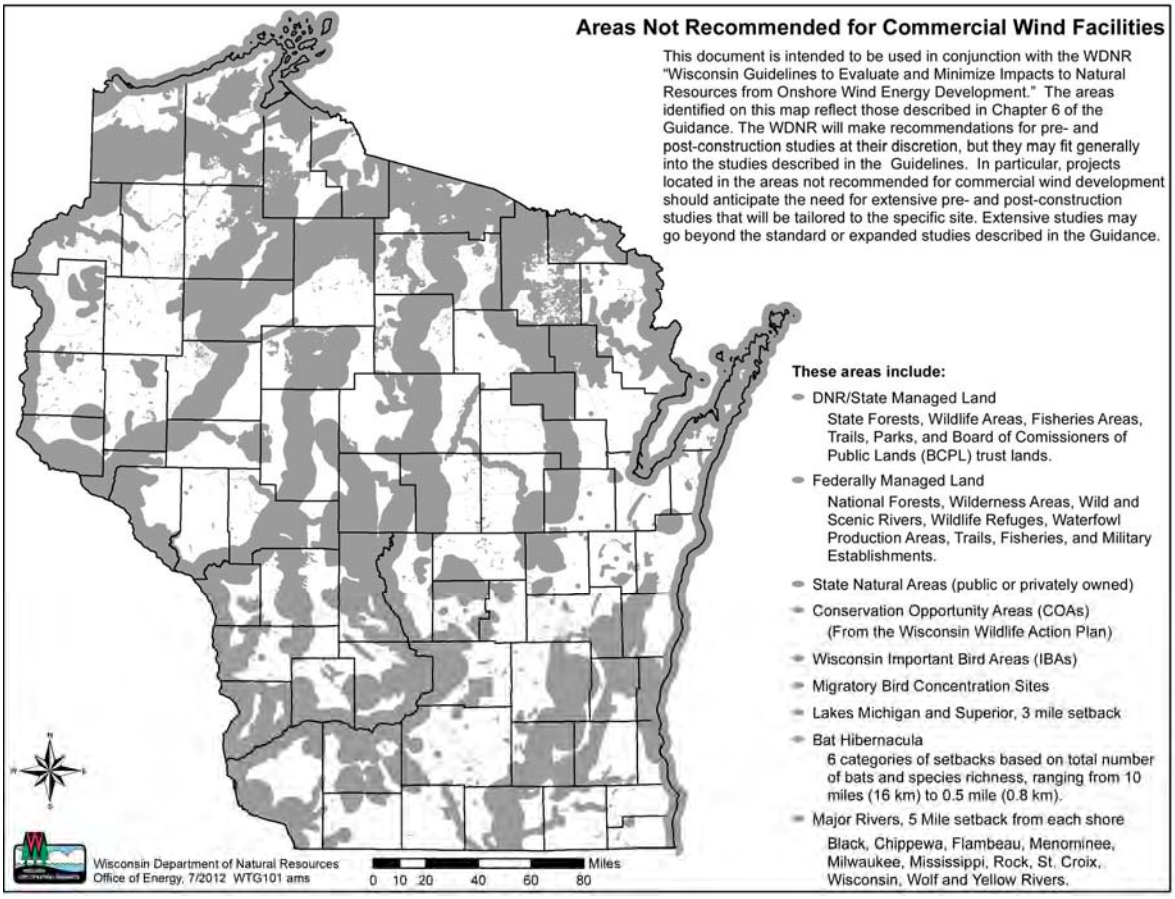
APPENDIX A

Map of Places Not Recommended for Wind Project Development in Wisconsin



APPENDIX B

Sources of Information on Birds, Bats and Interactions with Wind Turbines

Web Sources:

http://www.nationalwind.org/

http://www.fws.gov/r9dhcbfa/windenergy.htm

http://www.safewind.com/index.htm

http://www.nrel.gov/wind/nwtc_library.html#ald

Additional Sources:

- Wisconsin Breeding Bird Atlas (http://www.uwgb.edu/birds/wbba/)
- NHI county maps (http://www.dnr.state.wi.us/org/land/er/nhi/CountyMaps/interp_co_maps.htm)[8]
- the Wisconsin Wildlife Action Plan (http://www.dnr.state.wi.us/org/land/er/wwap/explore/tool.asp)
- Bat Conservation of Wisconsin (http://www.batcow.org/index.html)
- Wisconsin Society for Ornithology
- County Foresters and Planning Departments
- UW-Madison Department of Wildlife Ecology, local UW campuses
- Local land conservancies and birding groups.

County Forest and Planning Departments or land conservancies/trusts may have information on natural communities, land use, wildlife use, or the presence of endangered resources on their properties. The UW-Madison Department of Wildlife Ecology and local UW campuses can provide information on survey projects in a particular area.

Natural community and wildlife databases may be incomplete because they can reflect surveys done primarily on public properties, whereas wind projects are generally sited on private property. Accordingly, private landowners knowledgeable about wildlife and habitats on their properties may prove to be a valuable resource.

Data describing meteorological conditions may be available from existing met stations or offsite sources such as Wisconsin Focus on Energy, UW Department of Atmospheric and Oceanic Sciences, and local weather authorities.

[8] Web-based NHI county maps are not updated as frequently as the NHI database and may not contain the most current rare species and natural community information.

APPENDIX C
Suggested Best Management Practices (BMPs) for Wind Siting

During site planning, the following BMPs can assist a developer to reduce potential impacts to species of concern. Use of these BMPs, which are adapted from FWS guidelines, should ensure that the potentially adverse impacts to most species of concern and their habitats would be reduced, although compensatory mitigation may be appropriate in some instances to address site-specific concerns and Tier 2 study results.

These BMPs will evolve as additional data become available on how to best minimize wildlife and habitat impacts from wind energy projects.

- Minimize, to the extent practicable, the area disturbed by pre-construction site monitoring and testing activities and installations.
- Avoid locating wind energy facilities in areas identified as a high risk to birds and bats.
- Use available data from the WDNR NHI program and Tier 2 studies that show the location of sensitive resources to establish the layout of roads, power lines, fences, and other infrastructure.
- Use native species when seeding or planting during restoration on non-agricultural or developed lands.
- To reduce avian collisions, place low and medium voltage connecting power lines associated with the wind energy development underground to the extent possible, unless burial of the lines is prohibitively expensive (e.g., where shallow bedrock exists) or where greater adverse impacts to biological resources would result. Overhead lines may be acceptable if sited away from high bird crossing locations such as between roosting and feeding areas or between lakes, rivers, leks, and nesting habitats. To the extent practicable, the transmission line structures should be designed and marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines. Overhead lines may be used when the lines parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced. Above-ground low and medium voltage lines, transformers and conductors should follow the most recent APLIC “Suggested Practices for Avian Protection on Power Lines” (APLIC 2006).
- Avoid guyed communication towers (Travis 2009) and permanent met towers at wind energy project sites. If guy wires are necessary, bird flight diverters or high visibility marking devices should be used.
- Use construction and management practices to minimize activities that may attract prey and predators to the wind energy facility.
- Employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights (Travis 2009) to meet Federal Aviation Administration (FAA) requirements for visibility lighting of wind turbines, permanent met towers, and

communication towers. Only a portion of the turbines within the wind project should be lighted, and all pilot warning lights should fire synchronously.

- Keep lighting at both operation and maintenance facilities and substations located within half a mile of the turbines to the minimum required: Use lights with motion or heat sensors and switches to keep lights off when not required. Lights should be hooded downward and directed to minimize horizontal and skyward illumination. Minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.
- Establish non-disturbance buffer zones to protect sensitive habitats or areas of
- high risk for species of concern identified in pre-construction studies. If not recommended in Section 4 of this document, determine the extent of the buffer zone (setback) in consultation with the WDNR Office of Energy.
- Establish turbine locations to avoid separating bird and bat species of concern from their daily roosting, feeding, or nesting sites if documented that the turbines' presence poses a risk to these species.
- Avoid impacts to hydrology and stream morphology, especially where federal or state-listed aquatic or riparian species may be involved.
- Although it is unclear whether tubular or lattice towers reduce risk of collision, when practical use tubular towers or best available technology to reduce ability of birds to perch and to reduce risk of collision.
- Minimize the number and length of access roads; use existing roads when feasible.
- Minimize impacts to wetlands and water resources by following all applicable provisions of the Clean Water Act (33 USC 1251-1387) and the Rivers and Harbors Act (33 USC 301 et seq.); for instance, by developing and implementing a storm water management plan and taking measures to reduce erosion.
- Reduce vehicle collision risk to wildlife by instructing project personnel to drive at appropriate speeds, be alert for wildlife, and use additional caution in low visibility conditions. Do not harass or disturb wildlife at any time and during any season.
- Reduce fire hazard from vehicles and human activities (instruct employees to use spark arrestors on power equipment, ensure that no metal parts are dragging from vehicles, use caution with open flame, cigarettes, etc.).
- Follow federal and state measures for handling toxic substances to minimize danger to water and wildlife resources from spills.
- Reduce the introduction and spread of invasive species by following applicable local policies for noxious weed control, cleaning vehicles and equipment arriving from areas with known invasive species issues, using locally sourced topsoil, and monitoring for and rapidly removing noxious weeds at least annually.
- Utilize pest and weed control measures as specified by county or state requirements, or by applicable federal agency requirements (such as Integrated Pest Management) when federal policies apply. Refer also to Chapter NR 40, Wisconsin's Invasive

Species Identification. Available: http://www.dnr.state.wi.us/invasives/classification/.

APPENDIX D
Suggested Methodologies for Bird and Bat Pre-Construction Studies

This Appendix describes methodologies for pre-construction avian and bat studies that may be undertaken as part of Tier 2 studies.

D.1 Standard Pre-Construction Bird Studies

In Wisconsin, non-urban or non-residential areas can exhibit considerable annual and seasonal variation in bird abundance and/or composition. Generally, we recommend that bird studies documenting occurrences, breeding/roosting locations, and presence/absence be carried out for a minimum of 2 years covering all four seasons. A 1-year study may be sufficient if there are: a) recent, comparable sources of baseline information (post-construction studies at wind projects in similar landscapes confirming a conclusion of low or no impact), b) populations of species of concern known not to be at risk, and c) there are no resource features that concentrate nesting, overwintering, or migrating birds near proposed turbine sites.

The commonly used data collection methods for estimating the spatial distribution and relative abundance of diurnal birds include counts of birds seen or heard at specific survey points (point count) or along transects (line transect surveys). Both methods result in estimates of bird use, which are assumed to be indices of abundance in the area surveyed. Point counts or line transects should collect vertical (flight heights) as well as horizontal data to identify levels of activity within the rotor-swept zone.

D.1.1 Study Duration

In Wisconsin, non-urban or non-residential areas can exhibit considerable annual and seasonal variation in bird abundance and/or composition. Surveys should be conducted at different intervals for up to 2 years to account for variation in expected bird activity, with lower frequency during winter months when bird activity is low. Sampling frequency should also consider the episodic nature of activity during fall and spring migration. Standardized protocols for estimating avian abundance should be consulted (e.g. Dettmers et al. 1999).

A 1-year study may be sufficient if there are recent, comparable sources of baseline information, populations of rare or vulnerable species are not believed to be at risk, there are no resource features that concentrate nesting, overwintering, or migrating birds near proposed turbine sites, and especially, if post-construction studies at nearby wind projects in similar landscapes confirm a conclusion of low or no impact. An additional year or season of study may be recommended, depending on the results of that study or post-construction results from neighboring wind projects.

D.1.2 Sample Number

In consultation with a professional ornithologist, determine the number and location of sample points needed to meet analytical and statistical goals. .

If the proposed project consists of ≤ 10 turbines, then all turbine sites should be sampled. If they are representative of the sampled habitat(s), the study may be focused on one or a few turbine sites.

If the approximate number of turbines is known and there is access to the turbine sites or the with-turbine parcels, then sample 2/3 of turbine sites for projects with 11-34 turbines and 1/3 of the sites for projects with >35 turbines. In cases where there is no or limited access, an equivalent accessible area can be sampled as a surrogate.
From these initial estimates, adjustments in the number of sampling locations can be made to ensure coverage of the range of habitat types at the site.

D.1.3 Sample Location

Sampling locations (waypoints) may be selected using random, stratified-random, or systematic design. For larger projects or those in a complex environment, a stratified-random method of selecting count locations may be preferred where the variable being stratified may be distance from an important resource or topographic feature, geographic sector, land cover or habitat type. For example, many wind projects are proposed in areas of the state where forested or wetland habitat patches are distributed in an agricultural or rural residential matrix, and may be missed by an entirely random selection. In areas where there is relief, such as the Niagara Escarpment and the Driftless Area of the coulee-ridge region, point counts need to include these important natural features. A systematic design may be applied where there is no access to with-turbine parcels and counts are spaced evenly along roads.

Any adjustments to sample size or location should be discussed by Study Team and the reasons for any adjustments should be well documented.

Even with an unbiased method for selecting point count locations (waypoints), other factors should be considered in developing the final sampling design:

- Count locations should coincide with turbine locations or the observation radii should overlap as much as possible with proposed turbine locations.
- Random sampling may miss unique habitat types or under-represent large habitat patches.
- Point counts should be designed to distinguish the influence that small forested areas (e.g., < 40 acres) in a non-forested matrix may have on bird composition and abundance[9].
- Regardless of their location on or off roads, point counts should be spaced no closer than every 250 m in forested or densely vegetated cover, or every 500 m in open areas.

[9] There is no standard definition of a “small forested area” or “small patch size”. In this case, we assumed an area of 450 m in diameter, which would allow for two point counts set back 100 m.

- Count locations should be set back at least 100 m from habitat edges or unique anthropogenic features (e.g. gravel pit, rural residences, etc.). If this is not possible due to the small size of a forest patch, then the point should be placed in the center and this limitation should be noted in the field sheet.
- The sampling design should also account for setbacks that are established by local governments, but point counts should be at least 100 m from roadsides, residences, and other constructed structures so that the counts are not influenced by these structures.
- If point count locations can only be placed along roadsides, we recommend starting with points every 805 m (0.5 miles) from a randomly selected starting point
- Observation waypoints are marked with a GPS and in the field according to WDNR's standard geo-referencing system: Wisconsin Transverse Mercator based on the 1991 adjustment to the North American Datum of 1983 (WTM83/91).
- Point counts should be established with the expectation that data will be collected from the same locations after construction.

D.1.4 Reference Locations

To answer questions based on pre- and post-construction comparisons, a reference site needs to be selected that is outside any influence of the turbines, including wake effects. For grassland or open field sites, it may be appropriate to site these count locations up to 1 mile (0.6 km) from turbine locations. For other sites, the appropriate distance may need to be determined by the assessment team, but we recommend a minimum distance of two or three times the maximum height of the turbine from base to blade tip at the 12:00 position. Reference sites should approximate environmental conditions at turbine sites and should be selected in the same manner (random, stratified random or systematic) as sampling points in the assessment area.

D.1.5 Count Timing and Duration

The survey period should begin a half hour before sunrise and end four hours after sunrise. There are exceptions: Although early morning is the best time for surveying, forest birds are also active in the evening, and may even sing throughout the day early in the breeding season. If the objective is to count nocturnal species, this may require nighttime visual monitoring or surveys at dusk or pre-dawn at potential stopover locations.

Point count surveys at each location should be 10 minutes long. Each 10-minute count should consist of two segments, from 0-5 minutes and 5-10 minutes. This time interval maximizes detection of birds across different landscapes and ensures consistency among studies.

Travel time between stations should average from 15 to 20 minutes. The order of the point counts should be reversed for successive counts. Using this methodology, a single person can complete approximately 9-11 point counts in one day.

Documentation of birds should begin immediately upon reaching the point count station. Birds seen or heard at a point station after the point count period has ended should be assigned to that station. Birds observed between count locations should also be recorded.

D.1.6 Weather Conditions

Surveys should not be conducted during rain or heavy fog; but may continue through light drizzle. Surveys should not be conducted in steady winds greater than 10 mph or a "3" on the Beaufort Wind Scale. The sky code, wind code, and temperature (ºF) should be recorded at each point count station at the end of the 10 minute count.

If surveys are being conducted to characterize the use of stopover areas during migration, then visits may be scheduled to coincide with poor weather conditions.

D.1.7 Sampling Frequency

Surveys should be conducted during all seasons. The frequency of the counts can be adjusted to cover the seasonality of migration and nesting. During the periods 1 March to 15 May and 16 August to 15 November, all points should be surveyed once every 1 to 3 days. During the period 16 May to 15 August, points may be surveyed on a 10 day cycle or less. During the period 15 November to 28 February, all points should be surveyed on a 12 day cycle or less.

D.1.8 Survey Radius/Detection

A point count consists of standing in a specific location and counting birds. The investigator counts the number of individual birds (of each species) within a circle of a certain radius based on what can be heard and seen. In most cases, especially when gathering data to compare successive point counts, radius size should be consistent. The radius should be as large as possible to maximize information gathering, but not so large that birds cannot be seen or heard throughout the survey area. Also, landscapes are very different from one survey site to the next, and it is difficult to select a radius that works for every situation; 100 m ensures that most rare birds are detected if they can be, but the maximum radius should be 250 m in forested or heavily vegetated areas and 500 m in open areas. Consistent survey boundaries in forested and non-forested areas make comparing different point counts easier in the long run. Observations should be recorded within this radius as <50m, 50-100m, and >100m.

To detect birds during forest surveys, we suggest continually scanning for movement from the ground up to the canopy while listening for vocalizations or other auditory indicators.

D.1.9 Species Identification

All bird species should be counted in surveys. Additional species-specific survey protocols may be used if there is potential for the presence of specific state or federally-listed endangered, threatened or species of special concern, Wisconsin Species of Greatest

Conservation Need and raptors. Use standard four letter codes for bird names (See http://www.uwgb.edu/birds/wso/).

D.1.10 Describing Cover and Habitat

For the site, identify WDNR natural community types[10] (or most similar), list dominant plant species in each structural layer, describe canopy, shrub and herbaceous associates, percent canopy and understory cover, estimate tree size class[11] and presence of other features such as waterbodies, snags and woody debris. Estimate dominant vegetation/crop cover in the four quadrants surrounding each point count location. A current aerial photo should be obtained for each year of pre-construction study to describe and quantify the type (crop, rotation, grazing etc.) and area of agricultural activities.

Relating use to site characteristics requires measuring site characteristics thought to influence use (i.e., covariates such as vegetation and topography) in relation to the location of use. The statistical relationship of use to these covariates can be used to predict occurrence for the same areas in the future.

D.1.11 Other Environmental Variables

In addition to the bird species, other data to collect in the surveys are:

- date, time, location and observer name
- weather conditions
- flight height (above, within and/or below the rotor swept area)
- distance of the bird from observer based survey radius intervals
- observed evidence of possible, probable and confirmed breeding activity (courtship, mating, incubating, etc.)
- observations of other bird behaviors or items of interest using Breeding Bird Atlas behavior codes
- location of nesting birds or active nests
- direction of flight
- habitat and cover type
- prey type and abundance at site

[10] WDNR natural community types in Wisconsin: http://www.dnr.state.wi.us/org/land/er/communities/.
[11] Seedling – a usually young tree smaller than a sapling. Trees less than 1 inch dbh.
Sapling – a usually young tree larger than a seedling but smaller than a poletimber tree. Trees ranging from 1 to 5 inches dbh.
Poletimber – A tree of a size between a sapling and a sawtimber tree. Hardwood trees ranging in size from 5 to 11 incheds dbh and conifers ranging in size from 5 to 9 inches dbh.
Sawtimber – Trees with minimum diameter and length and with stem quality suitable for conversion to lumber. Hardwood trees larger than 11 inches dbh and conifers larger than 9 inches dbh.

- presence and movements of vehicles, loud and disruptive noises and other unusual, intermittent or infrequent anthropogenic disturbances.

Flight height is difficult to estimate accurately. Accuracy can be improved with experience and training by comparing estimates against objects of a known height. This uncertainty is outweighed by the importance of being able to characterize bird behavior in the project area as a factor affecting the risk of mortality or displacement.

D.1.12 Sampling Methods

The usefulness of any of the methods described in this section is dependent on access to appropriate sampling locations. The Department may also be able to assist in this effort.

Point Counts

In moderate to large habitat areas where points can be placed at least 100 m from an edge, points should be placed in proportion to available habitat. For example, if 80% of the area is mixed hardwood forest, 80% of counts should be in that habitat and so on. Exceptions might be a single habitat such as wetland, grassland or old field that is less than 1% of the landscape but may have different species. Points may be placed in a stratified random design to represent major habitat types or geographical units. If the landscape is primarily a mosaic of small habitat patches where most or all points would be placed within 100 m of a habitat edge, then the area may be viewed as a single unit and points may be placed randomly or systematically. Sampling points may also be selected randomly from within grids overlaid on the project area plus a buffer to ensure representative coverage. The grids may also be placed to control for important differences in environmental characteristics within the project boundary such as topography or land use.

Roadside point counts ensure that the points are accessible to observers. They are usually not representative of available habitat or the conditions at turbine site, but the outer part of the observation radius may overlap with turbine sites in the interior of the landscape. Where access to proposed turbine sites is possible, roadside counts are not acceptable.

Line Transects

Line Transects are not practical if it is difficult to walk through a landscape, there is no access, or the area of interest is too small. If vegetation or other obstacles prevent walking through a property, point counts are generally used. Transects can follow established roads, trails, or watercourses or may be new routes away from these features. Transects should be placed randomly within a habitat area and with certainty that enough transects are selected to adequately cover the project area.

During the transect survey, the researcher counts the number of individual birds (of each species) on either side of the path (transect) within a certain distance. This distance should be consistent and as large as possible to maximize information gathering, but not so large that birds cannot be seen or heard from the transect. It is difficult to select a distance between

transects that works for every situation, but the distance should ensure representative coverage of the project area and avoid duplicate counting of birds.

D.2 Other Types of Tier 2 Pre-Construction Avian Methodologies

D.2.1 Nocturnal Bird Survey Methods – Radar and Acoustic Monitoring

For most of their migratory flights, songbirds and other nocturnal migrants are above the reach of wind turbines. They may pass, however, through the altitudinal range of wind turbines during ascents and descents and may also fly closer to the ground during inclement weather (Able 1977, Richardson 2000, Travis 2009). Precipitation, low cloud ceilings/overcast skies associated with fall cold fronts, and northerly winds often lead to poor visibility and increase the risks of birds colliding with structures protruding upwards into their aerial habitats (Travis 2009).

No single method can adequately assess the spatial and temporal variation in nocturnal bird populations or the potential collision risk. There are, however, different types of radar and acoustic monitoring techniques that exist both as established and developing technologies to assess the flight altitude, direction, passage rates, and general composition during typical and high-risk migration scenarios.

The primary objective of radar methods is to assess the flight altitude, direction, passage rates, and general composition during typical and high risk migration scenarios. In Wisconsin we are especially concerned with migration patterns to and from stopover habitat and in reaction to environmental conditions such as inclement weather, head winds, and topographic features. If there is insufficient information to determine whether these situations exist, how birds react, or what measures can be taken to minimize their impact, then it is a strong indication that radar surveys should be used during pre-construction surveys.

In designing radar studies, single or multiple radar units are positioned to cover as much of the airspace over the project area as possible. The radar units must be capable of horizontal and vertical scanning to describe flight direction and altitude, and maximize distinction of interference from insect activity and weather events. Passage rates should be estimated nightly, from dusk to dawn during migration. Measuring passage rates against altitude on an hourly basis will aid in assessing times of increased risk of mortality. Radar units should be configured properly to be used in conjunction with acoustic monitors to maximize the ability to distinguish targets (e.g., birds and bats) in the project environment.

NEXRAD Doppler Radar can provide information on general migratory patterns and density of targets, but its coverage is limited. Moreover, it cannot distinguish species and it cannot distinguish passage rates and altitudes over small areas. Most radar studies for wind projects have employed some type of mobile marine surveillance radar with vertical and horizontal scanning capabilities or tracking radar.

Acoustic monitoring complements radar by its ability to estimate passage rates and distinguish some species or groups of birds at low altitudes. The number of nights per

migration season, frequency, and hours per night should be agreed upon by the Study Team based on the variability of passage rates and flight altitudes, weather conditions, and presence of stopover habitats in the study area.

Radar and acoustic monitoring can be effective methods for capturing the presence of night migrants in places where migrants concentrate, particularly along the Great Lakes' coasts. Existing survey information, environmental features, and weather conditions throughout the year should be evaluated by the *Wind and Wildlife Study Team* (See Section 3.4) to determine if nocturnal migrants are at risk from the proposed project. Observing the nocturnal study methods in Kunz et al. (2007a) is also recommended to determine relative abundance, flight direction and flight altitude for assessing risk to migrating birds.

D.2.2 Raptor Nest Searches

An estimate of raptor use of the project site can be obtained through point counts, but if potential impacts to breeding raptors are a concern, raptor nest searches conducted in suitable habitat during the breeding season are also recommended within 2 miles (3.2 km) of the project area. These surveys provide information to predict risk to the local breeding population of raptors, for micro-siting decisions, and for developing an appropriate-sized non-disturbance buffer around nests. Surveys also provide baseline data for estimating impacts and determining mitigation requirements.

Methods for these surveys are fairly common and will vary with the species, terrain, and vegetation within the survey area. It is recommended that draft protocols be discussed with the Study Team.

D.2.3 Density Estimates and Detection Probability

In cases where a particularly vulnerable bird species, rare species or group of birds may be affected, accurate estimates of density are required to monitor population changes or changes in use due to the presence of wind turbines. To make an estimate of density it is important to also define detection probability. In these cases, the number of sites, location and frequency of sampling may be driven by making a sufficient number of observations so that this value can be estimated.

D.2.4 Changes in Habitat Use

Inasmuch as radar and acoustic monitoring can be used to estimate migratory behavior as a tool for properly siting wind projects and turbines, it can also be used to monitor changes in how birds use airspace after a wind project is constructed. The answer to this question may best be researched on a regional population scale with individual projects making a contribution to the dataset.

Habitat avoidance and decreased use by songbirds during the breeding season is a concern for species that are rare or declining in population. Pre-construction point counts are established to determine bird density and vegetation cover at increasing distance from the

proposed turbine location based on the protocols identified by the National Wind Coordinating Collaborative for assessing displacement effects for grassland songbirds (http://www.nationalwind.org/publications/wildlife.htm). This protocol relies on a combination of BACI and Impact Gradient design.

D.2.5 Marshbird Broadcast Surveys

Some species of marsh birds, rails, bitterns, coots and grebes, are protected in the state and are best detected. Protocols for completing this type of survey are provided by the Wisconsin Bird Conservation Initiative (WBCI) at: http://wiatri.net/projects/birdroutes/marshbirds.htm.

D.2.6 Other Surveys

Methods other than point counts or line transects may be used to address matters that are specific to a given site. The frequency and timing of these surveys is not standard and may be specific to the survey objectives. For smaller projects of less than 10 turbines, **area searches** may be used. This method provides a list of species using the site and some relative information on abundance relative to habitat. **Behavioral surveys** may be appropriate if a species or group of birds exhibits a behavior that makes it more vulnerable to collision or displacement (e.g., waterbirds moving between resource areas or raptors searching for prey). **Nest surveys** are useful for estimating raptor use within a large area or population effects on a specific species. **Focused surveys** may be designed to maximize the likelihood of detecting rare bird species or groups of birds that are vulnerable to wind turbine projects. **Stopover counts** can determine if resources within a landscape are used by large numbers of birds primarily for resting or feeding during migration. Stopover counts may be carried out when birds are most readily counted, e.g. early morning for songbirds. **Diurnal migration** surveys require long duration counts that can monitor daily migrations during the breeding season or during seasonal migration. **Migration counts** may require intensive sampling to cover variability in migration during optimal and poor weather conditions. Any of these methods may be used in conjunction with **radar** and **acoustic** monitoring.

D.3 Bat Survey Methods

Pre-construction bat studies are needed to: 1) measure bat activity levels in relation to landscape features and insect abundance; 2) create a threshold predictive model and decision matrix to establish any correlations between environmental conditions and fatality events that produce high seasonal bat mortality for the project site. A predictive model will help identify possible solutions for mitigating bat mortality (Kunz et al. 2007a). At least 2 years of pre-construction bat studies should be completed prior to construction, with the survey period extending throughout spring migration (1 April-31 May), summer (1 June- 1 August), and fall migration (15 July 15- 31 October).

D.3.1 Radar Detection

Redell and Au (2007) have described the efficacy of radar detection in describing bat behavior. Single or multiple radar units are positioned to cover as much of the airspace over

the project area as possible. Night vision goggles and/or forward looking infrared (FLIR) are additional tools that can be used to ground-truth radar targets (Kunz et al. 2007a).

D.3.2 Acoustic Monitoring

Acoustic detectors are the primary tools used in pre-construction bat studies (Redell et al. 2006, Kunz et al. 2007a). Acoustic detectors should ideally be positioned at the edges of the project area in the four cardinal directions, but the location of stationary monitors is often determined by the location of meteorological (met) towers. At a minimum, detectors should be placed on three met towers within the study area, and mounted at 2 meters and > 30 meters - as high as possible to reach within the rotor swept area. Detectors should be at the same height so that data are comparable within and among projects. If topography and land cover are heterogeneous then more detectors are warranted. Monitors can be placed on towers as they are constructed, or a pulley system for raising and lowering acoustic microphones can be installed along with the met towers, so they can be mounted at a later time. Taking down pre-existing met towers to install monitors should be considered because ground level data cannot be used as an index of bat activity at rotor height. Removing the towers once sufficient met data are collected should be weighed against the need for continued bat monitoring.

Microphones should be pointed away from the prevailing winds and a shielding system should be used that minimizes rain exposure but does not interfere with ultrasound reception. Detectors must be set to record at least 30 minutes before sunset to 30 minutes after sunrise.

A combination of acoustic detectors mounted on met towers and movable (roaming) acoustic detectors may be considered to monitor bat occurrences. Roaming acoustic detectors are located at randomly selected proposed turbines sites (without duplication) at least one blade length from the site so that the same sampling point can be used post-construction without interfering with turbine operation. At least two acoustic detectors should be positioned in reference (control) sites. Roaming detectors should be used for three consecutive nights at each monitoring location. Locations should be selected at random without replacement so that the full rotation of monitoring locations is included in each survey period.

The following information should be determined from the acoustic detectors and provided in the study report:

- total number of bat passes, defined as a continuous series of $\geq$ 1 call notes by an individual bat with no pause greater than 1 second between notes;
- mean number of bat passes per detector night (excluding nights with measurable precipitation) ;
- mean number of bat passes per detector night per detector;
- bat passes in relation to each 60 minute period after sunset, weekly interval and season;
- feeding rate based on the proportion of passes including a feeding buzz; and

- evaluation of passes by high (≥ 35 kHz) and low (< 35 kHz) frequency call bat groups by detector.

D.3.3 Roost Searches and Exit Counts

Pre-construction survey efforts may include determining whether bat roosts exist in mines, caves, bridges, and buildings within the project vicinity through exit counts and roost searches to determine colony size and species composition of roosts (Rainey 1995, Kunz and Parsons 2009, Sherwin et al. 2003). Roost searches should be performed cautiously because roosting bats are sensitive to human disturbance (Kunz et al. 1996). Known maternity and hibernation roosts should not be entered or otherwise disturbed unless authorized by the WDNR. Internal searches of abandoned mines or caves can be dangerous and should only be conducted by trained researchers. For mine survey protocol and guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999). Exit surveys at known roosts generally should be limited to noninvasive observation using low-light binoculars and infrared video cameras. For some bat species, typically threatened, endangered, or state-listed species, radio telemetry or radar may be recommended to assess both the direction of movement as bats leave roosts, and the bats' use of the area being considered for development. Kunz et al. (2007a) describe the use of telemetry, radar, and other tools to evaluate use of roosts, activity patterns, and flight direction from roosts.

Multiple surveys will be required to determine the presence or absence of bats in caves and mines, and the number of surveys needed will vary by species of bats, sex (maternity or bachelor colony) of bats, seasonality of use, and type of roost structure (e.g., caves or mines). It is recommended that decisions on level of effort follow discussions with WDNR's Bat Team in the Bureau of Endangered Resources.

Additional Data Needed

The following meteorological data should also be recorded during bat surveys.

- temperature and relative humidity at 10 minute intervals
- wind speed (m/s) and direction (degrees) at 30 minute intervals
- barometric pressure and change in pressure in one hour trends
- precipitation in daily and nightly totals, and
- passage of storm fronts based on 12 hour intervals.

- Other variables that should be measured and described during bat surveys are:
- location and percent vegetation cover and edges by cover types (e.g.: deciduous woods/cornfield)
- anthropogenic and natural environmental features
- forests, forest edges and tree lines (characteristics – continuous/broken, sapling/mature, etc.)

- water features within the project area and major features (e.g., lakes, rivers and wetlands) within 10 miles of the project boundary
- elevation and topographic relief, noting variation throughout the project area and prominent features, e.g.: ridge lines and valleys, within 10 miles of the project boundary, and
- directions and distances to these features from proposed turbines and acoustic detectors.

Overall, for the project site, the project developer should identify WDNR natural community types[12], list dominant plant species in each structural layer, describe canopy, shrub and herbaceous associates, percent canopy and understory cover, estimate tree size class[13] and presence of other features such as water bodies, snags, and woody debris. A current aerial photo should be obtained for each year of pre-construction study to describe and quantify the project area habitat types, as well as agricultural uses (crop, rotation, grazing etc.), and area of agricultural activities if known to occur within the project area.

[12] WDNR natural community types in Wisconsin: http://dnr.wi.gov/org/land/er/biodiversity/.
[13] Seedling – a young tree smaller than a sapling. Trees less than 1 inch dbh.
Sapling – a young tree larger than a seedling but smaller than a poletimber tree. Trees ranging from 1 to 5 inches dbh.
Poletimber – Hardwood trees ranging in size from 5 to 11 inches dbh and conifers ranging in size from 5 to 9 inches dbh.
Sawtimber – Trees with minimum diameter and length and with stem quality suitable for conversion to lumber. Hardwood trees larger than 11 inches dbh and conifers larger than 9 inches dbh.

APPENDIX E
Suggested Methodologies for Post-Construction Studies

E.1 Permits Needed

A wildlife salvage/collection permit must be obtained from the WDNR and FWS to facilitate legal transport of injured animals and/or carcasses. WDNR permits are obtained from the Bureau of Wildlife Management - Area Manager for the county in which the proposed project is located. Because of the critical threat of white-nose syndrome to Wisconsin's cave-dwelling bats, consult with the Bat Monitoring Program (http://wiatri.netinventory/bats/index.cfm) in the WDNR Bureau of Endangered Resources to obtain and submit tissue samples from bat carcasses. The WDNR permit may include other special conditions for the handling of bird and bat carcasses.

E.2 Number of Turbines to Monitor

Generally, we recommend that as many turbines as possible be searched within the project area, but if available, data on turbine sample size from existing Midwest projects are recommended as a basis for determining the needed sample size (see Morrison et al. 2008). If data are not available, it is recommended that a sufficient number of turbines be selected via a systematic sample with a random start point. If the project contains 10 or fewer turbines, it is recommended that all turbines in the project area be searched. When selecting turbines, it is recommended that a systematic sample with a random start be used when selecting search plots to ensure interspersion among turbines. Stratification among different habitat types also is recommended to account for differences in fatality rates among different habitat types (e.g., grassland versus forest); a sufficient number of turbines should be sampled in each strata.

It is recognized that some of the turbines are considered unavailable for study a priori, while others may later become unavailable or unsuitable for study for various reasons (e.g., landowner withdrawal, turbine malfunction). Under the lease held between the landowners and project owner, landowners might decline to participate in the study. This is why it is important to discuss the possibility of performing mortality studies with landowners early during the planning of the project (see Section 5.5). Should any of the turbines selected for study become unsuitable after the study has begun, decisions regarding whether or not to replace the turbine from the sampling frame will be made in consultation with the WDNR and the Study Team. At any rate, 2 to 3 additional turbines should be kept available as alternative replacements.

E.3 General Search Protocol: Delineation of Carcass Search Plots, Transects, Habitat Mapping, and Data Recorded

The basic method of measuring fatality rates is the carcass search. Search protocols should be standardized and they should include methods for adequately accounting for sampling biases (searcher efficiency and scavenger removal).

Evidence suggests that greater than 80 percent of bat fatalities fall within half the maximum distance of turbine height to ground (Erickson 2003 a, b), and a minimum plot size of 120 X 120 meters should be established at sample turbines. Plots will need to be larger for birds, with a width twice the turbine height to ground. In some cases, this may place part of the search plot on another parcel owned by a non-participating landowner or a different participating landowner. The Study Team should determine whether these turbines should be excluded from search plot selection, whether the plot should be searched in a different manner, or whether an effort should be made to obtain an agreement from the additional landowner. Final decisions regarding search plot size should be made in discussions with the Study Team and the WDNR.

Square rather than circular plots are typically used because it is easier for landowners to cultivate around the plot; this shape is easier to mow and, if needed, to determine compensation. Circular plots may also be used. This design allows for a more consistent proportion of the plot to be searched with distance from the turbine.

Because most of the turbines located in Wisconsin's landscape will likely occur in cultivated cropland (typically corn, soybeans, and alfalfa) or old field communities, searcher efficiency in search plots that extend into these areas is expected to be quite low in late summer, early autumn, and late spring, yielding biased estimates of mortality. To enable efficient searching, five strips in each turbine search plot should be mowed or otherwise kept clear of taller vegetation (e.g., via herbicide treatment with landowner approval) to conduct the fatality surveys.

Personnel trained in proper search techniques should look for bird and bat carcasses along transects or subplots within each plot and record and collect all carcasses located in the searchable areas. A complete search of the area should be accomplished and subplot size (e.g., transect width) should be adjusted to compensate for detection differences in the search area. Subplots should be smaller when vegetation makes it difficult to detect carcasses; subplots can be wider in open terrain. In some cases, it may be preferable to search a portion of the maximum plot instead of the entire plot because of the time required to do an effective search, even if it is accessible (e.g., croplands). Data from a sample of subplots within the maximum plot size can provide a reasonable estimate of fatalities. Subplot width also can vary depending on the size of the species targeted. For example, small species such as bats may require smaller subplots than larger species such as raptors.

For plots that consist of managed (i.e., mowed) strips, we recommend searchers walk at a rate of approximately 45-60 meters per minute along each transect. We recommend searchers scan the area on both sides out to approximately 2.5 meters for casualties as they walk each transect. Everything within the search plot, including the turbine access road and turbine pad, should be searched. For plots that are entirely cleared, searchers should walk parallel transects spaced 10 meters apart while searching 5 meters on either side of the transect line. Search area and speed may be adjusted after evaluation of the first searcher efficiency trial. It is important to delineate and map the area searched for each turbine to adjust fatality estimates based on the actual area searched. Global positioning systems (GPS) are useful for accurately mapping the actual total area searched and area searched, which can be used to

adjust fatality estimates. The width of the belt or subplot searched may vary depending on the habitat and species of concern; the key is to determine actual searched area and area searched regardless of transect width. An adjustment may also be needed to take into account the density of fatalities as a function of the width of the search plot.

Condition of plots, vegetation cover and changes in vegetation should be documented throughout the study by taking reference pictures at bi-weekly intervals. Documentation should also include an estimate of vegetation height.

During some portions of the year plot conditions may be unsuitable for searching, e.g., early or late snowfalls, inclement weather, deep mud or flooding. In these cases, the search shall be scheduled as soon as possible from the scheduled date or the Study Team shall be consulted to make temporary adjustments in the schedule and study duration.

Data to be recorded include date, start time, end time, observer, which turbine area was searched (including GPS coordinates) and weather data for each search. Weather conditions during the previous 24-hour period or longer, depending on the search interval, should also be described. Meteorological and climate data, including precipitation, cloud ceiling level, temperature, wind speed and direction, and barometric pressure should be obtained from an area meteorological station. Also, searchers should record whether a turbine is rotating during searches, and this should be verified with the wind facility manager.

When a dead bat or bird is found, the searcher should place a flag near the carcass and continue the search. After searching the entire plot, the searcher returns to each carcass and records information on a fatality data sheet, including date, species, sex and age (when possible), observer name, turbine number, distance from turbine, azimuth from turbine (including GPS coordinates), habitat surrounding carcass, condition of carcass (entire, partial, scavenged), and estimated time of death (e.g., $\leq$1 day, 2 days). A digital photograph of the carcass should be taken. Rubber gloves should be used to handle all carcasses to eliminate possible transmission of diseases and to reduce possible human scent bias for carcasses later used in scavenger removal trials. Carcasses should be placed in a plastic bag and labeled.

E.4 Duration and Frequency of Carcass Searches

The objective of the standardized carcass searches is to search plots systematically for bat and bird casualties. Plots should be assigned randomly to the searchers.

The duration and frequency (search interval) of carcass searches may vary for birds and bats, and will vary depending on the questions to be answered, the species of concern, and their seasonal abundance at the project site. The carcass searching protocol should be adequate to answer applicable Tier 3 questions at an appropriate level of precision to make general conclusions about the project, and is not intended to provide highly precise measurements of fatalities.

The condition of each carcass found should be recorded using the following categories:

- Intact - a carcass that is completely intact, is not badly decomposed, and shows no sign of predation.
- Scavenged - an entire carcass, which shows signs of being eaten, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.
- Feather Spot - 10 or more feathers found at 1 location indicating predation or scavenging.

In addition to carcasses, any injured bats and birds observed in search plots should be recorded and treated as a fatality. All carcasses found should be labeled with a unique number, bagged, and frozen for future reference and possible necropsy. A copy of the original data sheet for each carcass should be placed in the bag with the frozen carcass. For all casualties found, data recorded should include species, sex and age when possible, date and time collected, GPS location, condition (intact, scavenged, feather spot), and any comments that may indicate cause of death. All casualties located should be photographed as found and plotted on a detailed map of the study area showing the location of the wind turbines and associated facilities, such as overhead power lines and met towers.

Casualties found by carcass searchers during scheduled searches but outside the designated search area should be treated following the above protocol. Bat and bird casualties found in non-designated search areas should be coded as incidental and should be documented in a similar fashion as those found during standard searches.

Any injured native birds found during standard searches should be carefully captured by the observer and transported to a wildlife rehabilitation center or veterinary clinic in a timely fashion.

The FWS and WDNR should be notified (by email and phone) within 24 hours if any eagles, and federally or state-threatened/endangered species are discovered. If any dead or injured species of concern (rare birds, bats or other wildlife on the Natural Heritage Inventory working list or the list of SGCN) are found[14], a NHI Rare Animal Field Report (Form 1700-048) should be submitted to the Bureau of Endangered Resources with a copy to the WDNR Office of Energy. This form may be downloaded at: http://dnr.wi.gov/org/land/er/forms/#field.

E.5 Search Schedule

Except during winter, we recommend that carcass searches occur within the project area as follows: 1) If the primary focus is on fatalities of large raptors, where carcass removal is typically low, then a longer interval between searches (e.g., 14-28 days) is sufficient. 2) If the

[14] NHI Working List: http://dnr.wi.gov/org/land/er/wlist/
Wisconsin Species of Greatest Conservation Need: http://dnr.wi.gov/org/land/er/wwap/explore/profiles.asp

focus is on fatalities of bats and small birds, however, and carcass removal is high, then a shorter search interval will be necessary (e.g. 3-7 days, with 2-6 days between searches), but depending on weather there may be situations in which searches occur at individual turbines immediately following a weather event (cold front, fog, low cloud ceiling).

E.6 Searcher Efficiency Trials

The objective of the searcher efficiency trials is to estimate the percentage of casualties that are found by the observers. Searcher efficiency trials should begin when carcass search studies begin. Prior to a trial's inception, each trial carcass should be discreetly marked so that it can be identified as a "detection" carcass after it is found. Trial carcasses should be distributed as equally as possible throughout the study period and study area. We recommend that all "detection" carcasses be placed at random locations and at random distances (in meters) from turbines within areas being searched prior to the carcass search on the same day. Searchers should be unaware of which turbines are to be used, when the trials are being conducted, or the number of carcasses placed beneath those turbines during trials.

Carcasses of birds and bats representing different size classes should be placed at intervals during the study. It is recommended that multiple trials of all searchers be conducted weekly to mark changes in vegetation cover or other environmental conditions. During the study, some carcasses will be placed at all turbine plots being searched. An attempt should also be made to place carcasses in each of the various habitats being searched.

Data recorded for each trial carcass prior to placement should include date of placement, species, turbine number, distance and direction from turbine, and description of visibility surrounding the carcass. The number and location of the "detection" carcasses found during the carcass search should be recorded and summarized. The number of carcasses available for detection during each trial will be determined immediately after the trial by the person responsible for distributing the carcasses.

Studies should attempt to avoid "over-seeding" any one turbine with carcasses by placing no more than one or two carcasses at any one time at a given turbine. There is no agreed upon sample size for searcher efficiency trials, though some state guidelines recommend 50 -200 carcasses (FWS 2010).

Carcass counts must be adjusted by some factor that accounts for imperfect detectability (FWS 2010). Important sources of bias and error include: 1) fatalities that occur on a highly periodic basis; 2) carcass removal by scavengers; 3) differences in searcher efficiency; 4) failure to account for the influence of site (e.g. vegetation) conditions in relation to carcass removal and searcher efficiency; and 5) fatalities or injured birds and bats that may land or move outside search plots.

Some fatalities may occur on a highly periodic basis creating a potential sampling error (number 1 above). It is recommended that sampling be scheduled so that some turbines are searched most days and episodic events are more likely detected, regardless of the search

interval. To address bias sources 2-4 above, it is strongly recommended that all fatality studies conduct carcass removal and searcher efficiency trials using accepted methods (Anderson et al. 1999, Kunz et al. 2007a, Arnett et al. 2007, NRC 2007). Estimates of searcher efficiency can be used to correct for detection bias by adjusting the total number of carcasses found for those missed by observers.

We recommend that carcasses for the searcher efficiency trials be removed on the same day of the trial and stored frozen and reused.

E.7 Carcass Removal Trials

The objective of carcass removal trails is to estimate the likelihood a carcass is removed by scavengers as a function of time. Carcass removal includes removal by predation or scavenging, or removal by other means (e.g., cultivation, harvesting). Estimates of carcass removal will be used to correct for removal bias by adjusting the total number of carcasses found by the relative rate at which carcasses are removed from the study area.

Carcass removal trials should be conducted during the period that standardized carcass searches are conducted. Carcass removal trials should be conducted at turbines to determine if there are different scavenging rates between managed and unmanaged areas. During each month of the study during the spring and autumn, carcasses of birds and bats of 2-3 different size classes should be placed for carcass removal trials. The number of trials chosen should avoid inundating the study area with carcasses and potentially influencing scavenger behavior.

By spreading trials throughout the study period, the effects of varying weather, climatic conditions, and scavenger densities will be taken into account. Bird carcasses and bat carcasses similar to those used in the searcher efficiency trials should be used, and unfrozen carcasses should be used in the carcass removal trials to the greatest extent possible. Fresh bat carcasses found in plots either during scheduled searches, or incidentally, may be left in place for use as trial carcasses.

To minimize the chance of confusing a trial bird with a true casualty, any removal-trial birds placed in the search plots should be marked discreetly (e.g., with dark electrical tape around one or both legs) for recognition by searchers and other personnel. Turbines not included in standardized searches should be randomly selected for inclusion in the removal trials, and trial carcasses should be randomly located in a similar-sized plot as used to search turbines. Major habitats represented around the site's turbines should be included in these trials. Trial carcasses will be placed in a variety of postures to simulate a range of conditions. For example, carcasses should be: 1) placed in an exposed posture (tossed randomly to one side); 2) hidden to simulate a crippled bird (e.g., placed beneath a tuft of grass), and; 3) partially hidden.

The observer(s) conducting the trials should monitor the trial birds over a period of up to 30 days. Carcasses should be checked every day for the first 4 days, and then on day 7, day 10, day 14, day 20, and day 30. Carcasses should be photographed during checks to document

decomposition rates, timing and extent of insect infestations, and the rate at which predators/scavengers reduce the carcass to skeletal remains. This information should be used to help train searchers in estimation of carcass age. This schedule should be followed as closely as possible, but it will undoubtedly vary depending on weather and coordination with the other survey work.

Experimental carcasses should be left at the location until the end of the carcass removal trial. At the end of the 30-day period, any remaining evidence of the carcasses should be removed.

E.8 Statistical Methods for Estimating Fatalities

If a direct relationship existed between the number of carcasses observed and the number killed, there would be no need to adjust observed counts for detectability, and observed counts could be used as a simple index of fatality. But the relationship is not direct: raw carcass counts recorded using different search intervals and under different carcass removal rates and searcher efficiency rates are not directly comparable. Rates of carcass removal by scavengers are likely to vary with time of year, scavenger density, conspicuousness of carcasses, and other factors. If carcass removal rates are high, then fewer carcasses will be available to be found during searches. Variation in searcher efficiency comes primarily from differences in vegetative condition in search plots, color and disposition of carcasses, and individual searcher skill. Searchers are likely never 100% efficient, so not accounting for this variability will result in mortality estimates that are biased low. Separate scavenger removal and searcher efficiency trials are designed to estimate these sources of bias.

Accordingly, we recommend that estimates of facility-related fatalities be based on:

- Observed number of carcasses found during standardized searches during the monitoring period for which the cause of death is either unknown or is probably facility-related;
- Non-removal rates expressed as the estimated average probability a carcass is expected to remain in the study area and be available for detection by the searchers during removal trials; and
- Searcher efficiency expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials.

The equation and statistical methods used for estimating fatality rates are likely to change as knowledge of factors influencing fatality and the relationships among those factors improves. We strongly recommended that only the most contemporary equations for estimating fatality be used, as some original versions are now known to be extremely biased under many commonly encountered field conditions (Strickland et al. in review, Erickson et al. 2000b, Johnson et al. 2003, Kerns and Kerlinger 2004, Fiedler et al. 2007, Smallwood 2007). Accordingly, the Department has chosen not to cite a specific equation or method. At a minimum, the fatality estimate accounts for the following variables:

- the number of carcasses detected at a given plot for the study period of interest (e.g., one monitoring year), for which the cause of death is either unknown or is attributed to the facility;
- the number of search plots;
- the number of turbines searched (including the turbines centered within each search plot);
- the average number of carcasses observed per turbine per monitoring year;
- the number of carcasses used in removal trials;
- the number of carcasses in removal trials that remain in the study area after 30 days, apply mean and standard error (square of the sample variance of the mean);
- the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials;
- the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials;
- the total number of carcasses placed in searcher efficiency trials;
- the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials;
- the average interval between standardized carcass searches, in days;
- proportion of the search area of a turbine actually searched;
- the estimated probability that a carcass is both available to be found during a search and is found, as determined by the removal trials and the searcher efficiency trials;
- the estimated annual average number of fatalities per turbine per year, adjusted for removal and searcher efficiency bias.

The observed number of carcasses per turbine is combined with the estimated carcass-non-removal rates and searcher efficiency rates to arrive at an estimation of facility-related fatality rates. The final reported estimates of fatality rates should be reported with standard errors and 90% confidence intervals.

E.9 Sources of Bird and Bat Carcasses

No bird and bat carcasses may be brought in to Wisconsin from out of the state. All carcasses must be obtained legally. Carcasses should consist of common and preferably non-native species such as House Sparrows, European Starlings, Rock Pigeons, or game bird species. Birds or bats salvaged during the study may be collected and used when possible using a valid salvage permit from the WDNR. Carcasses collected during the study should be housed in a freezer at the project site. Individual carcasses should be maintained until after the final report is prepared in case questions about identity or cause of death should arise. The final

disposition of individual casualties will be based on direction from the appropriate salvage permits (Wisconsin DNR and FWS) and the legal status of individual casualties.

Birds or bats obtained from rehabilitation centers, laboratories, or other non-commercial sources may only be used if death is apparently due to physical trauma, i.e., animals that exhibit symptoms or are suspected of illness or disease may not be used. Bat carcasses without heads that have been tested for rabies may be obtained from the State Laboratory of Hygiene (SLH) during certain times of the year. The WDNR should be contacted to assist in obtaining carcasses from the SLH. If bat carcasses cannot be found, small brown birds (House Sparrows, especially) may be used to simulate bat carcasses.

A list of potential sources of carcasses should be provided to the Department prior to commencing the trials.

E.10 Data Sharing and Interim/Final Reports

The post-construction bat and bird mortality study data will be used to evaluate the overall impacts of the project on birds and bats. All data, including maps and electronic data files, should be filed with the project developer and shared with the WDNR, the PSC, regional FWS Office, other wind project developers, and other interested parties.

Informal update reports should be provided to the Study Team monthly during the study to track progress and provide cursory results. Interim reports should be prepared within 60 days of the completion of each season. A final report should be prepared within 90 days of the conclusion of the study. Interim reports should include preliminary results, seasonal estimates and an assessment of mortality. The final report should integrate the two interim reports, including total estimates of bird and bat fatalities discovered during the study, but will also include more comprehensive analyses and discussion of fatalities in relation to environmental variables and site conditions.