Large Filing Separator Sheet

Case Number: 16-1871-EL-BGN

File Date: 10/10/2018

Section: 1

Number of Pages: 195

Description of Document: Exhibits for Transcript, Volume III, held on September 26, 2018 before Nick Walstra and Megan Addison, Administrative Law Judges, at the Public Utilities Commission of Ohio, 180 E. Broad Street, Columbus, Ohio 43215.

Applicant Exhibits No. 36, 37, 38 and 39
Bratenahl Residence Exhibits No. 7 through 16

FILE

PUCO EXHIBIT FILING

Date of Hearing: September 24 - October 2, 2018

Case No. 16-1871-EL-BGN

PUCO Case Caption: In the Matter of the Application of Icebreaker Windpower Inc. for a Certificate to Construct a Wind-Powered Electric Generation Facility in Cuyahoga County, Ohio.

List of exhibits being filed: Volume III

Applicant 36, 37, 38, 39

Bratenahl Residents 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

Reporter's Signature: Karen Sue Gibson

Date Submitted:

BEFORE THE OHIO POWER SITING BOARD

- - -

In the Matter of the Application of Icebreaker Windpower Inc. for a Certificate to Construct a Wind-Powered Electric Generation Facility in Cuyahoga County, Ohio. : Case No. 16-1871-EL-BGN

- - -

PROCEEDINGS

before Mr. Nick Walstra and Ms. Megan Addison, Administrative Law Judges, at the Public Utilities Commission of Ohio, 180 East Broad Street, Room 11-A, Columbus, Ohio, called at 9:00 a.m. on Wednesday, September 26, 2018.

- - -

VOLUME III

- - -

ARMSTRONG & OKEY, INC.
222 East Town Street, Second Floor
Columbus, Ohio 43215-5201
(614) 224-9481 - (800) 223-9481

- - -

U.S. Fish & Wildlife Service

U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines

EXHIBIT
PENGAD 800-631-6989
Applicant
36

Cover Photo:

Wind Turbine. Photo by Stefanie Stavrakas, USFWS

OMB Control No, 1018-0148
Expiration Date: 12/31/2014

U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines

March 23, 2012

Acknowledgements

The U.S. Fish and Wildlife Service (Service) would like to recognize and thank the Wind Turbine Guidelines Advisory Committee for its dedication and preparation of its Recommendations. The Recommendations have served as the basis from which the Service's team worked to develop the Service's Land-Based Wind Energy Guidelines. The Service also recognizes the tireless efforts of the Headquarters, Regional and Field Office staff that helped to review and update these Guidelines.

Paperwork Reduction Act Statement: The Land-Based Wind Energy Guidelines contain reporting and recordkeeping requirements that require Office of Management and Budget approval in accordance with the Paperwork Reduction Act of 1995. Your response is voluntary. We collect this information in order to provide technical assistance related to addressing wildlife conservation concerns at all stages of land-based wind energy development. For each response, we estimate the time necessary to provide the information as follows:

Tier 1 – 83 hours
Tier 2 – 375 hours
Tier 3 – 2,880 hours
Tier 4 – 2,550 hours
Tier 5 – 2,400 hours

The above estimates include time for reviewing instructions, gathering and maintaining data, and preparing and transmitting reports. Send comments regarding these estimates or any other aspect of the requirements to the Service Information Collection Clearance Officer, U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, MS 2042-PDM, Arlington, VA 22203.

We may not conduct and you are not required to respond to a collection of information unless it displays a currently valid OMB control number.

Table of Contents

List of Figures and Tables

Executive Summary

As the Nation shifts to renewable energy production to supplant the need for carbon-based fuel, wind energy will be an important source of power. As wind energy production increases, both developers and wildlife agencies have recognized the need for a system to evaluate and address the potential negative impacts of wind energy projects on species of concern. These voluntary Guidelines provide a structured, scientific process for addressing wildlife conservation concerns at all stages of land-based wind energy development. They also promote effective communication among wind energy developers and federal, state, and local conservation agencies and tribes. When used in concert with appropriate regulatory tools, the Guidelines form the best practical approach for conserving species of concern. The Guidelines have been developed by the Interior Department's U.S. Fish and Wildlife Service (Service) working with the Wind Turbine Guidelines Advisory Committee. They replace interim voluntary guidance published by the Service in 2003.

The Guidelines discuss various risks to "species of concern" from wind energy projects, including collisions with wind turbines and associated infrastructure; loss and degradation of habitat from turbines and infrastructure; fragmentation of large habitat blocks into smaller segments that may not support sensitive species; displacement and behavioral changes; and indirect effects such as increased predator populations or introduction of invasive plants. The Guidelines assist developers in identifying species of concern that may potentially be affected by their proposed project, including migratory birds; bats; bald and golden eagles and other birds of prey; prairie and sage grouse; and listed, proposed, or candidate endangered and threatened species. Wind energy development in some areas may be precluded by federal law; other areas may be inappropriate for development because they have been recognized as having high wildlife value based on their ecological rarity and intactness.

The Guidelines use a "tiered approach" for assessing potential adverse effects to species of concern and their habitats. The tiered approach is an iterative decision-making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to species of concern and their habitats; and evaluating those risks to make siting, construction, and operation decisions. During the pre-construction tiers (Tiers 1, 2, and 3), developers are working to identify, avoid and minimize risks to species of concern. During post-construction tiers (Tiers 4 and 5), developers are assessing whether actions taken in earlier tiers to avoid and minimize impacts are successfully achieving the goals and, when necessary, taking additional steps to compensate for impacts. Subsequent tiers refine and build upon issues raised and efforts undertaken in previous tiers. Each tier offers a set of questions to help the developer evaluate the potential risk associated with developing a project at the given location.

Briefly, the tiers address:

- Tier 1 – Preliminary site evaluation (landscape-scale screening of possible project sites)
- Tier 2 – Site characterization (broad characterization of one or more potential project sites)
- Tier 3 – Field studies to document site wildlife and habitat and predict project impacts
- Tier 4 – Post-construction studies to estimate impacts[1]
- Tier 5 – Other post-construction studies and research

The tiered approach provides the opportunity for evaluation and decision-making at each stage, enabling a developer to abandon or proceed with project development, or to collect additional information if required. This approach does not require that every tier, or every element within each tier, be implemented for every project. The Service anticipates that many distributed or community facilities will not need to follow the Guidelines beyond Tiers 1 and 2. Instead, the tiered approach allows efficient use of developer and wildlife agency resources with increasing levels of effort.

If sufficient data are available at a particular tier, the following outcomes are possible:

1. The project proceeds to the next tier in the development process without additional data collection.
2. The project proceeds to the next tier in the development process with additional data collection.
3. An action or combination of actions, such as project

[1] The Service anticipates these studies will include fatality monitoring as well as studies to evaluate habitat impacts.

modification, mitigation, or specific post-construction monitoring, is indicated.

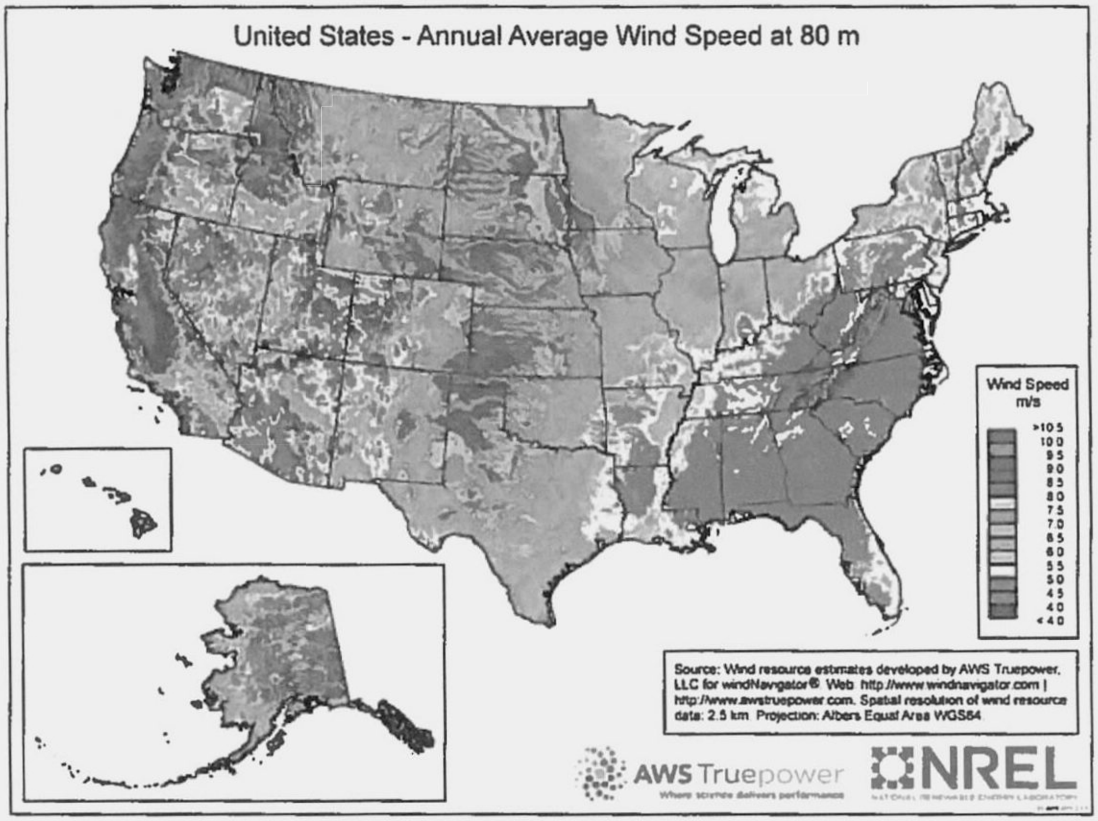
4. The project site is abandoned because the risk is considered unacceptable.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to modify the project, proceed with the project, or abandon the project.

The most important thing a developer can do is to consult with the Service as early as possible in the development of a wind energy project. Early consultation offers the greatest opportunity for avoiding areas where development is precluded or where wildlife impacts are likely to be high and difficult or costly to remedy or mitigate at a later stage. By consulting early, project developers can also incorporate appropriate wildlife conservation measures and monitoring into their decisions about project siting, design, and operation.

Adherence to the Guidelines is voluntary and does not relieve any individual, company, or agency of the responsibility to comply with laws and regulations. However, if a violation occurs the Service will consider a developer's documented efforts to communicate with the Service and adhere to the Guidelines. The Guidelines include a Communications Protocol which provides guidance to both developers and Service personnel regarding appropriate communication and documentation.

The Guidelines also provide Best Management Practices for site development, construction, retrofitting, repowering, and decommissioning. For additional reference, a glossary of terms and list of literature cited are included in the appendices.



Wind Resource Map. Credit: NREL

Chapter 1 - General Overview

The mission of the U.S. Fish and Wildlife Service (Service) is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. As part of this, the Service implements statutes including the Endangered Species Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act. These statutes prohibit taking of federally listed species, migratory birds, and eagles unless otherwise authorized.

Recent studies have documented that wind energy facilities can kill birds and bats. Mortality rates in fatalities per nameplate MW per year vary among facilities and regions. Studies have indicated that relatively low raptor (e.g., hawks, eagles) fatality rates exist at most modern wind energy developments with the exception of some facilities in California and Wyoming. Turbine-related bat deaths have been reported at each wind facility to date. Generally, studies in the West have reported lower rates of bat fatalities than facilities in the East. There is still much uncertainty regarding geographic distribution and causes of bat fatalities (NWCC 2010).

These Guidelines are intended to:

(1) Promote compliance with relevant wildlife laws and regulations;

(2) Encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern;

(3) Produce potentially comparable data across the Nation;

(4) Mitigate, including avoid, minimize, and compensate for potential adverse effects on species of concern and their habitats; and,

(5) Improve the ability to predict and resolve effects locally, regionally, and nationally.

As the United States moves to expand wind energy production, it also must maintain and protect the Nation's wildlife and their habitats, which wind energy production can negatively affect. As with all responsible energy development, wind energy projects should adhere to high standards for environmental protection. With proper diligence paid to siting, operations, and management of projects, it is possible to mitigate for adverse effects to wildlife, and their habitats. This is best accomplished when the wind energy project developer communicates as early as possible with the Service and other stakeholders. Such early communication allows for the greatest range of development and mitigation options. The following website contains contact information for the Service Regional and Field offices as well as State wildlife agencies: http://www.fws.gov/offices/statelinks.html.

In response to increasing wind energy development in the United States, the Service released a set of voluntary, interim guidelines for reducing adverse effects to fish and wildlife resources from wind energy projects for public comment in July 2003. After the Service reviewed the public comments, the Secretary of the Interior (Secretary) established a Federal Advisory Committee[2] to provide recommendations to revise the guidelines related to land-based wind energy facilities. In March 2007, the U.S. Department of the Interior established the Wind Turbine Guidelines Advisory Committee (the Committee). The Committee submitted its final Recommended Guidelines (Recommendations) to the Secretary on March 4, 2010. The Service used the Recommendations to develop its Land-Based Wind Energy Guidelines.

The Service encourages project proponents to use the process described in these voluntary Land-based Wind Energy Guidelines (Guidelines) to address risks to species of concern. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will form the best practical approach for conservation of species of concern.

Statutory Authorities

These Guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, or from conducting enforcement action against any individual, company, or agency. They are not meant to relieve any individual, company, or agency of its obligations to comply with any applicable federal, state,

[2] Committee membership, from 2008 to 2011, has included: Taber Allison, Massachusetts Audubon; Dick Anderson, California Energy Commission; Ed Arnett, Bat Conservation International; Michael Azeka, AES Wind Generation; Thomas Bancroft, National Audubon; Kathy Boydston, Texas Parks and Wildlife Department; René Braud, EDP Renewables; Scott Darling, Vermont Fish and Wildlife Department; Michael Daulton, National Audubon; Aimee Delach, Defenders of Wildlife; Karen Douglas, California Energy Commission; Sam Enfield, MAP Royalty; Greg Hueckel, Washington Department of Fish and Wildlife; Jeri Lawrence, Blackfeet Nation; Steve Lindenberg, U.S. Department of Energy; Andy Linehan, Iberdrola Renewables; Rob Manes, The Nature Conservancy, Kansas; Winifred Perkins, NextEra Energy Resources; Steven Quarles, Crowell & Moring; Rich Rayhill, Ridgeline Energy; Robert Robel, Kansas State University; Keith Sexson, Association of Fish and Wildlife Agencies; Mark Sinclair, Clean Energy States Alliance; David Stout, U.S. Fish and Wildlife Service; Patrick Traylor, Hogan Lovells.

tribal, or local laws, statutes, or regulations. The Guidelines do not prevent the Service from referring violations of law for enforcement when a company has not followed the Guidelines.

Ultimately it is the responsibility of those involved with the planning, design, construction, operation, maintenance, and decommissioning of wind projects to conduct relevant wildlife and habitat evaluation and determine, which, if any, species may be affected. The results of these analyses will inform all efforts to achieve compliance with the appropriate jurisdictional statutes. Project proponents are responsible for complying with applicable state and local laws.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute, meaning that proof of intent, knowledge, or negligence is not an element of an MBTA violation. The statute's language is clear that actions resulting in a "taking" or possession (permanent or temporary) of a protected species, in the absence of a Service permit or regulatory authorization, are a violation of the MBTA.

The MBTA states, "Unless and except as permitted by regulations ... it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill ... possess, offer for sale, sell ... purchase ... ship, export, import ... transport or cause to be transported ... any migratory bird, any part, nest, or eggs of any such bird .... [The Act] prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." 16 U.S.C. 703. The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 CFR 10.12.

The MBTA provides criminal penalties for persons who commit any of the acts prohibited by the statute in section 703 on any of the species protected by the statute. See 16 U.S.C. 707. The Service maintains a list of all species protected by the MBTA at 50 CFR 10.13. This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines. The MBTA does not protect introduced species such as the house (English) sparrow, European starling, rock dove (pigeon), Eurasian collared-dove, and non-migratory upland game birds. The Service maintains a list of introduced species not protected by the Act. See 70 Fed. Reg. 12,710 (Mar. 15, 2005).

Bald and Golden Eagle Protection Act

Under authority of the Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668–668d, bald eagles and golden eagles are afforded additional legal protection. BGEPA prohibits the take, sale, purchase, barter, offer of sale, purchase, or barter, transport, export or import, at any time or in any manner of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. 16 U.S.C. 668. BGEPA also defines take to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," 16 U.S.C. 668c, and includes criminal and civil penalties for violating the statute. See 16 U.S.C. 668. The Service further defined the term "disturb" as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior. 50 CFR 22.3. BGEPA authorizes the Service to permit the take of eagles for certain purposes and under certain circumstances, including scientific or exhibition purposes, religious purposes of Indian tribes, and the protection of wildlife, agricultural, or other interests, so long as that take is compatible with the preservation of eagles. 16 U.S.C. 668a.

In 2009, the Service promulgated a final rule on two new permit regulations that, for the first time, specifically authorize the incidental take of eagles and eagle nests in certain situations under BGEPA. See 50 CFR 22.26 & 22.27. The permits authorize limited, non-purposeful (incidental) take of bald and golden eagles; authorizing individuals, companies, government agencies (including tribal governments), and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities such as operating utilities and airports.

Bald Eagle, Credit: USFWS

Removal of active eagle nests would usually be allowed only when it is necessary to protect human safety or the eagles. Removal of inactive nests can be authorized when necessary to ensure public health and safety, when a nest is built on a human-engineered structure rendering it inoperable, and when removal is necessary to protect an interest in a particular locality, but only if the take or mitigation for the take will provide a clear and substantial benefit to eagles.

To facilitate issuance of permits under these new regulations, the Service has drafted Eagle Conservation Plan (ECP) Guidance. The ECP Guidance is compatible with these Land-Based Wind Energy Guidelines. The Guidelines guide developers through the process of project development and operation. If eagles are identified as a potential risk at a project site, developers are strongly encouraged to refer to the ECP Guidance. The ECP Guidance describes specific actions that are recommended to comply with the regulatory requirements in BGEPA for an eagle take permit, as described in 50 CFR 22.26 and 22.27. The ECP Guidance provides a national framework for assessing and mitigating risk specific to eagles through development of ECPs and issuance of programmatic incidental takes of eagles at wind turbine facilities. The Service will make its final ECP Guidance available to the public through its website.

Endangered Species Act

The Endangered Species Act (16 U.S.C. 1531–1544; ESA) was enacted by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The ESA directs the Service to identify and protect these endangered and threatened species and their critical habitat, and to provide a means to conserve their ecosystems. To this end, federal agencies are directed to utilize their authorities to conserve listed species, and ensure that their actions are not likely to jeopardize the continued existence of these species or destroy or adversely modify their critical habitat. Federal agencies are encouraged to do the same with respect to "candidate" species that may be listed in the near future. The law is administered by the Service and the Commerce Department's National Marine Fisheries Service (NMFS). For information regarding species protected under the ESA, see: http://www.fws.gov/endangered/.


Indiana bat. Credit: USFWS

The Service has primary responsibility for terrestrial and freshwater species, while NMFS generally has responsibility for marine species. These two agencies work with other agencies to plan or modify federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the states, through federal financial assistance and a system of incentives available to encourage state participation. The Service also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take is defined as "... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." 16 U.S.C. 1532(19). The terms harass and harm are further defined in our regulations. See 50 CFR 17.3. However, the Service may authorize "incidental take" (take that occurs as a result of an otherwise legal activity) in two ways.

Take of federally listed species incidental to a lawful activity may be authorized through formal consultation under section 7(a)(2) of the ESA, whenever a federal agency, federal funding, or a federal permit is involved. Otherwise, a person may seek an incidental take permit under section 10(a)(1)(B) of the ESA upon completion of a satisfactory habitat conservation plan (HCP) for listed species. Developers not receiving federal funding or authorization should contact the Service to obtain an incidental take permit if a wind

Utility-Scale Wind turbine with an anemometer tower in the background. Credit: University of Minnesota College of Science and Engineering

energy project is likely to result in take of listed threatened or endangered wildlife species. For more information regarding formal consultation and the requirements of obtaining HCPs, please see the Endangered Species Consultation Handbook at http://www.fws.gov/endangered/esa-library/index.html#consultations and the Service's HCP website, http://www.fws.gov/endangered/what-we-do/hcp-overview.html.

Implementation of the Guidelines

Because these Guidelines are voluntary, the Service encourages developers to use them as soon as possible after publication. To receive the considerations discussed on page 6 regarding enforcement priorities, a wind energy project would fall into one of three general categories relative to timing and implementation:

- For projects initiated after publication, the developer has applied the Guidelines, including the tiered approach, through site selection, design, construction, operation and post-operation phases of the project, and has communicated and shared information with the Service and considered its advice.
- For projects initiated prior to publication, the developer should consider where they are in the planning process relative to the appropriate tier and inform the Service of what actions they will take to apply the Guidelines.
- For projects operating at the time of publication, the developer should confer with the Service regarding the appropriate period of fatality monitoring consistent with Tier 4, communicate and share information with the Service on monitoring results, and consider Tier 5 studies and mitigation options where appropriate.

Projects that are already under development or are in operation are not expected to start over or return to the beginning of a specific tier. Instead, these projects should implement those portions of the Guidelines relevant to the current phases of the project per the bullets above.

The Service is aware that it will take time for Service staff and other personnel, including wind energy developers and their biologists, to develop expertise in the implementation of these Guidelines. Service staff and many staff associated with the wind energy industry have been involved with developing these Guidelines. Therefore, they have a working knowledge of the Guidelines. To further refine their training, the Service will make every effort to offer an in-depth course within 6 months of the final Guidelines being published.

The Communications Protocol on page 5 provides guidance to Service staff and developers in the exchange of information and recommendations at each tier in the process. Although the advice of the Service is not binding, a developer should review such advice, and either accept or reject it. If they reject it, they should contemporaneously document with reasoned justification why they did so. Although the Guidelines leave decisions up to the developer, the Service retains authority to evaluate whether developer efforts to mitigate impacts are sufficient, to determine significance, and to refer for prosecution any unlawful take that it believes to be reasonably related to lack of incorporation of Service recommendations or insufficient adherence with the Guidelines.

Table 1. Suggested Communications Protocol
This table provides examples of potential communication opportunities between a wind energy project developer and the Service. Not all projects will follow all steps indicated below.

TIER	*Project Developer/Operator Role*	*Service Role*
Tier 1: Preliminary site evaluation	• Landscape level assessment of habitat for species of concern • Request data sources for existing information and literature	• Provide lists of data sources and references, if requested
Tier 2: Site characterization	• Assess potential presence of species of concern, including species of habitat fragmentation concern, likely to be on site • Assess potential presence of plant communities present on site that may provide habitat for species of concern • Assess potential presence of critical congregation areas for species of concern • One or more reconnaissance level site visit by biologist • Communicate results of site visits and other assessments with the Service • Provide general information about the size and location of the project to the Service	• Provide species lists, for species of concern, including species of habitat fragmentation concern, for general area, if available • Provide information regarding plant communities of concern, if available • Respond to information provided about findings of biologist from site visit • Identify initial concerns about site(s) based on available information • Inform lead federal agencies of communications with wind project developers
Tier 3: Field studies and impact prediction	• Discuss extent and design of field studies to conduct with the Service • Conduct biological studies • Communicate results of all studies to Service field office in a timely manner • Evaluate risk to species of concern from project construction and operation • Identify ways to mitigate potential direct and indirect impacts of building and operating the project	• Respond to requests to discuss field studies • Advise project proponent about studies to conduct and methods for conducting them • Communicate with project proponent(s) about results of field studies and risk assessments • Communicate with project proponents(s) ways to mitigate potential impacts of building and operating the project • Inform lead federal agencies of communications with wind project developers
Tier 4: Post construction studies to estimate impacts	• Discuss extent and design of post-construction studies to conduct with the Service • Conduct post-construction studies to assess fatalities and habitat-related impacts • Communicate results of all studies to Service field office in a timely manner • If necessary, discuss potential mitigation strategies with Service • Maintain appropriate records of data collected from studies	• Advise project operator on study design, including duration of studies to collect adequate information • Communicate with project operator about results of studies • Advise project operator of potential mitigation strategies, when appropriate
Tier 5: Other post-construction studies and research	• Communicate with the Service about the need for and design of other studies and research to conduct with the Service, when appropriate, particularly when impacts exceed predicted levels • Communicate with the Service about ways to evaluate cumulative impacts on species of concern, particularly species of habitat fragmentation concern • Conduct appropriate studies as needed • Communicate results of studies with the Service • Identify potential mitigation strategies to reduce impacts and discuss them with the Service	• Advise project proponents as to need for Tier 5 studies to address specific topics, including cumulative impacts, based on information collected in Tiers 3 and 4 • Advise project proponents of methods and metrics to use in Tier 5 studies • Communicate with project operator and consultants about results of Tier 5 studies • Advise project operator of potential mitigation strategies, when appropriate, based on Tier 5 studies

Consideration of the Guidelines in MBTA and BGEPA Enforcement

The Service urges voluntary adherence to the Guidelines and communication with the Service when planning and operating a facility. While it is not possible to absolve individuals or companies from MBTA or BGEPA liability, the Office of Law Enforcement focuses its resources on investigating and prosecuting those who take migratory birds without identifying and implementing reasonable and effective measures to avoid the take. The Service will regard a developer's or operator's adherence to these Guidelines, including communication with the Service, as appropriate means of identifying and implementing reasonable and effective measures to avoid the take of species protected under the MBTA and BGEPA.[3] The Chief of Law Enforcement or more senior official of the Service will make any decision whether to refer for prosecution any alleged take of such species, and will take such adherence and communication fully into account when exercising discretion with respect to such potential referral. Each developer or operator will be responsible for maintaining internal records sufficient to demonstrate adherence to the Guidelines and response to communications from the Service. Examples of these records could include: studies performed in the implementation of the tiered approach; an internal or external review or audit process; a bird and bat conservation strategy; or a wildlife management plan.

If a developer and operator are not the same entity, the Service expects the operator to maintain sufficient records to demonstrate adherence to the Guidelines.

Scope and Project Scale of the Guidelines

The Guidelines are designed for "utility-scale" land-based wind energy projects to reduce potential impacts to species of concern, regardless of whether they are proposed for private or public lands. A developer of a distributed or community scale wind project may find it useful to consider the general principles of the tiered approach to assess and reduce potential impacts to species of concern, including answering Tier 1 questions using publicly available information. In the vast majority of situations, appropriately sited small wind projects are not likely to pose significant risks to species of concern. Answering Tier 1 questions will assist a developer of distributed or community wind projects, as well as landowners, in assessing the need to further communicate with the Service, and precluding, in many cases, the need for full detailed pre-construction assessments or monitoring surveys typically called for in Tiers 2 and 3. If landowners or community/distributed wind developers encounter problems locating information about specific sites they can contact the Service and/or state wildlife agencies to determine potential risks to species of concern for their particular project.

Communication with Christy Johnson-Hughes. Credit: Rachel London, USFWS

The tiered approach is designed to lead to the appropriate amount of evaluation in proportion to the anticipated level of risk that a project may pose to species of concern and their habitats. Study plans and the duration and intensity of study efforts should be tailored specifically to the unique characteristics of each site and the corresponding potential for significant adverse impacts on species of concern and their habitats as determined through the tiered approach. This is why the tiered approach begins with an examination of the potential location of the project, not the size of the project. In all cases, study plans and selection of appropriate study methods and techniques may be tailored to the relative scale, location, and potential for significant adverse impacts of the proposed site.

The Service considers a "project" to include all phases of wind energy development, including, but not limited to, prospecting, site assessment, construction, operation, and decommissioning, as well as all associated infrastructure and interconnecting electrical lines. A "project site" is the land and airspace where development occurs

[3] With regard to eagles, this paragraph will only apply when a project is not likely to result in take. If Tiers 1, 2, and/or 3 identify a potential to take eagles, developers should consider developing an ECP and, if necessary, apply for a take permit

or is proposed to occur, including the turbine pads, roads, power distribution and transmission lines on or immediately adjacent to the site; buildings and related infrastructure, ditches, grades, culverts; and any changes or modifications made to the original site before development occurs. Project evaluations should consider all potential effects to species of concern, which includes species 1) protected by the MBTA, BGEPA, or ESA (including candidate species), designated by law, regulation or other formal process for protection and/or management by the relevant agency or other authority, or that have been shown to be significantly adversely affected by wind energy development; and 2) determined to be possibly affected by the project.

These Guidelines are not designed to address power transmission beyond the point of interconnection to the transmission system.

Service Review Period

The Service is committed to providing timely responses. Service Field Offices should typically respond to requests by a wind energy developer for information and consultation on proposed site locations (Tiers 1 and 2), pre- and post-construction study designs (Tiers 3 and 4), and proposed mitigation (Tier 3) within 60 calendar days. The request should be in writing to the Field Office and copied to the Regional Office with information about the proposed project, location(s) under consideration, and point of contact. The request should contain a description of the information needed from the Service. The Service will provide a response, even if it is to notify a developer of additional review time, within the 60 calendar day review period. If the Service does not respond within 60 calendar days of receipt of the document, then the developer can proceed through Tier 3 without waiting for Service input. If the Service provides comments at a later time, the developer should incorporate the comments if feasible. It is particularly important that if data from Tier 1-3 studies predict that the project is likely to produce significant adverse impacts on species of concern, the developer inform the Service of the actions it intends to implement to mitigate those impacts. If the Service cannot respond within 60 calendar days, this does not relieve developers from their MBTA, BGEPA, and ESA responsibilities.

The tiered approach allows a developer in certain limited circumstances to move directly from Tier 2 to construction (e.g., adequate survey data for the site exists). The developer should notify the Service of this decision and give the Service 60 calendar days to comment on the proposed project prior to initiating construction activities.

Introduction to the Decision Framework Using a Tiered Approach

The tiered approach provides a decision framework for collecting information in increasing detail to evaluate risk and make siting and operational decisions. It provides the opportunity for evaluation and decision-making at each tier, enabling a developer to proceed with or abandon project development, or to collect additional information if necessary. This approach does not require that every tier, or every element within each tier, be implemented for every project. Instead, it allows efficient use of developer and wildlife agency resources with increasing levels of effort until sufficient information and the desired precision is acquired for the risk assessment.

Figure 1 ("General Framework of Tiered Approach") illustrates the tiered approach, which consists of up to five iterative stages, or tiers:

- Tier 1 – Preliminary site evaluation (landscape-scale screening of possible project sites)
- Tier 2 – Site characterization (broad characterization of one or more potential project sites)
- Tier 3 – Field studies to document site wildlife and habitat and predict project impacts
- Tier 4 – Post-construction studies to estimate impacts[4]
- Tier 5 – Other post-construction studies and research

At each tier, potential issues associated with developing or operating a project are identified and questions formulated to guide the decision process. Chapters Two through Six outline the questions to be posed at each tier, and describe recommended methods and metrics for gathering the data needed to answer those questions.

The first three tiers correspond to the pre-construction evaluation phase of wind energy development. At each of the three tiers, the Guidelines provide questions that developers should answer, followed by recommended methods and metrics to use in answering the questions. Some questions are repeated at each tier, with successive tiers requiring a greater investment in data collection to answer certain questions. For example, while Tier 2 investigations may discover some existing information on federal or state-listed species and their use of the proposed development site, it may be necessary to collect empirical data in Tier 3 studies to determine the presence of federal or state-listed species.

Developers decide whether to proceed to the next tier. Timely communication and sharing of information will allow opportunities for the Service to provide, and developers to consider, technical advice. A developer should base the decision on the information obtained from adequately answering the questions in this tier, whether the methods used were appropriate for the site selected, and the resulting

[4] The Service anticipates these studies will include fatality monitoring as well as studies to evaluate habitat impacts.

Wind turbines in California. Credit: Rachel London, USFWS

assessment of risk posed to species of concern and their habitats.

If sufficient data are available at a particular tier, the following outcomes are possible:

1. The project proceeds to the next tier in the development process without additional data collection.

2. The project proceeds to the next tier in the development process with additional data collection.

3. An action or combination of actions, such as project modification, mitigation, or specific post-construction monitoring, is indicated.

4. The project site is abandoned because the risk is considered unacceptable.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to modify the project, proceed with the project, or abandon the project.

The tiered approach used in these Guidelines embodies adaptive management by collecting increasingly detailed information that is used to make decisions about project design, construction, and operation as the developer progresses through the tiers. Adaptive management is an iterative learning process producing improved understanding and improved management over time (Williams et al 2007). DOI has determined that its resource agencies, and the natural resources they oversee, could benefit from adaptive management. Use of adaptive management in DOI is guided by the DOI Policy on Adaptive Management. DOI has adopted the National Research Council's 2004 definition of adaptive management, which states:

"Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders."

This definition gives special emphasis to uncertainty about management effects, iterative learning to reduce uncertainty, and improved management as a result of learning. The DOI Adaptive Management Technical Guide is located on the web at: www.doi.gov/initiatives/AdaptiveManagement/index.html.

Figure 1. General Framework of Tiered Approach

TIER 1

A. Species of concern known to be present?
   1. No ....proceed to Tier 2
   2. Unknown - Insufficient or inconclusive data ....proceed to Tier 2
   3. Yes..........................abandon site or proceed to Tier 2

TIER 2

A. Probability of significant adverse impacts?
   1. Unknown - Insufficient or inconclusive data ....proceed to Tier 3
   2. Low...........proceed to obtain state and local permit (if required), design, and construction following BMPs
   3. Moderate ....proceed to Tier 3 and mitigate
   4. High, and:
      a. can be adequately mitigated...modify project and proceed to Tier 3
      b. cannot be adequately mitigated..........................abandon project

TIER 3

A. Probability of significant adverse impacts?
   1. Low ....proceed to Tier 4
   2. Moderate to high, and:
      a. certainty regarding mitigation .... proceed to Tier 4
      b. uncertainty regarding mitigation ....proceed to Tier 4
   3. High, and:
      a. can be adequately mitigated..............................proceed to Tier 4
      b. cannot be adequately mitigated ....modify or abandon project

TIER 4a (See Table 2, pg 39)

A. Tier 3 studies indicate low probability of significant adverse impacts
   1. Documented fatalities are equal to or lower than predicted..................no further studies or mitigation needed
   2. Documented fatalities are higher than predicted, but not significant, and:
      a. comparable data are available that support findings of not significant.............................no further studies needed
      b. comparable data not available to support findings of not significant..............additional year(s) of monitoring recommended
   3. Documented fatalities are higher than predicted and are significant...........................communicate with Service

B. Tier 3 studies indicate moderate probability of significant adverse impacts
   1. Documented fatalities are lower than or no different predicted, and:
      a. are not significant and no ESA or BGEPA species are affected ....no further monitoring or mitigation needed
      b. are significant *OR* ESA or BGEPA species are affected ....communicate with Service
   2. Documented fatalities are greater than predicted and are likely to be significant *OR* ESA or BGEPA species are affected.............................communicate with Service

C. Tier 3 studies indicate high probability of significant adverse impacts
   1. Documented fatalities are less than predicted and are not significant, and no ESA or BGEPA species are affected.......................no further monitoring or mitigation needed
   2. Documented fatalities are less than predicted but are still significant, and no ESA or BGEPA species are affected..................further monitoring or mitigation needed
   3. Fatalities are equal to or greater than predicted and are significant OR ESA or BGEPA species are affected....................communicate with Service regarding additional mitigation

TIER 4b (See Table 3, pg. 42)

A. Species of habitat fragmentation concern potentially present?
   1. No...no further studies needed
   2. Yes, and:
      a. Tier 3 studies do not confirm presence...no further studies needed
      b. Tier 3 studies confirm presence, but no significant adverse impacts predicted, and:
         i. Tier 4b studies confirm Tier 3 predictions....................no further studies or mitigation needed
         ii. Tier 4b studies indicate potentially significant adverse impacts ....Tier 5 studies and mitigation may be needed
      c. Tier 3 studies confirm presence, and significant adverse impacts predicted and mitigation plan is developed and implemented, and:
         i. Tier 4b studies determine mitigation is effective ....no further studies or mitigation needed
         ii. Tier 4b studies determine mitigation not effective...........further mitigation and, where appropriate, Tier 5 studies needed

Considering Risk in the Tiered Approach

In the context of these Guidelines, risk refers to the likelihood that adverse impacts will occur to individuals or populations of species of concern as a result of wind energy development and operation. Estimates of fatality risk can be used in a relative sense, allowing comparisons among projects, alternative development designs, and in the evaluation of potential risk to populations. 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 regarding avian and bat fatality and wind energy projects, estimates of risk would typically be qualitative, but should be based upon quantitative site information.

For the purposes of these Guidelines, risk can also be defined in the context of populations, but that calculation is more complicated as it could involve estimating 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 relevant wildlife agency and industry wildlife experts. Predicted risk of these impacts could provide useful information for determining appropriate mitigation measures if determined to be necessary. In practice in the tiered approach, risk assessments conducted in Tiers 1 and 2 require less information to reach a risk-based decision than those conducted at higher tiers.

Cumulative Impacts of Project Development

Cumulative impacts are the comprehensive effect on the environment that results from the incremental impact of a project when added to other past, present, and reasonably foreseeable future actions. Developers are encouraged to work closely with federal and state agencies early in the project planning process to access any existing information on the cumulative impacts of individual projects on species and habitats at risk, and to incorporate it into project development and any necessary wildlife studies. To achieve that goal, it is important that agencies and organizations take the following actions to improve cumulative impacts analysis:

- review the range of development-related significant adverse impacts;
- determine which species of concern or their habitats within the landscape are most at risk of significant adverse impacts from wind development in conjunction with other reasonably foreseeable significant adverse impacts; and
- make that data available for regional or landscape level analysis.

The magnitude and extent of the impact on a resource depend on whether the cumulative impacts exceed the capacity for resource sustainability and productivity.

For projects that require a federal permit, funding, or other federal nexus, the lead federal agency is required to include a cumulative impacts analysis in their National Environmental Policy Act (NEPA) review. The federal action agency coordinates with the developer to obtain the necessary information for the NEPA review and cumulative impacts analysis. To avoid project delays, federal and state agencies are encouraged to use existing wildlife data for the cumulative impacts analysis until improved data are available.

Where there is no federal nexus, individual developers are not expected to conduct their own cumulative impacts analysis. However, a cumulative impacts analysis would help developers and other stakeholders better understand the significance of potential impacts on species of concern and their habitats.

Other Federal Agencies

Other federal agencies, such as the Bureau of Land Management, National Park Service, U.S. Department of Agriculture Forest Service and Rural Utility Service, Federal Energy Regulatory Commission and Department of Energy are often interested in and involved with wind project developments. These agencies have a variety of expertise and authorities they implement. Wind project developers on public lands will have to comply with applicable regulations and policies of those agencies. State and local agencies and Tribes also have additional interests and knowledge. The Service recommends that, where appropriate, wind project developers contact these agencies early in the tiered process and work closely with them throughout project planning and development to assure that projects address issues of concern to those agencies. The definition of "species of concern" in these Guidelines includes species which are trust resources of States and of federal agencies (See Glossary). In those instances where a project may significantly affect State trust resources, wind energy developers should work closely with appropriate State agencies.

Relationship to Other Guidelines

These Guidelines replace the Service's 2003 interim voluntary guidelines. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will form the best practical approach for conservation of species of concern. For instance, when developers find that a project may affect an endangered or threatened species, they should comply with Section 7 or 10 of the ESA to obtain incidental take authorization. Other federal, state, tribal and local governments may use these Guidelines to complement their efforts to address wind energy development/wildlife interactions. They are not intended to supplant existing regional or local guidance, or landscape-scale tools for conservation planning, but were developed to provide a means of improving consistency with the goals of the wildlife statutes that the Service is responsible for implementing. The Service will continue to work with states, tribes, and other local stakeholders on map-based tools, decision-support systems, and other products to help guide future development and conservation. Additionally, project proponents should utilize any relevant guidance of the appropriate jurisdictional entity, which will depend on the species and resources potentially affected by proposed development.

Pronghorn Antelope. Credit: Steve Hillebrand, USFWS

Chapter 2: Tier 1 – Preliminary Site Evaluation

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 working with the federal, state, tribal, and/or local agencies. The Service is available to assist wind energy project developers to identify potential wildlife and habitat issues and should be contacted as early as possible in the company's planning process. With this internal screening process, the developer can begin to identify broad geographic areas of high sensitivity due to the presence of: 1) large blocks of intact native landscapes; 2) intact ecological communities; 3) fragmentation-sensitive species' habitats; or 4) other important landscape-scale wildlife values.

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

1. To identify regions where wind energy development poses significant risks to species of concern or their habitats, including the fragmentation of large-scale habitats and threats to regional populations of federal- or state-listed species.

2. To "screen" a landscape or set of multiple potential sites to avoid those with the highest habitat values.

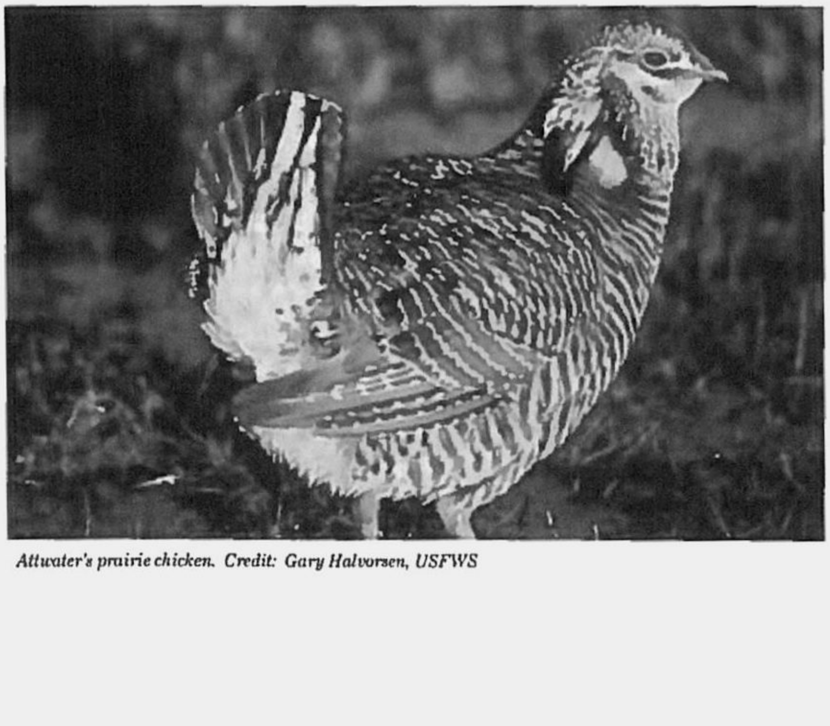
3. To begin to determine if a single identified potential site poses serious risk to species of concern or their habitats.

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 additional study need, greater mitigation requirements, 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 significant adverse impacts to the species of concern or local population(s). This may facilitate discussions with the federal, state, tribal, and/or local agencies in a region being considered for development. In some cases, Tier 1 studies could reveal serious concerns indicating that a site should not be developed.

Developers of distributed or community scale wind projects are typically considering limited geographic areas to install turbines. Therefore, they would not likely consider broad geographic areas. Nevertheless, they should consider the presence of habitats or species of concern before siting projects.

Development in some areas may be precluded by federal law. This designation is separate from a determination through the tiered approach that an area is not appropriate for development due to feasibility, ecological reasons, or other issues. Developers are encouraged to visit Service and other publicly available databases or other available information during Tier 1 or Tier 2 to see if a potential wind energy area is precluded from development by federal law. Some areas may be protected from development through state or local laws or ordinances, and the appropriate agency should be contacted accordingly. Service field offices are available to answer questions where they are knowledgeable, guide developers to databases, and refer developers to other agency contacts.

Some areas may be inappropriate for large scale development because they have been recognized according to scientifically credible information as having high wildlife value, based solely on their ecological rarity and intactness (e.g., Audubon Important Bird Areas, The Nature Conservancy portfolio sites, state wildlife action plan priority habitats). It is important to identify such areas through the tiered approach, as reflected in Tier 1, Question 2 below. Many of North America's native landscapes are greatly diminished, with some existing at less than 10 percent of their pre-settlement occurrence.



Attwater's prairie chicken. Credit: Gary Halvorsen, USFWS

Herbaceous scrub-shrub steppe in the Pacific Northwest and old growth forest in the Northeast represent such diminished native resources. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Developers should collaborate with such entities specifically about such areas in the vicinity of a prospective project site.

Tier 1 Questions

Questions at each tier help determine potential environmental risks at the landscape scale for Tier 1 and project scale for Tiers 2 and 3. Suggested questions to be considered for Tier 1 include:

1. **Are there species of concern present on the potential site(s), or is habitat (including designated critical habitat) present for these species?**

2. **Does the landscape contain areas where development is precluded by law or areas designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: federally-designated critical habitat; high-priority conservation areas for non-government organizations (NGOs); or other local, state, regional, federal, tribal, or international categorizations.**

3. **Are there known critical areas of wildlife congregation, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

4. **Are there large areas of intact habitat with the potential for fragmentation, with respect to species of habitat fragmentation concern needing large contiguous blocks of habitat?**

Tier 1 Methods and Metrics

Developers who choose to conduct Tier 1 investigations would generally be able to utilize existing public or other readily available landscape-level maps and databases from sources such as federal, state, or tribal wildlife or natural heritage programs, the academic community, conservation organizations, or the developers' or consultants' own information. The Service recommends that developers conduct a review of the publicly available data. The analysis of available sites in the region of interest will be based on a blend of the information available in published and unpublished reports, wildlife range distribution maps, and other such sources. The developer should check with the Service Field Office for data specific to wind energy development and wildlife at the landscape scale in Tier 1.

Tier 1 Decision Points

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 impact 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 significant adverse impact.

2. If a developer answers "yes" to one or more of the Tier 1 questions, they should proceed to Tier 2 to further assess the probability of significant adverse impacts to wildlife. A developer may consider abandoning the area or identifying possible means by which the project can be modified to avoid or minimize potential significant 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.

Chapter 3: Tier 2 – Site Characterization

At this stage, the developer has narrowed consideration down to specific sites, and additional data may be necessary to systematically and comprehensively characterize a potential site in terms of the risk wind energy development would pose to species of concern and their habitats. In the case where a site or sites have been selected without the Tier 1 preliminary evaluation of the general ecological context, Tier 2 becomes the first stage in the site selection process. The developer will address the questions asked in Tier 1; if addressing the Tier 1 questions here, the developer will evaluate the site within a landscape context. However, a distinguishing feature of Tier 2 studies is that they focus on site-specific information and should include at least one visit by a knowledgeable biologist to the prospective site(s). Because Tier 2 studies are preliminary, normally one reconnaissance level site visit will be adequate as a "ground-truth" of available information. Notwithstanding, if key issues are identified that relate to varying conditions and/or seasons, Tier 2 studies should include enough site visits during the appropriate times of the year to adequately assess these issues for the prospective site(s).

If the results of the site assessment indicate that one or more species of concern are present, a developer should consider applicable regulatory or other agency processes for addressing them. For instance, if migratory birds and bats are likely to experience significant adverse impacts by a wind project at the proposed site, a developer should identify and document possible actions that will avoid or compensate for those impacts. Such actions might include, but not be limited to, altering locations of turbines or turbine arrays, operational changes, or compensatory mitigation. As soon as a developer anticipates that a wind energy project is likely to result in a take of bald or golden eagles, a developer should prepare an ECP and, if necessary, apply for a programmatic take permit. As soon as a developer realizes endangered or threatened species are present and likely to be affected by a wind project located there, a federal agency should consult with the Service under Section 7(a)(2) of the ESA if the project has a federal nexus or the developer should apply for a section 10(a)(1)(B) incidental take permit if there is not a federal nexus, and incidental take of listed wildlife is anticipated. State, tribal, and local jurisdictions may have additional permitting requirements.

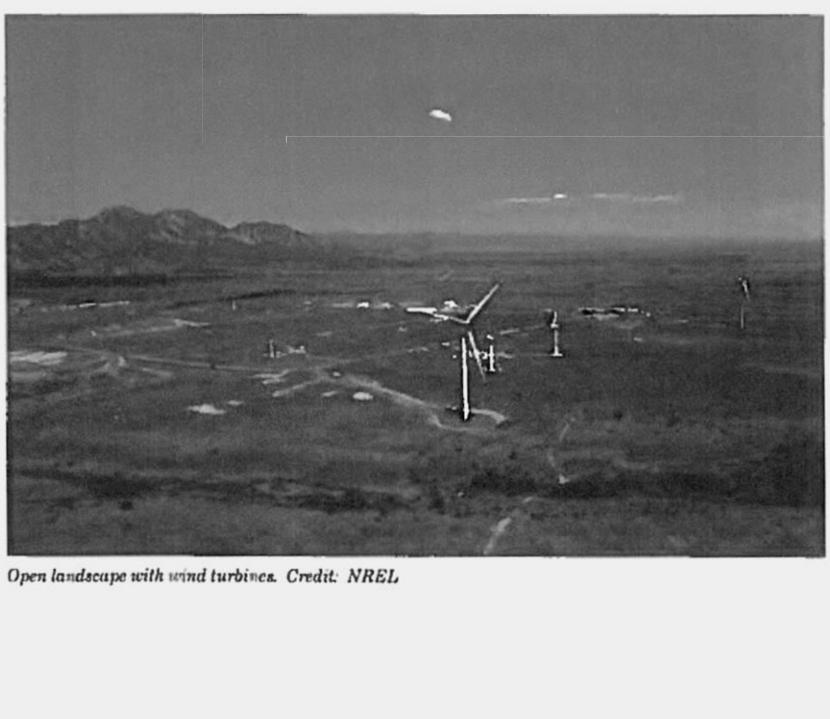
Developers of distributed or community scale wind projects are typically considering limited geographic areas to install turbines. Therefore, they would likely be familiar with conditions at the site where they are considering installing a turbine. Nevertheless, they should do preliminary site evaluations to determine the presence of habitats or species of concern before siting projects.

Tier 2 Questions

Questions suggested for Tier 2 can be answered using credible, publicly available information that includes published studies, technical reports, databases, and information from agencies, local conservation organizations, and/or local experts. Developers or consultants working on their behalf should contact the federal, state, tribal, and local agencies that have jurisdiction or management authority and responsibility over the potential project.

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

2. **Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: federally-designated critical habitat;**



Open landscape with wind turbines. Credit: NREL

high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

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

4. **Are there known critical areas of congregation of species of concern, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

5. **Using best available scientific information has the developer or relevant federal, state, tribal, and/or local agency identified the potential presence of a population of a species of habitat fragmentation concern?**

6. **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?**

7. **Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?**

Tier 2 Methods and Metrics

Obtaining answers to Tier 2 questions will involve a more thorough review of the existing site-specific information than in Tier 1. Tier 2 site characterizations studies will generally contain three elements:

1. 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 species of habitat fragmentation concern, this information can help with the analysis.

2. Contact with agencies and organizations that have relevant scientific information to further help identify if there are bird, bat or other wildlife issues. The Service recommends that the developer make contact with federal, state, tribal, and local agencies that have jurisdiction or management authority over the project or information about the potentially affected resources. In addition, because key NGOs and relevant local groups are often valuable sources of relevant local environmental information, the Service recommends 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.

3. One or more reconnaissance level site visits by a wildlife biologist to evaluate current vegetation/habitat coverage and land management/use. Current habitat and land use practices will be noted to help in determining the baseline against which potential impacts from the project would be evaluated. The vegetation/habitat will 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. Vegetation types or habitats will be noted and evaluated against available information such as land use/land cover mapping. Any sensitive resources located during the site visit will be noted and mapped or digital location data recorded for future reference. Any individuals or signs of species of concern observed during the site visit will be noted. If land access agreements are not in place, access to the site will be limited to public roads.

Specific resources that can help answer each Tier 2 question include:

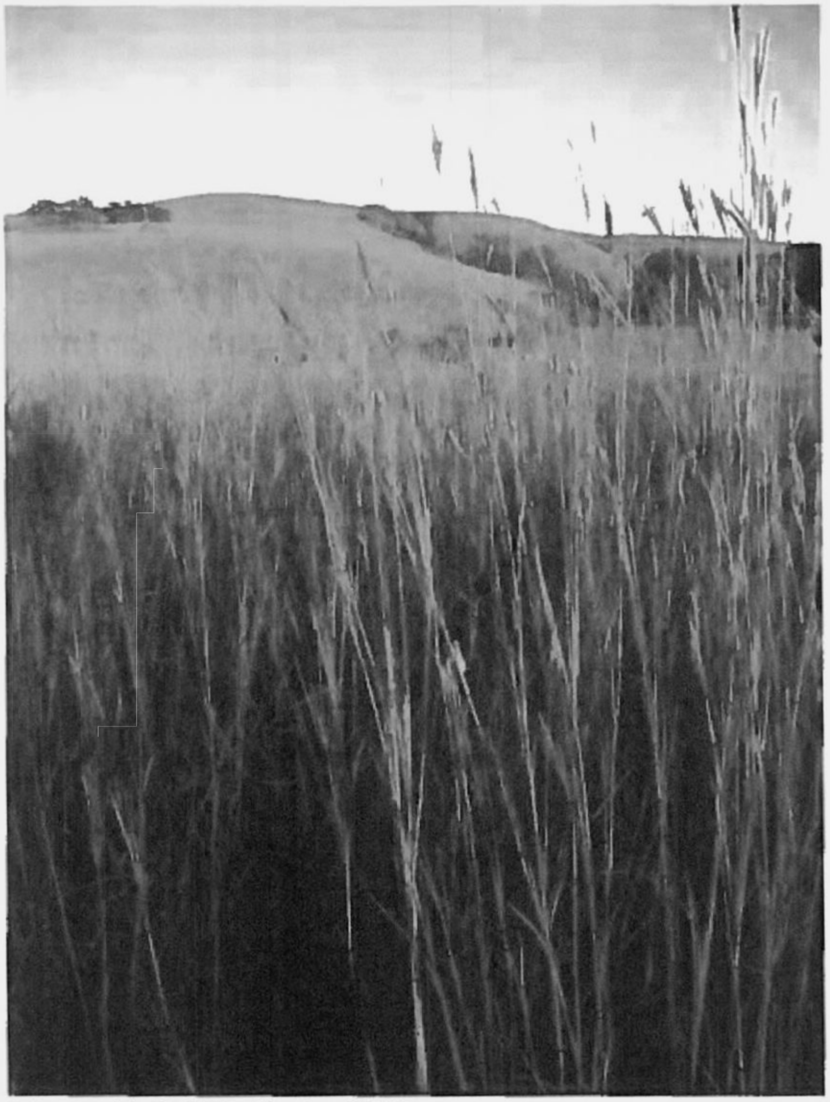
1. **Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?**

   Information review and agency contact: locations of state and federally listed, proposed and candidate species and species of concern are frequently documented in state and federal wildlife databases. Examples include published literature such as: Natural Heritage Databases, State Wildlife Action Plans, NGOs publications, and developer and consultant information, or can be obtained by contacting these entities.

   Site Visit: To the extent practicable, the site visit(s) should evaluate the suitability of habitat at the site for species identified and the likelihood of the project to adversely affect the species of concern that may be present.

2. **Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information?** Examples of designated areas include, but are not limited to: federally-designated critical habitat; high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

   Information review and agency contact such as: maps of political and administrative boundaries; 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 Wildlife Action Plans; State Land and Water Resource Plans; Natural Heritage databases; scientifically credible information provided by NGO and local



Tall grass prairie. Credit: Amy Thornburg, USFWS

resources; and the additional resources listed in Appendix C: Sources of Information Pertaining to Methods to Assess Impacts to Wildlife of this document, or through contact of agencies and NGOs, to determine the presence of high priority habitats for species of concern or conservation areas.

Site Visit: To the extent practicable, the site visit(s) should characterize and evaluate the uniqueness of the site vegetation relative to surrounding areas.

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

   Information review and agency contact such as: Natural Heritage Data of 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. If plant communities of concern are present, developers should also assess in Tier 3 whether the proposed project poses risk of significant adverse impacts and opportunities for mitigation.

4. **Are there known critical areas of wildlife congregation, including, but not limited to, maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

   Information review and agency contact such as: existing databases, State Wildlife Action Plan, Natural Heritage Data, and NGO and agency information regarding the presence of Important Bird Areas, migration corridors or stopovers, leks, bat hibernacula or maternity roosts, or game winter ranges at the site and in the surrounding area.

   Site Visit: To the extent practicable, the site visit should, during appropriate times to adequately assess these issues for prospective site(s), 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.

5. **Using best available scientific information, has the relevant federal, state, tribal, and/or local agency determined the potential presence of a population of a species of habitat fragmentation concern?**

   If not, the developer need not assess impacts of the proposed project on habitat fragmentation.

   Habitat fragmentation is defined as the separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments 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 expanses of habitat for activities such as breeding 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.

Site Visit: If the answer to Tier 2 Question 5 is yes, developers should use the general framework for evaluating habitat fragmentation at a project site in Tier 2 outlined below. Developers and the Service may use this method to analyze the impacts of habitat fragmentation at wind development project sites on species of habitat fragmentation concern. Service field offices may be able to provide the available information on habitat types, quality and intactness. Developers may use this information in combination with site-specific information on the potential habitats to be impacted by a potential development and how they will be impacted.

General Framework for Evaluating Habitat Fragmentation at a Project Site (Tier 2)

A. The developer should define the study area. The study area should not only include the project site for the proposed project, but be based on the distribution of habitat for the local population of the species of habitat fragmentation concern.

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

   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., highways).

   ii. 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
   - Low quality: Extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

C. The 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 provide the collective information from steps A-C for all potential developments to the Service for use in assessing whether the habitat impacts, including habitat fragmentation, are likely to affect population viability of the potentially affected species of habitat fragmentation concern.

6. **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?**

   Information review and agency contact: existing published information and databases from NGOs and federal and state resource agencies regarding the potential presence of:

   - Raptors: species potentially present by season
   - Prairie grouse and sage grouse: species potentially present by season and location of known leks
   - Other birds: species potentially present by season that may be at risk of collision or adverse impacts to habitat, including loss, displacement and fragmentation
   - Bats: species likely to be impacted by wind energy facilities and likely to occur on or migrate through the site

   Site Visit: To the extent practicable, the site visit(s) should identify landscape features or habitats that could be important to raptors, prairie grouse, and other birds that may be at risk of adverse impacts, and bats, including nesting and brood-rearing habitats, areas of high prey density, movement corridors and features such as ridges that may concentrate raptors. Raptors, prairie grouse, and other presence or sign of species of concern seen during the site visit should be noted, with species identification if possible.

7. **Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?**

The developer has assembled answers to the questions above and should make an initial evaluation of the probability of significant adverse impacts to species of concern and their habitats. The developer should make this evaluation based on assessments of the potential presence of species of concern and their habitats, potential presence of critical congregation areas for species of concern, and any site visits. The developer is encouraged to communicate the results of these assessments with the Service.

Tier 2 Decision Points

Possible outcomes of Tier 2 include the following:

1. The most likely outcome of Tier 2 is that the answer to one or more Tier 2 questions is inconclusive to address wildlife risk, either due to insufficient data to answer the question or because of uncertainty about what the answers indicate. The developer proceeds to Tier 3, formulating questions, methods, and assessment of potential mitigation measures based on issues raised in Tier 2 results.

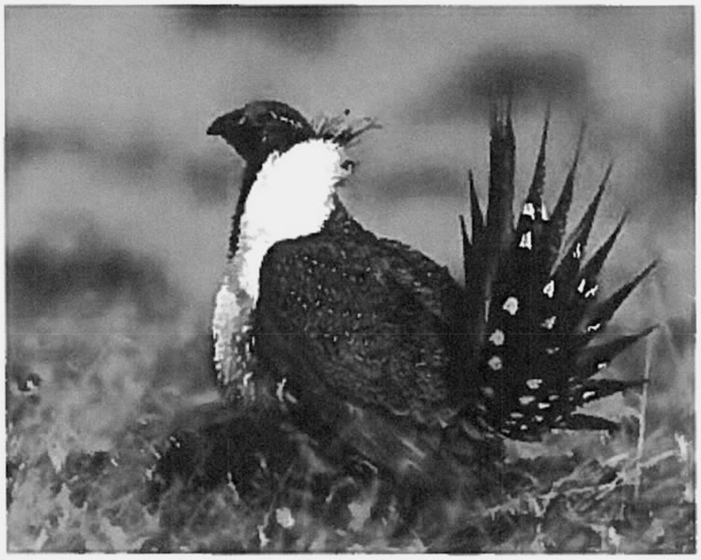
2. Sufficient information is available to answer all Tier 2 questions, and the answer to each Tier 2 question indicates a low probability of significant adverse impact to wildlife (for example, infill or expansion of an existing facility where impacts have been low and Tier 2 results indicate that conditions are similar, therefore wildlife risk is low). The developer may then decide to proceed to obtain state and local permit (if required), design, and construction following best management practices (see Chapter 7: Best Management Practices).

3. Sufficient information is available to answer all Tier 2 questions, and the answer to each Tier 2 question indicates a moderate probability of significant adverse impacts to species of concern or their habitats. The developer should proceed to Tier 3 and identify measures to mitigate potential significant adverse impacts to species of concern.

4. The answers to one or more Tier 2 questions indicate a high probability of significant adverse impacts to species of concern or their habitats that:

   a) Cannot be adequately mitigated. The proposed site should be abandoned.

   b) Can be adequately mitigated. The developer should proceed to Tier 3 and identify measures to mitigate potential significant adverse impacts to species of concern or their habitats.



Greater sage grouse, Credit: Stephen Ting, USFWS

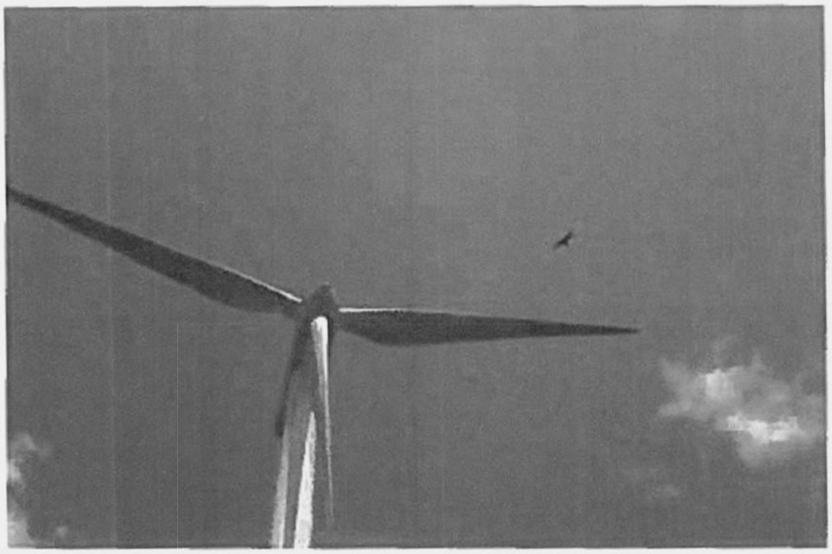
Chapter 4: Tier 3 – Field Studies to Document Site Wildlife and Habitat and Predict Project Impacts

Tier 3 is the first tier in which a developer would conduct quantitative and scientifically rigorous studies 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 be developed or abandoned
- Design and operate a site to avoid or minimize significant adverse impacts if a decision is made to develop
- Design compensatory mitigation measures if significant adverse habitat impacts cannot acceptably be avoided or minimized
- Determine duration and level of effort of post-construction monitoring. If warranted, provide the pre-construction component of post-construction studies necessary to estimate and evaluate impacts

At the beginning of Tier 3, a developer should communicate with the Service on the pre-construction studies. At the end of Tier 3, developers should communicate with the Service regarding the results of the Tier 3 studies and consider the Service's comments and recommendations prior to completing the Tier 3 decision process. The Service will provide written comments to a developer that identify concerns and recommendations to resolve the concerns based on study results and project development plans.

Not all Tier 3 studies will continue into Tiers 4 or 5. For example, surveys conducted in Tier 3 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 3 that remove identified concerns, thus removing the need for continued efforts in later tiers. Additional detail on the design issues for post-construction studies that begin in Tier 3 is provided in the discussion of methods and metrics in Tier 3.



Turkey vulture and wind turbine. Credit: Rachel London, USFWS

Tier 3 Questions

Tier 3 begins as the other tiers, with problem formulation: what additional studies are necessary to enable a decision as to whether the proposed project can proceed to construction or operation or should be abandoned? This step includes an evaluation of data gaps identified by Tier 2 studies as well as the gathering of data necessary to:

- Design a project to avoid or minimize predicted risk
- Evaluate predictions of impact and risk through post-construction comparisons of estimated impacts
- Identify compensatory mitigation measures, if appropriate, to offset significant adverse impacts that cannot be avoided or minimized

The problem formulation stage for Tier 3 also will include an assessment of which species identified in Tier 1 and/or Tier 2 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 Project Site (see Glossary in Appendix A) visit(s) in Tier 2, and on the likelihood of presence and the degree of adverse impact to species or their habitat. If the habitat is suitable for a species 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 is unlikely to be present or is present but adverse impact is unlikely or of minor significance.

Tier 3 studies address many of the questions identified for Tiers 1 and 2, but Tier 3 studies differ because they attempt to quantify the distribution, relative abundance, behavior, and site use of species of concern. Tier 3 data also attempt to estimate the extent that these factors expose these species to risk from the proposed wind energy facility. Therefore, in answering Tier 3 questions 1-3, developers should collect data sufficient to analyze and answer Tier 3 questions 4-6. High risk sites may warrant additional years of pre-construction studies. The duration and intensity of studies needed should be determined through communication with the Service.

If Tier 3 studies identify species of concern or important habitats, e.g., wetlands, which have specific regulatory processes and requirements, developers should work with appropriate state, tribal, or federal agencies to obtain required authorizations or permits.

Tier 3 studies should be designed to answer the following questions:

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 significant adverse impacts on affected population of species of habitat fragmentation concern?**

3. **What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind energy project?**

4. **What are the potential risks of adverse impacts of the proposed wind energy project to individuals and local populations of species of concern and their habitats? (In the case of rare or endangered species, what are the possible impacts to such species and their habitats?)**

5. **How can developers mitigate identified significant adverse impacts?**

6. **Are there studies that should be initiated at this stage that would be continued in post-construction?**

The Service encourages the use of common methods and metrics in Tier 3 assessments for measuring wildlife activity and habitat features. Common methods and metrics provide great benefit over the long-term, allowing for comparisons among projects and for greater certainty regarding what will be asked of the developer for a specific project. Deviation from commonly used methods should be carefully considered, scientifically justifiable and discussed with federal, tribal, or state natural resource agencies, or other credible experts, as appropriate. It may be useful to consult other scientifically credible information sources.

Tier 3 studies will be designed to accommodate local and regional characteristics. The specific protocols by which common methods and metrics are implemented in Tier 3 studies depend on the question being addressed, the species or ecological communities being studied and the characteristics of the study sites. Federally-listed threatened and endangered species, eagles, and some other species of concern and their habitats, may have specific protocols required by local, state or federal agencies. The need for special surveys and mapping that address these species and situations should be discussed with the appropriate stakeholders.

In some instances, a single method will not adequately assess potential collision risk or habitat impact. For example, when there is concern about moderate or high risk to nocturnally active species, such as migrating passerines and local and migrating bats, a combination of remote sensing tools such as radar, and acoustic monitoring for bats and indirect inference from diurnal bird surveys during the migration period may be necessary. Answering questions about habitat use by songbirds may be accomplished by relatively small-scale observational studies, while answering the same question related to wide-ranging species such as prairie grouse and sage grouse may require more time-consuming surveys, perhaps including telemetry.

Because of the points raised above and the need for flexibility in application, the Guidelines do not make specific recommendations on protocol elements for Tier 3 studies. The peer-reviewed scientific literature (such as the articles cited throughout this section) contains numerous recently published reviews of methods for assessing bird and bat activity, and tools for assessing habitat and landscape level risk. Details on specific methods and protocols for recommended studies are or will be widely available and should be consulted by industry and agency professionals.

Many methods for assessing risk are components of active research involving collaborative efforts of public-private research partnerships with federal, state and tribal agencies, wind energy developers and NGOs interested in wind energy-wildlife interactions (e.g., Bats and Wind Energy Cooperative and the Grassland Shrub Steppe Species Cooperative). It is important to recognize the need to integrate the results of research that improves existing methods or describes new methodological developments, while acknowledging the value of utilizing common methods that are currently available.

The methods and metrics that may be appropriate for gathering data to answer Tier 3 questions are compiled and outlined in the Technical Resources section, page 26. These are not meant to be all inclusive and other methods and metrics are available, such as the NWCC Methods & Metrics document (Strickland et al. 2011) and others listed in Appendix C:

Avian Radar

Sources of Information Pertaining to Methods to Assess Impacts to Wildlife.

Each question should be considered in turn, followed by a discussion of the methods and their applicability.

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

In many situations, this question can be answered based on information accumulated in Tier 2. Specific presence/absence studies may not be necessary, and protocol development should focus on answering the remaining Tier 3 questions. Nevertheless, it may be necessary to conduct field studies to determine the presence, or likelihood of presence, when little information is available for a particular site. The level of effort normally contemplated for Tier 3 studies should detect common species and species that are relatively rare, but which visit a site regularly (e.g., every year). In the event a species of concern is very rare and only occasionally visits a site, a determination of "likely to occur" would be inferred from the habitat at the site and historical records of occurrence on or near the site.

State, federal and tribal agencies often require specific protocols be followed when species of concern are potentially present on a site. The methods and protocols for determining presence of species of concern at a site are normally established for each species and required by federal, state and tribal resource agencies. Surveys should sample the wind turbine sites and applicable disturbance area during seasons when species are most likely present. Normally, the methods and protocols by which they 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.

Determining the presence of diurnally or nocturnally active mammals, reptiles, amphibians, and other species of concern will typically be accomplished by following agency-required protocols. Most listed species have required protocols for detection (e.g., the black-footed ferret). State, tribal and federal agencies should be contacted regarding survey protocols for those species of concern. See Corn and Bury 1990, Olson et al. 1997, Bailey et al. 2004, Graeter et al. 2008 for examples of reptile and amphibian protocols, survey and analytical methods. See Tier 3 Study Design Considerations on page 24 for further details.

2. **Do field studies indicate the potential for significant adverse impacts on affected populations of species of habitat fragmentation concern?**

If Tier 2 studies indicate the presence of species of habitat fragmentation concern, 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 3.

As in Tier 2, the particulars of the analysis will depend on the species of habitat fragmentation concern and how habitat block size and fragmentation are defined for the life cycles of that species, 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 for species of habitat fragmentation concern will be significantly altered by the presence of a wind energy facility.

A general framework for evaluating habitat fragmentation at a project site, following that described in Tier 2, is outlined on page 27. This framework should be used in those circumstances when the developer, or a relevant federal, state, tribal and/or other local agency determines the potential presence of a population of a species of habitat fragmentation concern that may be adversely affected by the project. Otherwise, the developer need not assess the impacts of the proposed project on habitat fragmentation. This method for analysis of habitat fragmentation at project sites must be adapted to the local population of the species of habitat fragmentation concern potentially affected by the proposed development.

3. **What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind energy project?**

For those species of concern that are considered at risk of collisions or habitat impacts, the questions to be answered in Tier 3 include: where are they likely to occur (i.e., where is their habitat) within a project site or vicinity, when might they occur, and in what abundance. The spatial distribution of species 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 3, question 1, above) 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. Suggested survey protocols for birds, bats, and other wildlife are found in the Technical Resources section on page 26.

Whooping crane. Credit: Ryan Hagerty, USFWS

4. **What are the potential risks of adverse impacts of the proposed wind energy project to individuals and local populations of species of concern and their habitats? (In the case of rare or endangered species, what are the possible impacts to such species and their habitats?)**

Methods used for estimating risk will vary with the species of concern. For example, estimating potential bird fatalities in Tier 3 may be accomplished by comparing exposure estimates (described earlier in estimates of bird use) 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, and have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the United States (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. A statistical model based on the relationship of pre-construction estimates of raptor abundance and post-construction raptor fatalities is described in Strickland et al. (2011) and promises to be a useful tool for risk assessment.

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. The risk to a population increases as the proportion of individuals in the population at risk to collision increases.

At some projects, bat fatalities are higher than bird fatalities, but the exposure risk of bats at these facilities is not fully understood (National Research Council (NRC) 2007). Horn et al. (2008) and Cryan (2008) hypothesize that bats are attracted to turbines, which, if true, would further complicate estimation of exposure. Further research is required to determine if bats are attracted to turbines and if so, to evaluate 1) the influence on Tier 2 methods and predictions, and 2) if this increased individual risk translates into higher population-level impacts for bats.

The estimation of indirect impact risk requires an understanding of animal behavior in response to a project and its infrastructure, and a pre-construction estimate of presence/absence of 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 indirect impact will depend on the amount of habitat available to the affected population. If the indirect impacts include habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased. Quantifying cause and effect may be very difficult, however.

5. **How can developers mitigate identified significant adverse impacts?**

Results of Tier 3 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.

Chapter 7, Best Management Practices, and Chapter 8, Mitigation, outline measures that can be taken to mitigate impacts throughout all phases of a project.

The following discussion of prairie grouse and sage grouse as species of concern illustrates the uncertainty mentioned above by describing the present state of scientific knowledge relative to these species, which should be considered when designing mitigation measures. The extent of the impact of wind energy development on prairie grouse and sage grouse lekking activity (e.g., social structure, mating success, persistence) and the associated impacts on productivity (e.g., nesting, nest success, chick survival) is poorly understood (Arnett et al. 2007, NRC 2007, Manville 2004). However, recent published research documents that anthropogenic features (e.g., tall structures, buildings, roads, transmission lines) can adversely impact vital rates (e.g., nesting, nest success, lekking behavior) of lesser prairie-chickens (Pruett et al. 2009, Pitman et al. 2005, Hagen et al. 2009, Hagen et al. 2011) and greater prairie-chickens over long distances. Pitman et al. (2005) found that transmission lines reduced nesting of lesser prairie chicken by 90 percent out to a distance of 0.25 miles, improved roads at a distance of 0.25 miles, a house at 0.3 miles, and a power plant at >0.6 miles. Reduced nesting activity of lesser prairie chickens may extend farther, but Pitman et al. (2005) did not analyze their data for lower impacts (less than 90 percent reduction in nesting) of those anthropogenic features on lesser prairie chicken nesting activities at greater distances. Hagen et al. (2011) 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. Kansas State University, as part of the National Wind Coordinating Collaborative's Grassland and Shrub Steppe Species Subgroup, is undertaking a multi-year telemetry study to evaluate the effects of a proposed wind-energy facility on displacement and demographic parameters (e.g., survival, nest success, brood success, fecundity) of greater prairie-chickens in Kansas.[5]

The distances over which anthropogenic activities impact sage grouse are greater than for prairie grouse. Based primarily on data documenting reduced fecundity (a combination of nesting, clutch size, nest success, juvenile survival, and other factors) in sage grouse populations near roads, transmissions lines, and areas of oil and gas development/production (Holloran 2005, Connelly et al. 2000), development within three to five miles (or more) of active sage grouse leks may have significant adverse impacts on the affected grouse population. Lyon and Anderson (2003) found that in habitats fragmented by natural gas development, only 26 percent of hens captured on disturbed leks nested within 1.8 miles of the lek of capture, whereas 91 percent of hens from undisturbed areas nested within the same area. Holloran (2005) found that active drilling within 3.1 miles of sage grouse lek reduced the number of breeding males by displacing adult males and reducing recruitment of juvenile males. The magnitudes and proximal causes (e.g., noise, height of structures, movement, human activity, etc.) of those impacts on vital rates in grouse populations are areas of much needed research (Becker et al. 2009). Data accumulated through such research may improve our understanding of the buffer distances necessary to avoid or minimize significant adverse impacts to prairie grouse and sage grouse populations.

When significant adverse impacts cannot be fully avoided or adequately minimized, some form of compensatory mitigation may be

[5] www.nationalwind.org

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.

6. Are there studies that should be initiated at this stage that would be continued in post-construction?

During Tier 3 problem formulation, it is necessary to identify the studies needed to address the Tier 3 questions. Consideration of how the resulting data may be used in conjunction with post-construction Tier 4 and 5 studies is also recommended. The design of post-construction impact or mitigation assessment studies will depend on the specific impact questions being addressed. Tier 3 predictions will be evaluated using data from Tier 4 studies designed to estimate fatalities for species of concern and impacts to their habitat, including species of habitat fragmentation concern. Tier 3 studies may demonstrate the need for mitigation of significant adverse impacts. Where Tier 3 studies indicate the potential for significant adverse direct and indirect impacts to habitat, Tier 4 studies will provide data that evaluate predictions of those impacts, and Tier 5 studies, if necessary, will provide data to evaluate the effect of those impacts on populations and the effectiveness of mitigation measures. Evaluations of the impacts of a project on demographic parameters of local populations, habitat use, or some other parameter(s) are considered Tier 5 studies, and typically will require data on these parameters prior to as well as after construction of the project.

Tier 3 Study Design Considerations

Specific study designs will vary from site to site and should be adjusted to the circumstances of individual projects. Study designs will depend on the types of questions, the specific project, and practical considerations. The most common considerations include the area being studied, the species of concern and potential risk to those species, potentially confounding variables, time available to conduct studies, project budget, and the magnitude of the anticipated impacts. Studies will be necessary in part to assess a) which species of concern are present within the project area; b) how these species are using the area (behavior); and c) what risks are posed to them by the proposed wind energy project.

Rows of wind turbines. Credit: Joshua Winchell, USFWS

Assessing Presence

A developer should assess whether species of concern are likely to be present in the project area during the life of the project. Assessing species use from databases and site characteristics is a potential first step. However, it can be difficult to assess potential use by certain species from site characteristics alone. Various species in different locations may require developers to use specific survey protocols or make certain assumptions regarding presence. Project developers should seek local wildlife expertise, such as Service Field Office staff, in using the proper procedures and making assumptions.

Some species will present particular challenges when trying to determine potential presence. For instance, species that a) are rare or cryptic; b) migrate, conduct other daily movements, or use areas for short periods; c) are small or nocturnal; or d) have become extirpated in parts of their historical range can be difficult to observe. One of these challenges is migration, broadly defined as the act of moving from one spatial unit to another (Baker 1978), or as a periodic movement of animals from one location to another. Migration is species-specific, and for birds and bats occurs throughout the year.

Assessing Site Use/Behavior

Developers should monitor potential sites to determine the types of migratory species present, what type of spatial and temporal use these species make of the site (e.g., chronology of migration or other use), and the ecological function the site may provide in terms of the migration cycle of these species. Wind developers should determine not only what species may migrate through a proposed development site and when, but also whether a site may function as a staging area or stopover habitat for wildlife on their migration pathway.

For some species, movements between foraging and breeding habitat, or between sheltering and feeding habitats, occur on a daily basis. Consideration of daily movements (morning and evening; coming and going) is a critical factor when considering project development.

Duration/Intensity of Studies

Where pre-construction assessments are warranted to help assess risk to wildlife, the studies should be of sufficient duration and intensity to ensure adequate data are collected to accurately characterize wildlife presence and use of the area. In ecological systems, resource quality and quantity can fluctuate rapidly. These fluctuations occur naturally, but human actions can significantly affect (i.e., increase or decrease) natural oscillations. Pre-construction monitoring and assessment of proposed wind energy sites are "snapshots in time," showing occurrence or no occurrence of a species or habitat at the specific time surveyed. Often due to prohibitive costs, assessments and surveys are conducted for very low percentages (e.g., less than 5 percent) of the available sample time in a given year, however, these data are used to support risk analyses over the projected life of a project (e.g., 30 years of operations).

To establish a trend in site use and conditions that incorporates annual and seasonal variation in meteorological conditions, biological factors, and other variables, pre-construction studies may need to occur over multiple years. However, the level of risk and the question of data requirements will be based on site sensitivity, affected species, and the availability of data from other sources. Accordingly, decisions regarding studies should consider information gathered during the previous tiers, variability within and between seasons, and years where variability is likely to substantially affect answers to the Tier 3 questions. These studies should also be designed to collect data during relevant breeding, feeding, sheltering, staging, or migration periods for each species being studied. Additionally, consideration for the frequency and intensity of pre-construction monitoring should be site-specific and determined through consultation with an expert authority based on their knowledge of the specific species, level of risk and other variables present at each individual site.

Assessing Risk to Species of Concern

Once likely presence and factors such as abundance, frequency of use, habitat use patterns, and behavior have been determined or assumed, the developer should consider and/or determine the consequences to the "populations" and species.

Below is a brief discussion of several types of risk factors that can be considered. This does not include all potential risk factors for all species, but addresses the most common ones.

<u>Collision</u>

Collision likelihood for individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, "relative abundance," behavior, visibility, weather conditions, and site characteristics. Collision likelihood for an individual may be low regardless of abundance if its behavior does not place it within the "rotor-swept zone." Individuals that frequently occupy the rotor-swept zone but effectively avoid collisions are also at low likelihood of collision with a turbine.

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 likelihood of collisions with turbines regardless of abundance. Some species, even at lower abundance, may have a higher collision rate than similar species due to subtle differences in their ecology and behavior.

At many projects, the numbers of bat fatalities are higher than the numbers of bird fatalities, but the exposure risk of bats at these facilities is not fully understood. Researchers (Horn et al. 2008 and Cryan 2008) hypothesize that some bats may be attracted to turbines, which, if true, would further complicate estimation of exposure. Further research is required to determine whether bats are attracted to turbines and if so, whether this increased individual risk translates into higher population-scale effects.

<u>Habitat Loss and Degradation</u>

Wind project development results in direct habitat loss and habitat modification, especially at sites previously undeveloped. Many of North America's native landscapes are greatly diminished or degraded from multiple causes unrelated to wind energy. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Species that depend on these landscapes are susceptible to further loss of habitat, which will affect their ability to reproduce and survive. While habitat lost due to footprints of turbines, roads, and other infrastructure is obvious, less obvious is the potential reduction of habitat quality.

<u>Habitat Fragmentation</u>

Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Site clearing, access roads, transmission lines, and arrays of turbine towers may displace some species or fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding, foraging, and sheltering.

Habitat fragmentation can result in increases in "edge" resulting in direct effects of barriers and displacement as well as indirect effects of nest parasitism and predation. Sensitivity to fragmentation effects varies among species. Habitat fragmentation and site modification are important issues that should be assessed at the landscape scale early in the siting process. Identify areas of high sensitivity due to the presence of blocks of native habitats, paying particular attention to known or suspected "species sensitive to habitat fragmentation."

Displacement and Behavioral Changes

Estimating displacement risk requires an understanding of animal behavior in response to a project and its infrastructure and activities, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid or seek areas in proximity to turbines, roads, and other components of the project. Displacement is a function of the sensitivity of individuals to the project and activity levels associated with operations.

Indirect Effects

Wind development can also have indirect effects to wildlife and habitats. Indirect effects include reduced nesting and breeding densities and the social ramifications of those reductions; loss or modification of foraging habitat; loss of population vigor and overall population density; increased isolation between habitat patches, loss of habitat refugia; attraction to modified habitats; effects on behavior, physiological disturbance, and habitat unsuitability. Indirect effects can result from introduction of invasive plants; increased predator populations or facilitated predation; alterations in the natural fire regime; or other effects, and can manifest themselves later in time than the causing action.

When collection of both pre- and post-construction data in the areas of interest and reference areas is possible, then the Before-After-Control-Impact (BACI) is the most statistically robust design. The BACI design is most like the classic manipulative experiment.[6] In the absence of a suitable reference area, the design is reduced to a Before-After (BA) analysis of effect where the differences between pre- and post-construction parameters of interest are assumed to be the result of the project, independent of other potential factors affecting the assessment area. With respect to BA studies, the key question is whether the observations taken immediately after the incident can reasonably be expected within the expected range for the system (Manly 2009). Reliable quantification of impact usually will include additional study components to limit variation and the confounding effects of natural factors that may change with time.

Virginia big-eared bat. Credit: USFWS

The developer's timeline for the development of a wind energy facility often does not allow for the collection of sufficient pre-construction data and/or identification of suitable reference areas to complete a BACI or BA study. Furthermore, alterations in land use or disturbance over the course of a multi-year BACI or BA study may complicate the analysis of study results. Additional discussion of these issues can be found in Tier 5 Study Design Considerations.

Tier 3 Technical Resources

The following methods and metrics are provided as suggested sources for developers to use in answering the Tier 3 questions.

Tier 3, Question 1

Acoustic monitoring can be a practical method for determining the presence of threatened, endangered or otherwise rare species of bats throughout a proposed project (Kunz et al. 2007). There are two general types of acoustic detectors used for collection of information on bat activity and species identification: the full-spectrum, time-expansion and the zero-crossing techniques for ultrasound bat detection (see Kunz et al. 2007 for detailed discussion). Full-spectrum time expansion detectors provide nearly complete species discrimination, while zero-crossing detectors provide reliable and cost-effective estimates of total bat use at a site and some species discrimination. Myotis species can be especially difficult to discriminate with zero-crossing detectors (Kunz et al. 2007). Kunz et al. (2007) describe the strengths and weaknesses of each technique for ultrasonic bat detection, and either type of detector may be useful in most situations except where species identification is especially important and zero-crossing methods are inadequate to provide the necessary data. Bat acoustics technology is evolving rapidly and study objectives are an important consideration when selecting detectors. When rare or endangered species of bats are suspected, sampling should occur during different seasons and at

[6] In this context, such designs are not true experiments in that the treatments (project development and control) are not randomly assigned to an experimental unit, and there is often no true replication. Such constraints are not fatal flaws, but do limit statistical inferences of the results.

multiple sampling stations to account for temporal and spatial variability.

Mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or otherwise rare species. Mist-netting is best used in combination with acoustic monitoring to inventory the species of bats present at a site, especially to detect the presence of threatened or endangered species. Efforts should concentrate on potential commuting, foraging, drinking, and roosting sites (Kuenzi and Morrison 1998, O'Farrell et al. 1999). Mist-netting and other activities that involve capturing and handling threatened or endangered species of bats will require permits from state and/or federal agencies.

Tier 3, Question 2

The following protocol should be used to answer Tier 3, Question 2. This protocol for analysis of habitat fragmentation at project sites should be adapted to the species of habitat fragmentation concern as identified in response to Question 5 in Tier 2 and to the landscape in which development is contemplated. The developer should:

1. 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, including indirect impacts, within the distribution of habitat for the species of habitat fragmentation concern.
2. Determine the potential for occupancy of the study area based on the guidance provided for the species of habitat fragmentation concern described above in Question 1.
3. Analyze current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.
   a. 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.
      i. 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
         - Low quality: extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)
      ii. Determine edge and interior habitat metrics of the study area:
         - Identify habitat, non-habitat landscape features and existing fragmenting features relative to the species of habitat fragmentation concern, to estimate existing edge
         - Calculate area and acres of edge
         - Calculate area of intact patches of habitat and compare to needs of species of habitat fragmentation concern
   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 turbines and ancillary infrastructure:
      i. Identify, delineate and classify all additional features added by the development that potentially fragment habitat for the species of habitat fragmentation concern (e.g., roads, transmission lines, maintenance structures, etc.)
      ii. Assess the expected future size and quality of habitat patches for the species of habitat fragmentation concern and the additional fragmenting features, and categorize into three classes as described above
      iii. Determine expected future acreages of edge and interior habitats
      iv. Calculate the area of the remaining patches of intact habitat
   c. Compare pre-construction and expected post-construction fragmentation metrics:
      i. Determine the area of intact habitat lost (to the displacement footprint or by alteration due to the edge effect)
      ii. Identify habitat patches that are expected to be moved to a lower habitat quality classification as a result of the development
4. Assess the likelihood of a significant reduction in the demographic and genetic viability of the local population of the species of habitat fragmentation concern using the habitat fragmentation information collected under item 3 above and any currently available demographic and genetic data. Based on this assessment, the developer makes the finding whether or not there is significant reduction. The developer should share the finding with the relevant agencies. 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 of habitat fragmentation concern in the area of interest.

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 habitat fragmentation concern in the area.

c. Identify areas of medium or low quality habitat within the range of the impacted population 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).

Tier 3, Question 3

The following protocols are suggested for use in answering Tier 3, Question 3.

Bird distribution, abundance, behavior and site use

Diurnal Avian Activity Surveys

The commonly used data collection methods for estimating the spatial distribution and relative abundance of diurnal birds includes counts of birds seen or heard at specific survey points (point count), along transects (transect surveys), and observational studies. Both methods result in estimates of bird use, which are assumed to be indices of abundance in the area surveyed. Absolute abundance is difficult to determine for most species and is not necessary to evaluate species risk. Depending on the characteristics of the area of interest and the bird species potentially affected by the project, additional pre-construction study methods may be necessary. Point counts or line transects should collect vertical as well as horizontal data to identify levels of activity within the rotor-swept zone.

Avian point counts should follow the general methodology described by Reynolds et al. (1980) for point counts within a fixed area, or the line transect survey similar to Schaffer and Johnson (2008), where all birds seen within a fixed distance of a line are counted. These methods are most useful for pre- and post-construction studies to quantify avian use of the project site by habitat, determine the presence of species of concern, and to provide a baseline for assessing displacement effects and habitat loss. Point counts for large birds (e.g., raptors) follow the same point count method described by Reynolds et al. (1980), Ralph et al. (1993) and Ralph et al. 1995).

Point count plots, transects, and observational studies should allow for statistical extrapolation of data and be distributed throughout the area of interest using a probability sampling approach (e.g., systematic sample with a random start). For most projects, the area of interest is the area where wind turbines and permanent meteorological (met) towers are proposed or expected to be sited. Alternatively, the centers of the larger plots can be located at vantage points throughout the potential area being considered with the objective of covering most of the area of interest. Flight height should also be collected to focus estimates of use on activity occurring in the rotor-swept zone.

Sampling duration and frequency will be determined on a project-by-project basis and by the questions being addressed. The most important consideration for sampling frequency when estimating abundance is the amount of variation

Hoary bat. Credit: Paul Cryan, USGS

expected among survey dates and locations and the species of concern.

The use of comparable methods and metrics should allow data comparison from plot to plot within the area of interest and from site to site where similar data exist. The data should be collected so that avian activity can be estimated within the rotor-swept zone. Relating use to site characteristics requires that samples of use also measure 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 in unsurveyed areas during the survey period and for the same areas in the future.

Surveys should be conducted at different intervals during the year to account for variation in expected bird activity with lower frequency during winter months if avian activity is low. Sampling frequency should also consider the episodic nature of activity during fall and spring migration. Standardized protocols for estimating avian abundance are well-established and should be consulted (e.g., Dettmers et al. 1999). If a more precise estimate of density is required for a particular species (e.g., when the goal is to determine densities of a special-status breeding bird species), the researcher will need more sophisticated sampling procedures, including estimates of detection probability.

Raptor Nest Searches

An estimate of raptor use of the project site is obtained through appropriate surveys, but if potential impacts to breeding raptors are a concern on a project, raptor nest searches are also recommended. 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

Red-tailed hawk. Credit: Dave Menke, USFWS

requirements. A good source of information for raptor surveys and monitoring is Bird and Bildstein (2007).

Searches for raptor nests or raptor breeding territories on projects with potential for impacts to raptors should be conducted in suitable habitat during the breeding season. While there is no consensus on the recommended buffer zones around nest sites to avoid disturbance of most species (Sutter and Jones 1981), a nest search within at least one mile of the wind turbines and transmission lines, and other infrastructure should be conducted. However, larger nest search areas are needed for eagles, as explained in the Service's ECP Guidance, when bald or golden eagles are likely to be present.

Methods for these surveys are fairly common and will vary with the species, terrain, and vegetation within the survey area. The Service recommends that protocols be discussed with biologists from the lead agency, Service, state wildlife agency, and Tribes where they have jurisdiction. It may be useful to consult other scientifically credible information sources. At minimum, the protocols should contain the list of target raptor species for nest surveys and the appropriate search protocol for each site, including timing and number of surveys needed, search area, and search techniques.

Prairie Grouse and Sage Grouse Population Assessments

Sage grouse and prairie grouse merit special attention in this context for three reasons:

1. The scale and biotic nature of their habitat requirements uniquely position them as reliable indicators of impacts on, and needs of, a suite of species that depend on sage and grassland habitats, which are among the nation's most diminished ecological communities (Vodehnal and Haufler 2007).

2. Their ranges and habitats are highly congruent with the nation's richest inland wind resources.

3. They are species for which some known impacts of anthropogenic features (e.g., tall structures, buildings, roads, transmission lines, wind energy facilities, etc.) have been documented.

Populations of prairie grouse and sage grouse generally are assessed by either lek counts (a count of the maximum number of males attending a lek) or lek surveys (classification of known leks as active or inactive) during the breeding season (e.g., Connelly et al. 2000). Methods for lek counts vary slightly by species but in general require repeated visits to known sites and a systematic search of all suitable habitat for leks, followed by repeated visits to active leks to estimate the number of grouse using them.

Recent research indicates that viable prairie grouse and sage grouse populations are dependent on suitable nesting and brood-rearing habitat (Connelly et al. 2000, Hagen et al. 2009). These habitats generally are associated with leks. Leks are the approximate centers of nesting and brood-rearing habitats (Connelly et al. 2000, but see Connelly et al. 1988 and Becker et al. 2009). High quality nesting and brood rearing habitats surrounding leks are critical to sustaining viable prairie grouse and sage grouse populations (Giesen and Connelly 1993, Hagen et al. 2004, Connelly et al. 2000). A population assessment study area should include nesting and brood rearing habitats that may extend several miles from leks. For example, greater and lesser prairie-chickens generally nest in suitable habitats within one to two miles of active leks (Hagen et al. 2004), whereas the average distances from nests to active leks of non-migratory sage grouse range from 0.7 to four miles (Connelly et al. 2000), and potentially much more for migratory populations (Connelly et al. 1988).

While surveying leks during the spring breeding season is the most common and convenient tool for monitoring population trends of prairie grouse and sage grouse, documenting available nesting and brood rearing habitat within and adjacent to the potentially affected area is recommended. Suitable nesting and brood rearing habitats can be mapped based on habitat requirements of individual species. The distribution and abundance of nesting and brood rearing habitats can be used to help in the assessment of adverse impacts of the proposed project to prairie grouse and sage grouse.

Mist-Netting for Birds

Mist-netting is not recommended as a method for assessing risk of wind development for birds. Mist-netting cannot generally be used to develop indices of relative bird abundance, nor does it provide an estimate of collision risk as mist-netting is not feasible at the heights of the rotor-swept zone and captures below that zone may not adequately reflect risk. Operating mist-nets requires considerable experience, as well as state and federal permits.

Occasionally mist-netting can help confirm the presence of rare species at documented fallout or migrant stopover sites near a proposed project. If mist-netting is to be used, the Service recommends that procedures for operating nets and collecting data be followed in accordance with Ralph et al. (1993).

Nocturnal and Crepuscular Bird Survey Methods

Additional studies using different methods should be conducted if characteristics of the project site and surrounding areas potentially pose a high risk of collision to night migrating songbirds and other nocturnal or crepuscular species. For most of their flight, songbirds and other nocturnal migrants are above the reach of wind turbines, but they pass through the altitudinal range of wind turbines during ascents and descents and may also fly closer to the ground during inclement weather (Able, 1970; Richardson, 2000). Factors affecting flight path, behavior, and "fall-out" locations of nocturnal migrants are reviewed elsewhere (e.g., Williams et al., 2001; Gauthreaux and Belser, 2003; Richardson, 2000; Mabee et al., 2006).

In general, pre-construction nocturnal studies are not recommended unless the site has features that might strongly concentrate nocturnal birds, such as along coastlines that are known to be migratory songbird corridors. Biologists knowledgeable about nocturnal bird migration and familiar with patterns of migratory stopovers in the region should assess the potential risks to nocturnal migrants at a proposed project site. No single method can adequately assess the spatial and temporal variation in nocturnal bird populations or the potential collision risk. Following nocturnal study methods in Kunz et al. (2007) is recommended to determine relative abundance, flight direction and flight altitude for assessing risk to migrating birds, if warranted. If areas of interest are within the range of nocturnal species of concern (e.g., marbled murrelet, northern spotted owl, Hawaiian petrel, Newell's shearwater), surveyors should use species-specific protocols recommended by state wildlife agencies, Tribes or Service to assess the species' potential presence in the area of interest.

In contrast to the diurnal avian survey techniques previously described, considerable variation and uncertainty exist on the optimal protocols for using acoustic monitoring devices, radar, and other techniques to evaluate species composition, relative abundance, flight height, and trajectory of nocturnal migrating birds. While an active area of research, the use of radar for determining passage rates, flight heights and flight directions of nocturnal migrating animals has yet to be shown as a good indicator of collision risk. Pre- and post-construction studies comparing radar monitoring results to estimates of bird and bat fatalities will be necessary to evaluate radar as a tool for predicting collision risk. Additional studies are also needed before making recommendations on the number of nights per season or the number of hours per night that are appropriate for radar studies of nocturnal bird migration (Mabee et al., 2006).

Bat survey methods

The Service recommends that all techniques discussed below be conducted by biologists trained in bat identification, equipment use, and the analysis and interpretation of data resulting from the design and conduct of the studies. Activities that involve capturing and handling bats may require permits from state and/or federal agencies.

Acoustic Monitoring

Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species occurrence and use, but does not measure the number of individual bats or population density. The goal of acoustic monitoring is to provide a prediction of the potential risk of bat fatalities resulting from the construction and operation of a project. Our current state of knowledge about bat-wind turbine interactions, however, does not allow a quantitative link between pre-construction acoustic assessments of bat activity and operations fatalities. Discussions with experts, state wildlife trustee agencies, Tribes, and

Tri-colored bat. Credit: USFWS

Service will be needed to determine whether acoustic monitoring is warranted at a proposed project site.

The predominance of bat fatalities detected to date are migratory species and acoustic monitoring should adequately cover periods of migration and periods of known high activity for other (i.e., non-migratory) species. Monitoring for a full year is recommended in areas where there is year round bat activity. Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so these weather data can be used in the analysis of bat activity levels.

The number and distribution of sampling stations necessary to adequately estimate bat activity have not been well established but will depend, at least in part, on the size of the project area, variability within the project area, and a Tier 2 assessment of potential bat occurrence.

The number of detectors needed to achieve the desired level of precision will vary depending on the within-site variation (e.g., Arnett et al. 2006, Weller 2007, See also, Bat Conservation International website for up-to-date survey methodologies). One frequently used method is to place acoustic detectors on existing met towers, approximately every two kilometers across the site where turbines are expected to be sited. Acoustic detectors should be placed at high positions (as high as practicable, based on tower height) on each met tower included in the sample to record bat activity at or near the rotor swept zone, the area of presumed greatest risk for bats. Developers should evaluate whether it would be cost effective to install detectors when met towers are first established on a site. Doing so might reduce the cost of installation later and might alleviate time delays to conduct such studies.

If sampling at met towers does not adequately cover the study area or provide sufficient replication, additional sampling stations can be established at low positions (~1.5-2 meters) at a sample of existing met towers and one or more mobile units (i.e., units that are moved to different locations throughout the study period) to increase coverage of the proposed project area. When practical and based on information from Tier 2, it may be appropriate to conduct some acoustic monitoring of features identified as potentially high bat use areas within the study area (e.g., bat roosts and caves) to determine use of such features.

There is growing interest in determining whether "low" position samples (~1.5-2 meters) can provide equal or greater correlation with bat fatalities than "high" position samples (described above) because this would substantially lower cost of this work. Developers could then install a greater number of detectors at lower cost resulting in improved estimates of bat activity and, potentially, improved qualitative estimates of risk to bats. This is a research question that is not expected to be addressed at a project.

Other bat survey techniques

Occasionally, other techniques may be needed to answer Tier 3 questions and complement the information from acoustic surveys. Kunz et al. (2007), NAS (2007), Kunz and Parsons (2009) provide comprehensive descriptions of bat survey techniques, including those identified below that are relevant for Tier 3 studies at wind energy facilities.

Roost Searches and Exit Counts

Pre-construction survey efforts may be recommended to determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the project vicinity, and to confirm whether known or likely bat roosts are present and occupied by bats. If active roosts are detected, it may be appropriate to address questions about colony size and species composition of roosts. Exit counts and roost searches are two approaches to answering these questions, and Rainey (1995), Kunz and Parsons (2009), and Sherwin et al. (2009) are resources that describe options and approaches for these techniques. 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 state and/or federal wildlife agencies. 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 non-invasive observation using low-light binoculars and infrared video cameras.

Multiple surveys should be conducted 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). For example, Sherwin et al. (2003) demonstrated that a minimum of three surveys are needed to determine the absence of large hibernating colonies of Townsend's big-eared bats in mines (90 percent probability), while a minimum of nine surveys (during a single warm season) are necessary before a mine could be eliminated as a bachelor roost for this species (90 percent probability). An average of three surveys was needed before surveyed caves could be eliminated as bachelor roosts (90 percent probability). The Service recommends that decisions on level of effort follow discussion with relevant agencies and bat experts.

Activity Patterns

If active roosts are detected, it may be necessary to answer questions about behavior, movement patterns, and patterns of roost use for bat species of concern, or to further investigate habitat features that might attract bats and pose fatality risk. 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. (2007) describe the use of telemetry, radar and other tools to evaluate use of roosts, activity patterns, and flight direction from roosts.

Mist-Netting for Bats

While mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or other bat species of concern, mist-netting is not generally recommended for determining levels of activity or assessing risk of wind energy development to bats for the following reasons: 1) not all proposed or operational wind energy facilities offer conditions conducive to capturing bats, and often the number of suitable sampling points is minimal or not closely associated with the project location; 2) capture efforts often occur at water sources offsite or at nearby roosts and the results may not reflect species presence or use on the site where turbines are to be erected; and 3) mist-netting isn't feasible at the height of the rotor-swept zone, and captures below that zone may not adequately reflect risk of fatality. If mist-netting is employed, it is best used in combination with acoustic monitoring to inventory the species of bats present at a site.

White-Nose Syndrome

White-nose syndrome is a disease affecting hibernating bats. Named for the white fungus that appears on the muzzle and other body parts of hibernating bats, WNS is associated with extensive mortality of bats in eastern North America. All contractors and consultants hired by developers should employ the most current version of survey and handling protocols to avoid transmitting white-nose syndrome between bats.

Mule deer. Credit: Tupper Ansel Blake, USFWS

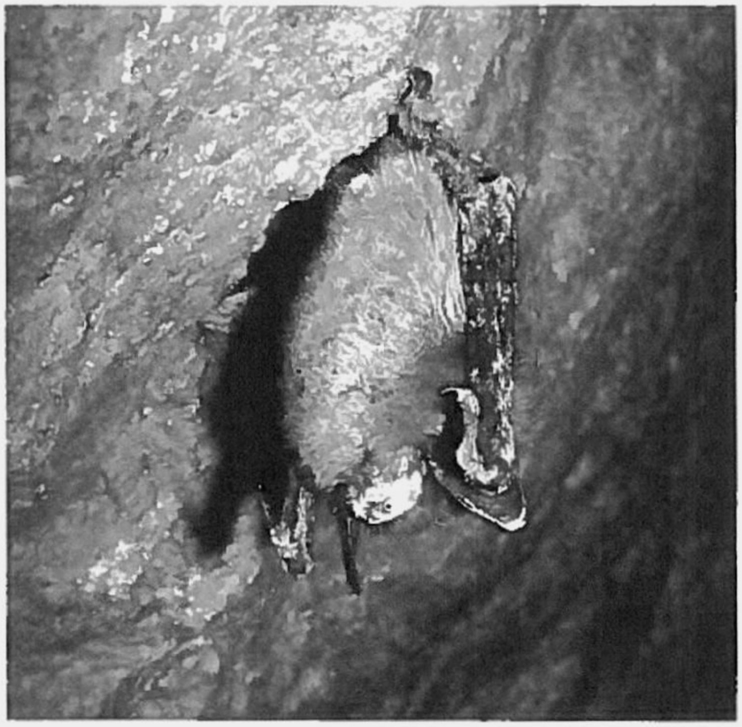
Other wildlife

While the above guidance emphasizes the evaluation of potential impacts to birds and bats, Tier 1 and 2 evaluations may identify other species of concern. Developers are encouraged to assess adverse impacts potentially caused by development for those species most likely to be negatively affected by such development. Impacts to other species are primarily derived from potential habitat loss or displacement. The general guidance on the study design and methods for estimation of the distribution, relative abundance, and habitat use for birds is applicable to the study of other wildlife. References regarding monitoring for other wildlife are available in Appendix C:

Sources of Information Pertaining to Methods to Assess Impacts to Wildlife. Nevertheless, most methods and metrics will be species-specific and developers are advised to work with the state, tribal, or federal agencies, or other credible experts, as appropriate, during problem formulation for Tier 3.

Tier 3 Decision Points

Developers and the Service should communicate prior to completing the Tier 3 decision process. A developer should inform the Service of the results of its studies and plans. The Service will provide written comments to a developer on study and project development plans that identify concerns and recommendations to resolve the concerns. The developer and, when applicable, the permitting authority will make a decision regarding whether and how to develop the project. The decision point at the end of Tier 3 involves three potential outcomes:



Little brown bat with white nose syndrome. Credit: Marvin Moriarty, USFWS

1. Development of the site has a low probability of significant adverse 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 Tier 4.

2. Development of the site has a moderate to high probability of significant adverse impacts without proper measures being taken to mitigate those impacts. This outcome may be subdivided into two possible scenarios:

   a. There is certainty regarding how to develop the site to adequately mitigate significant adverse impacts. The developer bases their decision to develop the site adopting proper mitigation measures and appropriate post-construction fatality and habitat studies (Tier 4).

   b. There is uncertainty regarding how to develop the site to adequately mitigate significant adverse impacts, or a permitting process requires additional information on potential significant adverse wildlife impacts before permitting future phases of the project. The developer bases their decision to develop the site adopting proper mitigation measures and appropriate post-construction fatality and habitat studies (Tier 4).

3. Development of the site has a high probability of significant impact that:

   a. Cannot be adequately mitigated.

   Site development should be delayed until plans can be developed that satisfactorily mitigate for the significant adverse impacts. Alternatively, the site should be abandoned in favor of known sites with less potential for environmental impact, or the developer begins an evaluation of other sites or landscapes for more acceptable sites to develop.

   b. Can be adequately mitigated.

   Developer should implement mitigation measures and proceed to Tier 4.

Chapter 5: Tier 4 – Post-construction Studies to Estimate Impacts

The outcome of studies in Tiers 1, 2, and 3 will determine the duration and level of effort of post-construction studies.

Tier 4 post-construction studies are designed to assess whether predictions of fatality risk and direct and indirect impacts to habitat of species of concern were correct. Fatality studies involve searching for bird and bat carcasses beneath turbines to estimate the number and species composition of fatalities (Tier 4a). Habitat studies involve application of GIS and use data collected in Tier 3 and Tier 4b and/or published information. Post-construction studies on direct and indirect impacts to habitat of species of concern, including species of habitat fragmentation concern need only be conducted if Tier 3 studies indicate the potential for significant adverse impacts.

Tier 4a – Fatality Studies

At this time, community- and utility-scale projects should conduct at least one year of fatality monitoring. The intensity of the studies should be related to risks of significant adverse impacts identified in pre-construction assessments. As data collected with consistent methods and metrics increases (see discussion below), it is possible that some future projects will not warrant fatality monitoring, but such a situation is rare with the present state of knowledge.

Fatality monitoring should occur over all seasons of occupancy for the species being monitored, based on information produced in previous tiers. The number of seasons and total length of the monitoring may be determined separately for bats and birds, depending on the pre-construction risk assessment, results of Tier 3 studies and Tier 4 monitoring from comparable sites (see Glossary in Appendix A) and the results of first year fatality monitoring. Guidance on the relationship between these variables and monitoring for fatalities is provided in Table 2.

A male Eastern red bat perches among green foliage. Credit: ©MerlinD.Tuttle,BatConservationInternational,www.batcon.org

It may be appropriate to conduct monitoring 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 monitoring should include estimates of carcass removal and carcass detection bias likely to influence those rates.

Tier 4a Questions

Post-construction fatality monitoring should be designed to answer the following questions as appropriate for the individual project:

1. **What are the bird and bat fatality rates for the project?**
2. **What are the fatality rates of species of concern?**
3. **How do the estimated fatality rates compare to the predicted fatality rates?**
4. **Do bird and bat fatalities vary within the project site in relation to site characteristics?**
5. **How do the fatality rates compare to the fatality rates from existing projects in similar landscapes with similar species composition and use?**
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 measures to reduce impacts?**

Tier 4a studies should be of sufficient statistical validity to address Tier 4a questions and enable determination of whether Tier 3 fatality predictions were correct. Fatality monitoring results also should allow comparisons with other sites, and provide a basis for determining if operational changes or other mitigation measures at the site are appropriate. The Service encourages project operators to discuss Tier 4 studies with local, state, federal, and tribal wildlife agencies. The number of years of monitoring is based on outcomes of Tier 3 and Tier 4 studies and analysis of comparable Tier 4 data from other projects as indicated in Table 2. The Service may recommend multiple years of monitoring for projects located near a listed species or bald or golden eagle, or other situations, as appropriate.

Tier 4a Protocol Design Considerations

The basic method of measuring fatality rates is the carcass search. Search protocols should be standardized to the greatest extent possible, especially for common objectives and species of concern, and they should include methods for adequately accounting for sampling biases (searcher efficiency and scavenger removal). However, some situations warrant exceptions to standardized protocol. The responsibility of demonstrating that an exception is appropriate and applicable should be on the project operator to justify increasing or decreasing the duration or intensity of operations monitoring.

Some general guidance is given below with regard to the following fatality monitoring protocol design issues:

- Duration and frequency of monitoring
- Number of turbines to monitor
- Delineation of carcass search plots, transects, and habitat mapping
- General search protocol
- Field bias and error assessment
- Estimators of fatality

More detailed descriptions and methods of fatality search protocols can be found in the California (California Energy Commission 2007) and Pennsylvania (Pennsylvania Game Commission 2007) state guidelines and in Kunz et al. (2007), Smallwood (2007), and Strickland et al. (2011).

Duration and frequency of monitoring

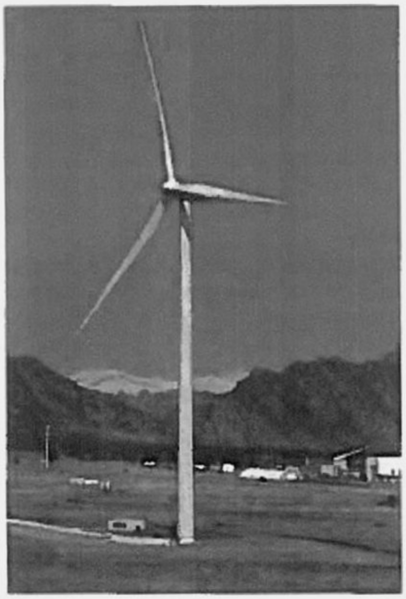
Frequency of carcass searches (search interval) may vary for birds and bats, and will vary depending on the questions to be answered, the species of concern, and their seasonal abundance at the project site. The carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make general conclusions about the project, and is not intended to provide highly precise measurements of fatalities. Except during low use times (e.g. winter months in northern states), the Service recommends that protocols be designed such that carcass searches occur at some turbines within the project area most days each week of the study.

The search interval is the interval between carcass searches at individual turbines, and this interval may be lengthened or shortened depending on the carcass removal rates. 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. However, if the focus is on fatalities of bats and small birds and carcass removal is high, then a shorter search interval will be necessary.

There are situations in which studies of higher intensity (e.g., daily searches at individual turbines within the sample) may be appropriate. These would be considered only in Tier 5 studies or in research programs because the greater complexity and level of effort goes beyond that recommended for typical Tier 4 post construction monitoring. Tier 5 and research studies could include evaluation of specific measures that have been implemented to mitigate potential significant adverse impacts to species of concern identified during pre-construction studies.

Number of turbines to monitor

If available, data on variability among turbines from existing



Wind turbine. Credit: NREL

projects in similar conditions within the same region are recommended as a basis for determining needed sample size (see Morrison et al., 2008). If data are not available, the Service recommends that an operator select a sufficient number of turbines via a systematic sample with a random start point. Sampling plans can be varied (e.g., rotating panels [McDonald 2003, Fuller 1999, Breidt and Fuller 1999, and Urquhart et al. 1998]) to increase efficiency as long as a probability sampling approach is used. If the project contains fewer than 10 turbines, the Service recommends that all turbines in the area of interest be searched unless otherwise agreed to by the permitting or wildlife resource agencies. When selecting turbines, the Service recommends 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 habitats (e.g., grass versus cropland or forest); a sufficient number of turbines should be sampled in each strata.

Delineation of carcass search plots, transects, and habitat mapping

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 width of 120 meters from the turbine should be established at sample turbines. Plots will need to be larger for birds, with a width twice the turbine height to ground. Decisions regarding search plot size should be made in discussions with the Service, state wildlife agency, permitting agency and Tribes. It may be useful to consult other scientifically credible information sources.

The Service recommends that each search plot should be divided into oblong subplots or belt transects and that each subplot be searched. The objective is to find as many carcasses as possible so the width of the belt will vary depending on the ground cover and its influence on carcass visibility. In most situations, a search width of 6 meters should be adequate, but this may vary from 3-10 meters depending on ground cover.

Searchable area within the theoretical maximum plot size varies, and heavily vegetated areas (e.g., eastern mountains) often do not allow surveys to consistently extend to the maximum plot width. In other cases it may be preferable to search a portion of the maximum plot instead of the entire plot. For example, in some landscapes it may be impractical to search the entire plot because of the time required to do an effective search, even if it is accessible (e.g., croplands), and data from a probability sample of subplots within the maximum plot size can provide a reasonable estimate of fatalities. It is important to accurately delineate and map the area searched for each turbine to adjust fatality estimates based on the actual area searched. It may be advisable to establish habitat visibility classes in each plot to account for differential detectability, and to develop visibility classes for different landscapes (e.g., rocks, vegetation) within each search plot. For example, the Pennsylvania Game Commission (2007) identified four classes based on the percentage of bare ground.

The use of visibility classes requires that detection and removal biases be estimated for each class. Fatality estimates should be made for each class and summed for the total area sampled. Global positioning systems (GPS) are useful for accurately mapping the actual total area searched and area searched in each habitat visibility class, 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 in each visibility class 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.

General search protocol

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. The Service will work with developers and operators to provide necessary permits for carcass possession. A complete search of the area should be accomplished and subplot size (e.g., transect width) should be adjusted to compensate for detectability differences in the search area. Subplots should be smaller when vegetation makes it difficult to detect carcasses; subplots can be wider in open terrain. Subplot width also can vary depending on the size of the species being looked for. For example, small species such as bats may require smaller subplots than larger species such as raptors.

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. 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., <1 day, 2 days). The recorded data will ultimately be housed in the FWS Office of Law Enforcement Bird Mortality Reporting System. A digital photograph of the carcass should be taken. Rubber gloves should be used to handle all carcasses to eliminate possible transmission of rabies or other 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. Unless otherwise conditioned by the carcass possession permit, fresh carcasses (those determined to have been killed the night immediately before a search) should be redistributed at random points on the same day for scavenging trials.

Field bias and error assessment

During searches conducted at wind turbines, actual fatalities are likely incompletely observed. Therefore carcass counts must be adjusted by some factor that accounts for imperfect detectability (Huso 2011). 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). The Service recommends 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 1999, Kunz et al. 2007, Arnett et al. 2007, NRC 2007, Strickland et al. 2011). Bias trials should be conducted throughout the entire study period and searchers should be unaware of which turbines are to be used or the number of carcasses placed beneath those turbines during trials. Carcasses or injured individuals may land or move outside the search plots (number 5 above). With respect to Tier 4a fatality estimates, this potential sampling error is considered to be small and can be assumed insignificant (Strickland et al. 2011).

Prior to a study's inception, a list of random turbine numbers and random azimuths and distances (in meters) from turbines should be generated for placement of each bat or bird used in bias trials. Data recorded for each trial carcass prior to placement should include date of placement, species, turbine number, distance and direction from turbine, and visibility class surrounding the carcass. Trial carcasses should be distributed as equally as possible among the different visibility classes throughout the study period and study area. 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. Before placement, each carcass must be uniquely marked in a manner that does not cause additional attraction, and its location should be recorded. There is no agreed upon sample size for bias trials, though some state guidelines recommend from 50 - 200 carcasses (e.g., PGC 2007).

Estimators of fatality

If there were a direct relationship between the number of carcasses observed and the number killed, there would be no need to develop a complex estimator that adjusts observed counts for detectability, and observed counts could be used as a simple index of fatality (Huso 2011). But the relationship is not direct and raw carcass counts recorded using different search intervals and under different carcass removal rates and searcher efficiency rates are not directly comparable. It is 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 (Erickson et al. 2000b, Erickson et al. 2004, Johnson et al. 2003, Kerns and Kerlinger 2004, Fiedler et al. 2007, Kronner et al. 2007, Smallwood 2007, Huso 2011, Strickland et al. 2011).

Tier 4a Study Objectives

In addition to the monitoring protocol design considerations described above, the metrics used to estimate fatality rates must be selected with the Tier 4a questions and objectives in mind. Metrics considerations for each of the Tier 4a questions are discussed briefly below. Not all questions will be relevant for each project, and which questions apply would depend on Tier 3 outcomes.

1. What are the bird and bat fatality rates 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. However, this metric 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, the Service recommends that fatality rates be expressed on a per-turbine and per-nameplate MW basis until a better metric becomes available.

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 several ways that predictions can be evaluated with actual fatality data. During the planning stages in Tier 2, 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 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, physical 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.

The most current equations for estimating fatality should be used to evaluate fatality predictions. Several statistical methods can be found in the revised Strickland et al. 2011 and used to evaluate fatality predictions. Metrics derived from Tier 3 pre-construction assessments may be correlated with fatality rates, and (using the project as the experimental unit), in Tier 5 studies it should be possible to determine if different preconstruction metrics can in fact accurately predict fatalities and, thus, risk.

4. Do bird and bat fatalities vary within the project site in relation to site characteristics?

Data from pre-construction studies can demonstrate patterns of activity that may depend upon the site characteristics. Turbines placed near escarpments or cliffs may intrude upon airspace used by raptors soaring on thermals. Pre-construction and post construction studies and assessments can be used to avoid siting individual, specific turbines within an area used by species of concern. 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.

5. 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 can be useful to determine patterns and broader landscape relationships. Developers should communicate with the Service to ensure that such comparisons are appropriate to avoid false conclusions. Fatality rates should be expressed on a per nameplate MW or some other standardized metric basis for comparison with other projects,

Big brown bat. Credit: USFWS

and may be correlated with site characteristics – such as proximity to wetlands, riparian corridors, mountain-foothill interface, wind patterns, 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.

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, prairie horned lark) 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] In situations where a project operator was not the developer, the Service expects that obligations of the developer for adhering to the Guidelines transfer with the project.

Table 2. Decision Framework for Tier 4a Fatality Monitoring of Species of Concern.[8]

Probability of Significant Adverse Impacts in Tier 3	*Recommended Fatality Monitoring Duration and Effort*	*Possible Outcomes of Monitoring Results*
Tier 3 Studies indicate LOW probability of significant adverse impacts	Duration: At least one year of fatality monitoring to estimate fatalities of birds and bats. Field assessments should be sufficient to confirm that risk to birds and/or bats is indeed "low."	1. Documented fatalities are approximately equal to or lower than predicted risk. No further fatality monitoring or mitigation is needed. 2. Fatalities are greater than predicted, but are not likely to be significant (i.e., unlikely to affect the long-term status of the population). If comparable fatality data at similar sites also supports that impacts are not likely to be high enough to affect population status, no further monitoring or mitigation is needed. If no comparable fatality data are available or such data indicates high risk, one additional year of fatality monitoring is recommended. If two years of fatality monitoring indicate levels of impacts that are not significant, no further fatality monitoring or mitigation is recommended. 3. Fatalities are greater than predicted and are likely to be significant OR federally endangered or threatened species or BGEPA species are affected. Communication with the Service is recommended. Further efforts to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.
Tier 3 studies indicate MODERATE probability of significant adverse impacts	Duration: Two or more years of fatality monitoring may be necessary. Field assessments should be sufficient to confirm that risk to birds and/or bats is indeed "moderate." Closely compare estimated effects to species to those determined from the risk assessment protocol(s).	1. Documented fatalities after the first two years are lower or not different than predicted and are not significant and no federally endangered species or BGEPA species are affected - no further fatality monitoring or mitigation is needed. 2. Fatalities are greater than predicted and are likely to be significant OR federally endangered or threatened species or BGEPA species are affected, communication with the Service is recommended. Further efforts to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.
Tier 3 studies indicate HIGH probability of significant adverse impacts	Duration: Two or more years of fatality monitoring may be necessary to document fatality patterns. If fatality is high, developers should shift emphasis to exploring opportunities for mitigation rather than continuing to monitor fatalities. If fatalities are variable, additional years are likely warranted.	1. Documented fatalities during each year of fatality monitoring are less than predicted and are not likely to be significant, and no federally endangered or threatened species or BGEPA species are affected – no further fatality monitoring or mitigation is needed. 2. Fatalities are equal to or greater than predicted and are likely to be significant - further efforts to reduce impacts are necessary; communication with the Service are recommended. Further efforts, such as Tier 5 studies, to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.

[8] Ensure that survey protocols, and searcher efficiency and scavenger removal bias correction factors are the most reliable, robust, and up to date (after Huso 2009).

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

The Service recommends that the wind project operator[7] and the relevant agencies discuss the results from Tier 4 studies to determine whether these impacts are significant. If fatalities are considered significant, the wind project operator and the relevant agencies should develop a plan to mitigate the impacts.

Tier 4b – Assessing direct and indirect impacts of habitat loss, degradation, and fragmentation

The objective of Tier 4b studies is to evaluate Tier 3 predictions of direct and indirect impacts to habitat and the potential for significant adverse impacts on species of concern as a result of these impacts. Tier 4b studies should be conducted if Tier 3 studies indicate the presence of species of habitat fragmentation concern, or if Tier 3 studies indicate significant direct and indirect adverse impacts to species of concern (see discussion below). Tier 4b studies should also inform project operators and the Service as to whether additional mitigation is necessary.

Tier 4b studies should evaluate the following questions:

1. **How do post-construction habitat quality and spatial configuration of the study area compare to predictions for species of concern identified in Tier 3 studies?**
2. **Were any behavioral modifications or indirect impacts noted in regard to species of concern?**
3. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**
4. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**

The answers to these questions will be based on information estimating habitat loss, degradation, and fragmentation information collected in Tier 3, currently available demographic and genetic data, and studies initiated in Tier 3. As in the case of Tier 4a, the answers to these questions will determine the need to conduct Tier 5 studies. For example, in the case that significant adverse impacts to species of concern were predicted, but mitigation was not successful, then additional mitigation and Tier 5 studies may be necessary. See Table 3 for further guidance.

1. **How do post-construction habitat quality and spatial configuration of the study area compare to predictions for species of concern identified in Tier 3 studies?**

GIS and demographic data collected in Tier 3 and/or published information can be used to determine predictions of impacts to species of concern from habitat loss, degradation, and fragmentation. The developer can provide development assumptions based on Tier 3 information that can be compared to post-construction information. Additional post-construction studies on impacts to species of concern due to direct and indirect impacts to habitat should only be conducted if Tier 3 studies indicate the potential for significant adverse impacts.

2. **Were any behavioral modifications or indirect impacts noted in regard to affected species?**

Evaluation of this question is based on the analysis of observed use of the area by species of concern prior to construction in comparison with observed use during operation. Observations and demographic data collected during Tier 3, and assessment of published information about the potential for displacement and demographic responses to habit impacts could be the basis for this analysis. If this analysis suggests that direct and/or indirect loss of habitat for a species of concern leads to behavioral modifications or displacement that are significant, further studies of these impacts in Tier 5 may be appropriate.

3. **If significant adverse impacts were not predicted in Tier 3 because of loss, degradation, or fragmentation of habitat, but Tier 4b studies indicate such impacts have the potential to occur, can these impacts be mitigated?**

When Tier 4b studies indicate significant impacts may be occurring, the developer may need to conduct an assessment of these impacts and what opportunities exist for additional mitigation.

4. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**

When Tier 4b studies indicate significant impacts may be occurring, the developer may need to conduct an assessment of these impacts and what opportunities exist for additional mitigation. Evaluation of the effectiveness of mitigation is a Tier 4 study and should follow design considerations discussed in Tier 5 and from guidance in the scientific literature (e.g. Strickland et al. 2011).

When Tier 3 studies identified potential moderate or high risks to species of concern that caused a developer to incorporate mitigation measures into the project, Tier 4b studies should evaluate the effectiveness of those mitigation measures. Determining such effectiveness is important for the project being evaluated to ascertain whether additional mitigation measures are appropriate as well as informing future decisions about how to improve mitigation at wind energy facilities being developed.

Tier 4b Protocol Design Considerations

Impacts to a species of concern resulting from the direct and indirect loss of habitat are important and must be considered when a wind project is being considered for development. Some species of concern are likely to occur at every proposed wind energy facility. This occurrence may range from a breeding population, to seasonal occupancy, such as a brief occurrence while migrating through the area. Consequently the level of concern regarding impacts due to direct and indirect loss of habitat will vary depending on the species and the impacts that occur.

If a breeding population of a species of habitat fragmentation concern occurs in the project area and Tier 3 studies indicate that fragmentation of their habitat is possible, these predictions should be evaluated following the guidance indicated in Table 3 using the protocols described in Tier 3. If the analysis of post-construction GIS data on direct and indirect habitat loss suggests that fragmentation is likely, then additional displacement studies and mitigation may be necessary. These studies would typically begin immediately and would be considered Tier 5 studies using design considerations illustrated by examples in Tier 5 below and from guidance in the scientific literature (e.g. Strickland et al. 2011).

Significant direct or indirect loss of habitat for a species of concern may occur without habitat fragmentation if project impacts result in the reduction of a habitat resource that potentially is limiting to the affected population. Impacts of this type include loss of use of breeding habitat or loss of a significant portion of the habitat of a federally or state protected species. This would be evaluated by determining the amount of the resource that is lost and determining if this loss would potentially result in significant impacts to the affected population. Evaluation of potential significant

Black-capped Vireo. Credit: Greg W. Lasley

impacts would occur in Tier 5 studies that measure the demographic response of the affected population.

The intention of the Guidelines is to focus industry and agency resources on the direct and indirect loss of habitat and limiting resources that potentially reduce the viability of a species of concern. Not all direct and indirect loss of a species' habitat will affect limiting resources for that species, and when habitat losses are minor or non-existent no further study is necessary.

Tier 4b Decision Points

The developer should use the results of the Tier 4b studies to evaluate whether further studies and/or mitigation are needed. The developer should communicate the results of these studies, and decisions about further studies and mitigation, with the Service. Table 3 provides a framework for evaluating the need for further studies and mitigation. Level of effort for studies should be sufficient to answer all questions of interest. Refer to the relevant methods sections for Tier 2 Question 5 and Tier 3 Question 2 in the text for specific guidance on study protocols.

Table 3. Decision Framework to Guide Studies for Minimizing Impacts to Habitat and Species of Habitat Fragmentation (HF) Concern.

Outcomes of Tier 2	*Outcomes of Tier 3*	*Outcomes of Tier 4b*	*Suggested Study/Mitigation*
• No species of HF concern potentially present	• No further studies needed	• n/a	• n/a
• Species of HF concern potentially present	• No species of HF concern confirmed to be present	• No further studies needed	• n/a
	• Species of HF concern demonstrated to be present, but no significant adverse impacts predicted	• Tier 4b studies confirm Tier 3 predictions	• No further studies or mitigation needed
		• Tier 4b studies indicate potentially significant adverse impacts	• Tier 5 studies and mitigation may be needed
• Species of HF concern potentially present	• Species of HF concern demonstrated to be present; significant adverse impacts predicted	• Tier 4b studies determine mitigation plan is effective; no significant adverse impacts demonstrated	• No further studies or mitigation needed
	• Mitigation plan developed and implemented	• Tier 4b studies determine mitigation plan is NOT effective; potentially significant adverse impacts	• Further mitigation and, where appropriate, Tier 5 studies

Chapter 6: Tier 5 – Other Post-construction Studies

Tier 5 studies will not be necessary for most wind energy projects. Tier 5 studies can be complex and time consuming. The Service anticipates that the tiered approach will steer projects away from sites where Tier 5 studies would be necessary.

When Tier 5 studies are conducted, they should be site-specific and intended to: 1) analyze factors associated with impacts in those cases in which Tier 4 analyses indicate they are potentially significant; 2) identify why mitigation measures implemented for a project were not adequate; and 3) assess demographic effects on local populations of species of concern when demographic information is important, including species of habitat fragmentation concern.

Tier 5 Questions

Tier 5 studies are intended to answer questions that fall in three major categories; answering yes to any of these questions might indicate a Tier 5 study is needed:

1. **To the extent that the observed fatalities exceed anticipated fatalities, are those fatalities potentially having a significant adverse impact on local populations? Are observed direct and indirect impacts to habitat having a significant adverse impact on local populations?**

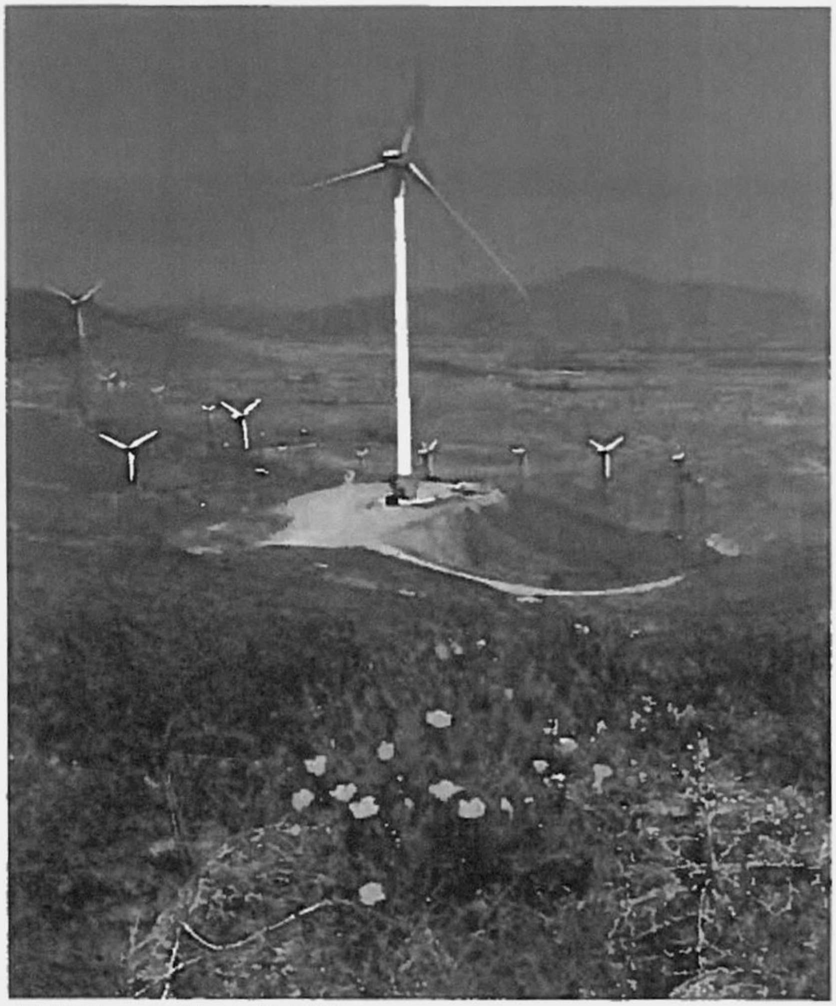
For example, in the Tier 3 risk assessment, predictions of collision fatalities and habitat impacts (direct and indirect) are developed. Post-construction studies in Tier 4 evaluate the accuracy of those predictions by estimating impacts. If post-construction studies demonstrate potentially significant adverse impacts, Tier 5 studies may also be warranted and should be designed to understand observed versus predicted impacts.

2. **Were mitigation measures implemented (other than fee in lieu) not effective? This includes habitat mitigation measures as well as measures undertaken to reduce collision fatalities.**

Tier 4a and b studies can assess the effectiveness of measures taken to reduce direct and indirect impacts as part of the project and to identify such alternative or additional measures as are necessary. If alternative or additional measures were unsuccessful, the reasons why would be evaluated using Tier 5 studies.

3. **Are the estimated impacts of the proposed project likely to lead to population declines in the species of concern (other than federally-listed species)?**

Impacts of a project will have population level effects if the project causes a population decline in the species of concern. For non-listed species, this assessment will apply only to the local population.



Wind turbines and habitat. Credit: NREL

Tier 5 studies may need to be conducted when:

- Realized fatality levels for individual species of concern reach a level at which they are considered significant adverse impacts by the relevant agencies.

  For example, if Tier 4a fatality studies document that a particular turbine or set of turbines exhibits bird or bat collision fatality higher than predicted, Tier 5 studies may be useful in evaluating alternative mitigation measures at that turbine/turbine string.

- There is the potential for significant fatality impacts or significant adverse impacts to habitat for species of concern, there is a need to assess the impacts more closely, and there is uncertainty over how these impacts will be mitigated.

- Fatality and/or significant adverse habitat impacts suggest the potential for a reduction in the viability of an affected population, in which case studies on the potential for population impacts may be warranted.

- A developer evaluates the effectiveness of a risk reduction measure before deciding to continue the measure permanently or whether to use the measure when implementing future phases of a project.

  In the event additional turbines are proposed as an expansion of an existing project, results from Tier 4 and Tier 5 studies and the decision-making framework contained in the tiered approach can be used to determine whether the project should be expanded and whether additional information should be collected. It may also be necessary to evaluate whether additional measures are warranted to reduce significant adverse impacts to species.

Tier 5 Study Design Considerations

As discussed in Chapter 4 Tier 3, Tier 5 studies will be highly variable and unique to the circumstances of the individual project, and therefore these Guidelines do not provide specific guidance on all potential approaches, but make some general statements about study design. Specific Tier 5 study designs will depend on the types of questions, the specific project, and practical considerations. The most common practical considerations include the area being studied, the time period of interest, the species of concern, potentially confounding variables, time available to conduct studies, project budget, and the magnitude of the anticipated impacts. When possible it is usually desirable to collect data before construction to address Tier 5 questions. Design considerations for these studies are including in Tier 3.

One study design is based on an experimental approach to evaluating mitigation measures, where the project proponent will generally select several alternative management approaches to design, implement, and test. The alternatives are generally incorporated into sound experimental designs. Monitoring and evaluation of each alternative helps the developer to decide which alternative is more effective in meeting objectives, and informs adjustments to the next round of management decisions. The need for this type of study design can be best determined by communication between the project operator, the Service field office, and the state wildlife agency, on a project-by-project basis. This study design requires developers and operators to identify strategies to adjust management and/or mitigation measures if monitoring indicates that anticipated impacts are being exceeded. Such strategies should include a timeline for periodic reviews and adjustments as well as a mechanism to consider and implement additional mitigation measures as necessary after the project is developed.

When pre-construction data are unavailable and/or a suitable reference area is lacking, the reference Control Impact Design (Morrison et al. 2008) is the recommended design. The lack of a suitable reference area also can be addressed using the Impact Gradient Design, when habitat and species use are homogenous in the assessment area prior to development. When applied both pre- and post-construction, the Impact Gradient Design is a suitable replacement for the classic BACI (Morrison et al. 2008).

In the study of habitat impacts, the resource selection function (RSF) study design (see Anderson et al 1999; Morrison et al. 2008; Manly et al. 2002) is a statistically robust design, either with or without pre-construction and reference data. Habitat selection is modeled as a function of characteristics measured on resource units and the use of those units by the animals of interest. The RSF allows the estimation of the probability of use as a function of the distance to various environmental features, including wind energy facilities, and thus provides a direct quantification of the magnitude of the displacement effect. RSF could be improved with pre-construction and reference area data. Nevertheless, it is a relatively powerful approach to documenting displacement or the effect of mitigation measures designed to reduce displacement even without those additional data.

Tier 5 Examples

As described earlier, Tier 5 studies will not be conducted at most projects, and the specific Tier 5 questions and methods for addressing these questions will depend on the individual project and the concerns raised during pre-construction studies and during operational phases. Rather than provide specific guidance on all potential approaches, these Guidelines offer the following case studies as examples of studies that have attempted to answer Tier 5 questions.

<u>Habitat impacts - displacement and demographic impact studies</u>

Rows of wind turbines. Credit: Joshua Winchell, USFWS

Studies to assess impacts may include quantifying species' habitat loss (e.g., acres of lost grassland habitat for grassland songbirds) and habitat modification. For example, an increase in edge may result in greater nest parasitism and nest predation. Assessing indirect impacts may include two important components: 1) indirect effects on wildlife resulting from displacement, due to disturbance, habitat fragmentation, loss, and alteration; and 2) demographic effects that may occur at the local, regional or population-wide levels due to reduced nesting and breeding densities, increased isolation between habitat patches, and effects on behavior (e.g., stress, interruption, and modification). These factors can individually or cumulatively affect wildlife, although some species may be able to habituate to some or perhaps all habitat changes. Indirect impacts may be difficult to quantify but their effects may be significant (e.g., Stewart et al. 2007, Pearce-Higgins et al. 2008, Bright et al. 2008, Drewitt and Langston 2006, Robel et al. 2004, Pruett et al. 2009).

Example: in southwestern Pennsylvania, development of a project is proceeding at a site located within the range of a state-listed terrestrial species. Surveys were performed at habitat locations appropriate for use by the animal, including at control sites. Post-construction studies are planned at all locations to demonstrate any displacement effects resulting from the construction and operation of the project.

The Service recognizes that indirect impact studies may not be appropriate for most individual projects. Consideration should be given to developing collaborative research efforts with industry, government agencies, and NGOs to conduct studies to address indirect impacts.

Indirect impacts are considered potentially significant adverse threats to species such as prairie grouse (prairie chickens, sharp-tailed grouse), and sage grouse, and demographic studies may be necessary to determine the extent of these impacts and the need for mitigation.

Displacement studies may use any of the study designs describe earlier. The most scientifically robust study designs to estimate displacement effects are BACI, RSF, and impact gradient. RSF and impact gradient designs may not require specialized data gathering during Tier 3.

Telemetry studies that measure impacts of the project development on displacement, nesting, nest success, and survival of prairie grouse and sage grouse in different environments (e.g., tall grass, mixed grass, sandsage, sagebrush) will require spatial and temporal replication, undisturbed reference sites, and large sample sizes covering large areas. Examples of study designs and analyses used in the studies of other forms of energy development are presented in Holloran et al. (2005), Pitman et al. (2005), Robel et al. (2004), and Hagen et al. (2011). Anderson et al. (1999) provides a thorough discussion of the design, implementation, and analysis of these kinds of field studies and should be consulted when designing the BACI study.

Studies are being initiated to evaluate effects of wind energy development on greater sage grouse in Wyoming. In addition to measuring demographic patterns, these studies will use the RSF study design (see Sawyer et al. 2006) to estimate the probability of sage grouse use as a function of the distance to environmental features, including an existing and a proposed project.

In certain situations, such as for a proposed project site that is relatively small and in a more or less homogeneous landscape, an impact gradient design may be an appropriate means to assess avoidance of the wind energy facility by resident populations (Strickland et al., 2002). For example, Leddy et al. 1999 used the impact gradient design to evaluate grassland bird density as a function of the distance from wind turbines. Data were collected at various distances from turbines along transects.

This approach provides information on whether there is an effect, and may allow quantification of the gradient of the effect and the distance at which the displacement effect no longer exists – the assumption being that the data collected at distances beyond the influence of turbines are the reference data (Erickson et al., 2007). An impact gradient analysis could also involve measuring the number of breeding grassland birds counted at point count plots as a function of distance from the wind turbines (Johnson et al. 2000).

Sound and Wildlife

Turbine blades at normal operating speeds can generate levels of sound beyond ambient background levels. Construction and maintenance activities can also contribute to sound levels by affecting communication distance, an animal's ability to detect calls or danger, or to forage. Sound associated with developments can also cause behavioral and/or physiological effects, damage to hearing from acoustic over-exposure, and masking of communication signals and other biologically relevant sounds (Dooling and Popper 2007). Some birds are able to shift their vocalizations to reduce the masking effects of noise. However, when shifts don't occur or are insignificant, masking may prove detrimental to the health and survival of wildlife (Barber et al. 2010). Data suggest noise increases of 3 dB to 10 dB correspond to 30 percent to 90 percent reductions in alerting distances for wildlife, respectively (Barber et al. 2010).

The National Park Service has been investigating potential impacts to wildlife due to alterations in sound level and type. However, further research is needed to better understand this potential impact. Research may include: how wind facilities affect background sound levels; whether masking, disturbance, and acoustical fragmentation occur; and how turbine, construction, and maintenance sound levels can vary by topographic area.

Levels of fatality beyond those predicted

More intensive post-construction fatality studies may be used to determine relationships between fatalities and weather, wind speed or other covariates, which usually require daily carcass searches. Fatalities determined to have occurred the previous night can be correlated with that night's weather or turbine characteristics to establish important relationships that can then be used to evaluate the most effective times and conditions to implement measures to reduce collision fatality at the project.

Measures to address fatalities

The efficacy of operational changes (e.g. changing turbine cut-in speed) of a project to reduce collision fatalities has only recently been evaluated (Arnett et al. 2009, Baerwald et al 2009). Operational changes to address fatalities should be applied only at sites where collision fatalities are predicted or demonstrated to have significant adverse impacts.

Tier 5 Studies and Research

The Service makes a distinction between Tier 5 studies focused on project-specific impacts and research (which is discussed earlier in the Guidelines). For example, developers may be encouraged to participate in collaborative studies (see earlier discussion of Research) or asked to conduct a study on an experimental mitigation technique, such as differences in turbine cut-in speed to reduce bat fatalities. Such techniques may show promise in mitigating the impacts of wind energy development to wildlife, but their broad applicability for mitigation purposes has not been demonstrated. Such techniques should not be routinely applied to projects, but application at appropriate sites will contribute to the breadth of knowledge regarding the efficacy of such measures in addressing collision fatalities. In addition, studies involving multiple sites and academic researchers can provide more robust research results, and such studies take more time and resources than are appropriately carried out by one developer at a single site. Examples below demonstrate collaborative research efforts to address displacement, operational changes, and population level impacts.

Studies of Indirect Effects

The Service provides two examples below of ongoing studies to assess the effects of indirect impacts related to wind energy facilities.

Kansas State University, as part of the NWCC Grassland Shrub-steppe Species Collaborative, is undertaking a multi-year research project to assess the effects of wind energy facilities on populations of greater prairie-chickens (GPCH) in Kansas. Initially the research was based on a Before/After Control/Impact (BACI) experimental design involving three replicated study sites in the Flint Hills and Smoky Hills of eastern Kansas. Each study site consisted of an impact area where a wind energy facility was proposed to be developed and a nearby reference area with similar rangeland characteristics where no development was planned. The research project is a coordinated field/laboratory effort, i.e., collecting telemetry and observational data from adult and juvenile GPCH in the field, and determining population genetic attributes of GPCH in the laboratory from blood samples of birds and the impact and reference areas. Detailed data on GPCH movements, demography, and population genetics were gathered from all three sites from 2007 to 2010. By late 2008, only one of the proposed wind energy facilities was developed (the Meridian Way Wind Farm in the Smoky Hills of Cloud County), and on-going research efforts are focused on that site. The revised BACI study design now will produce two years of pre-construction data (2007 and 2008), and three years of post-construction data (2009, 2010, and 2011) from a single wind energy facility site (impact area) and its reference area. Several hypotheses were formulated for testing to determine if wind energy facilities impacted GPCH populations, including but not limited to addressing issues relating to: lek attendance, avoidance of turbines and associated features, nest success and chick survival, habitat usage, adult mortality and survival, breeding behavior, and natal dispersal. A myriad of additional significant avenues are being pursued as a result of the rich database that has been developed for the GPCH during this research effort. GPCH reproductive data will be collected through the summer of 2011 whereas collection of data from transmitter-equipped GPCH will extend through the lekking season of 2012 to allow estimates of survival of GPCH over the 2011-2012 winter. At the conclusion of the study, the two years of pre-construction data and three years of post-construction data will be analyzed and submitted to peer-reviewed journals for publication.

Erickson et al. (2004) evaluated the displacement effect of a large wind energy facility in the Pacific Northwest. The study was conducted in a relatively homogeneous grassland landscape. Erickson et al. (2004) conducted surveys of breeding grassland birds along 300 meter transects perpendicular to strings of wind turbines. Surveys were conducted prior to construction and after commercial operation. The basic study design follows the Impact Gradient Design (Morrison et al. 2008) and in this application, conformed to a special case of BACI where areas at the distal end of each transect were considered controls (i.e., beyond the influence of the turbines). In this study, there is no attempt to census birds in the area, and observations per survey are used as an index of abundance. Additionally, the impact-gradient study design resulted in less effort than a BACI design with offsite control areas. Erickson et al. (2004) found that grassland passerines as a group, as well as grasshopper sparrows and western meadowlarks, showed reduced use in the first 50 meter segment nearest the turbine string. About half of the area within that segment, however, had disturbed vegetation and separation of behavior avoidance from physical loss of habitat in this portion of the area was impossible. Horned larks and savannah sparrows appeared unaffected. The impact gradient design is best used when the study area is relatively small and homogeneous.

Operational Changes to Reduce Collision Fatality

Arnett et al. (2009) conducted studies on the effectiveness of changing turbine cut-in speed on reducing bat fatality at wind turbines at the Casselman Wind Project in Somerset County, Pennsylvania. Their objectives were to: 1) determine the difference in bat fatalities at turbines with different cut-in-speeds relative to fully operational turbines; and 2) determine the economic costs of the experiment and estimated costs for the entire area of interest under different curtailment prescriptions and timeframes. Arnett et al. (2009) reported substantial reductions in bat fatalities with relatively modest power losses.

In Kenedy County, Texas, investigators are refining and testing a real-time curtailment protocol. The projects use an avian profiling radar system to detect approaching "flying vertebrates" (birds and bats), primarily during spring and fall bird and bat migrations. The blades automatically idle when risk reaches a certain level and weather conditions are particularly risky. Based on estimates of the number and timing of migrating raptors, feathering (real-time curtailment) experiments are underway in Tehuantepec, Mexico, where raptor migration through a mountain pass is extensive.

Other tools, such as thermal imaging (Horn et al. 2008) or acoustic detectors (Kunz et al. 2007), have been used to quantify post-construction bat activity in relation to weather and turbine characteristics for improving operational change efforts. For example, at the Mountaineer project in 2003, Tier 4 studies (weekly searches at every turbine) demonstrated unanticipated and high levels of bat fatalities (Kerns and Kerlinger 2004). Daily searches were instituted in 2004 and revealed that fatalities were strongly associated with low-average-wind-speed nights, thus providing a basis for testing operational changes (Arnett 2005, Arnett et al. 2008). The program also included behavioral observations using thermal imaging that demonstrated higher bat activity at lower wind speeds (Horn et al. 2008).

Studies are currently underway to design and test the efficacy of an acoustic deterrent device to reduce bat fatalities at wind facilities (E.B. Arnett, Bat Conservation International, under the auspices of BWEC). Prototypes of the device have been tested in the laboratory and in the field with some success. Spanjer (2006) tested the response of big brown bats to a prototype eight speaker deterrent emitting broadband white noise at frequencies from 12.5–112.5 kHz and found that during non-feeding trials, bats landed in the quadrant containing the device significantly less when it was broadcasting broadband noise. Spanjer (2006) also reported that during feeding trials, bats never successfully took a tethered mealworm when the device broadcast sound, but captured mealworms near the device in about 1/3 of trials when it was silent. Szewczak and Arnett (2006, 2007) tested the same acoustic deterrent in the field and found that when placed by the edge of a small pond where nightly bat activity was consistent, activity dropped significantly on nights when the deterrent was activated. Horn et al. (2007) tested the effectiveness of a larger, more powerful version of this deterrent device on reducing nightly bat activity and found mixed results. In 2009, a new prototype device was developed and tested at a project in Pennsylvania. Ten turbines were fitted with deterrent devices, daily fatality searches were conducted, and fatality estimates were compared with those from 15 turbines without deterrents (i.e., controls) to determine if bat fatalities were reduced. This experiment found that estimated bat fatalities per turbine were 20 to 53 percent lower at treatment turbines compared to controls.

More experimentation is required. At the present time, there is not an operational deterrent available that has demonstrated effective reductions in bat kills (E. B. Arnett, Bat Conservation International, unpublished data).

Assessment of Population-level Impacts

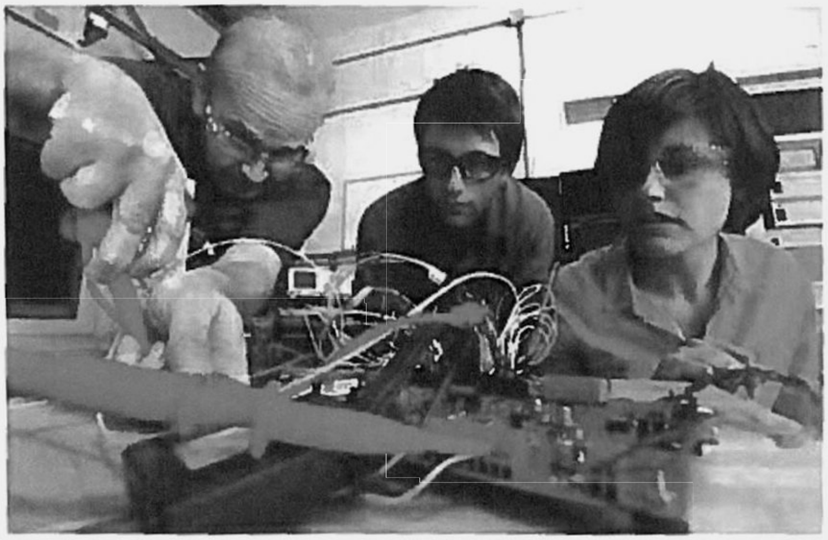
The Altamont Pass Wind Resource Area (APWRA) has been the subject of intensive scrutiny because of avian fatalities, especially for raptors, in an area encompassing more than 5,000 wind turbines (e.g., Orloff and Flannery 1992; Smallwood and Thelander 2004, 2005). Field studies on golden eagles, a long-lived raptor species, have been completed using radio telemetry at APWRA to understand population demographics, assess impacts from wind turbines, and explore measures to effectively reduce the incidence of golden eagle mortality for this area. (Hunt et al. 1999, and Hunt 2002). Results from nesting surveys (Hunt 2002) indicated that there was no decline in eagle territory occupancy. However Hunt (2002) also found that subadult and floater components of golden eagle populations at APWRA are highly vulnerable to wind turbine mortality and results from this study indicate that turbine mortality prevented the maintenance of substantial reserves of nonbreeding adults characteristic of healthy populations elsewhere, suggesting the possibility of an eventual decline in the breeding population (Hunt and Hunt 2006). Hunt conducted follow-up surveys in 2005 (Hunt and Hunt 2006) and determined that all 58 territories occupied by eagle pairs in 2000 were occupied in 2005. It should be noted however that golden eagle studies at APWRA (Hunt et al. 1999, Hunt 2002, and Hunt and Hunt 2006) were all conducted after the APWRA was constructed and the species does not nest within the footprint of the APWRA itself (Figure 4; Hunt and Hunt 2006). The APWRA is an area of about 160 sq. km (Hunt 2002) and presumably golden eagles formerly nested within this area. The loss of breeding eagle pairs from the APWRA suggests these birds have all been displaced by the project, or lost due to various types of mortality including collisions with turbine blades.

Golden eagle. Credit: George Gentry, USFWS

Chapter 7: Best Management Practices

Site Construction and Operation

During site planning and development, careful attention to reducing risk of adverse impacts to species of concern from wind energy projects, through careful site selection and facility design, is recommended. The following BMPs can assist a developer in the planning process to reduce potential impacts to species of concern. Use of these BMPs should ensure that the potentially adverse impacts to most species of concern and their habitats present at many project sites would be reduced, although compensatory mitigation may be appropriate at a project level to address significant site-specific concerns and pre-construction study results.



Wind electronic developers. Credit: NREL

These BMPs will evolve over time as additional experience, learning, monitoring and research becomes available on how to best minimize wildlife and habitat impacts from wind energy projects. Service should work with the industry, stakeholders and states to evaluate, revise and update these BMPs on a periodic basis, and the Service should maintain a readily available publication of recommended, generally accepted best practices.

1. Minimize, to the extent practicable, the area disturbed by pre-construction site monitoring and testing activities and installations.
2. Avoid locating wind energy facilities in areas identified as having a demonstrated and unmitigatable high risk to birds and bats.
3. Use available data from state and federal agencies, and other sources (which could include maps or databases), that show the location of sensitive resources and the results of Tier 2 and/or 3 studies to establish the layout of roads, power lines, fences, and other infrastructure.
4. Minimize, to the maximum extent practicable, roads, power lines, fences, and other infrastructure associated with a wind development project. When fencing is necessary, construction should use wildlife compatible design standards.
5. Use native species when seeding or planting during restoration. Consult with appropriate state and federal agencies regarding native species to use for restoration.
6. 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:
   a. Overhead lines may be acceptable if sited away from high bird crossing locations, to the extent practicable, such as between roosting and feeding areas or between lakes, rivers, prairie grouse and sage grouse leks, and nesting habitats. To the extent practicable, the lines should be marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines.
   b. 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.
   c. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."
7. Avoid guyed communication towers 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.

8. Where permanent meteorological towers must be maintained on a project site, use the minimum number necessary.

9. Use construction and management practices to minimize activities that may attract prey and predators to the wind energy facility.

10. Employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights, 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.

11. Keep lighting at both operation and maintenance facilities and substations located within half a mile of the turbines to the minimum required:

    a. Use lights with motion or heat sensors and switches to keep lights off when not required.

    b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

    c. Minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

    d. All internal turbine nacelle and tower lighting should be extinguished when unoccupied.

12. Establish non-disturbance buffer zones to protect sensitive habitats or areas of high risk for species of concern identified in pre-construction studies. Determine the extent of the buffer zone in consultation with the Service and state, local and tribal wildlife biologists, and land management agencies (e.g., U.S. Bureau of Land Management (BLM) and U.S. Forest Service (USFS)), or other credible experts as appropriate.

13. Locate turbines 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 species.

14. Avoid impacts to hydrology and stream morphology, especially where federal or state-listed aquatic or riparian species may be involved. Use appropriate erosion control measures in construction and operation to eliminate or minimize runoff into water bodies.

15. When practical use tubular towers or best available technology to reduce ability of birds to perch and to reduce risk of collision.

16. After project construction, close roads not needed for site operations and restore these roadbeds to native vegetation, consistent with landowner agreements.

17. Minimize the number and length of access roads; use existing roads when feasible.

18. 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 and avoid delivery of road-generated sediment into streams and waters.

19. 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.

20. Instruct employees, contractors, and site visitors to avoid harassing or disturbing wildlife, particularly during reproductive seasons.

21. 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.). Site development and operation plans should specifically address the risk of wildfire and provide appropriate cautions and measures to be taken in the event of a wildfire.

22. Follow federal and state measures for handling toxic substances to minimize danger to water and wildlife resources from spills. Facility operators should maintain Hazardous Materials Spill Kits on site and train personnel in the use of these.

23. Reduce the introduction and spread of invasive species by following applicable local policies for invasive species prevention, containment, and control, such as cleaning vehicles and equipment arriving from areas with known invasive species issues, using locally sourced topsoil, and monitoring for and rapidly removing invasive species at least annually.

24. Use invasive species prevention and control measures as specified by county or state requirements, or by applicable federal agency requirements (such as Integrated Pest Management) when federal policies apply.

25. Properly manage garbage and waste disposal on project sites to avoid creating attractive nuisances for wildlife by providing them with supplemental food.

26. Promptly remove large animal carcasses (e.g., big game,

domestic livestock, or feral animal).

27. Wildlife habitat enhancements or improvements such as ponds, guzzlers, rock or brush piles for small mammals, bird nest boxes, nesting platforms, wildlife food plots, etc. should not be created or added to wind energy facilities. These wildlife habitat enhancements are often desirable but when added to a wind energy facility result in increased wildlife use of the facility which may result in increased levels of injury or mortality to them.

Retrofitting, Repowering, and Decommissioning

As with project construction, these Guidelines offer BMPs for the retrofitting, repowering, and decommissioning phases of wind energy projects.

Retrofitting

Retrofitting is defined as replacing portions of existing wind turbines or project facilities so that at least part of the original turbine, tower, electrical infrastructure or foundation is being utilized. Retrofitting BMPs include:

1. Retrofitting of turbines should use installation techniques that minimize new site disturbance, soil erosion, and removal of vegetation of habitat value.

2. Retrofits should employ shielded, separated or insulated electrical conductors that minimize electrocution risk to avian wildlife per APLIC (2006).

3. Retrofit designs should prevent nests or bird perches from being established in or on the wind turbine or tower.

4. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.

5. Lighting at both operation and maintenance facilities and substations located within half a mile of the turbines should be kept to the minimum required:

   a. Use lights with motion or heat sensors and switches to keep lights off when not required.

   b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

   c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

6. Remove wind turbines when they are no longer cost effective to retrofit.

Repowering

Repowering may include removal and replacement of turbines and associated infrastructure. BMPs include:

1. To the greatest extent practicable, existing roads, disturbed areas and turbine strings should be re-used in repower layouts.

2. Roads and facilities that are no longer needed should be demolished, removed, and their footprint stabilized and re-seeded with native plants appropriate for the soil conditions and adjacent habitat and of local seed sources where feasible, per landowner requirements and commitments.

3. Existing substations and ancillary facilities should be re-used in repowering projects to the extent practicable.

4. Existing overhead lines may be acceptable if located away from high bird crossing locations, such as between roosting and feeding areas, or between lakes, rivers and nesting areas. Overhead lines may be used when they parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.

5. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."

6. Guyed structures should be avoided. If use of guy wires is absolutely necessary, they should be treated with bird flight diverters or high visibility marking devices, or are located where known low bird use will occur.

7. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.

8. Lighting at both operation and maintenance facilities and substations located within ½ mile of the turbines should be kept to the minimum required.

   a. Use lights with motion or heat sensors and switches to keep lights off when not required.

   b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

Towers are being lifted as work continues on the 2 MW Gamesa wind turbine that is being installed at the NWTC. Credit: NREL

c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

Decommissioning

Decommissioning is the cessation of wind energy operations and removal of all associated equipment, roads, and other infrastructure. The land is then used for another activity. During decommissioning, contractors and facility operators should apply BMPs for road grading and native plant re-establishment to ensure that erosion and overland flows are managed to restore pre-construction landscape conditions. The facility operator, in conjunction with the landowner and state and federal wildlife agencies, should restore the natural hydrology and plant community to the greatest extent practical.

1. Decommissioning methods should minimize new site disturbance and removal of native vegetation, to the greatest extent practicable.

2. Foundations should be removed to a minimum of three feet below surrounding grade, and covered with soil to allow adequate root penetration for native plants, and so that subsurface structures do not substantially disrupt ground water movements. Three feet is typically adequate for agricultural lands.

3. If topsoils are removed during decommissioning, they should be stockpiled and used as topsoil when restoring plant communities. Once decommissioning activity is complete, topsoils should be restored to assist in establishing and maintaining pre-construction native plant communities to the extent possible, consistent with landowner objectives.

4. Soil should be stabilized and re-vegetated with native plants appropriate for the soil conditions and adjacent habitat, and of local seed sources where feasible, consistent with landowner objectives.

5. Surface water flows should be restored to pre-disturbance conditions, including removal of stream crossings, roads, and pads, consistent with storm water management objectives and requirements.

6. Surveys should be conducted by qualified experts to detect populations of invasive species, and comprehensive approaches to preventing and controlling invasive species should be implemented and maintained as long as necessary.

7. Overhead pole lines that are no longer needed should be removed.

8. After decommissioning, erosion control measures should be installed in all disturbance areas where potential for erosion exists, consistent with storm water management objectives and requirements.

9. Fencing should be removed unless the landowner will be utilizing the fence.

10. Petroleum product leaks and chemical releases should be remediated prior to completion of decommissioning.

Chapter 8: Mitigation

Mitigation is defined in this document as avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts, as determined through the tiered approach described in the recommended Guidelines. The Service places emphasis in project planning on first avoiding, then minimizing, potential adverse impacts to wildlife and their habitats. Several tools are available to determine appropriate mitigation, including the Service Mitigation Policy (USFWS Mitigation Policy, 46 FR 7656 (1981)). The Service policy provides a common basis for determining how and when to use different mitigation strategies, and facilitates earlier consideration of wildlife values in wind energy project planning.

Under the Service Mitigation Policy, the highest priority is for mitigation to occur on-site within the project planning area. The secondary priority is for the mitigation to occur off-site. Off-site mitigation should first occur in proximity to the planning area within the same ecological region and secondarily elsewhere within the same ecological region. Generally, the Service prefers on-site mitigation over off-site mitigation because this approach most directly addresses project impacts at the location where they actually occur. However, there may be individual cases where off-site mitigation could result in greater net benefits to affected species and habitats. Developers should work with the Service in comparing benefits among multiple alternatives.

In some cases, a project's effects cannot be forecast with precision. The developer and the agencies may be unable to make some mitigation decisions until post-construction data have been collected. If significant adverse effects have not been adequately addressed, additional mitigation for those adverse effects from operations may need to be implemented.

Mitigation measures implemented post-construction, whether in addition to those implemented pre-construction or whether they are new, are appropriate elements of the tiered approach. The general terms and funding commitments for future mitigation and the triggers or thresholds for implementing such compensation should be developed at the earliest possible stage in project development. Any mitigation implemented after a project is operational should be well defined, bounded, technically feasible, and commensurate with the project effects.

NEPA Guidance on Mitigation

CEQ issued guidance in February 2011 on compliance with the National Environmental Policy Act (NEPA) entitled, "Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact." This new guidance clarifies that when agencies premise their Finding of No Significant Impact on a commitment to mitigate the environmental impacts of a proposed action, they should adhere to those commitments, publicly report on those efforts, monitor how they are implemented, and monitor the effectiveness of the mitigation.

To the extent that a federal nexus with a wind project exists, for example, developing a project on federal lands or obtaining a federal permit, the lead federal action agency should make its decision based in part on a developer's commitment to mitigate adverse environmental impacts. The federal action agency should ensure that the developer adheres to those commitments, monitors how they are implemented, and monitors the effectiveness of the mitigation. Additionally, the lead federal action agency should make information on mitigation monitoring available to the public through its web site;

Greater prairie chicken. Credit: Amy Thornburg, USFWS and should ensure that mitigation successfully achieves its goals.

Compensatory Mitigation

Compensatory mitigation as defined in this document refers to replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value.

- **In-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.

- **Out-of-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically or biologically different from those lost. This may include conservation or mitigation banking, research or other options.

The amount of compensation, if necessary, will depend on the effectiveness of any avoidance and minimization measures undertaken. If a proposed wind development is poorly sited with regard to wildlife effects, the most important mitigation opportunity is largely lost and the remaining options can be expensive, with substantially greater environmental effects.

Compensation is most often appropriate for habitat loss under limited circumstances or for direct take of wildlife (e.g., Habitat Conservation Plans). Compensatory mitigation may involve contributing to a fund to protect habitat or otherwise support efforts to reduce existing impacts to species affected by a wind project. Developers should communicate with the Service and state agency prior to initiating such an approach.

Ideally, project impact assessment is a cooperative effort involving the developer, the Service, tribes, local authorities, and state resource agencies. The Service does not expect developers to provide compensation for the same habitat loss more than once. But the Service, state resource agencies, tribes, local authorities, state and federal land management agencies may have different species or habitats of concern, according to their responsibilities and statutory authorities. Hence, one entity may seek mitigation for a different group of species or habitat than does another.

Migratory Birds and Eagles

Some industries, such as the electric utilities, have developed operational and deterrent measures that when properly used can avoid or minimize "take" of migratory birds. Many of these measures to avoid collision and electrocution have been scientifically tested with publication in peer-reviewed, scientific journals. The Service encourages the wind industry to use these measures in siting, placing, and operating all power lines, including their distribution and grid-connecting transmission lines.

E.O. 13186, which addresses responsibilities of federal agencies to protect migratory birds, includes a directive to federal agencies to restore and enhance the habitat of migratory birds as practicable. E.O. 13186 provides a basis and a rationale for compensating for the loss of migratory bird habitat that results from developing wind energy projects that have a federal nexus.

Regulations concerning eagle take permits in 50 CFR 22.26 and 50 CFR 22.27 may allow for compensation as part of permit issuance. Compensation may be a condition of permit issuance in cases of nest removal, disturbance or take resulting in mortality that will likely occur over several seasons, result in permanent abandonment of one or more breeding territories, have large scale impacts, occur at multiple locations, or otherwise contribute to cumulative negative effects. The draft ECP Guidance has additional information on the use of compensation for programmatic permits.

Endangered Species

The ESA has provisions that allow for compensation through the issuance of an Incidental Take Permit (ITP). Under the ESA, mitigation measures are determined on a case by case basis, and are based on the needs of the species and the types of effects anticipated. If a federal nexus exists, or if a developer chooses to seek an ITP under the ESA, then effects to listed species need to be evaluated through the Section 7 and/or Section 10 processes. If an ITP is requested, it and the associated HCP must provide for minimization and mitigation to the maximum extent practicable, in addition to meeting other necessary criteria for permit issuance. For further information about compensation under federal laws administered by the Service, see the Service's Habitat and Resource Conservation website http://www.fws.gov/habitatconservation.

Bald eagle. Credit: USFWS

Chapter 9: Advancing Use, Cooperation and Effective Implementation

This chapter discusses a variety of policies and procedures that may affect the way wind project developers and the Service work with each other as well as with state and tribal governments and non-governmental organizations. The Service recommends that wind project developers work closely with field office staff for further elaboration of these policies and procedures.

Conflict Resolution

The Service and developers should attempt to resolve any issues arising from use of the Guidelines at the Field Office level. Deliberations should be in the context of the intent of the Guidelines and be based on the site-specific conditions and the best available data. However, if there is an issue that cannot be resolved within a timely manner at the field level, the developer and Service staff will coordinate to bring the matter up the chain of command in a stepwise manner.

Bird and Bat Conservation Strategies (BBCS)

The Service has recommended that developers prepare written records of their actions to avoid, minimize and compensate for potential adverse impacts. In the past, the Service has referred to these as Avian and Bat Protection Plans (ABPP). However, ABPPs have more recently been used for transmission projects and less for other types of development. For this reason the Service is introducing a distinct concept for wind energy projects and calling them Bird and Bat Conservation Strategies (BBCS).

Typically, a project-specific BBCS will explain the analyses, studies, and reasoning that support progressing from one tier to the next in the tiered approach. A wind energy project-specific BBCS is an example of a document or compilation of documents that describes the steps a developer could or has taken to apply these Guidelines to mitigate for adverse impacts and address the post-construction monitoring efforts the developer intends to undertake. A developer may prepare a BBCS in stages, over time, as analysis and studies are undertaken for each tier. It will also address the post-construction monitoring efforts for mortality and habitat effects, and may use many of the components suggested in the Suggested Practices for Avian Protection on Power Lines (APLIC 2006). Any Service review of, or discussion with a developer, concerning its BBCS is advisory only, does not result in approval or disapproval of the BBCS by the Service, and does not constitute a federal agency action subject to the National Environmental Policy Act or other federal law applicable to such an action.

Project Interconnection Lines

The Guidelines are designed to address all elements of a wind energy facility, including the turbine string or array, access roads, ancillary buildings, and the above- and below-ground electrical lines which connect a project to the transmission system. The Service recommends that the project evaluation include consideration of the wildlife- and habitat-related impacts of these electrical lines, and that the developer include measures to reduce impacts of these lines, such

Electricity towers and wind turbines. Credit: NREL as those outlined in the Suggested Practices for Avian Protection on Power Lines (APLIC 2006). The Guidelines are not designed to address transmission beyond the point of interconnection to the transmission system. The national grid and proposed smart grid system are beyond the scope of these Guidelines.

Confidentiality of Site Evaluation Process as Appropriate

Some aspects of the initial pre-construction risk assessment, including preliminary screening and site characterization, occur early in the development process, when land or other competitive issues limit developers' willingness to share information on projects with the public and competitors. Any consultation or coordination with agencies at this stage may include confidentiality agreements.

Collaborative Research

Much uncertainty remains about predicting risk and estimating impacts of wind energy development on wildlife. Thus there is a need for additional research to improve scientifically based decision-making when siting wind energy facilities, evaluating impacts on wildlife and habitats, and testing the efficacy of mitigation measures. More extensive studies are needed to further elucidate patterns and test hypotheses regarding possible solutions to wildlife and wind energy impacts.

It is in the interests of wind developers and wildlife agencies to improve these assessments to better mitigate the impacts of wind energy development on wildlife and their habitats. Research can provide data on operational factors (e.g. wind speed, weather conditions) that are likely to result in fatalities. It could also include studies of cumulative impacts of multiple wind energy projects, or comparisons of different methods for assessing avian and bat activity relevant to predicting risk. Monitoring and research should be designed and conducted to ensure unbiased data collection that meets technical standards such as those used in peer review. Research projects may occur at the same time as project-specific Tier 4 and Tier 5 studies.

Research would usually result from collaborative efforts involving appropriate stakeholders, and is not the sole or primary responsibility of any developer. Research partnerships (e.g., Bats and Wind Energy Cooperative (BWEC[9], Grassland and Shrub Steppe Species Collaborative (GS3C)[10]) involving diverse players will be helpful for generating common goals and objectives and adequate funding to conduct studies (Arnett and Haufler 2003). The National Wind Coordinating Collaborative (NWCC)[11], the American Wind Wildlife Institute (AWWI)[12], and the California Energy Commission (CEC)'s Public Interest Energy Research Program[13] all support research in this area.

Study sites and access will be necessary to design and implement research, and developers are encouraged to participate in these research efforts when possible. Subject to appropriations, the Service also should fund priority research and promote collaboration and information sharing among research efforts to advance science on wind energy-wildlife interactions, and to improve these Guidelines.

Service - State Coordination and Cooperation

The Service encourages states to increase compatibility between state guidelines and these voluntary Guidelines, protocols, data collection methods, and recommendations relating to wildlife and wind energy. States that desire to adopt, or those that have formally adopted, wind energy siting, permitting, or environmental review regulations or guidelines are encouraged to cooperate with the Service to develop consistent state level guidelines. The Service may be available to confer, coordinate and share its expertise with interested states when a state lacks its own guidance or program to address wind energy-wildlife interactions. The Service will also use states' technical resources as much as possible and as appropriate.

The Service will explore establishing a voluntary state/federal program to advance cooperation and compatibility between the Service and interested state and local governments for coordinated review of projects under both federal and state wildlife laws. The Service, and interested states, will consider using the following tools to reach agreements to foster consistency in review of projects:

- Cooperation agreements with interested state governments.
- Joint agency reviews to reduce duplication and increase coordination in project review.
- A communication mechanism:
  - To share information about prospective projects
  - To coordinate project review
  - To ensure that state and federal regulatory processes, and/or mitigation requirements are being adequately addressed

[9] www.batsandwind.org
[10] www.nationalwind.org
[11] www.nationalwind.org
[12] http://www.awwi.org
[13] http://www.energy.ca.gov/research

- To ensure that species of concern and their habitats are fully addressed

- Establishing consistent and predictable joint protocols, data collection methodologies, and study requirements to satisfy project review and permitting.

- Designating a Service management contact within each Regional Office to assist Field Offices working with states and local agencies to resolve significant wildlife-related issues that cannot be resolved at the field level.

- Cooperative state/federal/ industry research agreements relating to wind energy -wildlife interactions.

Wind turbine in California. Credit: NREL

The Service will explore opportunities to:

- Provide training to states.
- Foster development of a national geographic data base that identifies development-sensitive ecosystems and habitats.
- Support a national database for reporting of mortality data on a consistent basis.
- Establish national BMPs for wind energy development projects.
- Develop recommended guidance on study protocols, study techniques, and measures and metrics for use by all jurisdictions.
- Assist in identifying and obtaining funding for national research priorities.

Service - Tribal Consultation and Coordination

Federally-recognized Indian Tribes enjoy a unique government-to-government relationship with the United States. The United States Fish and Wildlife Service (Service) recognizes Indian tribal governments as the authoritative voice regarding the management of tribal lands and resources within the framework of applicable laws. It is important to recall that many tribal traditional lands and tribal rights extend beyond reservation lands.

The Service consults with Indian tribal governments under the authorities of Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments" and supporting DOI and Service policies. To this end, when it is determined that federal actions and activities may affect a Tribe's resources (including cultural resources), lands, rights, or ability to provide services to its members, the Service must, to the extent practicable, seek to engage the affected Tribe(s) in consultation and coordination.

Tribal Wind Energy Development on Reservation Lands

Indian tribal governments have the authority to develop wind energy projects, permit their development, and establish relevant regulatory guidance within the framework of applicable laws.

The Service will provide technical assistance upon the request of Tribes that aim to establish regulatory guidance for wind energy development for lands under the Tribe's jurisdiction. Tribal governments are encouraged to strive for compatibility between their guidelines and these Guidelines.

Tribal Wind Energy Development on Lands that are not held in Trust

Indian tribal governments may wish to develop wind energy projects on lands that are not held in trust status. In such cases, the Tribes should coordinate with agencies other than the Service. At the request of a Tribe, the Service may facilitate discussions with other regulatory organizations. The Service may also lend its expertise in these collaborative efforts to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols.

Non-Tribal Wind Energy Development – Consultation with Indian Tribal Governments

When a non-Tribal wind energy project is proposed that may affect a Tribe's resources (including cultural resources), lands, rights, or ability to govern or provide services to its members, the Service should seek to engage the affected Tribe(s) in consultation and coordination as early as possible in the process. In siting a proposed project that has a federal nexus, it is incumbent upon the regulatory agency to notify potentially affected Tribes of the proposed activity. If the Service or other federal agency determines that a project may affect a Tribe(s), they should notify the Tribe(s) of the action at the earliest opportunity. At the request of a Tribe, the Service may facilitate and lend its expertise in collaborating with other organizations to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols or project implementation. This process ideally should be agreed to by all involved parties.

In the consultative process, Tribes should be engaged as soon as possible when a decision may affect a Tribe(s). Decisions made that affect Indian Tribal governments without adequate federal effort to engage Tribe(s) in consultation have been overturned by the courts. See, e.g., Quechan Tribe v. U.S. Dep't of the Interior, No. 10cv2241 LAB (CAB), 2010 WL 5113197 (S.D. Cal. Dec. 15, 2010). When a tribal government is consulted, it is neither required, nor expected that all of the Tribe's issues can be resolved in its favor. However, the Service must listen and may not arbitrarily dismiss concerns of the tribal government. Rather, the Service must seriously consider and respond to all tribal concerns. Regional Native American Liaisons are able to provide in-house guidance as to government-to-government consultation processes. (See Service - State Coordination and Cooperation, above).

Non-Governmental Organization Actions

If a specific project involves actions at the local, state, or federal level that provide opportunities for public participation, non-governmental organizations (NGOs) can provide meaningful contributions to the discussion of biological issues associated with that project, through the normal processes such as scoping, testimony at public meetings, and comment processes. In the absence of formal public process, there are many NGOs that have substantial scientific capabilities and may have resources that could contribute productively to the siting of wind energy projects. Several NGOs have made significant contributions to the understanding of the importance of particular geographic areas to wildlife in the United States. This work has benefited and continues to benefit from extensive research efforts and from associations with highly qualified biologists. NGO expertise can – as can scientific expertise in the academic or private consulting sectors – serve highly constructive purposes. These can include:

- Providing information to help identify environmentally sensitive areas, during the screening phases of site selection (Tiers 1 and 2, as described in this document)
- Providing feedback to developers and agencies with respect to specific sites and site and impact assessment efforts
- Helping developers and agencies design and implement mitigation or offset strategies
- Participating in the defining, assessing, funding, and implementation of research efforts in support of improved predictors of risk, impact assessments and effective responses
- Articulating challenges, concerns, and successes to diverse audiences

Non-Governmental Organization Conservation Lands

Implementation of these Guidelines by Service and other state agencies will recognize that lands owned and managed by non-government conservation organizations represent a significant investment that generally supports the mission of state and federal wildlife agencies. Many of these lands represent an investment of federal conservation funds, through partnerships between agencies and NGOs. These considerations merit extra care in the avoidance of wind energy development impacts to these lands. In order to exercise this care, the Service and allied agencies can coordinate and consult with NGOs that own lands or easements which might reasonably be impacted by a project under review.

Appendix A: Glossary

Accuracy – The agreement between a measurement and the true or correct value.

Adaptive management – An iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Comprehensively applying the tiered approach embodies the adaptive management process.

Anthropogenic – Resulting from the influence of human beings on nature.

Area of interest – For most projects, the area where wind turbines and meteorological (met) towers are proposed or expected to be sited, and the area of potential impact.

Avian – Pertaining to or characteristic of birds.

Avoid – To not take an action or parts of an action to avert the potential effects of the action or parts thereof. First of three components of "mitigation," as defined in Service Mitigation Policy. (See mitigation.)

Before-after/control-impact (BACI) – A study design that involves comparisons of observational data, such as bird counts, before and after an environmental disturbance in a disturbed and undisturbed site. This study design allows a researcher to assess the effects of constructing and operating a wind turbine by comparing data from the "control" sites (before and undisturbed) with the "treatment" sites (after and disturbed).

Best management practices (BMPs) – Methods that have been determined by the stakeholders to be the most effective, practicable means of avoiding or minimizing significant adverse impacts to individual species, their habitats or an ecosystem, based on the best available information.

Buffer zone – A zone surrounding a resource designed to protect the resource from adverse impact, and/or a zone surrounding an existing or proposed wind energy project for the purposes of data collection and/or impact estimation.

Community-scale – Wind energy projects greater than 1 MW, but generally less than 20 MW, in name-plate capacity, that produce electricity for off-site use, often partially or totally owned by members of a local community or that have other demonstrated local benefits in terms of retail power costs, economic development, or grid issues.

Comparable site – A site similar to the project site with respect to topography, vegetation, and the species under consideration.

Compensatory mitigation – Replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value.

- **In-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.
- **Out-of-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically or biologically different from those lost. This may include conservation or mitigation banking, research or other options.

Cost effective – Economical in terms of tangible benefits produced by money spent.

Covariate – Uncontrolled random variables that influence a response to a treatment or impact, but do not interact with any of the treatments or impacts being tested.

Critical habitat – For listed species, consists of the specific areas designated by rule making pursuant to Section 4 of the Endangered Species Act and displayed in 50 CFR § 17.11 and 17.12.

Cumulative impacts – See impact.

Curtailment – The act of limiting the supply of electricity to the grid during conditions when it would normally be supplied. This is usually accomplished by cutting-out the generator from the grid and/or feathering the turbine blades.

Cut-in Speed – The wind speed at which the generator is connected to the grid and producing electricity. It is important to note that turbine blades may rotate at full RPM in wind speeds below cut-in speed.

Displacement – The loss of habitat as result of an animal's behavioral avoidance of otherwise suitable habitat. Displacement may be short-term, during the construction phase of a project, temporary as a result of habituation, or long-term, for the life of the project.

Distributed wind – Small and mid-sized turbines between 1 kilowatt and 1 megawatt that are installed and produce electricity at the point of use to off-set all or a portion of on-site energy consumption.

Ecosystem – A system formed by the interaction of a community of organisms with their physical and chemical environment. All of the biotic elements (i.e., species, populations, and communities) and abiotic elements (i.e., land, air, water, energy) interacting in a given geographic area so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles. Service Mitigation Policy adopted definition from E. P. Odum 1971 Fundamentals of Ecology.

Edge effect – The effect of the juxtaposition of contrasting environments on an ecosystem.

Endangered species – See listed species.

Extirpation – The species ceases to exist in a given location; the species still exists elsewhere.

Fatality – An individual instance of death.

Fatality rate – The ratio of the number of individual deaths to some parameter of interest such as megawatts of energy produced, the number of turbines in a wind project, the number of individuals exposed, etc., within a specified unit of time.

Feathering – Adjusting the angle of the rotor blade parallel to the wind, or turning the whole unit out of the wind, to slow or stop blade rotation.

Federal action agency – A department, bureau, agency or instrumentality of the United States which plans, constructs, operates or maintains a project, or which reviews, plans for or approves a permit, lease or license for projects, or manages federal lands.

Federally listed species – See listed species.

Footprint – The geographic area occupied by the actual infrastructure of a project such as wind turbines, access roads, substation, overhead and underground electrical lines, and buildings, and land cleared to construct the project.

G1 (Global Conservation Status Ranking) Critically Imperiled – At very high risk of extinction due to extreme rarity (often five or fewer populations), very steep declines, or other factors.

G2 (Global Conservation Status Ranking) Imperiled – At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.

G3 (Global Conservation Status Ranking) Vulnerable – At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.

Guy wire – Wires used to secure wind turbines or meteorological towers that are not self-supporting.

Habitat – The area which provides direct support for a given species, including adequate food, water, space, and cover necessary for survival.

Habitat fragmentation – Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area.

Impact – An effect or effects on natural resources and on the components, structures, and functioning of affected ecosystems.

- **Cumulative** – Changes in the environment caused by the aggregate of past, present and reasonably foreseeable future actions on a given resource or ecosystem.
- **Direct** – Effects on individual species and their habitats caused by the action, and occur at the same time and place.
- **Indirect impact** – Effects caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts include displacement and changes in the demographics of bird and bat populations.

Infill – Add an additional phase to the existing project, or build a new project adjacent to existing projects.

In-kind compensatory mitigation – See compensatory mitigation.

Intact habitat – An expanse of habitat for a species or landscape scale feature, unbroken with respect to its value for the species or for society.

Intact landscape – Relatively undisturbed areas characterized by maintenance of most original ecological processes and by communities with most of their original native species still present.

Lattice design – A wind turbine support structure design characterized by horizontal or diagonal lattice of bars forming a tower rather than a single tubular support for the nacelle and rotor.

Lead agency – Agency that is responsible for federal or non-federal regulatory or environmental assessment actions.

Lek – A traditional site commonly used year after year by males of certain species of birds (e.g., greater and lesser prairie-chickens, sage and sharp-tailed grouse, and buff-breasted sandpiper), within which the males display communally to attract and compete for female mates, and where breeding occurs.

Listed species – Any species of fish, wildlife or plant that has been determined to be endangered or threatened under section 4 of the Endangered Species Act (50 CFR §402.02), or similarly designated by state law or rule.

Local population – A subdivision of a population of animals or plants of a particular species that is in relative proximity to a project.

Loss – As used in this document, a change in wildlife habitat due to human activities that is considered adverse and: 1) reduces the biological value of that habitat for species of concern; 2) reduces population numbers of species of concern; 3) increases population numbers of invasive or exotic species; or 4) reduces the human use of those species of concern.

Megawatt (MW) – A measurement of electricity-generating capacity equivalent to 1,000 kilowatts (kW), or 1,000,000 watts.

Migration – Regular movements of wildlife between their seasonal ranges necessary for completion of the species lifecycle.

Migration corridor – Migration routes and/or corridors are the relatively predictable pathways that a migratory species travel between seasonal ranges, usually breeding and wintering grounds.

Migration stopovers – Areas where congregations of wildlife assemble during migration. Such areas supply high densities of food or shelter.

Minimize – To reduce to the smallest practicable amount or degree.

Mitigation – (Specific to these Guidelines) Avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts.

Monitoring – 1) A process of project oversight such as checking to see if activities were conducted as agreed or required; 2) making measurements of uncontrolled events at one or more points in space or time with space and time being the only experimental variable or treatment; 3) making measurements and evaluations through time that are done for a specific purpose, such as to check status and/or trends or the progress towards a management objective.

Mortality rate – Population death rate, typically expressed as the ratio of deaths per 100,000 individuals in the population per year (or some other time period).

Operational changes – Deliberate changes to wind energy project operating protocols, such as the wind speed at which turbines "cut in" or begin generating power, undertaken with the object of reducing collision fatalities. Considered separately from standard mitigation measures due to the fact that operational changes are considered as a last resort and will rarely be implemented if a project is properly sited.

Passerine – Describes birds that are members of the Order Passeriformes, typically called "songbirds."

Plant communities of concern –Plant communities of concern are unique habitats that are critical for the persistence of highly specialized or unique species and communities of organisms. Often restricted in distribution or represented by a small number of examples, these communities are biological hotspots that significantly contribute to the biological richness and productivity of the entire region. Plant communities of concern often support rare or uncommon species assemblages, provide critical foraging, roosting, nesting, or hibernating habitat, or perform vital ecosystem functions. These communities often play an integral role in the conservation of biological integrity and diversity across the landscape. (Fournier et al. 2007) Also, any plant community with a Natural Heritage Database ranking of S1, S2, S3, G1, G2, or G3.

Population – A demographically and genetically self-sustaining group of animals and/or plants of a particular species.

Practicable – Capable of being done or accomplished; feasible.

Prairie grouse – A group of gallinaceous birds, includes the greater prairie-chicken, the lesser prairie-chicken, and the sharp-tailed grouse.

Project area – The area that includes the project site as well as contiguous land that shares relevant characteristics.

Project commencement – The point in time when a developer begins its preliminary evaluation of a broad geographic area to assess the general ecological context of a potential site or sites for wind energy project(s). For example, this may include the time at which an option is acquired to secure real estate interests, an application for federal land use has been filed, or land has been purchased.

Project Site – The land that is included in the project where development occurs or is proposed to occur.

Project transmission lines – Electrical lines built and owned by a project developer.

Raptor – As defined by the American Ornithological Union, a group of predatory birds including hawks, eagles, falcons, osprey, kites, owls, vultures and the California condor.

Relative abundance – The number of organisms of a particular kind in comparison to the total number of organisms within a given area or community.

Risk – The likelihood that adverse effects may occur to individual animals or populations of species of concern, as a result of development and operation of a wind energy project. For detailed discussion of risk and risk assessment as used in this document see Chapter One - General Overview.

Rotor – The part of a wind turbine that interacts with wind to produce energy. Consists of the turbine's blades and the hub to which the blades attach.

Rotor-swept area – The area of the circle or volume of the sphere swept by the turbine blades.

Rotor-swept zone – The altitude within a wind energy project which is bounded by the upper and lower limits of the rotor-swept area and the spatial extent of the project.

S1 (Subnational Conservation Status Ranking) Critically Imperiled – Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 (Subnational Conservation Status Ranking) Imperiled – Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.

S3 (Subnational Conservation Status Ranking) Vulnerable – Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.

Sage grouse – A large gallinaceous bird living in the sage steppe areas of the intermountain west, includes the greater sage grouse and Gunnison's sage grouse.

Significant – For purposes of characterizing impacts to species of concern and their habitats, "significance" takes into account the duration, scope, and intensity of an impact. Impacts that are very brief or highly transitory, do not extend beyond the immediate small area where they occur, and are minor in their intensity are not likely to be significant. Conversely, those that persist for a relatively long time, encompass a large area or extend well beyond the immediate area where they occur, or have substantial consequences are almost certainly significant. A determination of significance may include cumulative impacts of other actions. There is probably some unavoidable overlap among these three characteristics, as well as some inherent ambiguity in these terms, requiring the exercise of judgment and the development of a consistent approach over time.

Species of concern – For a particular wind energy project, any species which 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act; b) is designated by law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project.

Species of habitat fragmentation concern—Species of concern for which a relevant federal, state, tribal, and/or local agency has found that separation of their habitats into smaller blocks reduces connectivity such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Habitat fragmentation from a wind energy project may create significant barriers for such species.

String – A number of wind turbines oriented in close proximity to one another that are usually sited in a line, such as along a ridgeline.

Strobe – Light consisting of pulses that are high in intensity and short in duration.

Threatened species – See listed species.

Tubular design – A type of wind turbine support structure for the nacelle and rotor that is cylindrical rather than lattice.

Turbine height – The distance from the ground to the highest point reached by the tip of the blades of a wind turbine.

Utility-scale – Wind projects generally larger than 20 MW in nameplate generating capacity that sell electricity directly to utilities or into power markets on a wholesale basis.

Voltage (low and medium) – Low voltages are generally below 600 volts, medium voltages are commonly on distribution electrical lines, typically between 600 volts and 110 kV, and voltages above 110 kV are considered high voltages.

Wildlife – Birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent.

Wildlife management plan – A document describing actions taken to identify resources that may be impacted by proposed development; measures to mitigate for any significant adverse impacts; any post-construction monitoring; and any other studies that may be carried out by the developer.

Wind turbine – A machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity..

Appendix B: Literature Cited

Anderson, R., M. Morrison, K. Sinclair, and D. Strickland. 1999. Studying Wind Energy/Bird Interactions: A Guidance Document. Metrics and Methods for Determining or Monitoring Potential Impacts on Birds at Existing and Proposed Wind Energy Sites. National Wind Coordinating Committee/RESOLVE. Washington, D.C., USA.

Arnett, E.B., and J.B. Haufler. 2003. A customer-based framework for funding priority research on bats and their habitats. Wildlife Society Bulletin 31 (1): 98–103.

Arnett, E.B., technical editor. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA. http://www.batsandwind.org/pdf/ar2004.pdf

Arnett, E.B., J.P. Hayes, and M.M.P. Huso. 2006. An evaluation of the use of acoustic monitoring to predict bat fatality at a proposed wind facility in south-central Pennsylvania. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

http://batsandwind.org/pdf/ar2005.pdf.

Arnett, E.B., D.B. Inkley, D.H. Johnson, R.P. Larkin, S. Manes, A.M. Manville, R. Mason, M. Morrison, M.D. Strickland, and R. Thresher. 2007. Impacts of Wind Energy Facilities on Wildlife and Wildlife Habitat. Issue 2007-2. The Wildlife Society, Bethesda, Maryland, USA.

Arnett, E.B., K. Brown, W.P. Erickson, J. Fiedler, B. Hamilton, T.H. Henry, G. D. Johnson, J. Kerns, R.R. Kolford, C.P. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersley, Jr. 2008. Patterns of fatality of bats at wind energy facilities in North America. Journal of Wildlife Management 72: 61–78.

Arnett, E.B., M. Schirmacher, M.M.P. Huso, and J.P. Hayes. 2009. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

http://batsandwind.org/pdf/Curtailment_2008_Final_Report.pdf.

Arnett, E.B., M. Baker, M.M.P. Huso, and J. M. Szewczak. In review. Evaluating ultrasonic emissions to reduce bat fatalities at wind energy facilities. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Avian Powerline Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA. http://www.aplic.org/SuggestedPractices2006(LR-2watermark).pdf.

Baerwald, E.F., J. Edworthy, M. Holder, and R.M.R. Barclay. 2009. A Large-Scale Mitigation Experiment to Reduce Bat Fatalities at Wind Energy Facilities. Journal of Wildlife Management 73(7): 1077-81.

Bailey, L.L., T.R. Simons, and K.H. Pollock. 2004. Spatial and Temporal Variation in Detection Probability of Plethodon Salamanders Using the Robust Capture-Recapture Design. Journal of Wildlife Management 68(1): 14-24.

Becker, J.M., C.A. Duberstein, J.D. Tagestad, J.L. Downs. 2009. Sage-Grouse and Wind Energy: Biology, Habits, and Potential Effects from Development. Prepared for the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind & Hydropower Technologies Program, under Contract DE-AC05-76RL01830.

Breidt, F.J. and W.A. Fuller. 1999. Design of supplemented panel surveys with application to the natural resources inventory. Journal of Agricultural, Biological, and Environmental Statistics 4(4): 391-403.

Bright J., R. Langston, R. Bullman, R. Evans, S. Gardner, and J. Pearce-Higgins. 2008. Map of Bird Sensitivities to Wind Farms in Scotland: A Tool to Aid Planning and Conservation. Biological Conservation 141(9): 2342-56.

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. Commission Final Report. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. CEC-700-2007-008-CMF.

Chamberlain, D.E., M.R. Rehfisch, A.D. Fox, M. Desholm, and S.J. Anthony. 2006. The Effect of Avoidance Rates on Bird Mortality Predictions Made by Wind Turbine Collision Risk Models. Ibis 148(S1): 198-202.

"Clean Water Act." Water Pollution Prevention and Control. Title 33 U.S. Code, Sec. 1251 et. seq. 2006 ed., 301-482. Print.

Connelly, J.W., H.W. Browers, and R.J. Gates. 1988. Seasonal Movements of Sage Grouse in Southeastern Idaho. Journal of Wildlife Management 52(1): 116-22.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse population and their habitats. Wildlife Society Bulletin 28(4):967-85.

Corn, P.S. and R.B. Bury. 1990. Sampling Methods for Terrestrial Amphibians and Reptiles, Gen. Tech. Rep. PNW-GTR-256. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Cryan, P.M. 2008. Mating Behavior as a Possible Cause of Bat Fatalities at Wind Turbines. Journal of Wildlife Management 72(3): 845-49.

Dettmers, R., D.A. Buehler, J.G. Bartlett, and N.A. Klaus. 1999. Influence of Point Count Length and Repeated Visits on Habitat Model Performance. Journal of Wildlife Management 63(3): 815-23.

Drewitt, A.L. and R.H.W. Langston. 2006. Assessing the Impacts of Wind Farms on Birds. Ibis 148: 29-42.

Erickson, W.P., M.D. Strickland, G.D. Johnson, and J.W. Kern. 2000b. Examples of Statistical Methods to Assess Risk of Impacts to Birds from Windplants. Proceedings of the National Avian-Wind Power Planning Meeting III. National Wind Coordinating Committee, c/o RESOLVE, Inc., Washington, D.C.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report: July 2001 - December 2003. Technical report for and peer-reviewed by FPL Energy, Stateline Technical Advisory Committee, and the Oregon Energy Facility Siting Council, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Walla Walla, Washington, and Northwest Wildlife Consultants (NWC), Pendleton, Oregon, USA. December 2004. http://www.west-inc.com.

Erickson, W., D. Strickland, J.A. Shaffer, and D.H. Johnson. 2007. Protocol for Investigating Displacement Effects of Wind Facilities on Grassland Songbirds. National Wind Coordinating Collaborative, Washington, D. C. http://www.nationalwind.org/workgroups/wildlife/SongbirdProtocolFinalJune07.pdf

Fiedler, J.K., T.H. Henry, C.P. Nicholson, and R.D. Tankersley. 2007. Results of Bat and Bird Mortality Monitoring at the Expanded Buffalo Mountain Windfarm, 2005. Tennessee Valley Authority, Knoxville, Tennessee, USA. https://www.tva.gov/environment/bmw_report/results.pdf

Fournier, D., J. Fraser, M. Coppoletta, M. Johnson, B. Brady, S. Dailey, B. Davidson, M. Vollmer, E. Carey, E. Kelchin, C. Shade, A. Stanton, M. Morrison. 2007. Technical Supplement and Appendix for PATHWAY 2007 Evaluation Report: Vegetation Resource, Draft. Tahoe Regional Planning Agency.

Fuller, W.A. 1999. Environmental surveys over time. Journal of Agricultural, Biological, and Environmental Statistics 4(4): 331-45.

Gauthreaux, S.A., Jr., and C.G. Belser. 2003. Radar ornithology and biological conservation. Auk 120(2):266–77.

Giesen, K.M. and J.W. Connelly. 1993. Guidelines for management of Columbian sharp-tailed grouse habitats. Wildlife Society Bulletin 21(3):325-33.

Graeter, G.J., B.B. Rothermel, and J.W. Gibbons. 2008. Habitat Selection and Movement of Pond-Breeding Amphibians in Experimentally Fragmented Pine Forests. Journal of Wildlife Management 72(2): 473-82.

Hagen, C.A., B.E. Jamison, K.M. Giesen, and T.Z. Riley. 2004. Guidelines for managing lesser prairie-chicken populations and their habitats. Wildlife Society Bulletin 32(1):69-82.

Hagen, C.A., B.K. Sandercock, J.C. Pitman, R.J. Robel, and R.D. Applegate. 2009. Spacial variation in lesser prairie-chicken demography: a sensitivity analysis of population dynamics and management alternatives. Journal of Wildlife Management 73:1325-32.

Hagen, C.A., J.C. Pitman, T.M. Loughin, B.K. Sandercock, and R.J. Robel. 2011. Impacts of anthropogenic features on lesser prairie-chicken habitat use. Studies in Avian Biology. 39: 63-75.

Holloran, M.J. 2005. Greater Sage-Grouse (Centrocercus urophasianus) Population Response to Natural Gas Field Development in Western Wyoming. Ph.D. dissertation. University of Wyoming, Laramie, Wyoming, USA.

Holloran, M.J., B.J. Heath, A.G. Lyon, S.J. Slater, J.L. Kuipers, S.H. Anderson. 2005. Greater Sage-Grouse Nesting Habitat Selection and Success in Wyoming. Journal of Wildlife Management 69(2): 638-49.

Horn, J.W., E.B. Arnett and T.H Kunz. 2008. Behavioral responses of bats to operating wind turbines. Journal of Wildlife Management 72(1):123-32.

Hunt, G. 2002. Golden Eagles in a Perilous Landscape: Predicting the Effects of Mitigation for Wind Turbine Bladestrike Mortality. California Energy Commission Report P500-02-043F. Sacramento, California, USA.

Hunt, G. and T. Hunt. 2006. The Trend of Golden Eagle Territory Occupancy in the Vicinity of the Altamont Pass Wind Resource Area: 2005 Survey. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2006-056.

Huso, M. 2009. Comparing the Accuracy and Precision of Three Different Estimators of Bird and Bat Fatality and Examining the Influence of Searcher Efficiency, Average Carcass Persistence and Search Interval on These. Proceedings of the NWCC Wind Wildlife Research Meeting VII, Milwaukee, Wisconsin. Prepared for the Wildlife Workgroup of the National Wind Coordinating Collaborative by RESOLVE, Inc., Washington, D.C., USA. S. S. Schwartz, ed. October 28-29, 2008.

Johnson, G.D., D.P. Young, Jr., W.P. Erickson, C.E. Derby, M.D. Strickland, and R.E. Good. 2000. Wildlife Monitoring Studies, SeaWest Windpower Project, Carbon County, Wyoming, 1995-1999. Final report prepared for SeaWest Energy Corporation, and the Bureau of Land Management by Western EcoSystems Technology, Inc. Cheyenne, Wyoming, USA.

Johnson, G.D., W.P. Erickson, and J. White. 2003. Avian and Bat Mortality During the First Year of Operation at the Klondike Phase I Wind Project, Sherman County, Oregon. March 2003. Technical report prepared for Northwestern Wind Power, Goldendale, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, USA. http://www.west-inc.com.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003. Prepared for FPL Energy and the Mountaineer Wind Energy Center Technical Review Committee by Curry and Kerlinger, LLC. http://www.wvhighlands.org/Birds/MountaineerFinalAvianRpt-%203-15-04PKJK.pdf

Kronner, K., B. Gritski, Z. Ruhlen, and T. Ruhlen. 2007. Leaning Juniper Phase I Wind Power Project, 2006-2007: Wildlife Monitoring Annual Report. Unpublished report prepared by Northwest Wildlife Consultants, Inc. for PacifiCorp Energy, Portland, Oregon, USA.

Kuenzi, A.J. and M.L. Morrison. 1998. Detection of Bats by Mist-Nets and Ultrasonic Sensors. Wildlife Society Bulletin 26(2): 307-11.

Kunz, T.H., G.C. Richards, and C.R. Tidemann. 1996. Small Volant Mammals. In D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Mammals. Smithsonian Institution Press, Washington, D.C. USA. pp. 122-46.

Kunz, T. H., E. B. Arnett, B. M. Cooper, W. P. Erickson, R. P. Larkin, T. Mabee, M. L. Morrison, M. D. Strickland, and J. M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: a guidance document. Journal of Wildlife Management 71: 2449-2486.

Kunz, T.H. and S. Parsons, eds. 2009. Ecological and Behavioral Methods for the Study of Bats. Second Edition. Johns Hopkins University Press.

Leddy, K.L., K.F. Higgins, and D.E. Naugle. 1999. Effects of Wind Turbines on Upland Nesting Birds in Conservation Reserve Program Grasslands. Wilson Bulletin 111(1): 100-4.

Mabee, T. J., B. A. Cooper, J. H. Plissner, and D. P. Young. 2006. Nocturnal bird migration over an Appalachian ridge at a proposed wind power project. Wildlife Society Bulletin 34(3): 682–90.

Madders, M. and D.P. Whitfield. 2006. Upland Raptors and the Assessment of Wind Farm Impacts. Ibis 148: 43-56.

Manly, B.F., L. McDonald, D.L. Thomas, T.L. McDonald, and W.P. Erickson. 2002. Resource Selection by Animals: Statistical Design and Analysis for Field Studies. 2nd Edition. Kluwer, Boston.

Manly, B.F.J. 2009. Statistics for Environmental Science and Management. 2nd edition. CRC Press, Boca Raton, Florida, USA.

Manville, A. M. II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Division of Migratory Bird Management, Service, Arlington, VA, peer-reviewed briefing paper.

Master, L.L., B.A. Stein, L.S. Kutner and G.A. Hammerson. 2000. Vanishing Assets: Conservation Status of U.S. Species. pp. 93-118 IN B.A. Stein, L.S. Kutner and J.S. Adams (eds.). Precious Heritage: the Status of Biodiversity in the United States. Oxford University Press, New York. 399 pages. ("S1, S2, S3; G1, G2, G3")

McDonald, T.L. 2003. Review of environmental monitoring methods: survey designs. Environmental Monitoring and Assessment 85(2): 277-92.

Morrison, M.L., W.M. Block, M.D. Strickland, B.A. Collier, and M.J. Peterson. 2008. Wildlife Study Design. Second Edition. Springer, New York, New York, USA. 358 pp.

Murray, C. and D. Marmorek. 2003. Chapter 24: Adaptive Management and Ecological Restoration. In: P. Freiderici (ed.), Ecological Restoration of Southwestern Ponderosa Pine Forests. Island Press, Washington, California, and London. Pp. 417-28.

National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press. Washington, D.C., USA. www.nap.edu

National Wind Coordinating Collaborative. 2010. Wind Turbine Interactions with Birds, Bats and Their Habitats: A Summary of Research Results and Priority Questions. NWCC Spring 2010 Fact Sheet.

O'Farrell, M.J., B.W. Miller, and W.L. Gannon. 1999. Qualitative Identification of Free-Flying Bats Using the Anabat Detector. Journal of Mammalogy 80(1): 11-23.

Olson, D., W.P. Leonard, and B.R. Bury, eds. 1997. Sampling Amphibians in Lentic Habitats: Methods and Approaches for the Pacific Northwest. Society for Northwestern Vertebrate Biology, Olympia, Washington, USA.

Organ, A. & Meredith, C. 2004. 2004 Avifauna Monitoring for the proposed Dollar Wind Farm – Updated Risk Modeling. Biosis Research Pty. Ltd. Report for Dollar Wind Farm Pty. Ltd.

Orloff, S. and A. Flannery. 1992. Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report P700-92-001 to Alameda, Costra Costa, and Solano Counties, and the California Energy Commission by Biosystems Analysis, Inc., Tiburon, California, USA.

Pearce-Higgins, J.W., L. Stephen, R.H.W. Langston, & J.A. Bright. (2008) Assessing the cumulative impacts of wind farms on peatland birds: a case study of golden plover Pluvialis apricaria in Scotland. Mires and Peat, 4(01), 1–13.

Pennsylvania Game Commission (PGC). 2007. Wind Energy Voluntary Cooperation Agreement. Pennsylvania Game Commission, USA. http://www.pgc.state.pa.us/pgc/lib/pgc/programs/voluntary_agreement.pdf

Pierson, E.D., M.C. Wackenhut, J.S. Altenbach, P. Bradley, P. Call, D.L. Genter, C.E. Harris, B.L. Keller, B. Lengas, L. Lewis, B. Luce, K.W. Navo, J.M. Perkins, S. Smith, and L. Welch. 1999. Species Conservation Assessment and Strategy for Townsend's Big-Eared Bat (Corynorhinus townsendii townsendii and Corynorhinus townsendii pallescens). Idaho Conservation Effort, Idaho Department of Fish and Game, Boise, Idaho, USA.

Pitman, J.C., C.A. Hagen, R.J. Robel, T.M. Loughlin, and R.D. Applegate. 2005. Location and Success of Lesser Prairie-Chicken Nests in Relation to Vegetation and Human Disturbance. Journal of Wildlife Management 69(3):1259-69.

Pruett, C.L., M.A. Patten and D.H. Wolfe. Avoidance Behavior by Prairie Grouse: Implications for Development of Wind Energy. Conservation Biology. 23(5):1253-59.

Rainey, W.E. 1995. Tools for Low-Disturbance Monitoring of Bat Activity. In: Inactive Mines as Bat Habitat: Guidelines for Research, Survey, Monitoring, and Mine Management in Nevada. B. R. Riddle, ed. Biological Resources Research Center, University of Nevada-Reno, Reno, Nevada, USA.148 pp.

Ralph, C. John; Geupel, Geoffrey R.; Pyle, Peter; Martin, Thomas E.; DeSante, David F. 1993.

Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144-www. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p.

Ralph, C.J., J.R. Sauer, and S. Droege, eds. 1995. Monitoring Bird Populations by Point Counts. U.S. Department of Agriculture, Forest Service General Technical Report PSW-GTR-149.

Reynolds R.T., J.M. Scott, R.A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor. 82(3):309–13.

Richardson, W.J. 2000. Bird Migration and Wind Turbines: Migration Timing, Flight Behavior, and Collision Risk. In: Proceedings of the National Avian Wind Power Planning Meeting III (PNAWPPM-III). LGL Ltd., Environmental Research Associates, King City, Ontario, Canada, San Diego, California. www.nationalwind.org/publications/wildlife/avian98/20-Richardson-Migration.pdf

"Rivers and Harbors Act." Protection of Navigable Waters and of Rivers and of Harbor and River Improvements Generally. Title 33 U.S. Code, Sec. 401 et. seq. 2006 ed., 42-84. Print.

Robel, R.J., J. A. Harrington, Jr., C.A. Hagen, J.C. Pitman, and R.R. Reker. 2004. Effect of Energy Development and Human Activity on the Use of Sand Sagebrush Habitat by Lesser Prairie-Chickens in Southwestern Kansas. North American Wildlife and Natural Resources Conference 69: 251-66.

Sawyer, H., R.M. Nielson, F. Lindzey, and L.L. McDonald. 2006. Winter Habitat Selection of Mule Deer Before and During Development of a Natural Gas Field. Journal of Wildlife Management 70(2): 396-403. http://www.west-inc.com

Shaffer, J.A. and D.H. Johnson. 2008. Displacement Effects of Wind Developments on Grassland Birds in the Northern Great Plains. Presented at the Wind Wildlife Research Meeting VII, Milwaukee, Wisconsin, USA. Wind Wildlife Research Meeting VII Plenary. http://www.nationalwind.org/pdf/ShafferJill.pdf

Sherwin, R.E., W.L. Gannon, and J.S. Altenbach. 2003. Managing Complex Systems Simply: Understanding Inherent Variation in the Use of Roosts by Townsend's Big-Eared Bat. Wildlife Society Bulletin 31(1): 62-72.

Smallwood, K.S. and C.G. Thelander. 2004. Developing Methods to Reduce Bird Fatalities in the Altamont Wind Resource Area. Final report prepared by BioResource Consultants to the California Energy Commission, Public Interest Energy Research-Environmental Area, Contract No. 500-01-019; L. Spiegel, Project Manager.

Smallwood, K.S. and C.G. Thelander. 2005. Bird Mortality at the Altamont Pass Wind Resource Area: March 1998 - September 2001. Final report to the National Renewable Energy Laboratory, Subcontract No. TAT-8-18209-01 prepared by BioResource Consultants, Ojai, California, USA.

Smallwood, K.S. 2007. Estimating Wind Turbine-Caused Bird Mortality. Journal of Wildlife Management 71(8): 2781-91.

Stewart, G.B., A.S. Pullin and C.F. Coles. 2007. Poor evidence-base for assessment of windfarm impacts on birds. Environmental Conservation 34(1):1:1-11.

Strickland, M.D., G. Johnson and W.P. Erickson. 2002. Application of methods and metrics at the Buffalo Ridge Minnesota Wind Plant. Invited Paper. EPRI Workshop on Avian Interactions with Wind Power Facilities, Jackson, WY, October 16-17, 2002.

Strickland, M. D., E. B. Arnett, W. P. Erickson, D. H. Johnson, G. D. Johnson, M. L., Morrison, J.A. Shaffer, and W. Warren-Hicks. In Review. Studying Wind Energy/Wildlife Interactions: a Guidance Document. Prepared for the National Wind Coordinating Collaborative, Washington, D.C., USA.

Suter, G.W. and J.L. Jones. 1981. Criteria for Golden Eagle, Ferruginous Hawk, and Prairie Falcon Nest Site Protection. Journal of Raptor Research 15(1): 12-18.

Urquhart, N.S., S.G. Paulsen, and D.P. Larsen. 1998. Monitoring for policy-relevant regional trends over time. Ecological Applications 8(2):246-57.

U.S. Fish and Wildlife Service. 2009. DRAFT Rising to the Challenge: Strategic Plan for Responding to Accelerating Climate Change.

U.S. Fish and Wildlife Service Mitigation Policy; Notice of Final Policy, 46 Fed. Reg. 7644-7663 (January 23, 1981). Print.

Vodehnal. W.L., and J.B. Haufler, Compilers. 2007. A grassland conservation plan for prairie grouse. North American Grouse Partnership. Fruita, CO.

Walters, C. J., and C. S. Holling. 1990. Large-scale management experiments and learning by doing. Ecology 71(6): 2060–68.

Weller, T.J. 2007. Evaluating Preconstruction Sampling Regimes for Assessing Patterns of Bat Activity at a Wind Energy Development in Southern California. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-01-037.

Williams, T.C., J.M. Williams, P.G. Williams, and P. Stokstad. 2001. Bird migration through a mountain pass studied with high resolution radar, ceilometers, and census. The Auk 118(2):389-403.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Appendix C: Sources of Information Pertaining to Methods to Assess Impacts to Wildlife

The following is an initial list of references that provide further information on survey and monitoring methods. Additional sources may be available.

Anderson, R., M. Morrison, K. Sinclair, D. Strickland. 1999. Studying wind energy and bird interactions: a guidance document. National Wind Coordinating Collaborative (NWCC). Washington, D.C.

Bird D.M., and K.L. Bildstein, (eds). 2007. Raptor Research and Management Techniques. Hancock House Publishers, Surrey, British Columbia.

Braun. C.E. (ed). 2005. Techniques for Wildlife Investigations and Management. The Wildlife Society. Bethesda, MD.

California Bat Working Group. 2006. Guidelines for assessing and minimizing impacts to bats at wind energy development sites in California. http://www.wbwg.org/conservation/papers/CBWGwindenergyguidelines.pdf

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development Commission Final Report. http://www.energy.ca.gov/windguidelines/index.html

Corn, P.S. and R.B. Bury. 1990. Sampling Methods for Terrestrial Amphibians and Reptiles, Gen. Tech. Rep. PNW-GTR-256. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Environment Canada's Canadian Wildlife Service. 2006. Wind turbines and birds, a guidance document for environmental assessment. March version 6. EC/CWS, Gatineau, Quebec. 50 pp.

Environment Canada's Canadian Wildlife Service. 2006. Recommended protocols for monitoring impacts of wind turbines and birds. July 28 final document. EC/CWS, Gatineau, Quebec. 33 pp.

Heyer, W.R., M.A. Donnelley, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (Eds.) 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press. Washington, D.C., USA.

Knutson, M. G., N. P. Danz, T. W. Sutherland, and B. R. Gray. 2008. Landbird Monitoring Protocol for the U.S. Fish and Wildlife Service, Midwest and Northeast Regions, Version 1. Biological Monitoring Team Technical Report BMT-2008-01. U.S. Fish and Wildlife Service, La Crosse, WI.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: a guidance document. Journal Wildlife Management 71:2249-2486.

Kunz, T.H. and S. Parsons, eds. 2009. Ecological and Behavioral Methods for the Study of Bats. Second Edition. Johns Hopkins University Press.

Oklahoma Lesser-Prairie Chicken Spatial Planning Tool, at http://wildlifedepartment.com/lepcdevelopmentplanning.htm, Citation: Horton, R., L. Bell, C. M. O'Meilia, M. McLachlan, C. Hise, D. Wolfe, D. Elmore and J.D. Strong. 2010. A Spatially-Based Planning Tool Designed to Reduce Negative Effects of Development on the Lesser Prairie-Chicken (Tympanuchus pallidicinctus) in Oklahoma: A Multi-Entity Collaboration to Promote Lesser Prairie-Chicken Voluntary Habitat Conservation and Prioritized Management Actions. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 79 pp. http://www.wildlifedepartment.com/lepcdevelopmentplanning.htm

Ralph, C. J., G. R. Geupel, P. Pyle, T.E. Martin, E. Thomas, D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144-www. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p.

Ralph C.J, J.R. Sauer, S. Droege (Tech. Eds). 1995. Monitoring Bird Populations by Point Counts. U.S. Forest Service General Technical Report PSW-GTR-149, Pacific Southwest Research Station, Albany, California. iv 187 pp.

Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A. Shaffer, and W. Warren-Hicks. 2011. Comprehensive Guide to Studying Wind Energy/Wildlife Interactions. Prepared for the National Wind Coordinating Collaborative, Washington, D.C. USA.

Wilson, D. E., F.R. Cole, J.D. Nichols, R. Rudra and M.S. Foster (Eds). 1996. Measuring and monitoring biological diversity: standard methods for mammals. Smithsonian Institution Press. Washington, D.C., USA.

U.S. Fish & Wildlife Service
http://www.fws.gov

March 2012

Evaluation of Icebreaker Wind project vendor proposals for radar-based monitoring of flying animals

---

Prepared for:

Lake Erie Energy Development Corporation (LEEDCo)

Prepared by:

Robert H. Diehl
Research Ecologist
U.S. Geological Survey
Northern Rocky Mountain Science Center
Bozeman, MT

December 2017

Table of contents

I. Executive Summary

This report evaluates different radar data collection options proposed by vendors responding to a Lake Erie Energy Development Corporation request for information in relation to a wind energy facility, the Icebreaker Wind project, proposed for western Lake Erie. *The evaluation considers five vendor options proposed by three vendors,* here referred to as VendorA, VendorB, and VendorC, and is based on 15 different criteria and informed by a variety of radar-related concepts. Among the most important *criteria are concern over the ability to gather data on altitude-specific migration traffic* rate or density and behavioral response to turbine presence (pre- versus post-construction), and the ability do so with high reliability while avoiding contamination by clutter, primarily from insects and the lake surface. The evaluation was based solely on the ability of these systems to provide useful data toward the goal of understanding the biology of the airspace under review; no consideration was given to vendor cost estimates.

Initial examination of these criteria narrowed the field to two options referred to as VendorA and VendorC (Option2). For reasons expanded upon below, VendorA proposed the approach most likely to succeed among vendor responses and other information provided that forms the basis of this evaluation. This should not be taken to mean VendorA's approach is not without concern, particularly over the ability to track targets in an offshore setting where sea clutter will likely pose a persistent problem that is magnified by a rolling and pitching barge.

Owing to perceived shortcomings of vendor responses, the report concludes by seeking to identify an approach to address the challenge of monitoring vertebrate behavior in an offshore setting that would increase the likelihood of gathering useful data. For this reason, I suggest numerous modifications to VendorA's approach. *I also* suggest a couple alternative radar configurations that represent advances or variations on some of the vendor design options that may increase the likelihood of gathering useful data in an offshore setting.

II. Introduction

This opinion is offered to inform on how pre- and post-construction biological radar data is gathered in relation to the offshore Icebreaker Wind project proposed for an area within Lake Erie approximately 14 km northwest of Cleveland, Ohio. The report evaluates five vendor options to the Lake Erie Energy Development Corporation (LEEDCo) Request for Information (RFI) from three separate vendors referred to here as VendorA, VendorB, and VendorC. The number of options is necessarily constrained by the limited number of vendor responses, and one wonders what radar configurations might be available from other vendors and whether they might represent more suitable solutions. Although the vendor proposals considered here are specific to this case, certain aspects of the evaluation may have application in other settings.

Among other things, the best radar solutions will minimize ambiguity on the identity of the targets while simultaneously gathering the most accurate data on target altitude and lateral position. The kinds of radar units that come closest to that capability, portable tracking radars (Larkin and Diehl 2012), are rare in biological circles (to my knowledge there are three in the world), because they are costly to acquire and challenging to maintain. Therefore, most studies of this type necessarily make compromises owing to the limits of readily available and affordable technology, and an evaluation of this kind necessarily examines those trade-offs.

The evaluation is narrowly defined. Documents reviewed for this opinion include the LEEDCo RFI, all vendor responses to the RFI, vendor responses to US Fish and Wildlife Service (USFWS) questions, USFWS suggested study characteristics, the WEST, Inc review of RFI responses, and some LEEDCo application figures and exhibits. The report is also informed by discussions with LEEDCo/WEST and biologists within the USFWS. The evaluation was based solely on the ability of these systems to provide quality data toward the goal of understanding the biology of the airspace under review; no consideration was given to vendor cost estimates. Also, this is strictly a technical evaluation of remote sensing equipment (radar) that in no way endorses any specific vendor or takes a position on the proposed wind development itself.

The radar hardware available for these studies consists of repurposed commercial-off-the-shelf (COTS) marine-grade units commonly used for navigation by ships of varying sizes. Although companies deploying these units make at best modest changes to radar hardware (usually the antenna), they often develop sophisticated software processing capabilities to better accommodate the biological mission of these radars. Often the details of post-processing algorithms and the extent to which their performance has been assessed against verified datasets are not known as they are considered trade secrets. As such, I am in a poor position to evaluate certain claims made by vendors about their software capabilities (e.g., target discrimination) except where those claims intersect with the more evident capabilities of their hardware. I am also not evaluating non-radar remote sensing technologies or other forms of data collection that might inform on metrics relevant to this wind facility (e.g., methods for detecting and quantifying animal-rotor impacts in offshore settings).

It is recognized that this report may be received as guidance concerning radar data collection in relation to other wind energy projects. Caution in this regard is advised. The concepts discussed here may not apply elsewhere, since environmental, biological, and geographical circumstances vary from project to project. Also, as with all technologies, advances in hardware and software capabilities are expected that should improve airspace monitoring. With this in mind, I follow my conclusions by offering some alternative approaches for radar data collection that may improve on some of the shortcomings present among vendor proposals. In this way, the report attempts, however modestly, to live beyond its immediate suggestions regarding current vendor capabilities.

III. Basis for Evaluation

The LEEDCo RFI calls for study seasons generally consistent with the timing of passerine migration; in fall from 15 August to 31 October, and in spring from 15 April to 31 May. Knowing the primary biological targets of interest, small migratory songbirds and bats (hereafter "vertebrates" except where otherwise appropriate), is relevant to the evaluation, since the efficacy of proposed radar design and operational characteristics varies depending on the animals under consideration. As for larger birds, aerial surveys will map diurnal waterbird distributions. However, waterbirds may be diurnal or nocturnal migrants and subject to the same vulnerabilities as the smaller vertebrates that are the focus of this study. The study design should consider expanding current field seasons to include dates associated with migrating waterbirds. Viable radar operation, data collection, and reporting as described by vendors are evaluated based on the following criteria. These are coded respectively by topic (O#, D#, R#) for reference later in the report.

a. Operation

O1. Operation overseen by trained or experienced technicians

O2. Data collection monitored by on-site personnel or remotely monitored to ensure continuous operation with minimal interruption during study periods

O3. Hardware suitably armored against harsh environment conditions

O4. Radar setting sufficient to allow threshold levels (≥80%, as specified in the RFI) of reliable data collection with minimal impact from sea clutter and other sources of motion-based noise

b. Data collection

D1. Automated and continuous operation during the study period with data collection occurring during ≥80% of the study period where precipitation does not obscure data (in two-radar systems, this threshold applies to both radars individually since they gather complementary data). Data collection occurs throughout the diel without bias, or with bias in favor of periods when vertebrate movement is at a low ebb.

D2. Radars capable of gathering data on sufficient numbers of vertebrates to produce a statistically reliable estimate of key behaviors with hourly or better temporal resolution

D3. Methods of target recognition minimize the presence of insects while maximizing the inclusion of vertebrates in resulting datasets

D4. Data gathered on target direction, ground speed, and altitude; not necessarily on the same individual

D5. Noise mitigation sufficient to cope with a highly dynamic clutter environment that includes aircraft, sea clutter, and other non-target sources of radar echo

D6. Horizontal and vertical range capabilities of radars sufficient to capture vertebrate movements over an area representative of the scale of the proposed development, especially with respect to the rotor swept area

D7. Radar observations supported by collection of on-site weather information that includes data on wind speed and direction, temperature, and air pressure with high temporal resolution

D8. Use of the same system, approach, and setting for both pre- and post-construction studies to help ensure data comparability

c. Reporting

R1. Altitude-specific traffic rate and/or density and ability to detect evidence of avoidance/attraction behavior in post-construction studies

R2. Methods of quantification account for sources of variation (i.e., detection probability which is a function of sample volume, gain, radar cross-section (RCS), wavelength) which could introduce bias in traffic rate or density estimates, coverage, or other metrics

R3. Study reports provide a clear presentation of results and fully describe methodological approaches

IV. Supporting Concepts

The Basis for Evaluation (III) considers a range of technical issues associated with radar-based data collection on the detection and behavior of flying animals. Below I briefly review some of the topics taken into account in considering vendor proposals. Because many trade-offs exist among the various topics, I cross-reference between topics where appropriate.

a. Antennas

Two different types of antennas are proposed among the vendor responses to the RFI. Open-array antennas, also referred to as a T-bar antennas, are usually COTS antennas that produce a non-radially symmetric fan beam pattern. Operating in the horizontal plane, open-array antennas produce a 'narrow' yet 'tall' beam pattern that generally produces moderate gain. By contrast, parabolic antennas produce a usually narrow radially symmetric beam pattern, sometimes referred to as a pencil beam.

There are trade-offs to these antennas for biological applications. Open-array antennas are generally capable of covering much larger airspaces in a single sweep and require no or little hardware modification. This may leave them more susceptible to gathering data on >1 target within a single sample volume, which can complicate target identity and tracking though this is usually a minor concern. Use of parabolic antennas in biological portable radar work has a long history (e.g., Bruderer and Steidinger 1972). Relatively few radar operations outside academia deploy radars refit to accept parabolic antennas, presumably owing primarily to differences in the nature of their use. They generally sweep out smaller airspaces which may be a disadvantage in circumstances where rapid comprehensive coverage is considered necessary (e.g., airport monitoring for large birds). Parabolic antennas produce a relatively discrete beam pattern and concentrate radio energy in ways that often produce considerable gain. Gain varies with the diameter of the antenna, radar wavelength (IV.h), and RCS of the target (IV.g), and higher gain enables radar sampling at longer ranges than open-array antennas, all else being equal. They also possess much greater ability to locate flying animals in 3-dimensional space, a capability open-array antennas cannot reliably claim.

Depending on the nature of their deployment, antenna types differ in their susceptibility to sea clutter, but all are susceptible (IV.c). COTS open-array antennas operating in the horizontal plane are highly susceptible to sea clutter. Clutter persists even when these antennas are angled in an attempt to elevate the base of the radar beam above the sea surface. The same antennas rotating in the vertical plane are susceptible to clutter when sweeping through the horizon and from ~90° side lobes. Parabolic antennas operating at low elevation are also highly susceptible to sea clutter owing to the presence and impact of side lobes that may themselves have appreciable gain (e.g., Skolnik 1980, pg. 224). The discrete beam pattern of parabolic antennas allows them to be elevated above the horizon so as to potentially avoid some of the impacts from sea clutter. In this way (and not necessarily in relation to target 'tracking') either an open-array antenna rotating in the vertical plane or a parabolic antenna considerably elevated above the horizon may be less susceptible to sea clutter and the movement of a floating platform (IV.e) than an open-array antenna operating in the horizontal plane.

b. Aspect

All radar operations will be influenced by aspect, or body orientation with respect to the radar whereby flying animals are more readily detected side-on than head- or tail-on. The extent that aspect impacts quantification by radar varies depending on a variety of factors, not least the manner of data collection and the degree that movements of flying animals exhibit shared orientation. Data on the heights of flying animals gathered by open-array antennas rotating in the vertical plane may be susceptible to variation in body orientation in ways that may impact quantification. When the vertical plane of rotation is parallel to the general direction of movement, flying animals produce long track lengths. However, detection probability decreases on the horizons, since animals detected head- or tail-on produce a smaller RCS. The effect may be particularly acute at S-band if animals detected head- or tail-on become weak Rayleigh scatterers (e.g., Drake and Reynolds 2012, pg. 52). Alternatively, if the plane of rotation is perpendicular to the general direction of animal movement, the radar detects animals side-on throughout its rotation, and the detection probability should be uniform. Heights determined using elevated parabolic antennas may be less susceptible to variation in aspect, because part of the horizontal rotation is always perpendicular to the movement. (This is also true of open-array antennas rotating in the horizontal plane, sans information on height.) Also, animals moving toward or away from a radar are detected obliquely by an elevated beam rather than directly head- or tail-on which should produce higher RCS, all else being equal.

c. Clutter

In broadest terms, clutter refers to unwanted radar scatter. Sources of clutter for these purposes include insects, instances where multiple weather (usually precipitation), the sea surface (sea clutter), boats, planes, and turbines in post-construction studies. All vendors consider clutter and offer varying solutions in their reported ability to cope with it. However, sea clutter is a pernicious problem that even a fixed platform is unlikely to resolve. Open-array antennas operating horizontally from a fixed platform over open water experience severe clutter and the problem persists with open-array antennas rotating in the vertical plane and parabolic antennas (S. Gauthreaux, pers. comm.).

d. Data impacts

Missing data can occur for a variety of not necessarily independent reasons including limits to radar equipment, loss of power, malfunction of data gathering equipment, unfavorable data gathering conditions (IV.c, IV.e), and human error. The impact may be local; for example, most magnetron-based radars used in biological research experience a brief period of time during transmission when the radar is essentially deaf to its own echoes. This period is called a main bang or simply bang, and as a result, targets very near the radar are generally undetectable. Data impacts also occur at a seasonal scale; for example, a standard for how much data is necessary to adequately represent seasonal vertebrate movement (≥80%) has been proposed for this project. There is concern that excessive loss of data may render observations related to migratory passage moot if they fail to capture the occasional yet unpredictable large movements that almost inevitably occur with songbird migration. While considerable effort should be made to ensure a robust operation is in place, data loss or drop outs will likely occur.

Comparing data collection during calm and rough sea days would allow assessment of whether data was compromised during poor weather conditions in an effort to inform future sampling efforts. The primary cause of compromised data would likely be the inability to acquire or maintain tracks through successive sweeps of the radar either owing to sea clutter or barge movement. Clutter from the sea and other sources can cause tracking algorithms to produce false tracks that are spurious. Motion of the barge may also cause a target to be dropped and reacquired which may be interpreted as a separate track depending on the sophistication of the tracking software. If present, both of these factors can artificially inflate estimates of traffic rate. The magnitude of these errors would be expected to vary with conditions and the manner in which data were collected.

To help determine the meaningfulness of such loss, it may be useful to supplement offshore radar data collection with analysis of contemporaneous data from the fortuitously close Cleveland, OH NEXRAD station (KCLE). Advances in NEXRAD quantification enable estimates of vertebrate density (Chilson et al. 2012) that could be used to verify migration traffic rate (MTR) or density estimates determined by portable radar. This form of corroboration would help ensure any data drops did not correspond with particularly large migratory movements during the study, recognizing that this approach is imperfect given the complexity of movements that may occur in the vicinity of coasts (Archibald et al. 2017, Diehl et al. 2003) and that KCLE has an imperfect view of low altitude movements (Nations and Gordon 2017).

e. Platforms

Two platforms have been considered for this work, although all vendors propose to deploy radars on a floating barge anchored at four points to minimize platform movement. An alternative is to construct a fixed monitoring platform embedded in the lake bed. The latter has the distinct advantage of being stable in all lake conditions, whereas a floating platform will roll, pitch, and yaw in response to wave action. Differences of opinion exist regarding the practicality of establishing a fixed platform, a concern that is beyond the scope of this evaluation, although I again note here that a fixed platform is unlikely to address the problem of sea clutter (IV.c). Floating platforms have been used to gather radar data on biological targets for many years in support of both basic and applied biology (e.g., Larkin et al. 1979, Alerstam et al. 2001, Desholm et al. 2004).

As an alternative to construction of a fixed platform, vendors could mount just the radar to a stabilizing gimbal fastened to the barge. Vendors do not advocate such an approach, presumably owing to cost and complexity, and an evaluation of the costs and benefits of adopting this approach is beyond the scope of this evaluation. Motion of the platform will necessarily introduce errors into all movement-based radar metrics. Although these would tend to average out assuming no systematic bias in barge movement, certain observations of individual movements may be more sensitive to barge motion (e.g., the movements of animals in the vicinity of turbines in a post-construction study). The effects of barge movement on radar-determined animal movement data can in principle be corrected by sampling the three axes of a vessel-mounted gimbal or inertial measurement unit and use those data to adjust target position observations (Larkin et al. 1979).

f. Post-construction

Response by birds and bats to the presence of wind turbines may be studied as a comparison between pre- and post-construction behavior, which is facilitated by adopting the same study design before and after construction. Detection of behavior consistent with avoidance or attraction during post-construction then becomes a consideration in evaluating vendor options.

Birds and bats may respond differently to turbines with some indication that birds may largely avoid turbines while bats may be attracted (Cryan et al. 2014); however, this is an ongoing area of research. Turbine avoidance will usually take two general forms: lateral change in direction or change in height. Horizontal avoidance of turbines by flying animals moving laterally may be detectable by most radar systems using antennas rotating in the horizontal plane (e.g., Desholm and Kahlert 2005) unless that avoidance behavior occurs within the clutter field of the turbine or is disrupted by sea clutter. Avoidance by increasing height poses different and in some ways greater detection challenges for radar. Detecting change in height may manifest primarily in two different ways that depend largely on radar siting and/or antenna positioning with respect to a turbine. An open-array antenna rotating in the vertical plane can capture these movements for a given turbine for animals approaching from a given direction if the radar is properly sited. A parabolic antenna rotating in the horizontal plane but properly elevated may also capture behavior consistent with these movements, perhaps independent of animals approaching direction and in such a way as to avoid turbine clutter (IV.c).

Attraction to turbines by flying animals might be expected to produce much the opposite behavioral patterns on radar, although the nature of attraction necessarily moves the animal closer to a primary source of clutter. Clutter produced by turbines is dynamic and often obscures nearby animal movement, so the range from the turbine at which flying animals respond matters and may vary with turbine visibility which in turn likely varies with ambient light conditions (e.g., day versus night, moonlight, anthropogenic light).

g. Target identity

Knowing with reasonable certainty the identity of radar targets is arguably one of the greatest challenges facing radar biology and one of the most important to get right. Even "identity" is subject to some interpretation as it could refer to any of a number of taxonomic levels. Depending on certain radar metrics and our knowledge of animal morphology, behavior, and natural history, radar targets may be identified down to species (e.g., O'Neal et al. 2010) or at best to phylum (e.g., most other radar studies that attempt target discrimination). Considerable room for uncertainty in identity is created by the combined effects of the diversity of flying animals, their overlapping biology, and the wide range of hardware, software, and operational properties of radars. All else being equal, as one moves toward more coarse taxonomic classifications, flying animals tend to diverge in their biology and natural history in ways that make them more distinguishable on radar (i.e., it is considerably easier to distinguish vertebrates from insects than it is warblers from thrushes).

Biologists have long sought the ability to distinguishing different target types by their radar parameters. Radars are capable of generating a number of metrics on flying animals including speed, direction, height, track, wingbeat rate, wing flap behavior, RCS, orientation, and in many cases change and rates of change for these metrics.

Given the hazards posed by wind turbines to bats in particular, there is considerable interest in being able to reliably distinguish birds from bats via radar so as to apportion the hazard. Despite their taxonomic differences, convergent evolution together with certain allometric constraints have contributed to there being considerable overlap in the size and behavior of many bird and bat species. Erratic flight often attributed to bats is not necessarily a reliable distinguishing characteristic of bats; bats may well engage in straight-line flight similar to most nocturnal migratory birds, and the flight paths of some bird species can be quite erratic (e.g., common nighthawks, swallows). To date, no published radar methods reliably distinguish bird from bat echoes based on radar properties alone. This is not to be confused with highly reliable radar data on bats captured under idiosyncratic circumstances where knowledge of natural history, not the radar metrics themselves, offers high confidence in the identity of the biological target (e.g., Mirkovic et al. 2016, Horn and Kunz 2008). Fittingly, no vendor specifically identifies the ability to distinguish small birds from bats in radar data, but two give some consideration to distinguishing vertebrates from insects.

Currently, the three primary approaches for attempting to distinguish vertebrates from insects are based on 1) RCS, 2) airspeed, and 3) wingbeat rate. All have advantages and disadvantage. Two of these approaches, RCS and wingbeat rate, are considered among vendor responses. Currently, use of wingbeat rate is considered the most accurate approach to distinguishing vertebrates from insects.

Airspeed

A flying animal's airspeed is its rate of movement with respect to the surrounding air (Gauthreaux and Belser 1998), and vertebrates may be broadly distinguishable from insects by their airspeeds. Vertebrates often exhibit powered flight that produces high airspeeds relative to their insect counterparts which are generally weaker fliers that often essentially drift with the wind and therefore exhibit relatively low airspeeds. Radars measure the ground speed of flying animals, the rate of movement with respect to the ground. Ground speed results from the combined influence of an animal's airspeed and wind speed. A flying animal with an airspeed of 5 $m \cdot s^{-1}$ flying in the same direction as a 5 $m \cdot s^{-1}$ wind will have a 10 $m \cdot s^{-1}$ ground speed. Under windless conditions, ground speed equals airspeed. If local altitude specific wind conditions are known, the wind vector can be subtracted from an animal's ground speed to yield the animal's airspeed. Airspeeds below, say, 7 $m \cdot s^{-1}$ (the thresholds have varied over the years), are more likely insects (Larkin 1991).

Although it does have advantages, the airspeed approach to discrimination is relatively crude. Vertebrate and insect airspeed distributions overlap considerably (Larkin 1991). Vertebrate airspeeds may easily fall below specified thresholds, while not all insects are weak fliers. A more conservative approach would set two thresholds between which targets would be categorized as 'ambiguous'; although the arbitrariness of the thresholds matters, there is the risk of consistently and unwittingly excluding species that classify as ambiguous, and far too many meaningful targets may be excluded from further analysis. There are also challenges to knowing wind conditions at an animal's altitude, especially at sea where only surface data will be collected. Often, surface wind measures are correlated with winds aloft, especially over the low altitudes that concern wind energy. However, wind shear over short altitudinal distances occurs and will introduce error into airspeed estimates. The usual solution to this is to routinely launch radiosondes, an option not available to radar operations considered here, at least not at the radar site. Advantages of this method include that it can be applied using data from widely used track-while-scan radars operating in the horizontal plane; it is independent of operating frequency or antenna type, and it does not rely on sophisticated software for computation.

Radar cross-section

Wavelength matters (IV.h). Arguably one of the great advantages of S-band radar with respect to target discrimination is the theoretically reduced impact of insect clutter (IV.c) in the data. At S-band, most insects are likely to be so-called Rayleigh scatterers, meaning they produce reliably weak radar echoes relative to their larger vertebrate counterparts. This has implications for the resulting biological data. First, the presence of insect clutter should be considerably reduced, especially at range where power density within the radar beam is sufficiently weak that insect echoes are below the noise threshold of the radar (i.e., undetectable). Also, when weak insect echoes do occur, it may be possible to design either real-time or post-processing algorithms that can reliably remove much of this clutter by threshold filtering on RCS. However, owing to their longer wavelengths, S-band radars likely also inadvertently remove small vertebrates in ways that cannot be easily resolved. X-band radars tend to have the opposite problem.

One of the challenges of using X-band radar to study vertebrates is its susceptibility to biological clutter from insects (IV.h). At X-band, small- to mid-sized vertebrates and large insects return radar echoes that are non-linearly related to the actual size of the animal (Vaughan 1985). For these so-called Mie or resonance scatterers, an animal's actual size cannot be readily inferred from its RCS; some insects can actually produce larger echoes than vertebrates. For this reason, insects cannot reliably be removed from radar data by relatively simple RCS thresholding at X-band (Fig. 1), and vendor approaches that use RCS thresholding risk including some large

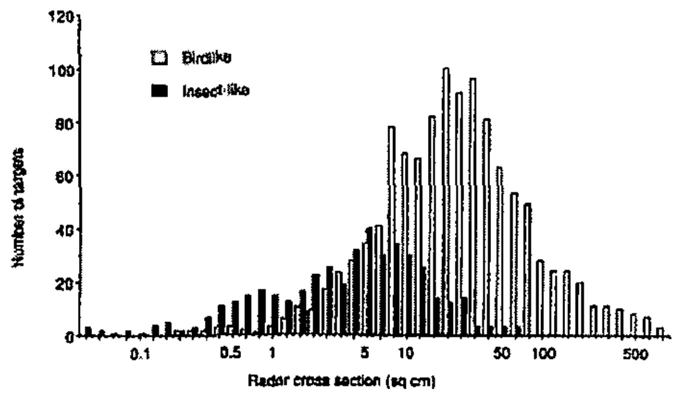


Fig. 2. Estimated radar cross section, σ, of all birdlike ($n = 1159$) (*unshaded bars*) and insectlike ($n = 438$) (*solid bars*) targets for which wing beat data were available

Figure 1. X-band radar cross-sections of bird-like and insect-like targets determined by wing beat rate. Consistent with Drake and Reynolds (2012, pg127) there is considerable overlap between targets types for cross-sections measuring 1-10 cm^2 (from Larkin 1991).

insects and rejecting some small vertebrates. This may be a particular concern for the wind energy industry (which presumably is not interested in deterrence or mitigation associated with insects) if, for example, on a given night insects happen to fly at lower altitudes than vertebrates. As with airspeed, a more conservative approach would set two RCS thresholds between which targets would be categorized as 'ambiguous'. Here again the arbitrariness of the thresholds matters, as there is the risk of consistently and unwittingly excluding species that classify as ambiguous, and far too many meaningful targets may be excluded from further analysis. A more accurate approach might require targets to satisfy both RCS and airspeed thresholds to be classified as vertebrates.

Wingbeat rate

Wingbeat rate is considered the most reliable method of distinguishing vertebrates from insects (Schmaljohann et al. 2008). Both wingbeat rate and airspeed-based approaches are also less aspect (IV.b) dependent than RCS-based discrimination. Like RCS, wingbeat rate measurement occurs entirely within the radar domain, no external data sources are required as with airspeed-based discrimination. Insects tend to beat their wings at much higher rates than vertebrates (Drake and Reynolds 2012) which allows for less ambiguous threshold-based discrimination than with other methods. Moreover, the wingbeat patterns themselves aid in discrimination; for example, flap-coast wing beating is characteristic of many bird species.

Measuring wing beat rate requires software and hardware modifications and data sampling procedures that, while relatively well understood, are not common. Multiple vendors already possess some of the necessary software infrastructure (e.g., high-speed AD sampling of radar 'video' signal) upon which to build this capability. The radar beam must be positioned to dwell on the flying animal for a duration long enough to estimate wingbeat rate, generally a half second or longer. This is not possible with the usual antenna rotation scheme found in COTS radars and employed by all vendors. VendorB is able to discriminate using wingbeat rate by rotating a parabolic antenna about a vertical axis thereby sufficiently increasing dwell time on the target. Other applications of this method would require stationary beam sampling strategies (unfamiliar to most users) to obtain wingbeat records. This requires hardware modifications to control antenna position in both elevation and azimuth (VII.a).

h. Wavelength

Vendor responses to the RFI included a total of five radar deployment options, four of those options propose use of X-band (~3-cm wavelength) radars, and one an S-band (~10-cm wavelength) radar. The different bands have numerous advantages and disadvantages, perhaps most relevant among them for these purposes concerns target discrimination in relation to RCS (IV.g).

V. Vendor Proposals

All vendors propose to use an anchored barge as a platform to conduct radar operations (IV.e). Each vendor response is evaluated in part in relation to the ability of their proposed operation to accommodate platform movement owing to sea state. In all cases, it appears vendors propose to work remotely through LEEDCo or some other representative rather than maintain experienced staff on site (III.a.O1). Although the latter is the more desirable approach, remote operation can be effective provided systems are monitored for their operational state in real time, and those acting on vendors' behalf are sufficiently empowered to address issues as they arise.

The effect of sea clutter and platform stability on data collection remains a lingering concern for all vendors in relation to achieving meaningful data collection (III.b.D1), although there is ample precedent for radar-based scientific data collection on floating platforms at sea (IV.e). It is this uncertainty that results in a 'fair' or 'poor' rating for criteria III.a.O4 and III.b.D5 in Table 1.

Three vendor options remove insect targets by threshold sampling on RCS at X-band with seemingly little regard to the considerable variation in RCS across target types (in the case of VendorA, as evidenced by their own citations in the caption of their Figure 1). Specifically, the detection probabilities for each size class of target may vary considerably depending on aspect (IV.b) and for many, the impact of Mie scattering (IV.g) which can be pronounced for vertebrate- and insect-sized targets at X-band. Threshold filtering based on RCS will naturally vary depending on where the threshold is set which in turn will determine how many insects are retained as vertebrates, or how many vertebrates are rejected as insects. Very small insects are likely Reyleigh scatterers at X-band and can reliably be rejected by this method. Only VendorB (Option2) uses wingbeat rate analysis for target discrimination.

Rather than be discursive concerning the various advantages and disadvantages of the vendor responses across all bases for evaluation (III), I attempt to rank the performance of each vendor response for each evaluation criterion in terms of good, fair, and poor in Table 1. The narrative below is reserved for highlights and specific points not evident from the table.

Table 1. Comparison of vendor responses with respect to the Basis for Evaluation criteria (III), assessed as good, fair, or poor.

	VendorA	VendorB (Option1)	VendorB (Option2)	VendorC (Option1)	VendorC (Option2)
Operation					
O1	FAIR	FAIR	FAIR	FAIR	FAIR
O2	GOOD	POOR	GOOD	GOOD	GOOD
O3	GOOD	GOOD	GOOD	GOOD	GOOD
O4	POOR	POOR	FAIR	POOR	POOR
Data					
D1	FAIR	FAIR	GOOD	FAIR	FAIR
D2	GOOD	GOOD	FAIR	GOOD	GOOD
D3	FAIR	POOR	GOOD	POOR	POOR
D4	GOOD	GOOD	FAIR	GOOD	GOOD
D5	POOR	POOR	FAIR	POOR	POOR
D6	GOOD	GOOD	POOR	GOOD	GOOD
D7	GOOD	FAIR	POOR	GOOD	GOOD
D8	GOOD	GOOD	GOOD	GOOD	GOOD
Reporting					
R1	GOOD	GOOD	POOR	GOOD	GOOD
R2	GOOD	GOOD	GOOD	FAIR	GOOD
R3	GOOD	GOOD	GOOD	GOOD	GOOD

a. VendorA

VendorA proposes to measure animal movements using volume scans, essentially stacking data from different elevational sweeps of a parabolic antenna, similar to the manner many weather radars operate. This method is effective for this purpose, although its data refresh rate at a given altitude (and depending on how they post-process data) would be less frequent than that of a rotating open-array antenna.

These differences in temporal resolution should matter little, however, in producing adequately updated information on animal movements (III.b.D4).

Vertical (90° from horizon) scanning directly over the radar would measure animal location in altitude with approximately the same precision as an open-array antenna rotating in the vertical plane. VendorA mentions limitations to this approach, but they do not include any concern over the impact of the main bang (IV.d). Depending on the type of radar, orientation of the antenna, and data processing methods, the range of this deafness may well include the rotor swept area, a possibility that is most acute when the antenna is pointed vertically but may also be a concern at lower elevation angles (V.b).

It is unclear how is the radar is 'tuned' at the start of the season and what sources of error or changes in the environment (other than clutter) require it to self-adjust. It is also unclear what the differences are between adjusted and unadjusted counts, though from context this likely refers to the application or not of detection probability correction. 'Many tools' are claimed for data validation, but it is unclear what is meant by validation, what are the tools, and what metrics require validating.

VendorA's response to the RFI was the most thorough of all the vendors and generally addresses the relevant issues (although I was surprised by the large number of minor grammatical errors). VendorA has experience with radar-based monitoring in relation to wind energy but not in offshore settings.

<u>Advantages</u>

- VendorA is correct in its general assessment of the advantages of a pencil-beam produced by a parabolic antenna over its open-array counterparts, especially in relation to their ability to provide a 3-dimensional position of flying animals (IV.a). This negates the need to deploy a two-radar system, simplifying the overall operation which in turn decreases the likelihood of technical difficulties during operation. However, the single radar design, while attractive from the standpoint of simplicity, also removes any redundancy. Failure of VendorA to track targets owing to barge motion results in complete loss of data, an less likely outcome for two-radar systems employing complementary sampling. Pencil beams are not without error in estimating position, and I would be interested in knowing how VendorA estimates that error which they seem to refer to as covariance, especially in the vertical dimension where even a narrow 4° beam is 35 m wide at 500 m range. Regardless, the practical effects of this uncertainty would be minor and average out across many tracked targets.

- A parabolic antenna and its associated beam properties may be more robust to the effects of sea clutter introduced by roll and pitch of the barge relative to a horizontally rotating open-array antenna. In no way should this suggest parabolic antennas are without concern in this regard (see below).
- VendorA has far more thoroughly studied the Icebreaker Wind project environment and crafted a more detailed and informed response than the other vendors.

<u>Disadvantages</u>

- I wonder about the ability of a 4° beam to maintain target tracking in the presence of seas that cause the barge to roll or pitch by an appreciable proportion of this beam width. Momentarily dropping targets in a track is a reality of any track-while-scan system (IV.d), and VendorA may have software that can cope with this eventuality, though perhaps not to the degree posed by a moving platform. It is entirely unknown to me how much the anchored barge is expected to pitch and roll in response to wave action on Lake Erie.
- VendorA and their equipment are untested operating in offshore environments, so there is the greater risk of otherwise avoidable problems occurring during operation. The vendor addresses many of the known challenges, so the risk is likely relatively minor.
- The capacity for VendorA to elevate their antenna may reduce clutter but is unlikely to eliminate it sufficient to reliably enable data collection on horizontal and altitudinal movements. Considerable unknowns exist depending largely on the impact of side lobes.

b. VendorB

VendorB (Option1) has numerous shortcomings in relation to operation (specifically, II.a.O2 and III.a.O4) and data gathering (specifically, III.b.D3 and II.b.D5) that render it the least desirable among the available options (Table 1). I do not comment on it further here. VendorB (Option2), however, represents a truly unique offering, and although when operating alone it has severe limitations in this particular application, it is nonetheless worth commenting upon. The capabilities of this radar were familiar to me before this evaluation was brought to my attention. The general approach is described in Chapman et al. (2003), and I first learned of this specific radar at a European Radar Aeroecology conference in Rome, Italy in early 2017. I was also invited to be an external reviewer for a graduate thesis from the University of Exeter that demonstrated some of the capabilities of this radar.

<u>Advantages</u>

- VendorB (Option2) rotates, or rather nutates, around a vertical axis in a way that enables it to gather data on height, speed, direction, and identity of the same target.
- VendorB (Option2) is the only vendor response that discriminates targets based on wingbeat rate, the current state-of-the-art (IV.g). Other vendor options discriminate according to RCS thresholding of which there is meaningful overlap between vertebrates and insects at X-band.
- With a nearly vertically oriented scan strategy, this option should be relatively robust against the effects of sea clutter, although the impact of ~90° is a lingering concern.

<u>Disadvantages</u>

- Nutating exclusively about a vertical axis places the radar at maximum exposure to the limits of detecting and identifying animals flying at very low heights. Minimum height matters a great deal in relation to studies of wind turbine impacts. The lower boundary of the rotor swept area for the Vestes V126 turbines proposed for this project as indicated in the "Icebreaker Wind VIA" document is 20 m above the water surface. The radar would sit a few meters above the water surface, further reducing the distance from radar to minimum height of the rotor swept area. The minimum height (above radar) claimed for VendorB (Option2) is 50 m, leaving approximately 30 m of a 126 m diameter rotor height (24%) unsampled. The reasons for this limit are not discussed. The effects of the main bang likely play a large role (IV.d), although this may also be a height below which targets travel too fast through too narrow a beam for wingbeat rate to be reliably estimated. Given the latter, it is not clear whether or not the lower limit of detectability is the same as the lower limit of wingbeat rate-based target discrimination.

- Movement of the beam in response to seas may impact estimates of speed and direction given the manner by which VendorB (Option2) determines those measures (Wills 2017). Specifically, movement of the radar platform during target passage changes the time required for the target to complete its passage through the nutating beam volume which in turn will bias speed estimates high or low depending on the motion. So, while the estimates for individual targets may be suspect, these biases may be expected to average out across many individuals. I also wonder whether sea state might impact target discrimination software which is sensitive to dwell time of the target within the beam. Depending on conditions, this could effectively increase the minimum height above radar at which some targets can be discriminated/counted, further limiting the ability of this unit to monitor the rotor swept area.
- The narrow region of direct monitoring severely limits the ability of this radar by itself to inform on turbine avoidance/attraction behavior in a post-construction study (IV.f).

c. VendorC

In deploying portable Doppler radar, VendorC proposes use of capable and somewhat uncommon hardware in biological circles. This unit purports to confer some advantages to their proposed approach, but these are not critical to successful data collection. VendorC reports the smallest RCS detectable at 5.5 km range as 10 cm and

5 cm for their S- (Option1) and X-band (Option2) horizontal radars, respectively. Overall, more capable hardware and software are invested in horizontal versus vertical monitoring, the latter possibly being the more relevant dimension in this project.

VendorC is arguably the most detailed in terms of data analysis, especially with respect to their statistical approach for determining weather conditions that influence the numbers of vertebrates flying at rotor swept height. If the relationship between weather conditions and animal density at rotor swept height is known, it may be possible to examine historic weather patterns in the area (as is likely already known) to determine the frequency of weather conditions associated with increased risk to flying animals (e.g., Kirsch et al. 2015). While VendorC discusses these capabilities at some length, any vendor that generates raw data on animal movements and weather conditions can provide those data such that a third party might generate the same or similar analyses as needed.

Advantages

- The wide vertical antenna angles (25° and 16°) of the horizontal radars increase the likelihood of maintaining target tracks despite barge movement.
- The Doppler capability of VendorC (Option2) enables a clutter filtering capability that may render it less sensitive to turbine clutter in ways that improve the ability of this radar to detect movements of vertebrates near turbines. This would presumably have value in post-construction studies examining vertebrate responses to actual structure.
- VendorC is the only vendor to offer some mechanism to correct radar-determined movements for the effects of barge roll, pitch, and yaw (3-axis accelerometers, IV.e).

Disadvantages

- VendorC vertical radar observations are gathered once every 5 sec using screen captures, presumably skipping every other sweep. The reason for this is unclear and compromises any effort at target tracking (to the extent that's desirable, see VII.b). MTR or vertically stratified measures of animal density are critical to this application of radar, yet VendorC documents no approach for target discrimination for these data. The "MUSE software" is not operational on the vertical radar presumably because it is based on analysis of entirely different methods of sampling used by the horizontal radars (high speed AD samples of radar 'video' signal output). Indeed, target discrimination generally is unclear across all radars, although it appears to be RCS-based on horizontal radars. Discrimination from aircraft are mentioned (which may identify their primary source of business), but there is no mention of insects which are by far the greater source of airborne clutter.

- The tracking advantage noted above assumes that pitch and roll of the barge does not produce sufficient sea clutter to interfere with data collection altogether. The reported false-positive rate for vertebrates when wave heights exceed 1 m is unknown for Option2. Response by VendorC to follow-up questions shows they have not deployed their horizontal radars from boats, so the impact of sea clutter remains a concern.
- Height bins are relatively coarse (50 m) but perhaps workable in pre-construction studies. However, the low spatial resolution compromises VendorC's ability to document animal responses to the presence of turbines in post-construction studies.

VI. Conclusions

Far too many unknowns are present to anticipate the outcome of radar work in relation to this project. Use of a barge magnifies an already existing problem, that seas will introduce clutter into radar data. The question becomes one of identifying what vendor approach among those presented is most likely to yield meaningful data collection. Taking into consideration that not all evaluation criteria are equal in their importance, Table 1 effectively narrows the field to two best options, VendorA and VendorC (Option2). (As a side note, VendorB (Option2) stands out for its novel design and best target discriminating capability. This option might be preferred in stable environments where target detection at minimum altitude and response to structure is not a concern in follow-up studies, although my European colleagues have some concerns over the reliability of ground speed estimates.) Arguably, the most important data criteria for a radar system in relation to the Icebreaker Wind project concern the ability to gather data on altitude-specific MTR or density and behavioral response to turbine presence (pre- versus post- construction comparison to attempt to assess avoidance/attraction), and the ability do so with high reliability (≥80% of available time) while avoiding contamination by clutter, primarily from insects and the lake surface.

VendorC (Option2) may well outperform other options in relation to documenting behavioral response to turbines, however this capability is cast into some doubt given uncertainties associated with how well the Doppler radar performs on vessels in relation to sea clutter. More critically, it appears little attention is given to target discrimination in vertically oriented radar data which may be the most valuable in relation to assessing animal's exposure to wind turbines.

VendorA's use of parabolic antennas has advantages unique among these vendor responses. Many desired capabilities are addressed, perhaps most important among them is the ability to elevate a highly discrete beam as a means of attempting to reduce the impact of sea clutter, if only because this proves challenging for open-array antennas rotating in a horizontal plane (but see below). Less clear is how tracking would perform across sweeps on a rolling and pitching barge. VendorA reports that tracking could tolerate 2° of pitch or roll, but it is easy to envision greater barge movement.

In sum, VendorA proposes the approach most likely to succeed among the vendor responses and other information provided that forms the basis of this evaluation. This is not to suggest VendorA's approach is without concern, particularly over target discrimination, the ability to track from a moving platform, and the impact of sea clutter. Designing a radar study from the ground up is beyond the scope of this review, however I offer some suggestions that may increase the likelihood of gathering meaningful data on vertebrates using VendorA's basic approach.

- Current RCS-based target discrimination might be improved by also including an airspeed-based approach (IV.g). Neither achieves the accuracy of wingbeat rate analyses which a rotating radar prohibits (but see VII.a below). However, the combined approach of requiring vertebrate targets to meet both RCS and airspeed criteria may increase the likelihood of proper target classification. Data on wind is required to estimate target airspeed, and VendorA proposes to gather surface wind data from a barge. The usefulness of surface wind data decreases with altitude owing to wind shear. However, surface wind data are more likely to usefully inform airspeeds at rotor swept heights, since turbines are relatively close to the lake surface.

- Concerning tracking, VendorA may consider refitting their radar with a smaller diameter antenna to increase beam width as a means of increasing the likelihood of maintaining tracks (sensu VII.a). Ideally, a barge pitch and roll test would be conducted to determine whether and/or how frequently barge movement would exceed the ability for VendorA to track.
- Elevation of the parabolic antenna considerably above the horizon would likely result in decreased clutter relative to open-array antennas rotating in the horizontal plane. Clutter will persist, however, and it is likely that even gathering data from a fixed platform will not satisfactorily address the problem (IV.c). As such, and in consultation with my colleague S. Gauthreaux, I suggest an alternative approach. Parabolic antennas radiate in relatively discrete patterns where side lobes, a primary cause of clutter, may be pronounced but distinct. As such it may be possible to considerably reduce the impact of sea clutter by blocking side lobe energy through installation of a radar fence on the periphery of the proposed barge. (The fence is unlikely to work as cleanly with an open-array antenna, because the beam radiates power in a less discrete manner.) To benefit most from the fence, the radar should be positioned relatively close to the barge surface (and must therefore be well armored against freeboard seas). Otherwise the fence must be elevated to capture side lobes which would require assembling more structure. It is unclear how much wave motion would impact the barge, but conceivably the fence could be positioned and the antenna elevated to account for barge movement. (Note, increasing antenna elevation angle will simultaneously tend to increase the lowest height at which the radar can detect targets owing to the impact of the main bang (IV.d).) This

in turn can interfere with directly monitoring heights consistent with the rotor swept area, depending on the angle of elevation and impacts of the bang.) Finally, to further reduce the impact of side lobes, the proposed smaller diameter antenna could be outfitted with a cuff ringed with material designed to absorb radio energy (radar-absorbent material or RAM). Some of these clutter-mitigating tactics are described in greater detail in Larkin and Diehl (2012).

The adjustments described above would require the obvious adjustments to hardware as well as re-computing detection probabilities and adjusting volume scan elevations. These would appear to be relatively minor modifications and the developer could likely bear the cost. Also, concurrent data from the KCLE NEXRAD station could be used to help identify the data consequences for periods when lake conditions may result in data dropouts (IV.d).

Finally, I would hope reports resulting from this work are subject to peer-review, and that track data of individual animals, clutter maps, and reports are placed in the public domain so that others may benefit from the knowledge gained by this effort.

VII. Alternative Configurations

None of the proposed radar configurations is without shortcomings; indeed, it is difficult to envision any reasonable scenario that does not bring some limitation. The conclusions of this evaluation should not promote a static standard, but rather an evolving one that upgrades with advances in technology. Most relevant among the limitations described above are those associated with target discrimination (III.b.D3) and ability to accommodate sea clutter and a moving platform (III.a.O4).

All options offer trade-offs on the ideal capability; to obtain reliable, high accuracy data on ground speed, direction, altitude, and target identity on the same individual, and to do so with sufficient spatial and temporal coverage to detect behavioral responses to turbines. For example, four of five vendor options examined trade better target discrimination capability for spatial coverage. Under some circumstances this may be a desirable trade-off (e.g., airport monitoring for large birds) but perhaps not in relation to wind energy monitoring for primarily small vertebrates. Another example, VendorA forgoes the 2-dimensional comprehensive coverage of open-array antennas in favor of acquiring more spatially constrained 3-dimensional data on individuals using only one radar. The necessity of such trade-offs prompts one to ask: what are the most important capabilities for offshore radar monitoring, and are there alternative radar configurations that might better capture those capabilities? As mentioned in the Conclusions (VI), the most important data criteria for radar systems monitoring flying animals in relation to an offshore wind facility likely concern the ability to gather data on altitude-specific MTR or density and response to turbine presence, and the ability do so with high reliability while avoiding contamination by clutter, primarily insects and sea clutter.

Below I suggest a couple alternative radar deployment scenarios that represent advances or variations on some of the vendor design options suggested here. The people employed by these and other vendors are often highly knowledgeable, and it would surprise me if some of the concepts presented below have not been considered. Investing in research and development (to the extent required) and deployment is another matter, however. What works best serving a flight safety role may not be as well suited to wind turbine monitoring of the kind considered here. There is a tendency among the vendors to promote the comprehensiveness of coverage by one mechanism or another (e.g., stacked volume scans, wide-angle sweeps using open-array antennas). However, the goal here, as with many other wind operations, is to learn something about MTR or animal density, how that density is vertically stratified, how animals respond to stimuli or structure, and how these measures vary through time. With the possible exception of response to stimuli/structure, comprehensive data collection is not required for such measures.

a. Adaptable sampling

None of the vendor options satisfactorily addresses all the challenges such operations face in an offshore context and in other settings as well. Target discrimination is a persistent concern in radar biology, and one of the most common shortcomings among vendors concerns target discrimination where only VendorB

(Option2) employs the current state-of-the-art of wingbeat rate analysis. In this option, the confined airspace monitored increases dwell time on the target allowing wingbeat rate estimation but also limits the radar in other ways that are important to these studies and presumably others (V.b). As with VendorB (Option2), VendorA also employs parabolic antennas and does so with some sophistication by including elevation control, but continuous rotation at angles considerably less than 90° (vertical) prevents the radar from gathering wingbeat rate data.

A common property among all vendor options is a rotating antenna where reliance on the internal COTS azimuthal motor essentially drives all data collection. This is an appealing option; the motors are time-testing, highly reliable, and armored against harsh environmental conditions. COTS antenna rotation is also well suited to airport monitoring concerning bird aircraft strike hazards, which may comprise the bulk of many vendors' business. However, programmable azimuth and elevation control allows highly customizable sampling strategies that can be finely tuned to the needs of a given study. As vendors are no doubt aware, obtaining control over azimuth represents a considerable but hardly extraordinary hardware and software modification.

Consider an X-band radar outfitted with a ~6° parabolic antenna and software control over antenna position in azimuth and elevation. A sampling strategy that alternates between stationary beam sampling (Drake et al. 2002) and rotation enables serial data collection on wingbeat rate, altitude, and speed and direction from one radar (see Drake and Reynolds 2012, Ch. 5). The parabolic antenna would possess generally advantageous clutter mitigating properties if paired with modifications described above (VI), and the wider beam width would limit the impact of sea motion on target tracking where a barge or boat serves as the data collection platform. Trade-offs remain, but they are likely more tolerable. For example, the wider beam produces larger sample volumes (but still on par with most open-array antennas) that are more likely to include clutter in the form of multiple targets. The antenna also produces less gain (again, still on par with most open-array antennas) which limits range but not critically in this application. Detection of avoidance/attraction behavior would be consistent with VendorA (V.a). I am unaware of any vendors, including those not responding to this RFI, capable of implementing such a strategy in the near term.

b. Orthogonal sampling

In this concept, vertical sampling is favored over comprehensive horizontal sampling, because it focuses on altitude-based metrics (e.g., altitude-specific MITR) and would limit but not eliminate the impact of sea clutter. As discussed in Conclusions (VI), it may be possible to deploy a radar fence on a barge-sized structure to limit the impact of ~90° side lobes in a manner similar to that described in Buler and Diehl (2009).

Most applications of biological radar use a rotating antenna to enable a track-while-scan capability that allows sequential locations on a target to be linked into tracks that allow estimates of target speed and direction. However, the speed and direction of individual animals is not required to obtain estimates of mean speeds and directions of populations of animals moving through an airspace.

In this approach, two radars with open-array antennas are deployed rotating in orthogonal vertical planes (Figure 2). Each radar by itself will usually show some rate of animal movement along the axis of rotation but this is not a reliable indicator of speed for that individual, since we do not know its direction of travel. However, when averaged across a number of individuals, this mean relative speed constitutes one component of a two-dimensional vector. Combining the relative speed components from the two orthogonal planes would allow one to compute height-specific mean and standard deviation speeds and directions. The calculation can be repeated hourly or over whatever time frame allows sufficient samples to accumulate for the calculation (it would not require many) to estimate the

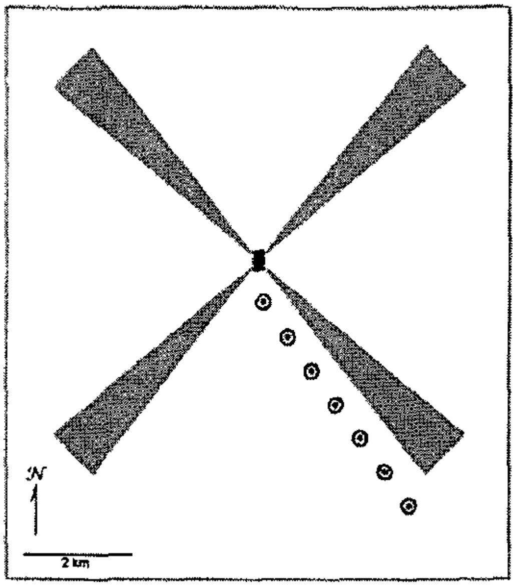


Figure 2. Conceptual layout of the orthogonal orientations of the vertical planes of rotation of two open-array antennas as they might be positioned during fall migration. During spring, the system would adopt a mirror configuration with respect the turbine array. The black rectangle represents the platform supporting the radars, gray wedges approximate the hypothetical horizontal coverage of 12° fan beams, and orange circles represent turbines.

components. Careful deployment with respect to a given turbine array should enable examination of behavioral response to turbines, especially where pre-construction data are available as reference, but the analysis would be more nuanced than examining tracks measured by horizontally rotating radars.

This approach relies on available software and hardware technology, so it should be relatively cost effective to deploy. Since it employs rotating antennas, the ability to use state-of-the-art target discrimination is compromised (only RCS-based approaches are possible; airspeeds cannot be used since the ground speeds of individuals is unknown) in favor of simplicity, cost effectiveness, clutter mitigation (from the sea and possibly turbines as well, depending on implementation), and the ability to examine behavioral response to structure, in this case turbines. Behavioral response may be subtle (which does not mean undetectable) given the limited coverage. As with other radar arrangements, pre- versus post-construction movement along, say, the southeast coverage area can be compared. It would also be possible during to compare movements along the southeast coverage to its counterpart to the northwest which would serve as an internal control of sorts. The desire for clutter mitigation is primarily but not exclusively a response to concerns over sea clutter in this evaluation. As with vendor responses, movement of a supporting barge or other floating platform would introduce error into vector component estimates of speed and direction, although these may average out (IV.e).

VIII. Acknowledgements

This report is informed by input from a variety of sources, among them the US Fish and Wildlife Service, LEEDCo, WEST Inc, and the Ohio Department of Natural Resources. Representatives from these organizations as well as two independent reviewers, Sidney Gauthreaux, Jr (who consulted briefly with VendorA) and Jeffrey Buler, provided helpful comments on an earlier draft. Ron Larkin also provided some useful confirmation. Any use or mention of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the US Government.

IX. References

Alerstam, T., G. A. Gudmundsson, M. Green, and A. Hedenstrom. 2001. Migration along orthodromic sun compass routes by Arctic birds. Science 291:300-303.

Archibald, K. M., J. J. Buler, J. A. Smolinsky, and R. J. Smith. 2017. Migrating birds reorient toward land at dawn over the Great Lakes, USA. Auk: Ornithological Advances. 134:193-201.

Bruderer, B. and P. Steidinger. 1972. Methods of quantitative and qualitative analysis of bird migration with a tracking radar. Pages 151-167 *in* S. R. Galler, K. Schmidt-Koenig, G. J. Jacobs, and R. E. Belleville, editors. Animal Orientation and Navigation. U.S. Govt. Printing Office, Washington, DC.

Buler, J. and R. Diehl. 2009. Quantifying bird density during migratory stopover using weather surveillance radar. IEEE Transactions on Geoscience & Remote Sensing 47:2741-2751.

Chapman, J. W., D. R. Reynolds, and A. D. Smith. 2003. Vertical-looking radar: a new tool for monitoring high-altitude insect migration. BioScience 53:503-511.

Chilson, P. B., W. F. Frick, P. M. Stepanian, J. R. Shipley, T. H. Kunz, and J. K. Kelly. 2012. Estimating animal densities in the aerosphere using weather radar: To Z or not to Z? Ecosphere 3:Article 72.

Desholm, M., A. D. Fox, and P. D. Beasley. 2004. Best practice guidance for the use of remote techniques for observing bird behavior in relation to offshore wind farms. Report for the Collaborative Offshore Wind Research into the Environment consortium, COWRIE-REMOTE-05-2004.

Desholm, M. and J. Kahlert. 2005. Avian collision risk at an offshore wind farm. Biology Letters 1:296-298.

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

Drake, V. A. and D. R. Reynolds. 2012. Radar entomology: observing insect flight and migration. CABI, Wallingford, UK.

Drake, V. A., I. T. Harman, and H. K. Wang. 2002. Insect monitoring radar: stationary-beam operating mode. 35:111-137.

Gauthreaux, S. A. and C. G. Belser. 1998. Displays of bird movements on the WSR-88D: Patterns and quantification. Weather and Forecasting 13:453-464.

Horn, J. W. and T. H. Kunz. 2008. Analyzing NEXRAD doppler radar images to assess nightly dispersal patterns and population trends in Brazilian free-tailed bats (Tadarida brasiliensis). Integrative and Comparative Biology 48:24-39.

Kirsch, E. M., M. J. Wellik, M. Suarez, R. H. Diehl, J. Lutes, W. Woyczik, J. Krapfl, and R. Sojda. 2015. Observation of sandhill crane flight behavior in heavy fog. Wilson Journal of Ornithology 127:281-288.

Larkin, R. P. 1991. Flight speeds observed with radar, a correction: slow "birds" are insects. Behavioral Ecology and Sociobiology 29:221-224.

Larkin, R. P. and R. H. Diehl. 2012. Radar techniques for wildlife research. Pages 319-335 *in* N. Silvy, editor. Techniques for Wildlife Investigations and Management. Wildlife Society, Bethesda, Maryland.

Larkin, R. P., D. R. Griffin, J. R. Torre-Bueno, and J. Teal. 1979. Radar observation of bird migration over the western North Atlantic Ocean. Behavioral Ecology and Sociobiology 4:225-264.

Mirkovic, D., P. M. Stepanian, J. F. Kelly, and P. B. Chilson. 2016. Electromagnetic Model Reliably Predicts Radar Scattering Characteristics of Airborne Organisms. Sci. Rep. 6, 35637; doi: 10.1038/srep35637.

Nations, C. and C. Gordon. 2017. Assessment of Nocturnal Bird Migration Activity from Weather Radar Data for the Proposed Icebreaker Wind Energy Facility, Lake Erie, Ohio. WEST, Inc., Laramie, WY.

O'Neal, B. J., J. D. Stafford, and R. P. Larkin. 2010. Waterfowl on weather radar: applying ground-truth to classify and quantify bird movements. Journal of Field Ornithology 81:71-82.

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

Skolnik, M. I. 1980. Introduction to Radar Systems. McGraw-Hill, New York, New York.

Vaughn, C. 1985. Birds and insects as radar targets: a review. Proceedings of the IEEE 73:205-227.

Wills, G. 2017. Monitoring avian migration with dedicated vertical-looking radar. MS Thesis, University of Exeter, South West England, UK.

MEMORANDUM OF UNDERSTANDING

Between the Ohio Department of Natural Resources and Icebreaker Windpower Inc. in the matter of the Application of Fred Olsen Renewables USA LLC/Icebreaker Windpower Inc. for a Certificate to Construct a Wind-Powered Electric Generation Facility

Case No. 16-1871-EL-BGN
Monitoring Protocols for Avian and Bat Resources
July 12, 2017

Since August 2016, Icebreaker Windpower, Inc. ("Applicant") and the Ohio Department of Natural Resources ("ODNR") (jointly referred to as the "Parties") have been working collaboratively to ensure compliance with the requirements in Ohio Revised Code ("R.C.") Chapter 4906 and Ohio Administrative Code ("O.A.C.") Chapter 4906-4 and develop pre-, during-, and post-construction monitoring protocols for avian and bat resources located in the vicinity of the Icebreaker Wind six turbine offshore wind demonstration Project located 8 to 10 miles off the shore of Cleveland, Ohio (the "Project"). On February 1, 2017, as supplemented on March 13, 2017, the Applicant filed its application ("Application") with the Ohio Power Siting Board ("OPSB") for a certificate to construct the Project in Case No. 16-1871-EL-BGN.

The Parties are entering into this Memorandum of Understanding ("MOU") to set forth the agreements that have been reached on the monitoring protocols for avian and bat resources. The purpose of these monitoring protocols will be to help assess, in a scientifically rigorous manner, any impacts that Project construction and operation may have on avian and bat species and resources in the Project vicinity or likely to encounter the Project area. The goal of assessing these impacts is: 1) to document existing conditions and patterns of use by the species of concern at the Project site; 2) to document changing conditions and patterns of use by species of concern and their associated habitats as a result of Project construction and operations at the Project site; 3) to develop and implement effective mitigation and adaptive management strategies to minimize avian and bat resource impacts; 4) to evaluate the feasibility of various monitoring protocols in an offshore setting; and 5) to better understand how future offshore wind projects in Lake Erie or the Great Lakes may affect birds and bats.

The Parties recognize that the location and size of any future offshore wind projects will be significant factors in future risk assessments. There are issues related to the statistical detectability of certain types of impacts due to natural variability, the limited footprint, and size of this demonstration Project. A determination of impact, or lack thereof, whether

EXHIBIT
PENGAD 800-631-6989
Applicant
38

positive or negative in this small Project, should not be construed to represent an impact condition for larger projects with different turbine configurations and offshore locations. Recognizing these limitations, these monitoring studies and protocols have been designed to provide information that will help to guide future monitoring efforts and provide a sound scientific basis for future decision-making.

By and through this MOU, the Parties hereby agree to the following:

A. The Icebreaker Wind Avian and Bat Monitoring Plan ("MP"), attached as Exhibit A, which was prepared by Western EcoSystems Technology Inc. ("WEST") for the Applicant, and modified pursuant to discussions with the ODNR, will serve as the basis for the avian and bat resources pre-, during-, and post-construction monitoring effort by the Applicant, any of its consultants or sub-consultants acting on its behalf, and any successor(s) to the Applicant, consultants, or sub-consultants. The sampling protocols set forth in the MP are based on the best available scientific methodologies to meet the study objectives defined in the requirements of the ODNR On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio, project specific recommendations provided to the OPSB by the ODNR and United States Fish and Wildlife Service ("USFWS") in comments dated February 28, 2017, and additional consultation between the Applicant and wildlife agencies.

B. The MP is a living document and will serve as a template for all future avian and bat monitoring work related to the Project. The length and type of sampling conducted will be reviewed annually by ODNR as outlined in the MP to determine whether the sampling intensity, frequency, and duration are necessary and appropriate to meet the study objectives. Any such adjustments to the existing protocol will be based on actual sampling results from prior years.

C. Prior to the date of construction as identified by the Applicant pursuant to OAC Section 4906-3-13(B), post-construction protocols in the Plan will be finalized and approved through written communication with the ODNR. In order to effectuate any adjustments, the Parties will review sampling results annually (at the end of the field season) and will meet annually to discuss and reach mutual agreement on any adjustments to the sampling program necessary to meet monitoring and assessment goals. The annual meeting will be held at least one month prior to the next field season. The Parties agree to meet prior to January 31 of each year. This will provide adequate lead time to make adjustments to the sampling program prior to the start of the field season.

D. Annual monitoring reports, including preliminary analyses and summaries of all data collected to date, must be submitted to ODNR at least two weeks prior to the scheduled date of the annual meeting provided for at Paragraph (C) above. Annual pre-construction monitoring reports will provide a summary of pre-construction baseline data collected from the prior sampling season. Annual post-construction monitoring reports will provide a summary of data collected for the prior sampling season and a comparative analysis to identify potential changes and/or impacts due to the construction and/or operation of the offshore wind facility to be developed by the Applicant. Annual monitoring reports will be shared with the USFWS and the OPSB for external review and analysis. These reports will be provided to those officials specified at those agencies to receive notices under Paragraph (L)(10) of this MOU.

E. The applicant shall submit quarterly and interim Project reports to ODNR summarizing monitoring activities performed according to the timeline provided in Exhibit B attached. Quarterly and interim reports will include an outline of all sampling attempted, completed, and a summary of data collected as described in the MP document. Quarterly and interim reports shall be submitted pursuant to the Notice provision set forth at Paragraph (L)(10) of this MOU. Quarterly reports will also be shared with USFWS and the OPSB for review and analysis.

F. Post-construction annual monitoring reports will be required for all post-construction sampling years as identified in Exhibit A attached, with interim, quarterly, and annual reports following the schedule established in Exhibit B, attached. A final Project report shall be submitted to ODNR one year after all sampling and monitoring work has been completed. The final report will include complete analysis of all data, discussion, conclusions, and any recommendations for mitigation if needed, and it will be transmitted pursuant to the Notice provision located at Paragraph (L)(10) of this MOU. A summary of reporting requirements is presented in Exhibit B attached.

G. All raw data collected will be submitted by the Applicant to ODNR within three months of the conclusion of each monitoring component set forth in the MP with each annual report. These data will be distributed to the USFWS for external review and analyses. Such data will become a public record and will be made available upon proper request unless the Applicant specifically identifies any data or information under this section which it believes to be proprietary in nature at the time of submission to the ODNR. If data or information is identified as proprietary in nature, then the ODNR will immediately notify the Applicant, through the contact person specified to receive notices under Paragraph (L)(10) of this MOU, of the fact of a records request under R.C. Section 149.43, et. seq., so that the Applicant will, within fourteen (14) business days, be able to consider and act as it may consider necessary and appropriate to protect its proprietary interest, including without limitation filing an action for injunctive relief to prevent the disclosure of its intellectual property.

H. ODNR, working cooperatively with the USFWS and with designated technical experts, will review all quarterly, annual, interim, and final reports to ensure they meet the assessment goals as outlined in paragraph two of page one of this document. If a finding of significant impact is determined, ODNR shall immediately notify the Applicant and follow-up with appropriate agencies and the Applicant to address and/or remediate the impact.

I. This MOU may be made a condition of Submerged Lands Lease SUB-2356-CU between the State of Ohio and the Applicant.

J. This MOU may be made a condition of any Certificate of Environmental Compatibility and Public Need issued to the Applicant in Case No. 16-1871-EL-BGN by the OPSB.

K. This MOU shall terminate on the date that is five years beyond the date on which commercial operations began for the Project, unless terminated earlier by mutual consent of the Parties. The term of the MOU may be extended beyond five years if the ODNR determines that post-construction assessment results demonstrate a significant adverse impact and that the continued collection of avian and bat sampling data for an additional period of time is scientifically warranted. The specific type of avian and bat sampling required to address the significant adverse impact will be mutually agreed to by the Parties.

L. General Terms and Conditions

   1. Liability. The Parties agree that Applicant shall be solely responsible for any and all claims, demands, or causes of action arising from Applicant's obligations under this MOU. Each Party to this MOU must seek its own legal representation and bear its own costs, attorney fees and expenses in any litigation that may arise from the performance of this MOU. It is specifically understood and agreed that ODNR does not indemnify Applicant. Nothing in this MOU shall be construed to be a waiver of

the sovereign immunity of the State of Ohio or the immunity of any of its employees or agents for any purpose. In no event shall ODNR be liable for indirect, consequential, incidental, special, liquidated, or punitive damages, or lost profits.

2. Ethics. By signing this MOU the Applicant certifies that it: (i) has reviewed and understands the Ohio ethics and conflict of interest laws as found in R.C. Chapter 102 and in R.C. Sections 2921.42 and 2921.43, and (ii) will take no action inconsistent with those laws. The Applicant understands that failure to comply with Ohio's ethics and conflict of interest laws is, in itself, grounds for termination of this MOU with the State of Ohio.

3. Ohio Elections Law. Applicant affirms that, as applicable to it, no party listed in Division (I) or (J) of Section 3517.13 of the R.C. has made, as an individual, within the two previous calendar years, one or more contributions to the Governor or to his campaign committees that exceed the limits established by that code.

4. Assignment/Delegation or Amendment. Neither Party to this MOU will assign any of its rights, amend this Agreement, nor delegate any of its duties and responsibilities under this MOU without the prior written consent of the other Party. Any assignment or delegation not consented to may be deemed void by the non-consenting Party.

5. Severability. In case any one or more of the provisions contained in this MOU shall for any reason be held to be invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall not affect any other provision thereof and this MOU shall be construed as if such invalid, illegal, or unenforceable provision had never been contained herein.

6. Counterparts. This MOU may be executed in two or more counterparts, each of which shall be deemed to be an original and taken together shall be deemed to be one and the same instrument.

7. Controlling Law. The laws of the state of Ohio shall govern this MOU and any claims arising in any way out of this MOU. Any provision of this MOU prohibited by the law of Ohio shall be deemed void and of no effect. Any litigation arising out of or relating in any way to this MOU or the performance hereunder shall be brought only in Franklin County, Ohio or before the OPSB.

8. Mediation. If a dispute arises between the Parties regarding the performance,

interpretation, or implementation of any provision in this MOU and the Parties reach an impasse, prior to pursuing litigation the Parties will engage a mutually agreed to third-party mediator and will, in good faith, attempt to reach agreement on the issue within a reasonable period of time.

9. Waiver. A waiver by any Party of any breach or default by the other Party under this MOU shall not constitute a continuing waiver by such Party of any subsequent act in breach of or in default hereunder.

10. Notices. Each Party will designate an individual by name, title, and both street and e-mail addresses for the receipt of any notifications required by this MOU and for the purpose of communicating on any issues that relate to the MOU and its objectives. Except to the extent expressly provided otherwise herein, all reports, notices, consents and communications required hereunder (each, a "Notice") shall be in writing and shall be deemed to have been properly given when: 1) hand delivered with delivery acknowledged in writing; 2) sent by U.S. Certified mail, return receipt requested, postage prepaid; 3) sent by overnight delivery service (Fed Ex, UPS, etc.) with receipt; or 4) sent by fax or email to the officers listed below. Notices shall be deemed given upon receipt thereof, and shall be sent to the addresses first set forth below. Notwithstanding the foregoing, notices sent by fax or email shall be effectively given only upon acknowledgement of receipt by the receiving Party. Any Party may change its address for receipt of Notices upon notice to the other Party. If delivery cannot be made at any address designated for Notices, a Notice shall be deemed given on the date on which delivery at such address is attempted.

Contact and delivery information for the Parties:

Wildlife Wind Biologist
Ohio Division of Wildlife
2045 Morse Road, Building G
Columbus, Ohio 43229-6693
(614) 265-6349
Erin.Hazelton@dnr.state.oh.us

President
Icebreaker Windpower, Inc.
1938 Euclid Avenue, Suite 200
Cleveland, Ohio 44115

MOU supersedes any and all previous agreements. whether written or oral. between the Parties.

12. Execution and Electronic Signatures. This MOU is not binding upon the Parties unless executed in full, and is effective as of the last date of signature by the Parties.

Any Party hereto may deliver a copy of its counterpart signature page to this MOU electronically pursuant to R.C. Chapter 1306. Each Party hereto shall be entitled to rely upon an electronic signature of any other Party delivered in such a manner as if such signature were an original.

The Remainder of this Page Intentionally Blank
Signature Page Follows

IN WITNESS THEREOF, ODNR and Icebreaker Windpower, Inc. have caused this Memorandum of Understanding to be duly executed and have caused their seals to be hereto affixed by their duly authorized officers on the date associated with each authorized signature.

This MOU shall be effective as of the date on which the last of the Parties executes it.

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES

ATTEST:

7/20/17

James Zehringer, Director for — Date

ICEBREAKER WINDPOWER, INC.

ATTEST:

07/12/2017

Lorry Wagner, President — Date

APPROVED:

7/18/17

Michael R. Miller, Chief, Ohio Division of Wildlife — Date

7/13/2017

Scudder D. Mackey, Chief, Office of Coastal Management — Date

ICEBREAKER WIND
AVIAN AND BAT MONITORING PLAN
LAKE ERIE, OHIO

Prepared for:

Icebreaker Windpower, Inc.

Prepared by:

Western EcoSystems Technology, Inc.
415 West 17th Street, Suite 200
Cheyenne, Wyoming, 82001

July 17, 2017

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The Icebreaker Wind Avian and Bat Monitoring Plan ("Monitoring Plan" or "Plan") describes the studies and analyses that will be performed to document the avian and bat resources at the Icebreaker Wind Project ("Icebreaker" or "Project") site and assess potential impacts to those resources during the final pre-construction and post-construction phases of the Project. This Project is a six turbine freshwater offshore wind facility proposed 8 to 10 miles off the shore of Cleveland, Ohio by Icebreaker Windpower Inc. ("Applicant" or "IWI"). This Monitoring Plan is based on currently available scientific methodologies (e.g., radar, acoustics, collision monitoring, etc.) to assess avian and bat displacement, avoidance, attraction/deterrence, and potential for mortality. The Plan considers the Project size, offshore location, and other factors specific to the unique design of this Project and is based on the requirements of the Ohio Department of Natural Resources ("ODNR") On-Shore Bird and Bat Pre- and Post- Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio. Project specific recommendations were provided to the Ohio Power Siting Board ("OPSB") by the ODNR and the US Fish and Wildlife Service ("USFWS") in comments dated February 28, 2017, and additional consultation between the IWI project team and the wildlife agencies. Per OPSB's order dated April 3, 2017, a Memorandum of Understanding and monitoring protocols are to be submitted for its consideration.

Due to the unprecedented nature of this demonstration project, protocols for determining potential impacts to birds and bats in an offshore environment have not been previously established for the Great Lakes. Thus, this Plan makes a good-faith effort to document and address the potential impacts of the Project on avian and bat behavior and mortality. The Plan proposes an adaptive management framework to further minimize and mitigate any unforeseen Project impacts. Pre-construction monitoring shall be completed prior to the date on which construction will begin as identified by the Applicant pursuant to Ohio Administrative Code 4906-3-13(B). Post-construction monitoring shall commence coincident with the date the Project begins commercial operation as identified by the Applicant pursuant to Ohio Administrative Code 4906-3-13(B).

The contents of the current Plan have been shaped by studies and risk assessments previously performed by the IWI project team, as well as by the numerous discussions between the IWI project team and wildlife agencies. Some elements described within the current Plan consist of monitoring studies that will supplement data collected by preceding studies. Potential behavioral impacts will be assessed by characterizing pre-construction baseline conditions using methodologies that will be duplicated during the Project's operational (post-construction) phase in order to provide robust pre- vs. post-construction comparisons for impact assessment. Other elements described within the Plan are unique to the operational phase of the Project. As this plan is a living document, certain elements (i.e., radar surveys, post-construction collision monitoring protocols) currently exist in draft form and will be finalized in consultation with the ODNR, OPSB, other agencies and stakeholders. Changes in the Plan, upon timely approval by ODNR in writing, will be incorporated into this document as an amendment.

The specific monitoring elements contained within the current Plan have been shaped by extensive discussions between the IWI project team, the resource agencies, and the Project's lead bird and bat consultant, Western EcoSystems Technology, Inc. ("WEST"). WEST proposed a Post-Construction Monitoring Plan on October 12, 2016. The Plan included a preliminary outline of potential options to assess project impacts. On October 20th, the ODNR and USFWS provided IWI (then the Lake Erie Energy Development Corporation [LEEDCo]) a document setting forth criteria and recommendations related to pre- and post-construction monitoring goals and objectives. In November, the USFWS and ODNR provided a response to WEST's proposed post-construction monitoring plan. Numerous conversations with representatives from the agencies occurred over the next two months. On December 13th and 14th, IWI and WEST met with the ODNR, USFWS, OPSB, and US Department of Energy ("DOE") in Columbus, Ohio to discuss post-construction monitoring, and any additional associated pre-construction baseline monitoring determined necessary. Subsequent to this meeting, WEST prepared a matrix of monitoring options that was presented to the agencies and discussed at a meeting in Columbus, Ohio on January 6, 2017. On February 28th, the ODNR and USFWS submitted recommendations for bird and bat monitoring at the Project to the OPSB in association with IWI's February 1, 2017 application for a Certificate of Environmental Compatibility for Icebreaker, and on March 6th IWI submitted a response.

The current Plan provides comprehensive detail on the monitoring elements of the pre- and post-construction studies for which methodologies can be defined and elaborated at the present time (i.e., bat acoustic monitoring and aerial water bird surveys). With regard to post-construction monitoring for bird and bat collision impacts during the Project's operational phase, no proven technologies or methodologies are currently available for the offshore environment. The Plan articulates the IWI project team's commitment to continue to evaluate emerging collision monitoring technologies in consultation with ODNR, OPSB, and other agencies and stakeholders to design and implement protocols that employ the most promising and viable collision monitoring technology available at the time such monitoring is set to commence. Such monitoring will be specific to the Project size, offshore location, and other factors specific to the unique design of this Project. With regard to radar monitoring, the Plan articulates the IWI project team's commitment to work with ODNR, OPSB, and other agencies and stakeholders to retain an objective third party radar expert to determine the feasibility and precise design of any pre- and post-construction radar monitoring surveys.

As a follow up to the discussions regarding the radar monitoring element, the wildlife agencies and the IWI project team prepared a Request for Information (RFI) to assess the viability of deploying radar on a large vessel with a four point anchor prior to construction at the project site. The RFI was sent to three potential providers and responses were received in late March. Follow-up questions were sent to the providers by the Applicant and the USFWS, and responses were received. The agencies and Project team held a conference call on April 13th to discuss the viability of vessel-based radar. Subsequent discussions have led to a commitment between the ODNR and Applicant to work with the DOE, USFWS, and one or more objective third-party radar experts to design the exact parameters of any pre- and post-construction radar surveys deemed feasible.

This Plan responds to issues and concerns raised by ODNR and the USFWS related to potential impacts on birds and bats resulting from implementation of the proposed Project. These protocols (and the executed Avian and Bat Monitoring MOU) demonstrate IWI's commitment to ODNR that IWI will implement the required pre- and post-construction protocols described herein to monitor and assess environmental impacts on the avian and bat resources in the Project area.

It is critical that sufficient and accurate data are collected pre-and post-construction in order to evaluate risk of the Project to avian and bat species. This Project is the first offshore freshwater wind installation in North America. Established land-based protocols may need to be modified or adapted in order to assess risk in an offshore environment. As a pilot project, it may be necessary to explore the use of experimental technologies or methods to collect the data necessary to assess behavioral impacts and mortality. The protocols described herein in no way establish a state-approved standard for future offshore wind energy development.

The Plan will be continually assessed through interim and quarterly status reports and annual summaries, and reviewed with ODNR and OPSB annually. The exact parameters of the Plan are flexible and will be subject to modification over time based on results of surveys. Any revisions and adjustments to the Plan, which could include changes to the location of sampling, sampling frequency and duration, and sampling protocols and parameters, will be made as appropriate, and only in consultation with the ODNR and OPSB, taking into consideration input from other agencies and stakeholders. ODNR and IWI will review sampling results annually (at the end of the field season) and will meet annually to discuss and reach mutual agreement on any adjustments to the Plan necessary to meet monitoring and assessment goals. Prior to the date of construction as identified by the Applicant pursuant to Ohio Administrative Code 4906-3-13(B), post-construction protocols in this Plan must be finalized and, upon timely approval by ODNR in writing, will be incorporated into this document as an amendment.

STUDY AREA

The proposed Project will consist of six turbines in a single row, located 8 to 10 miles from the Cleveland shore (Figure 1).

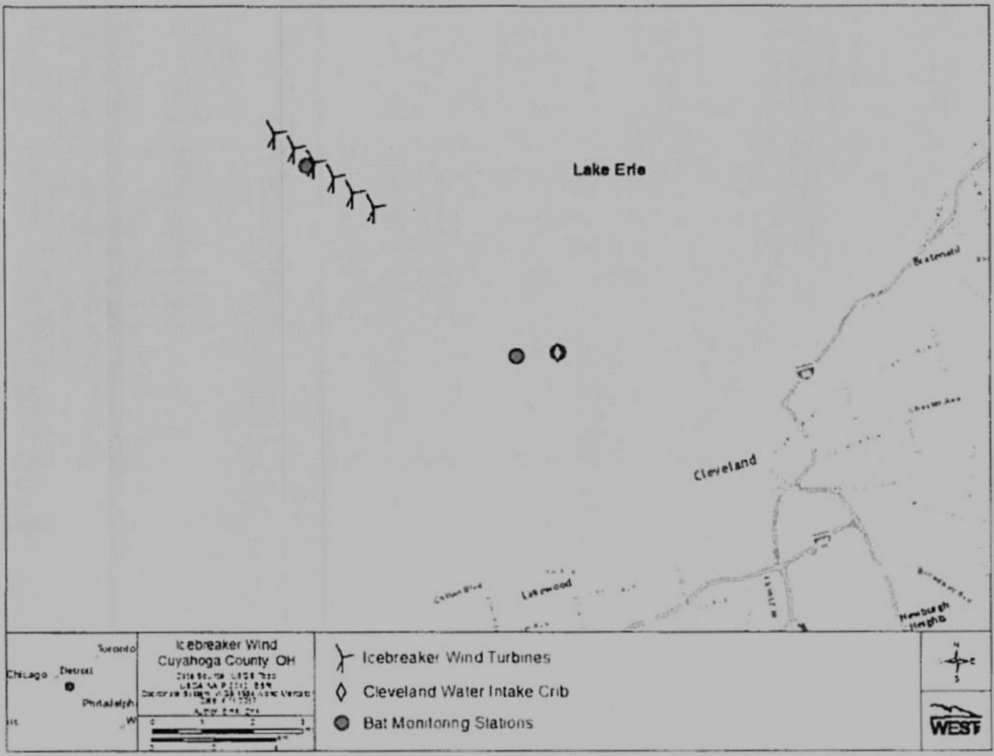


Figure 1. Turbine locations for the Proposed Icebreaker Wind Project, showing locations of pre-construction bat acoustic monitoring (see text). Two buoys have been deployed for bat acoustic monitoring at the location furthest offshore (Mile 7 buoy).

BAT ACOUSTICAL MONITORING

Objectives

The primary objectives of the bat acoustic monitoring element are as follows:

- Characterize the exposure of bats to potential impacts from the Project, pre- and post-construction.
- Characterize the potential behavioral responses of bats to the presence of the Project.
- Characterize bat species composition, activity, and seasonal patterns between the Project site and off site.

Overview of Pre-Construction Bat Monitoring Protocol

Beginning in 2017, the following methods will be deployed to monitor bat activity at and in the vicinity of the Project site:

- At least one full season (15 March – 15 November) of acoustic monitoring. Should inclement weather threaten to delay the monitoring season, IWI will immediately notify ODNR so that survey dates may be amended to maintain 80% functionality.
- Deploy acoustic monitors at the following locations: on the Cleveland Water Intake Crib (one at approximately 50 meter height above water level and one at 3 meter height above water level); on the mile 3 buoy near the water level; on a mile 7 buoy[1] near the water level; and, on a second mile 7 buoy at the 10 meter height to monitor the base of the rotor-swept zone (Figure 1).
- If a vessel is deployed at the project site pre-construction (see radar section, below), deploy an acoustic monitor on the vessel as close to a 50 meter height as mechanically feasible.
- Use Wildlife Acoustics SM4™ detectors, or the equivalent
- Detector sensitivity adjusted to detect a calibration tone at 20 meters
- Run all acoustic detectors 30 minutes before sunset to 30 minutes after sunrise continuously and concurrently during the monitoring season
- Monitor, repair, and replace detectors as needed to maintain 80% functionality at each detection location during monitoring season, with emphasis on the spring and fall migration season data
- Review results of acoustic monitoring with ODNR, Division of Wildlife within three months of deployment of all monitoring equipment to evaluate effectiveness of protocol

[1] The mile 7 buoy is in fact located approximately 9 miles off of the Cleveland shore, or almost in the middle of the Icebreaker Wind project's turbine string.

Overview of Post-Construction Bat Monitoring Protocol

After construction in years 1 and 3 and following the same protocol as pre-construction, bat acoustic monitors will be deployed as follows:

- On three turbines (at least one on an end) with high (nacelle) and low (turbine platform) detectors
- On the mile 7 buoys near the water level and at 10m height
- On the Crib at the same locations as pre-construction monitoring
- Review results of acoustic monitoring with ODNR, Division of Wildlife within three months of deployment to evaluate effectiveness of protocol
- Submit annual report and copy of raw data three months after the completion of the first monitoring season (post-construction) and determine applicability of year three acoustic monitoring

Protocol Discussion

Bat acoustic data gathering will be conducted as described above to complete one full monitoring season prior to Project construction. Bat monitoring will be conducted using full-spectrum acoustic SM4™ detectors (Model: SM4, Wildlife Acoustics™, Maynard, MA; Figure 2) or the equivalent.

Preliminary data was collected using two SM4 units deployed on March 21, 2017 on a buoy located approximately 9 miles offshore of Cleveland, Ohio, within the Project area (Figure 1). This deployment was managed by a WEST bat acoustics specialist working in conjunction with the Project's fisheries consultant, LimnoTech, who deployed and maintains the buoy, and whom WEST trained to monitor and maintain the bat acoustic detectors throughout the recording season. Microphone extension cables were used to raise the microphones to approximately two meters above the water level (Figure 3).

Figure 2. SM4 Bat Acoustic Detector

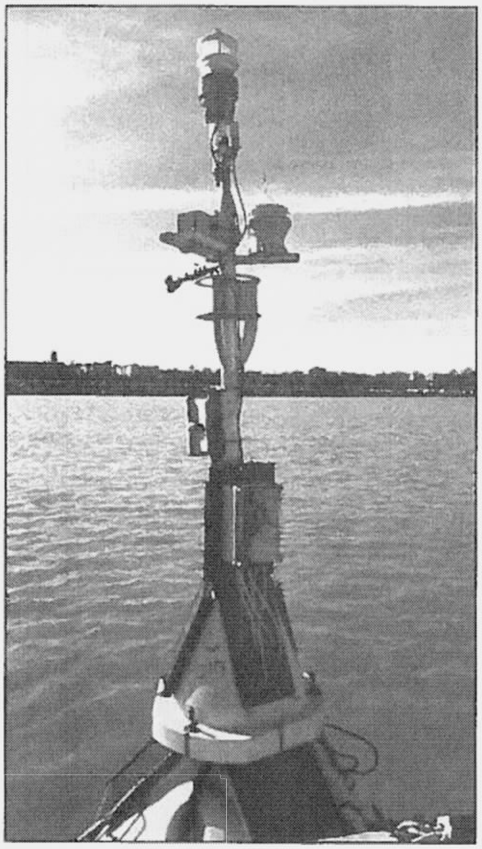


Figure 3. SM4 Bat Detector Deployed on a buoy for the Icebreaker Wind Project, showing microphones deployed at approximately 2m above the surface of the water

Two additional units were deployed at the Cleveland Water Intake Crib on March 23, 2017. One of these was deployed with its microphone located approximately 3 meters above the water level, and the other was deployed with its microphone located approximately 50 meters above water level on the Crib's meteorological tower (Figure 4). One additional detector was also deployed on March 23, 2017 on the mile 3 LimnoTech buoy located in close proximity to the Cleveland Crib (Figure 1). Similar to the deployment on the mile 7 buoy, the microphone on this detector was also deployed at an altitude approximately 2 meters above water level. Additional detectors have been deployed subsequently at all of these locations for redundancy in June so that there are now two detectors at each of the four recording locations, in order to minimize the potential for data gaps due to equipment malfunctions. An additional buoy with a 10m tall pole was deployed next to the mile 7 buoy on July 11, 2017. When the dual microphones are fitted to the top of this pole and begin recording in order to monitor the base of the rotor-swept zone, the start of the one-year pre-construction monitoring effort will begin. Recordings will be maintained at least 80% functionality for each location, with emphasis on spring and fall migration.

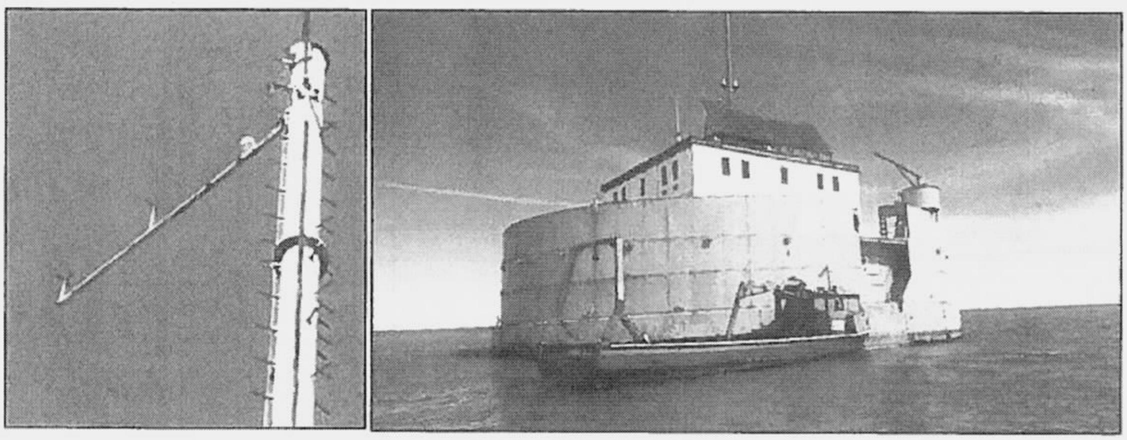


Figure 4. The Cleveland water intake Crib (right), and close-up shot of the Crib's meteorological tower (left) on which a bat acoustical detector was deployed at roughly 50 m above the water level during the March 23, 2017 deployment

If vessel based radar is deployed prior to construction at the project site, a bat acoustic detector will be deployed on the vessel as high as possible, but at a minimum of 20 meters.

All detectors have been, or will be, fitted with LimnoTech-fabricated brackets for attachment to buoys and Cleveland Crib components. LimnoTech will be responsible for bracket fabrication. External batteries (12 volt, 36 ah) and two Sandisk128 GB cards for each unit will be utilized to allow for monthly equipment checks and data card change-outs. Sensitivity has been, or will be adjusted to detect a calibration tone at 20 meters. Detectors have been or will be programmed to begin recording at least 30 minutes before sunset and continue recording until 30 minutes after sunrise. A copy of raw data, acoustic analysis, and methodology will be included in the annual reports to ODNR.

AERIAL WATERFOWL SURVEYS

Objectives

The primary objectives of the aerial waterfowl monitoring element are as follows:

- Characterize whether or not any water bird species are displaced from the Project area due to the presence of the Project
- Characterize the use of the project area by diurnal birds, including species composition, abundance, and distribution patterns

Overview of Pre- and Post-Construction Monitoring Protocol

IWI will adhere to all of the recommendations contained in the February 28, 2017 comments from the USFWS and ODNR regarding aerial waterfowl surveys. IWI will use human observers for these aerial surveys, and will work with the agencies to design the system that offers the most effective means to collect the waterfowl information sought. The Applicant will work with the ODNR, in consultation with the USFWS, to define the survey area and flight patterns to assure study objectives are achieved. The aerial survey project area and flight patterns will be approved by the ODNR in writing at least two months prior to the initiation of the initial survey. The surveys will be designed to include the following[2]:

Pre-construction

- Performed for one complete season (fall through spring) prior to Project construction
- Focus on waterfowl, bald eagles, and ice relative to location of birds
- Survey transects should run parallel to the turbine string
- Survey dates: mid-October through end of May
- Survey frequency: every 2 weeks
- Transect spacing: close enough to the turbines to observe birds between the turbines, but a safe distance from the blades
- Flight heights: 76-100 m in order to detect small water birds
- Flight speeds: 150-200 km/h unless constrained by local flying restrictions
- Suitable weather conditions for surveys defined as follows:

[2] Including recommendations contained within the document entitled "Preliminary recommendations to facilitate data collection during the autumn 2013 migration season Great Lakes aerial surveys" (Gilbert et al. 2013), which was included as an appendix to the ODNR/USFWS Feb 28 comments. Note, where specific recommendations differ between the ODNR/USFWS letter and the Gilbert et al. 2013 (e.g. transect orientation), the former is taken, as it was developed based on site- and application-specific considerations for the Project.

    - Beaufort scale wave conditions of 4 or below
    - winds of 37 km/h or below
    - minimum of 3.2 km visibility (or pilot's discretion)
- Conduct surveys at a variety of different times of day
- Standardize survey parameters
- Standardize environmental parameters
- Standardize observation methods, including the following:
    - Apply distance sampling using distance band method
    - Use a data logger or voice recorder to record data in flight
    - Record all bird species encountered
    - Record time and GPS position of each bird observation
    - Standardize collection of environmental data
    - Minimize the number of different observers used
- Conduct observer training
- Record survey transect times and GPS tracks
- Standardize data collection and QA/QC process, including the following data fields on the data sheets:
    - Survey area
    - Date
    - Time (GMT/UTC or other standardized system)
    - Observer location within the plane
    - Species code and/or common name (use standardized codes/names, as well as various degenerate categories, e.g. "unidentified gull", "unidentified diving duck")
    - Count (# of birds per observation)
    - Distance band
    - Sea state
    - Glare
    - Visibility
    - Geoposition
- Conduct statistical power analysis
- Standardize transect spacing. Transects should be spaced to maximize the number of transects within the project boundary while minimizing likelihood of observing the same flock/individual multiple times.

- Conduct double-observer studies

Post-construction

- Similar transect protocol as pre-construction
- Performed in years 1 and 4 subsequent to Project construction

RADAR

Objectives

The primary objectives of a radar monitoring element would be as follows:

- Characterize the altitudinal distribution and density of flying birds and bats at the Project site, pre- and post-construction
- Characterize behavioral avoidance/attraction effects in flying birds and bats in response to the presence of the Project

Overview of Pre- and Post-Construction Radar Monitoring Protocol

The ODNR, USFWS and IWI have retained an objective third party radar expert (Dr. Robb Diehl, USGS) to determine whether collection of pre-construction radar data at the project site on a vessel is feasible and will achieve the study objectives. A recommendation on the viability and precise design of any pre-construction radar is expected by the Fall of 2017. A decision on the final design of any post-construction radar will be made following the determination regarding pre-construction vessel based radar.

If either or both pre- or post-construction radar studies are determined unlikely to achieve the radar study objectives, the Applicant and agencies will work to re-direct resources to alternative monitoring efforts better designed to produce meaningful information concerning Project impacts.

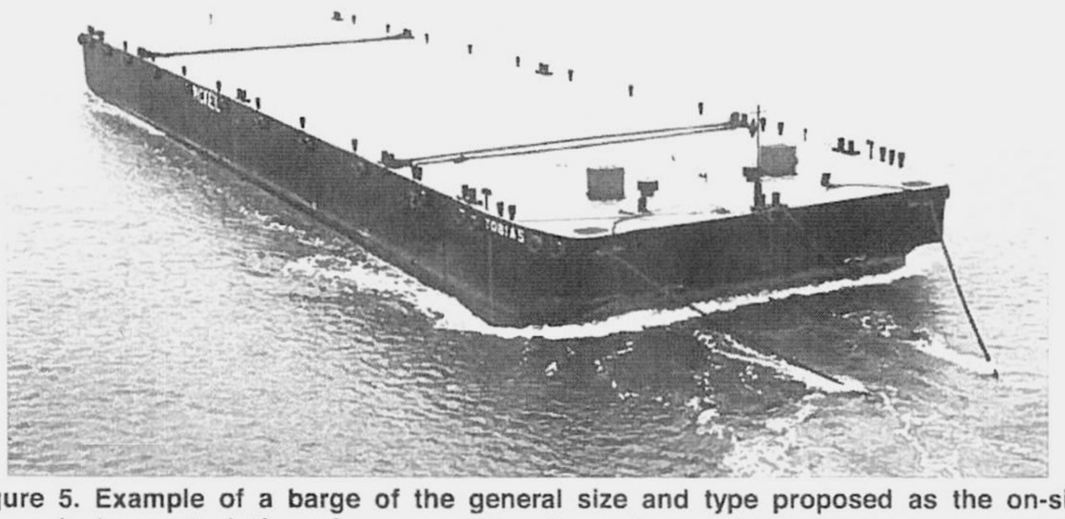


Figure 5. Example of a barge of the general size and type proposed as the on-site deployment platform for pre-construction radar monitoring to be conducted for the Icebreaker Wind Project.

COLLISION MONITORING

Objectives

The primary objective of the collision monitoring element is as follows:

- Detect collisions of birds and bats with wind turbines and identify to guild (if determined possible), post-construction

IWI recognizes that the potential for birds and/or bats to collide with Project infrastructure during the Project's operational phase is of primary importance for the Project and for the Monitoring Plan. IWI also recognizes that the well-established methods for monitoring such impacts at land-based wind energy facilities cannot be performed at an offshore facility such as the Project. Although several promising technologies are under active development, no proven effective technologies to perform bird/bat collision monitoring at offshore wind energy facilities are currently available; however, several emerging technologies appear promising.

The Applicant will consult with the ODNR, OPSB, and other agencies and stakeholders to design a post-construction mortality monitoring plan using innovative technologies that are economically and logistically feasible for this demonstration project. The commitment made by IWI at the present time is to continue to evaluate developing technologies and available options with the expectation of implementing a robust collision-monitoring program during the Project's operational phase, with the specific technology, protocol, and sampling parameters to be determined through continued consultation with wildlife agencies, experts, and other stakeholders. Depending on the limitations of the technology, additional methods may be warranted to supplement the data collected to provide post-construction collision information, specific to the project size, offshore location, and other factors specific to the unique needs of the project. The specific collision technology, protocol, and sampling parameters will be identified in the post-construction protocol and, upon timely approval by ODNR in writing, will be incorporated into this document as an amendment.

ADAPTIVE MANAGEMENT AND MITIGATION

Icebreaker Wind is a first of its kind U.S. demonstration project, and as such the Applicant recognizes the importance of rigorous post-construction monitoring to continuously evaluate the actual impacts of the Project on fish and wildlife. The Applicant is committed to taking adaptive management steps to further minimize and mitigate any unforeseen adverse impacts on fish and wildlife species. A comprehensive adaptive management plan specifying all of the impacts avoidance, minimization and mitigation measures to be implemented, including quantitative impact thresholds that trigger additional mitigation contingencies, will be developed in consultation with the agencies and included in the Project's Bird and Bat Conservation Strategy ("BBCS"). IWI will submit the results of the pre- and post-construction surveys within three months of the conclusion of the relevant survey and will discuss annually with the wildlife agencies and stakeholders practical and reasonable technologies and methods that can be employed to further avoid, minimize and mitigate any unforeseen adverse impacts that the project is having on bird and bat species.

The Applicant is developing a Bird and Bat Conservation Strategy (BBCS) to conduct thorough post-construction monitoring of Proposed Project impacts, and to undertake adaptive management measures, if necessary. Mitigation and adaptive management measures would be implemented if actual impacts exceed expectations. The BBCS will be submitted during the permitting process and will be finalized, in consultation with the wildlife agencies and stakeholders, well before construction.

The Applicant has agreed that the Proposed Project's turbines would be curtailed until winds reach 6.7 mph at night during the fall bat migratory period.

The Applicant will follow lighting recommendations per the USFWS 2012 land-based wind energy guidance documents. Gehring et al. (2009) found that the use of red or white flashing obstruction lights strongly correlated with a decrease in avian fatalities compared to non-flashing, steady burning lights at tower systems. Gehring et al. (2009) further stated that "Removing non-flashing lights from towers is one of the most effective and economically feasible means of achieving a significant reduction in avian fatalities at existing communication towers." The Proposed Project would use flashing red lights on turbines, as stipulated by FAA for bird safety.

Icebreaker will continue to work with state and federal agencies to: address any bird and bat issues that could arise during planning, construction, operation, or decommissioning of the Proposed Project to ensure that they remain in compliance with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Exhibit B

Timeline of Reporting Requirements, Pre-and Post-Construction

Quarterly status reports are due on the first day of March, June, September, and December for the term of this MOU.

Interim reports for the pre- and post-construction protocols described in Exhibit A (Icebreaker Wind Avian and Bat Monitoring Plan) are due three months after the start of data collection for each monitoring component.

Annual reports are due three months after completion of each monitoring season.

A final report is due one year after all sampling and monitoring work has been completed.

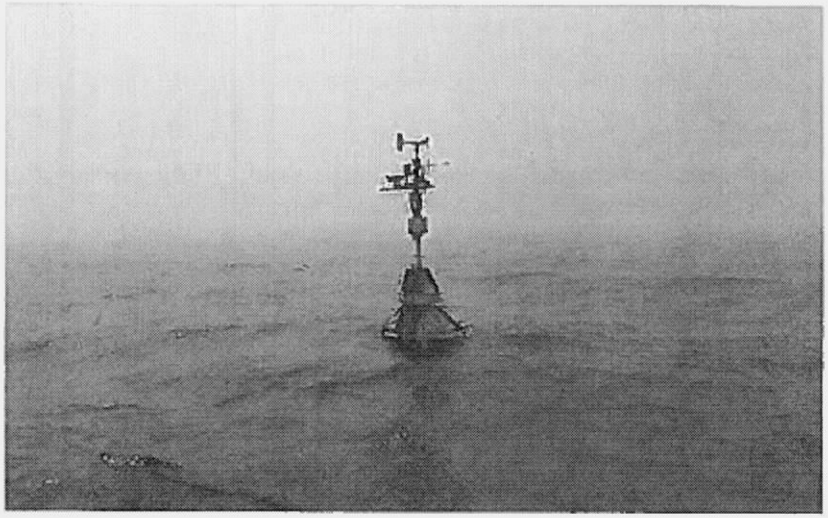
Icebreaker Wind Bat Activity Monitoring

(March 21 to November 14, 2017)

Lake Erie, Ohio

Final Report

February 15, 2018



Prepared for:

Icebreaker Windpower, Inc.

1938 Euclid Avenue, Suite 200
Cleveland, Ohio 44115

Prepared by:

Ashley Matteson, Rhett Good, and Caleb Gordon

Western EcoSystems Technology, Inc.
408 West 6th Street
Bloomington, Indiana 47404

February 15, 2018

WEST Inc.

EXHIBIT
PENGAD 800-631-6989
Applicant
39

STUDY PARTICIPANTS

Western EcoSystems Technology

Rhett Good	Project Manager, Senior Reviewer
Ashley Mattson	Bat Biologist, Qualitative Analyst, Data Analyst, and Report Writer
Kevin Murray	Bat Biologist, Qualitative Analyst, Bat Acoustic Expert
Ben Hale	Bat Biologist
Caleb Gordon	Consulting Biologist
Wendy Bruso	Technical Editing Manager
Katie Wynne	Technical Editing Coordinator
Linda Koepsell	Technical Editor

REPORT REFERENCE

Matteson, A., Good, R., Gordon, C. 2017. Icebreaker Wind Bat Activity Monitoring, Lake Erie, Ohio, Final Report, February 2018. Prepared for Icebreaker Windpower Inc., Cleveland, Ohio. Prepared by Western EcoSystems Technology, Inc., Bloomington, Indiana. February 15, 2018.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

INTRODUCTION

The Icebreaker Bat Activity Monitoring Final Report is being provided by Western EcoSystems Technology Inc. (WEST) to the Ohio Department of Natural Resources (ODNR) pursuant to the Memorandum of Understanding (MOU) between ODNR and Icebreaker Windpower Inc. (IWP) filed July 20, 2017, which MOU adopts the Avian and Bat Monitoring Plan ("MP") dated July 17, 2017, as well as reporting requirements and other commitments of the parties in regard to construction and operation of the Icebreaker Wind Project (Project), a 20.7 megawatt offshore wind demonstration project proposed 12.9 – 16 kilometers (km) (8-10 miles) off the shore of Cleveland, Ohio. IWP currently has an application for a Certificate of Environmental Compatibility and Public Need pending at the Ohio Power Siting Board, which has been assigned case no. 16-1871-EL-BGN.

This report covers all bat monitoring activities undertaken by the WEST team related to items described in the MOU for the entirety of the 2017 bat activity season as defined by ODNR, covering monitoring efforts from March 21 through November 15, 2017. WEST was assisted in the bat monitoring efforts by LimnoTech and Conserve First LLC, who took primary responsibility for deploying, maintaining, and retrieving data from the buoys and acoustic monitors used for this survey.

METHODS

As defined in the MP, the primary objectives of the bat acoustic monitoring were:

- Characterize the exposure of bats to potential impacts from the Project, pre- and post-construction.
- Characterize the potential behavioral responses of bats to the presence of the Project.
- Characterize bat species composition, activity, and seasonal patterns between the Project site and off site.

The exposure, behavioral responses, bat species composition, activity, and seasonal patterns of use were characterized through the use of acoustic bat detectors.

Overview of Bat Diversity

The Project is within the species distribution range of seven bat species. The state of Ohio lists the following species as state species of concern: little brown bat (Myotis lucifugus), big brown bat (Eptesicus fuscus), tri-colored bat (Perimyotis subflavus), silver-haired bat (Lasionycteris noctivagans), eastern red bat (Lasiurus borealis), and hoary bat (Lasiurus cinereus; ODNR 2012). The evening bat (Nycticeius humeralis) is within the range but is not a species of concern.

Table 1. Bat species with potential to occur within the Icebreaker Wind Project Bat Survey Area categorized by minimum echolocation call frequency.

Common Name	Scientific Name
High-Frequency (greater than 30 kHz)	
eastern red bat[1,3]	Lasiurus borealis
little brown bat[1]	Myotis lucifugus
evening bat[1]	Nycticeius humeralis
tri-colored bat[1,2]	Perimyotis subflavus
Low-Frequency (less than 30 kHz)	
big brown bat[1]	Eptesicus fuscus
hoary bat[1,3]	Lasiurus cinereus
silver-haired bat[1,3]	Lasionycteris noctivagans

[1] species known to have been killed at wind energy facilities
[2] currently being considered for listing by the U.S. Fish and Wildlife Service under the endangered species act
[3] long-distance migrant
Data source: Bat Conservation International (BCI) 2017
kHz = kilohertz

Study Area and Deployment Schedule

Bat acoustic surveys were conducted at one location within the proposed Project, and two locations outside the Project (Figure 1). Results in this report are a summary of our findings at all of the surveyed locations, referred to in the report at the Icebreaker Wind Project Bat Survey Area.

Five stations were monitored with Song Meter full-spectrum ultrasonic detectors (SM3 and SM4; Wildlife Acoustics, Inc.; Concord, Massachusetts) from either March 21 or March 23 through November 14, 2017, with the exception of the "seven mile" elevated, which was monitored from July 11 to August 30, 2017. The original plan described monitoring as starting on March 15 and ending November 15; detectors were not deployed at the stations until March 21 and 23, 2017, due to unsafe lake conditions, and were removed from the stations on November 14, 2017, due to weather conditions. Microphones were deployed at the following stations located within and outside the Project (Table 2, Figure 1):

- "Seven-mile" lower: Located within the Project at roughly one meter (m) above water level on a seven-mile buoy[1]
- "Seven-mile" elevated: Located within the Project at 10 m elevation on a second seven-mile buoy.
- Three-mile lower: Located outside the Project at roughly one m above water level at a three-mile buoy
- Crib elevated: Located outside the Project at an approximate 50 m elevation on the Cleveland water intake crib, and

[1] Both of the seven-mile buoys are nine miles offshore, at the Project site

- Crib lower: Located outside the Project site at an approximate three m elevation on the Cleveland water intake crib.

Acoustic monitoring began at the seven-mile lower station on March 21, 2017 (two SM4 detectors were deployed), and at the three-mile lower, crib elevated and crib lower stations on March 23, 2017 (one SM4 detector was deployed at each station). An additional SM4 detector was deployed at the crib elevated station on June 1, 2017, to add redundancy and further reduce the risk of data loss. Due to a detector failure, an SM3 detector was used on a temporary basis at the crib elevated station from June 8 to June 20, 2017. Additional SM4 detectors were deployed at the three-mile lower and crib lower stations on June 21, 2017, to add redundancy and further reduce the risk of data loss. As discussed below, SM4/SM3 microphones are more sensitive and record more bat calls than Anabat (Adams et al. 2012). Therefore, it is difficult to compare the results of this survey with results of other bat surveys that utilized Anabat detectors.

LimnoTech and Aaron Godwin of Conserve First LLC worked with WEST to install microphones and data loggers throughout 2017 on the Cleveland Crib and buoys. LimnoTech and Aaron Godwin received approval from the City of Cleveland prior to installation of bat detectors on the crib. LimnoTech visited each logger every two to three weeks to download data and ensure the logger and microphone were working correctly. Acoustic bat data were sent to WEST for processing after each visit.

The ODNR asked Icebreaker to test deployment of an additional elevated detector within the Project area, hereafter referred to as the seven-mile elevated station. LimnoTech designed an experimental system that included a detector elevated 10-m above water level on a pole attached to an offshore buoy. On July 11, 2017, a SM4 detector was deployed at the seven-mile elevated station (on a second buoy of the same design as the original seven-mile buoy, and moored near it), and on July 19, 2017, a second SM4 detector was deployed at the seven-mile elevated location for redundancy. On September 6, 2017, it was discovered that the 10 m pole on the seven-mile elevated station had snapped off of the buoy in high winds and/or high waves. On September 20, 2017, a dive team recovered one detector from the seven-mile elevated station from the bottom of the lake. Based on the recovered data, WEST inferred that the seven-mile elevated station went into the lake on August 31, 2017; the unit recorded data through the morning of August 31, but the detector did not turn on or record any data the night of August 31, 2017.

On November 14, 2017, detectors deployed at the seven-mile lower, three-mile lower, crib elevated, and crib lower stations were removed for the season (Table 2).

Table 2. Station deployment schedule at the Icebreaker Wind Project Bat Survey Area from March 21 to November 14, 2017.

Station	Station ID	Microphone Placement	Detector Type	Deployed Date	Takedown Date
Seven-mile elevated 1	X7.elevated.1	Elevated 10 m	SM4	July 11	August 30
Seven-mile elevated 2	X7.elevated.2	Elevated 10 m	SM4	July 19	August 30
Seven-mile lower 1	X7.lower.1	Water-level+one m	SM4	March 21	November 14
Seven-mile lower 2	X7.lower.2	Water-level+one m	SM4	March 21	November 14
Three-mile lower 1	X3.lower.1	Water-level+one m	SM4	March 23	November 14
Three-mile lower 2	X3.lower.2	Water-level+one m	SM4	June 21	November 14
Crib elevated 1	crib.elevated.1	Elevated 50 m	SM4	March 23	November 14
Crib elevated 2	crib.elevated.2	Elevated 50 m	SM4	June 1	November 14
Crib lower 1	crib.lower.1	Water-level+three m	SM4	March 23	November 14
			SM3	June 8	June 20
Crib lower 2	crib.lower.2	Water-level+three m	SM4	June 21	November 14

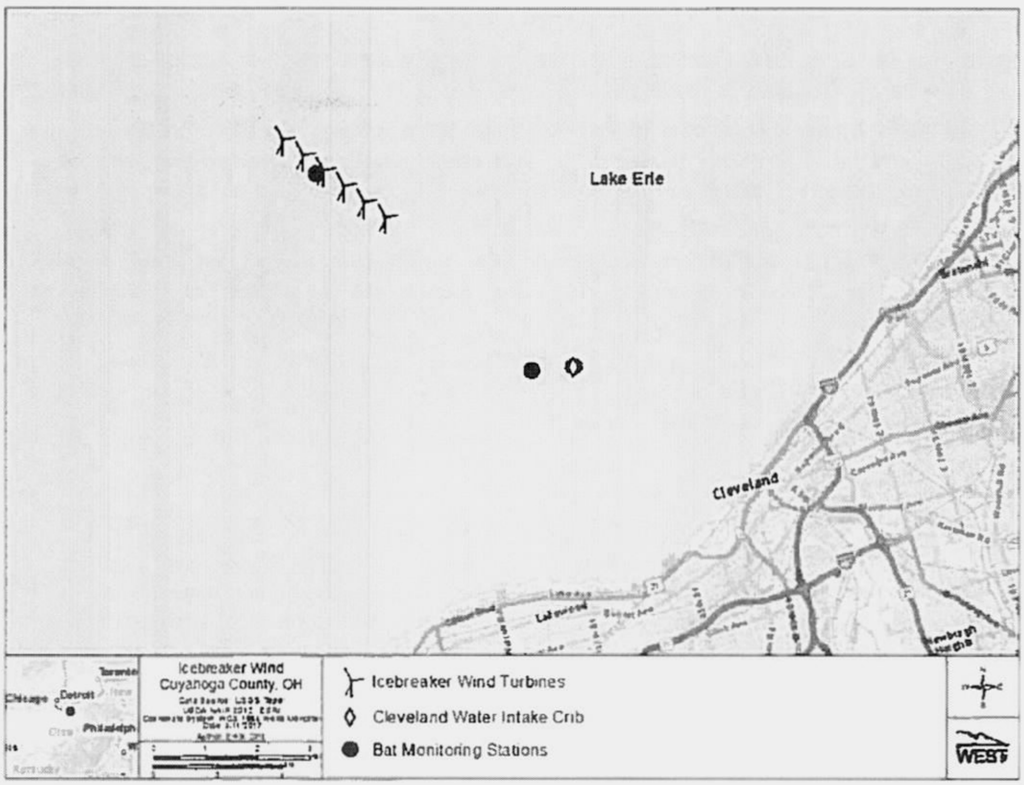


Figure 1. Acoustic sampling locations at the Icebreaker Wind Energy Project in 2017. The red dot among the turbines is the "seven-mile" location, where two buoys containing ultrasound microphones are located in close proximity to one another, and the red dot to the west of the Cleveland Water intake crib is the "three-mile buoy" location (see text). The "seven-mile" location is nine miles offshore at the Project site.

Data Collection and Call Analysis

Acoustic detectors were programmed to turn on 30 minutes before sunset and continue running until 30 minutes after sunrise the following morning throughout the monitoring period. A night of recording (hereafter referred to as detector-night) was defined as 30 minutes before sunset to 30 minutes after sunrise; for example, the night of September 4th began 30 minutes before sunset on September 4th and ended 30 minutes after sunrise on September 5th. If a detector failed at any time during the recording night, that night was not counted as a successful detector-night.

Bat passes were sorted into two groups based on their minimum frequency. High frequency (HF) bats such as eastern red bats, tri-colored bats, and Myotis species typically have minimum frequencies greater than 30 kilohertz (kHz). Low frequency (LF) bats such as big brown bats, silver-haired bats, and hoary bats typically emit echolocation calls with minimum frequencies below 30 kHz. HF and LF species that may occur in the study area are listed in Table 1.

Bat passes were identified to species where possible, depending on call quality. Bat call files recorded at all stations were initially identified to species using Wildlife Acoustics Kaleidoscope Pro (v4.2.0) automated acoustic identification program[2]. WEST bat biologists qualitatively (manually) reviewed each file to determine if they were bat calls or noise, and to verify species if possible. Unidentifiable calls lacked the necessary diagnostic characteristics needed to make a correct identification, contained primarily approach phase calls[3], or were of too poor quality to identify. Unidentified bat calls were classified either as high frequency unknown (calls greater than 30 kHz) or low frequency unknown (calls less than 30 kHz). In some cases, bat calls shared characteristics between two species, and were classified accordingly. For example, big brown bat and silver-haired bat calls, eastern red bat and evening bat calls, and eastern red bat and tri-colored bat calls, can be difficult to distinguish from one another in certain cases. Bat calls that fit that definition were labeled as EF_LN for big brown/silver-haired bats, LB_NH for eastern red/evening bats or LB_PS for eastern red/tri-colored bats.

Statistical Analysis

The number of bat passes per detector-night was used as the standard metric for measuring bat activity. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980). The same bat could be recorded echolocating during multiple passes at a given station; therefore, bat pass rates represent an index of bat activity, and do not represent numbers of individuals at each recording location. For example, 10 bats could echolocate near a detector once on a given night, or one bat could echolocate near a detector 10 times on a given night; both situations would result in 10 bat passes per detector-night. .The number of bat passes was

[2] Kaleidoscope software, Wildlife Acoustics, 2017, Concord, Massachusetts

[3] Approach phase calls refer to certain calls that bats make as they approach prey items. These calls are highly variable, and may have different characteristics than the regular echolocation calls on which most identification processes, both automated and manual, are based, confounding identification of such calls.

determined by a WEST bat biologist with significant experience in acoustic analysis and identification of bat calls.

The sampling period was broken down into different seasons (spring, summer, and fall) based on migratory patterns seen in bats, to provide information on how the bats are using the areas in the vicinity of the recording stations during different times of the year. Spring migration season (spring) was defined as March 21 to May 14, 2017. Summer maternity season (summer) was defined as May 15 to July 31, 2017. Fall season (fall) was defined as August 1 to November 15, 2017, and the fall migration period (FMP; July 30 to October 14) was included as a subset of the fall season. The FMP was defined by WEST as a standard for comparison with activity estimates from other wind energy facilities. During the FMP, bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational onshore wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013).

The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. If multiple seven-day periods equaled the peak sustained bat activity rate, all dates in these seven-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity (bat passes per detector-night) at each detector.

RESULTS

Acoustic detectors were deployed at the seven-mile elevated, seven-mile lower, three-mile lower, crib elevated, and crib lower stations for a total of 999 nights (station nights). Detectors were operational on 939 nights, (successful station nights; Table 3) resulting in a 93.7% success rate (including seven-mile elevated station during deployment of the station July 11 to August 30, 2017).

The MOU specified that detectors should be managed to ensure they operated correctly during at least 80% of the survey period. The seven-mile elevated station was not included in the following overall percent success calculations due to the experimental nature of the sampling. The overall project success during the warm season, defined as the nights of March 15 through November 15, 2017 by the MOU, was 90.2%, meeting the 80% minimum requirement of monitoring nights (Figure 2). The only nights where Figure 2 shows zero percent operational were nights that detectors were not deployed at the Project.

Duplicate detectors were deployed at each station for all or part of 2017 monitoring to add redundancy and further reduce the risk of data loss. Deployed nights include all nights that a detector was deployed at a station. Successful station nights include the number of nights at least one detector was functional at a station. Therefore, two detectors (both functioning) deployed at a station for one night equals one deployed night and one successful station night, or two detectors deployed for three nights, both functioned night one, one functioned night two, and neither functioned night three equals three deployed nights and two successful station nights. Non-successful detector nights were due to detector or microphone failure likely due to harsh weather conditions and/or lightning strikes.

Table 3. Operational success at the Icebreaker Wind Project Bat Survey Area, defined by detector-nights of acoustic data, by station and season.

	Station					
	Seven-Mile Elevated*	Seven-Mile Lower	Three-Mile Lower	Crib Elevated	Crib Lower	Overall
Spring	NA	55	40	53	52	200
Summer	21	78	58	75	78	310
Fall	30	105	105	89	100	429
Successful Detector- Nights	51	238	203	217	230	939
Number of Nights Detectors Were Deployed at a Given Station	51	238	238	238	238	999
Total Nights Available (full warm season)	246	246	246	246	246	1230
Success During Deployment	100%	100%	86.0%	91.6%	97.1%	93.7%**
Success of Total Warm Season	N/A	96.8%	82.5%	88.2%	93.5%	90.4%**

* Seven-mile elevated station was not included in overall percent success calculations

** includes only seven-mile tower, three-mile buoy, crib elevated, and crib lower stations

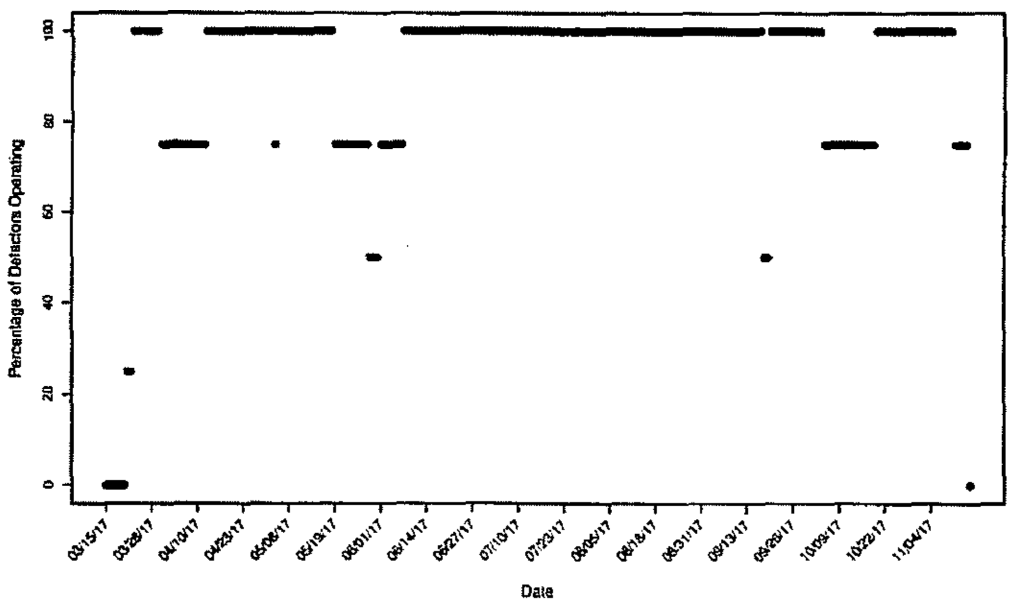


Figure 2. Operational success defined by successful station nights at the seven-mile lower, three-mile lower, crib elevated, and crib lower stations at the Icebreaker Wind Project Bat Survey Area during each night of deployment from March 15 to November 15, 2017. This does not incorporate the seven-mile elevated station due to the experimental nature of its deployment.

Overall Bat Activity

All 10 detectors at all five stations recorded a total of 10,114 bat passes on 1,531 successful detector nights[4]. The eight detectors deployed at seven-mile lower, three-mile lower, crib elevated, and crib lower stations from March 21 through November 14, 2017 recorded a total of 9,389 bat passes on 1,453 successful detector nights[4] for a mean ± standard error of 6.8±0.7 bat passes per detector-night. Lower detectors recorded a total of 9,128 bat passes over 1,118 successful detector-nights, with an average of 8.8±1.0 bat passes per detector-night. Elevated detectors recorded a total of 261 bat passes on 335 detector-nights, with an average of 0.8±0.1 bat passes per detector-night (Table 4; Figure 3). Low-frequency bat passes (5,499 bat passes recorded) were recorded more commonly than high-frequency bat passes (3,890 bat passes recorded; Table 4). Due to the duplicate detectors deployed at the same station it is likely that the same bat could be recorded echolocating on both detectors at the same time. It is also possible that the same bat could be recorded echolocating during multiple passes at a given station (or detector); therefore, bat pass rates (bat passes / detector night), also referred to as bat activity in this report, are a more appropriate metric for comparing use between detectors. Bat pass rates represent an index of bat activity, and do not represent numbers of individuals at each recording location.

Table 4. Results of acoustic bat surveys conducted at the Icebreaker Wind Project Bat Survey Area from March 21 to November 14, 2017. Bat passes are separated by call frequency: high frequency (HF) and low frequency (LF) groups.

Station	Microphone Placement	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night*
Seven-mile lower 1	Water-level+one m	467	518	985	238	4.1±0.5
Seven-mile lower 2	Water-level+one m	436	509	945	212	4.5±0.6
Three-mile lower 1	Water-level+one m	468	601	1,069	203	5.3±0.7
Three-mile lower 2	Water-level+one m	486	435	921	140	6.6±1.1
Crib elevated 1	Elevated 50 m	9	133	142	185	0.8±0.1
Crib elevated 2	Elevated 50 m	18	101	119	150	0.8±0.1
Crib lower 1	Water-level+three m	1,154	2,131	3,285	206	16.0±1.5
Crib lower 2	Water-level+three m	852	1,071	1,923	119	16.2±2.1
Total Lower		3,863	5,265	9,128	1,118	8.8±1.0
Total Elevated		27	234	261	335	0.8±0.1
Total		3,890	5,499	9,389	1,453	6.8±0.7

* ± bootstrapped standard error; m = meters

[4] Nightly success of every detector including duplicate detectors deployed at all stations except the 7-mi elevated station.

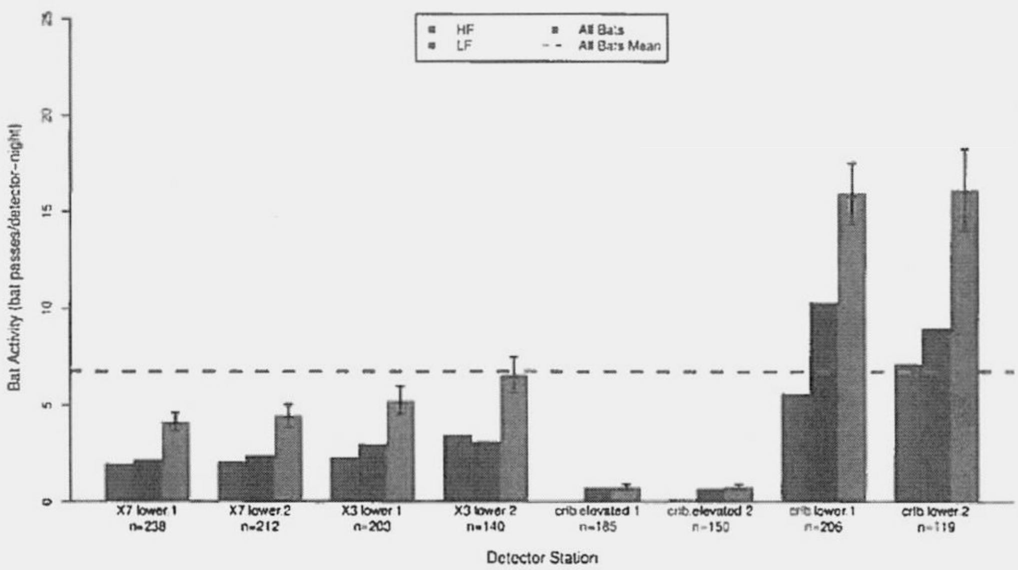


Figure 3. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at all detectors and stations at the Icebreaker Wind Project Bat Survey Area from March 21 to November 14, 2017.

X7.lower = seven-mile buoy lower stations, X3.lower = three mile buoy lower stations

Bat activity varied between stations, with the highest activity seen at the crib lower detectors (16.0±1.6 and 16.2±2.1 bat passes per detector-night), and the lowest activity seen at the crib elevated detectors (0.8±0.1 and 0.8±0.1 bat passes per detector-night; Table 3). Bat activity decreased as distance from land increased. The three-mile lower detectors recorded an average of 5.3±0.7 and 6.6±1.1 bat passes per detector-night, and the seven-mile lower detectors recorded an average of 4.1±0.5 and 4.5±0.6 bat passes per detector-night (Table 3).

"Seven-Mile" Elevated Station

The seven-mile elevated station was deployed only during the middle of the warm season, July 11 to August 30, 2017. This time period included the end of the summer season, beginning of the fall season and the fall migration period. In order to focus on direct comparison of bat activity at the different stations during this time period a subset of all data recorded at all stations were analyzed. Bat activity was highest at the crib lower detectors (28.7±4.5 and 20.9±3.5 bat passes per detector-night), and lowest at the crib elevated detectors (2.4±0.5 and 1.0±0.2 bat passes per detector-night). Bat activity at the seven-mile elevated, seven-mile lower, and three-mile lower stations was similar, falling within the bootstrapped standard error of mean bat passes per detector-night (Table 5; Figure 4).

Table 5. Results of acoustic bat surveys conducted at the Icebreaker Wind Project Bat Survey Area from July 11 through August 30, 2017*. Bat passes are separated by call frequency: high frequency (HF) and low frequency (LF) groups.

Station	Microphone Placement	Number of HF Bat Passes	Number of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night**
Seven-mile elevated 1	Elevated 10 m	112	189	301	35	8.6±1.7
Seven-mile elevated 2	Elevated 10 m	171	253	424	43	9.9±1.8
Seven-mile lower 1	Water-level+one m	212	225	437	51	8.6±1.7
Seven-mile lower 2	Water-level+one m	203	266	469	51	9.2±1.6
Three-mile lower 1	Water-level+one m	176	263	439	51	8.6±1.7
Three-mile lower 2	Water-level+one m	200	233	433	51	8.5±1.5
Crib elevated 1	Elevated 50 m	8	87	95	40	2.4±0.5
Crib elevated 2	Elevated 50 m	10	42	52	51	1.0±0.2
Crib lower 1	Water-level+three m	556	737	1,293	45	28.7±4.5
Crib lower 2	Water-level+three m	486	578	1,064	51	20.9±3.5
Total Lower		1,833	2,302	4,135	300	14.1±2.0
Total Elevated		301	571	872	169	5.5±0.8
Total		2,134	2,873	5,007	469	10.6±1.5

* July 11 through August 30, 2017 is the time period that the seven-mile elevated stations were deployed
** ± bootstrapped standard error.
m = meters

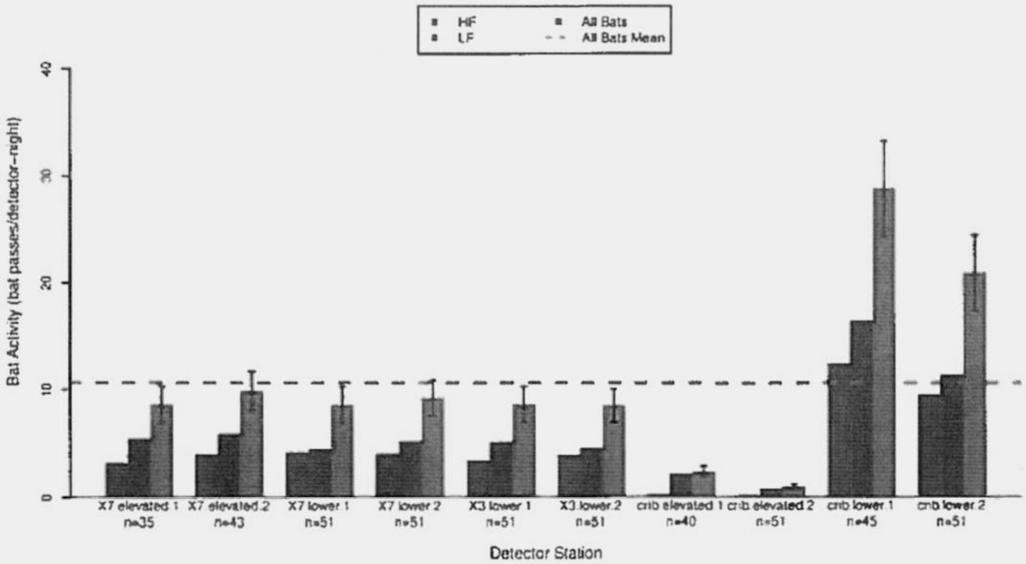


Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at all detectors and stations at the Icebreaker Wind Project Bat Survey Area from July 11 through August 30, 2017*.

X7. Elevated = seven-mile buoy elevated stations, X7.lower = seven-mile buoy lower stations. X3.lower = three mile buoy lower stations

* July 11 through August 30, 2017 is the time period that the seven-mile elevated stations were deployed

Seasonal Patterns of Bat Activity

Fall Migration Period

Data from the Seven-mile elevated station was excluded from seasonal comparisons of activity, because this station only operated during a portion of the fall migration period. Overall bat activity at the seven-mile lower, three-mile lower, crib elevated, and crib lower stations combined, was highest during the FMP with 10.0±1.4 bat passes per detector-night. Bat activity at lower stations was highest during the FMP with 13.2±1.9 bat passes per detector-night. Bat activity at elevated stations was highest during the summer season with 1.6±0.3 bat passes per detector-night.

Spring

Overall bat activity was lowest during the spring season with 1.7±0.6 bat passes per detector-night. The majority of bat activity during the spring season was attributed to low-frequency bats (1.6±0.6 bat passes per detector-night). There were very few high-frequency bats recorded during the spring (0.2±0.0 bat passes per detector-night). High-frequency bats were only recorded at lower stations in the spring.

Summer and Fall

Overall bat activity was higher during the summer season with 8.5±1.0 bat passes per detector-night than during the fall season with 7.0±1.0 bat passes per detector-night. Lower stations had slightly higher bat activity during the summer season (10.8±1.4 bat passes per detector-night) than during the fall season (9.2±1.5 bat passes per detector night). Crib elevated stations had higher bat activity in the summer season (1.6±0.3 bat passes per detector-night) than in the fall (0.3±0.1 bat passes per detector-night; Table 6; Figure 5).

Project Site – "Seven-mile" buoy

Bat activity at the seven-mile lower station was highest during the FMP with 9.2±1.4 bat passes per detector night, followed by fall with 6.3±1.0 bat passes per detector-night, summer with 4.1±0.8 bat passes per detector-night, and spring with 0.7±0.2 bat passes per detector-night. During the FMP and fall high-frequency bat activity was higher (FMP: 5.1±0.8 bat passes per detector-night; fall: 3.7±0.6 bat passes per detector-night) than low-frequency bat activity (FMP: 4.1±0.8 bat passes per detector-night; fall: 2.6±0.5 bat passes per detector-night). During the spring and summer low-frequency bat activity was higher (spring: 0.7±0.2 bat passes per detector-night; summer: 3.1±0.7 bat passes per detector-night) than high-frequency bat activity (spring: 0.1±0.0 bat passes per detector-night; summer: 1.0±0.2 bat passes per detector-night).

Table 6. The number of bat passes per detector-night recorded at the Icebreaker Wind Project Bat Survey Area during each season, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring March 21 – May 14*	Summer May 15 – July 31	Fall Aug 1 – Nov 15	Fall Migration Period Jul 30 – Oct 14
Seven-mile lower 1	LF	0.7	2.9	2.5	3.8
	HF	0.0	0.9	3.8	5.3
	AB	0.7	3.7	6.3	9.1
Seven-mile lower 2	LF	0.7	3.4	2.8	4.3
	HF	0.1	1.1	3.6	5.0
	AB	0.7	4.4	6.3	9.3
Three-mile lower 1	LF	1.7	4.7	2.5	4.0
	HF	0.1	2.3	3.1	4.5
	AB	1.8	7.0	5.6	8.5
Three-mile lower 2	LF	NA	4.4	2.6	3.8
	HF	NA	3.0	3.7	5.0
	AB	NA	7.4	6.2	8.7
Crib elevated 1	LF	0.1	1.7	0.2	0.5
	HF	0.0	0.1	0.0	0.1
	AB	0.1	1.8	0.2	0.6
Crib elevated 2	LF	NA	1.2	0.3	0.3
	HF	NA	0.1	0.1	0.1
	AB	NA	1.3	0.4	0.5
Crib lower 1	LF	4.8	16.0	8.4	14.3
	HF	0.6	6.7	7.9	12.5
	AB	5.4	22.7	16.3	26.8
Crib lower 2	LF	NA	12.4	7.2	8.6
	HF	NA	7.0	7.3	8.1
	AB	NA	19.4	14.5	16.7
Lower Totals	LF	2.0±0.7	7.3±1.1	4.3±0.7	6.5±1.0
	HF	0.2±0.1	3.5±0.5	4.9±0.9	6.7±1.1
	AB	2.1±0.7	10.8±1.4	9.2±1.5	13.2±1.9
Elevated Totals	LF	0.1±0.1	1.5±0.2	0.2±0.1	0.4±0.2
	HF	0.0±0.0	0.1±0.0	0.1±0.0	0.1±0.1
	AB	0.1±0.1	1.6±0.3	0.3±0.1	0.5±0.2
Overall	LF	1.6±0.6	5.8±0.7	3.3±0.5	5.0±0.7
	HF	0.2±0.0	2.6±0.3	3.7±0.6	5.1±0.7
	AB	1.7±0.6	8.5±1.0	7.0±1.0	10.0±1.4

* not all stations had duplicate detectors deployed during the spring season

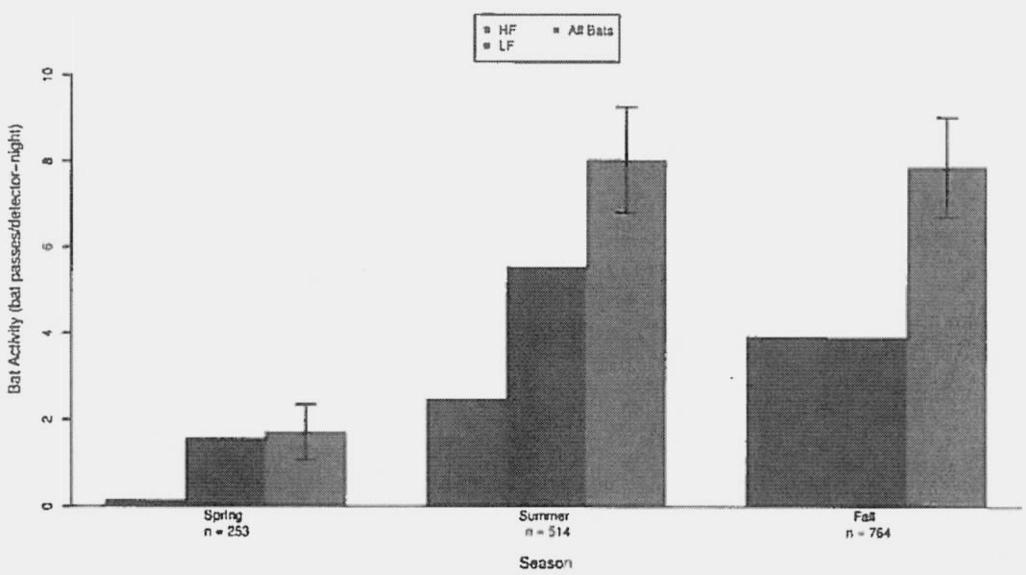


Figure 5. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Icebreaker Wind Project Bat Survey Area from March 21 through November 14, 2017. The bootstrapped standard errors are represented on the 'All Bats' columns.

Overall weekly acoustic activity at the crib elevated and lower, three-mile buoy, and seven-mile lower buoy stations for all bats peaked from September 20 to September 26, 2017 with 31.7 bat passes per detector-night. Low-frequency bat activity peaked during the same time week as all bat activity with 14.1 bat passes per detector-night. High-frequency bat activity peaked slightly earlier, from September 18 to September 24, 2017 with 17.9 bat passes per detector-night. In all seasons high-frequency bat activity peaked earlier than low-frequency and all bat activity (Table 7; Figure 6). Overall bat activity gradually decreased for the remainder of the study period from September 26 through November 14, 2017 (Figure 6).

Table 7. Periods of peak activity for high-frequency, low-frequency, and all bats at the Icebreaker Wind Project Bat Survey Area from March 21 to November 14, 2017.

	High-Frequency			Low-Frequency			All Bats		
Season	Start	End	Bat passes per detector-night	Start	End	Bat passes per detector-night	Start	End	Bat passes per detector-night
Spring	4/9	4/15	0.5	4/24	4/30	5.5	4/24	4/30	5.8
Summer	7/17	7/23	5.9	7/25	7/31	11.1	7/25	7/31	16.7
Fall	9/18	9/24	17.9	9/20	9/26	14.1	9/20	9/26	31.7
FMP	9/18	9/24	17.9	9/20	9/26	14.1	9/20	9/26	31.7
Overall	9/18	9/24	17.9	9/20	9/26	14.1	9/20	9/26	31.7

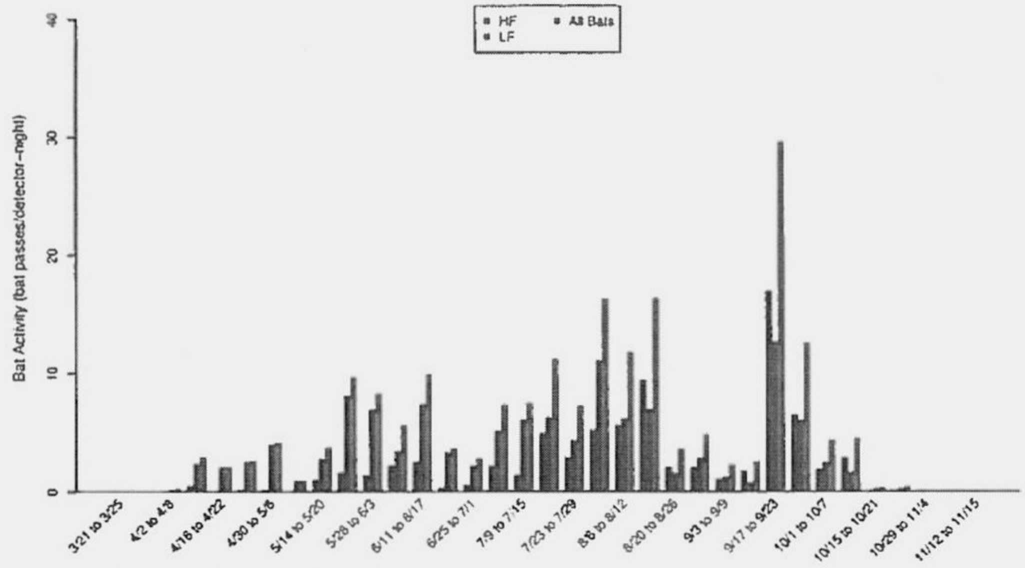


Figure 6. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at the Icebreaker Wind Project Bat Survey Area from March 21 to November 14, 2017.

Overall weekly acoustic activity at the seven-mile lower station for all bats peaked from September 20 to September 26, 2017 with 20.8 bat passes per detector-night. Low-frequency bat activity peaked from August 28 to September 3, 2017 with 10 bat passes per detector-night. High-frequency bat activity peaked from September 17 to September 23, 2017 with 14.4 bat passes per detector-night (Table 8).

Table 8. Periods of peak activity for high-frequency, low-frequency, and all bats at the Icebreaker Wind Project Seven-mile lower station from March 21 to November 14, 2017.

	High-Frequency			Low-Frequency			All Bats		
Season	Start	End	Bat passes per detector-night	Start	End	Bat passes per detector-night	Start	End	Bat passes per detector-night
Spring	4/8	4/16	0.3	4/12	4/21	2.1	4/12	4/21	2.2
Summer	7/16	7/25	2.4	7/25	7/31	7	7/25	7/31	8.6
Fall	9/17	9/23	14.4	8/28	9/3	10	9/20	9/26	20.8
FMP	9/17	9/23	14.4	8/28	9/3	10	9/20	9/26	20.8
Overall	9/17	9/23	14.4	8/28	9/3	10	9/20	9/26	20.8

Species Composition

Overall Bat Species Activity

Kaleidoscope isolated a total of 10,426 bat passes files from all seasons, detectors, and stations; this number also includes files containing bat calls that could not be identified to species by Kaleidoscope. WEST biologists identified 10,114 bat passes of these passes to species or species group (high- or low-frequency unknown, EF_LN, LB_NH or LB_PS; Table 9). There were 312 bat passes that were identified as bats by Kaleidoscope that were determined to be noise files during manual review.

Long-distance migratory species were the three most commonly identified bat species across all stations, accounting for approximately 80% of all bat activity. Eastern red bats were the most commonly identified species with a total of 4,097 bat passes (40.5%) recorded across all stations. Hoary bats were the second most commonly identified species with a total of 2,454 bat passes (24.3%) recorded across all stations. Silver-haired bats were the third most commonly identified species with a total of 1,545 bat passes (15.3%) recorded across all stations. Big brown bats were the fourth most commonly identified species with a total of 1,210 bat passes (12.0%) recorded across all stations. Less commonly identified species included low-frequency unknown bats (440 bat passes [4.4%]), big brown/silver-haired bat group (292 bat passes [2.9%]), high-frequency unknown bats (45 bat passes [0.4%]), tri-colored bats (13 bat passes [0.1%], eastern red/evening bat group (10 bat passes [0.1%]), eastern red/tri-colored bat group (7 bat passes [0.1%]), and little brown bats (1 bat pass [0.01%]; Table 9 and Table 10) All species across all seasons had higher activity at the lower stations than the elevated stations.

At the Project site, seven-mile lower buoy (nine miles offshore), long-distance migratory species were the three most commonly identified bat species at the seven-mile lower and elevated stations, accounting for approximately 80% of all bat activity. Eastern red bats were the most commonly identified species with a total of 1,159 bat passes (53.8%) recorded at the seven-mile elevated and lower stations for the entire duration of sampling. Hoary bats were the second most commonly identified with a total of 630 bat passes (29.2%) recorded. Silver-haired bats were the third most commonly identified species with a total of 365 bat passes (16.9%) recorded. Other less commonly recorded species included big brown bats (273 bat passes [7.9%]), tri-colored bats (three bat passes [less than 0.1%]), and little brown bats (one bat pass [less than 0.1%]). The little brown bat and tri-colored bats were both recorded at the seven-mile lower stations.

Bat species diversity was highest at the seven-mile lower station with the following six bat species identified: big brown, eastern red, hoary, silver-haired, little brown, and tri-colored bats. Five bat species and five bat species groups were identified at the crib lower station: big brown, eastern red, hoary, silver-haired, and tri-colored bats. The crib elevated station had the lowest bat diversity, with the following four bat species identified: big brown, eastern red, hoary, silver-haired bats (Figure 7).

Table 9. Number of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area from March 14, 2017.

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	10	28	112	124	13	0	0	0	0	0
Seven-mile elevated 2	8	51	170	137	31	0	0	0	0	1
Seven-mile lower 1	24	97	454	176	179	1	0	0	2	10
Seven-mile lower 2	26	97	423	193	142	1	0	1	1	10
Three-mile lower 1	44	85	461	269	184	0	0	0	0	7
Three-mile lower 2	26	76	475	211	90	2	0	0	0	9
Crib elevated 1	0	5	9	107	16	0	0	0	0	0
Crib elevated 2	1	1	17	75	19	0	0	0	0	1
Crib lower 1	107	488	1,141	719	690	1	2	0	6	4
Crib lower 2	46	282	835	443	181	5	5	0	4	3
Total Lower	273	1,125	3,789	2,011	1,466	10	7	1	13	43
Total Elevated	19	85	308	443	79	0	0	0	0	2
Total	292	1,210	4,097	2,454	1,545	10	7	1	13	45

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_ red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc UNLF = low frequency unidentified.

Table 10. Percentage[1] of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey A[illegible] fr
November 14, 2017.

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF	L
Seven-mile elevated 1	3.4%	2.3%	2.7%	5.1%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	3
Seven-mile elevated 2	2.7%	4.2%	4.1%	5.6%	2.0%	0.0%	0.0%	0.0%	0.0%	2.2%	5
Seven-mile lower 1	8.2%	8.0%	11.1%	7.2%	11.6%	10.0%	0.0%	0.0%	15.4%	22.2%	9
Seven-mile lower 2	8.9%	8.0%	10.3%	7.9%	9.2%	10.0%	0.0%	100%	7.7%	22.2%	1
Three-mile lower 1	15.1%	7.0%	11.3%	11.0%	11.9%	0.0%	0.0%	0.0%	0.0%	15.6%	4
Three-mile lower 2	8.9%	6.3%	11.6%	8.6%	5.8%	20.0%	0.0%	0.0%	0.0%	20.0%	7
Crib elevated 1	0.0%	0.4%	0.2%	4.4%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1
Crib elevated 2	0.3%	0.1%	0.4%	3.1%	1.2%	0.0%	0.0%	0.0%	0.0%	2.2%	1
Crib lower 1	36.6%	40.3%	27.8%	29.3%	44.7%	10.0%	28.6%	0.0%	46.2%	8.9%	2
Crib lower 2	15.8%	23.3%	20.4%	18.1%	11.7%	50.0%	71.4%	0.0%	30.8%	6.7%	2
Total Lower	93.5%	93.0%	92.5%	81.9%	94.9%	100%	100%	100%	100%	95.6%	8
Total Elevated	6.5%	7.0%	7.5%	18.1%	5.1%	0.0%	0.0%	0.0%	0.0%	4.4%	1
Total[2]	2.9%	12.0%	40.5%	24.3%	15.3%	0.1%	0.1%	<0.1%	0.1%	0.4%	4

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_
red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc
UNLF = low frequency unidentified.

[1] Calculated by taking the number of species bat passes recorded at a detector or station type divided by the total number of species bat passe

[2] Calculated by taking the number of species bat passes recorded divided by the all bats total number of bat passes recorded at the Icebreaker
Project.

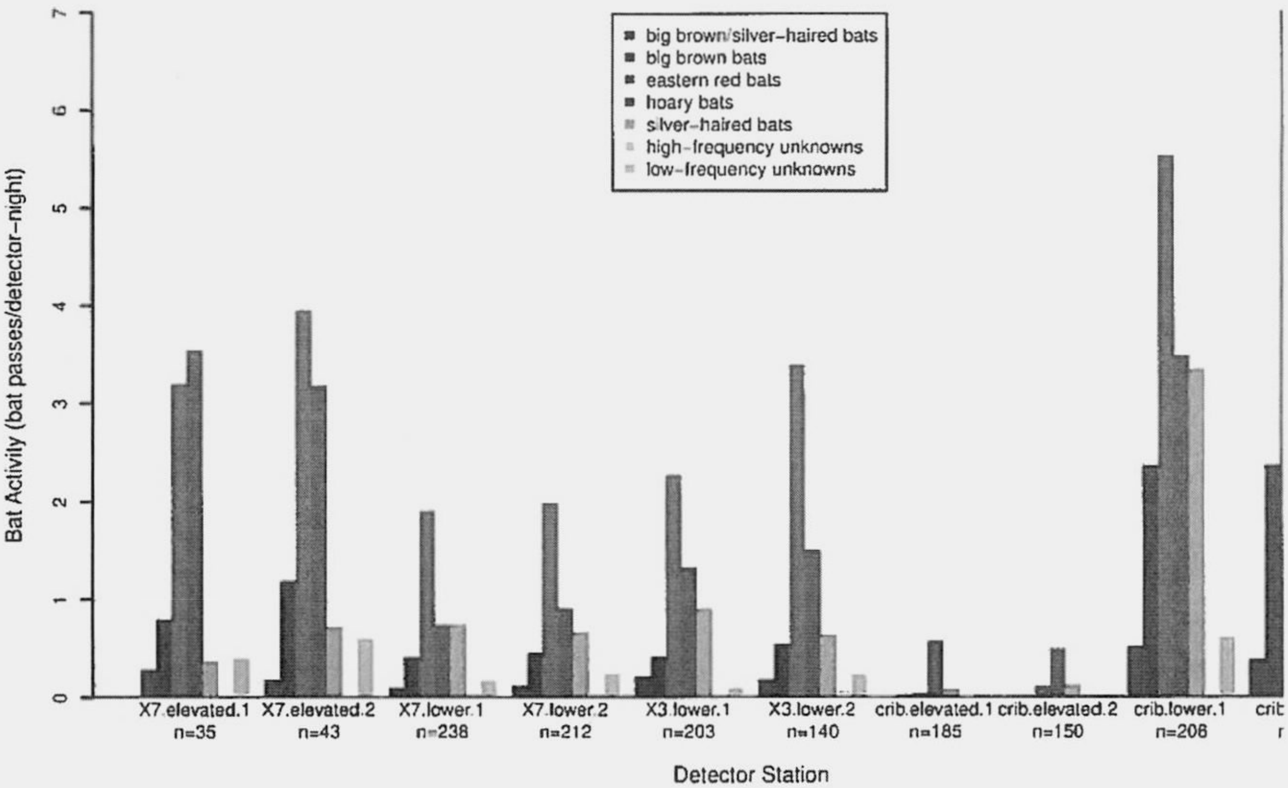


Figure 7. Bat species present at each detector location and station at the Icebreaker Wind Project Bat Survey Area f November 14, 2017.

X7.elevated = seven-mile buoy elevated stations, X7.lower = seven-mile buoy lower stations, X3.lower = three mile buoy lower stations

Seasonal Patterns of Bat Species Activity

Spring season was defined as beginning March 21 through May 14, 2017. There were 430 bat passes identified to species or species group during the spring season. Silver-haired bats were the most commonly identified species during the spring, with 312 bat passes (72.6%) recorded across all stations. Big brown bats, eastern red bats, and hoary bats were identified in low numbers during the spring season; eastern red bats with 37 bat passes (8.6%), big brown/silver-haired bat group with 33 bat passes (7.7%), hoary bats with 22 bat passes (5.1%), and big brown bats with 17 bat passes (4.0%). There were eight bat passes (1.9%) categorized into the low-frequency unknown group, and one bat pass (0.2%) categorized into the high-frequency unknown group (Table 11 and Table 12).

Summer season was defined as May 15 through July 31, 2017. There were 4,230 bat passes identified to species or species group during the summer season. Hoary bats were the most commonly identified species during the summer, with 1,359 bat passes (32.1%) recorded across all stations. Eastern red bats were the second most commonly identified species during the summer, with 1,258 bat passes (29.7%) recorded across all stations. Silver-haired bats and big brown bats were recorded in moderate numbers during the summer season; silver-haired bats (622 bat passes [14.7%]), and big brown bats (606 bat passes [14.3%]). Additional species detected in lower numbers included: low-frequency unknown group (215 bat passes [5.1%]), big brown/silver-haired bat group (157 bat passes [3.7%]), high-frequency unknown group (eight bat passes [0.2%]), tri-colored bats (three bat passes [0.1%]), eastern red/evening bat group (one bat pass [less than 0.1%]), and eastern red/tri-colored bat group (one bat pass [less than 0.1%]; Table 13 and Table 14).

Table 11. Number of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area during th (March 21 – May 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile lower 1	1	0	2	5	30	0	0	0	0	0
Seven-mile lower 2	0	0	3	2	33	0	0	0	0	0
Three-mile lower 1	1	3	2	3	58	0	0	0	0	1
Crib elevated 1	0	0	0	0	4	0	0	0	0	0
Crib lower 1	31	14	30	12	187	0	0	0	0	0
Total Lower	33	17	37	22	308	0	0	0	0	1
Total Elevated	0	0	0	0	4	0	0	0	0	0
Total	33	17	37	22	312	0	0	0	0	1

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_ red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc UNLF = low frequency unidentified.

Table 12. Percentage[1] of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area during th (March 21 – May 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile lower 1	3.0%	0%	5.4%	22.7%	9.6%	0%	0%	0%	0%	0%
Seven-mile lower 2	0%	0%	8.1%	9.1%	10.6%	0%	0%	0%	0%	0%
Three-mile lower 1	3.0%	17.6%	5.4%	13.6%	18.6%	0%	0%	0%	0%	100%
Crib elevated 1	0%	0%	0%	0%	1.3%	0%	0%	0%	0%	0%
Crib lower 1	93.9%	82.4%	81.1%	54.5%	59.9%	0%	0%	0%	0%	0%
Total Lower	100%	100%	100%	100%	98.7%	0%	0%	0%	0%	100%
Total Elevated	0%	0%	0%	0%	1.3%	0%	0%	0%	0%	0%
Total[2]	7.7%	4.0%	8.6%	5.1%	72.6%	0%	0%	0%	0%	0.2%

[1] Calculated by taking the number of species bat passes recorded at a detector or station type divided by the total number of species bat pass

[2] Calculated by taking the number of species bat passes recorded divided by the all bats total number of bat passes recorded at the IWP.

Table 13. Number of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area duri[illegible]e (May 15 – July 31, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	5	10	42	76	3	0	0	0	0	0
Seven-mile elevated 2	1	7	23	40	3	0	0	0	0	0
Seven-mile lower 1	14	40	66	82	64	0	0	0	0	0
Seven-mile lower 2	5	35	53	92	36	0	0	0	0	4
Three-mile lower 1	24	45	136	141	55	0	0	0	0	0
Three-mile lower 2	9	37	117	105	22	0	0	0	0	4
Crib elevated 1	0	4	8	98	11	0	0	0	0	0
Crib elevated 2	1	0	6	58	11	0	0	0	0	0
Crib lower 1	71	277	523	457	365	1	0	0	2	0
Crib lower 2	27	151	284	210	52	0	1	0	1	0
Total Lower	150	585	1,179	1,087	594	1	1	0	3	8
Total Elevated	7	21	79	272	28	0	0	0	0	0
Total	157	606	1,258	1,359	622	1	1	0	3	8

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_ red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc UNLF = low frequency unidentified.

Table 14. Percentage[1] of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area dur season (May 15 – July 31, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	3.2%	1.7%	3.3%	5.6%	0.5%	0%	0%	0%	0%	0%
Seven-mile elevated 2	0.6%	1.2%	1.8%	2.9%	0.5%	0%	0%	0%	0%	0%
Seven-mile lower 1	8.9%	6.6%	5.2%	6.0%	10.3%	0%	0%	0%	0%	0%
Seven-mile lower 2	3.2%	5.8%	4.2%	6.8%	5.8%	0%	0%	0%	0%	50%
Three-mile lower 1	15.3%	7.4%	10.8%	10.4%	8.8%	0%	0%	0%	0%	0%
Three-mile lower 2	5.7%	6.1%	9.3%	7.7%	3.5%	0%	0%	0%	0%	50%
Crib elevated 1	0%	0.7%	0.6%	7.2%	1.8%	0%	0%	0%	0%	0%
Crib elevated 2	0.6%	0%	0.5%	4.3%	1.8%	0%	0%	0%	0%	0%
Crib lower 1	45.2%	45.7%	41.6%	33.6%	58.7%	100%	0%	0%	66.7%	0%
Crib lower 2	17.2%	24.9%	22.6%	15.5%	8.4%	0%	100%	0%	33.3%	0%
Total Lower	95.5%	96.5%	93.7%	80%	95.5%	100%	100%	0%	100%	100%
Total Elevated	4.5%	3.5%	6.3%	20%	4.5%	0%	0%	0%	0%	0%
Total[2]	3.7%	14.3%	29.7%	32.1%	14.7%	<0.1%	<0.1%	0%	0.1%	0.2%

[1] Calculated by taking the number of species bat passes recorded at a detector or station type divided by the total number of species bat passe

[2] Calculated by taking the number of species bat passes recorded divided by the all bats total number of bat passes recorded at the IWP.

Fall season was defined as August 1 through November 14, 2017. There were 5,454 bat passes identified to species or species group during the fall season. Eastern red bats were the most commonly identified species during the fall, with 2,802 bat passes (51.4%) recorded across all stations. Hoary, silver-haired, and big brown bats were other commonly identified species during the fall season, with 1,073 hoary bat passes (19.7%), 611 silver-haired bat passes (11.2%), and 587 big brown bat passes (10.8%) recorded across all stations. Additional species detected in lower numbers included: low-frequency unknown group (217 bat passes [4.0%]), big brown/silver-haired bat group (102 bat passes [1.9%]), high-frequency unknown group (36 bat passes [0.7%]), tri-colored bats (10 bat passes [0.2%]), eastern red/evening bat group (nine bat passes [0.2%]), and eastern red/tri-colored bat group (six bat passes [0.1%]). The only little brown bat pass identified was recorded during the fall season (one bat pass [less than 0.1%]; Table 15 and Table 16).

The FMP overlaps with the end of the summer season and beginning of the fall season, beginning July 30 and ending October 14, 2017. There were 6,018 bat passes identified to species or species group during the FMP. Species activity during the FMP was similar to the fall season. The most commonly identified species during the FMP were eastern red bats (2,962 bat passes [49.2%]), followed by hoary bats (1,219 bat passes [21.5%]), big brown bats (713 bat passes [11.8%]), and silver-haired bats (618 bat passes [10.3%]). The little brown bat pass was recorded at the seven-mile lower station during the FMP (Table 17 and Table 18).

Table 15. Number of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area during (August 1 – November 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	5	18	70	48	10	0	0	0	0	0
Seven-mile elevated 2	7	44	147	97	28	0	0	0	0	1
Seven-mile lower 1	9	57	386	89	85	1	0	0	2	10
Seven-mile lower 2	21	62	367	99	73	1	0	1	1	6
Three-mile lower 1	19	37	323	125	71	0	0	0	0	6
Three-mile lower 2	17	39	358	106	68	2	0	0	0	5
Crib elevated 1	0	1	1	9	1	0	0	0	0	0
Crib elevated 2	0	1	11	17	8	0	0	0	0	1
Crib lower 1	5	197	588	250	138	0	2	0	4	4
Crib lower 2	19	131	551	233	129	5	4	0	3	3
Total Lower	90	523	2,573	902	564	9	6	1	10	34
Total Elevated	12	64	229	171	47	0	0	0	0	2
Total	102	587	2,802	1,073	611	9	6	1	10	36

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_ red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc UNLF = low frequency unidentified.

Table 16. Percentage[1] of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area during (August 1 – November 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	4.9%	3.1%	2.5%	4.5%	1.6%	0%	0%	0%	0%	0%
Seven-mile elevated 2	6.9%	7.5%	5.2%	9.0%	4.6%	0%	0%	0%	0%	2.8%
Seven-mile lower 1	8.8%	9.7%	13.8%	8.3%	13.9%	11.1%	0%	0%	20%	27.8%
Seven-mile lower 2	20.6%	10.6%	13.1%	9.2%	11.9%	11.1%	0%	100%	10%	16.7%
Three-mile lower 1	18.6%	6.3%	11.5%	11.6%	11.6%	0%	0%	0%	0%	16.7%
Three-mile lower 2	16.7%	6.6%	12.8%	9.9%	11.1%	22.2%	0%	0%	0%	13.9%
Crib elevated 1	0%	0.2%	0%	0.8%	0.2%	0%	0%	0%	0%	0%
Crib elevated 2	0%	0.2%	0.4%	1.6%	1.3%	0%	0%	0%	0%	2.8%
Crib lower 1	4.9%	33.6%	21.0%	23.3%	22.6%	0%	33.3%	0%	40%	11.1%
Crib lower 2	18.6%	22.3%	19.7%	21.7%	21.1%	55.6%	66.7%	0%	30%	8.3%
Total Lower	88.2%	89.1%	91.8%	84.1%	92.3%	100%	100%	100%	100%	94.4%
Total Elevated	11.8%	10.9%	8.2%	15.9%	7.7%	0%	0%	0%	0%	5.6%
Total[2]	1.9%	10.8%	51.4%	19.7%	11.2%	0.2%	0.1%	<0.1%	0.2%	0.7%

[1] Calculated by taking the number of species bat passes recorded at a detector or station type divided by the total number of species bat passes
[2] Calculated by taking the number of species bat passes recorded divided by the all bats total number of bat passes recorded at the IWP.

Table 17. Number of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area during tl period (July 30 – October 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	8	25	86	72	12	0	0	0	0	0
Seven-mile elevated 2	7	50	155	114	30	0	0	0	0	1
Seven-mile lower 1	8	64	394	112	87	1	0	0	2	10
Seven-mile lower 2	20	71	376	125	74	1	0	1	1	6
Three-mile lower 1	23	47	343	146	77	0	0	0	0	6
Three-mile lower 2	19	50	375	120	74	2	0	0	0	5
Crib elevated 1	0	1	5	17	1	0	0	0	0	0
Crib elevated 2	0	1	8	19	2	0	0	0	0	0
Crib lower 1	5	240	630	298	133	0	2	0	4	3
Crib lower 2	21	164	590	268	128	5	4	0	3	3
Total Lower	96	636	2,708	1,069	573	9	6	1	10	33
Total Elevated	15	77	254	222	45	0	0	0	0	1
Total	111	713	2,962	1,291	618	9	6	1	10	34

EF_LN = big brown /silver –haired bat group, EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver haired bat, LB_ red/evening bat group, LB_PS = eastern red/tri-colored bat group, MYLU = little brown bat, PESU = tri-colored bat, UNHF = high frequenc UNLF = low frequency unidentified.

Table 18. Percentage[1] of bat calls qualitatively verified at the Icebreaker Wind Energy Project Bat Survey Area du[illegible] t
period (July 30 – October 14, 2017).

Station	EF_LN	EPFU	LABO	LACI	LANO	LB_NH	LB_PS	MYLU	PESU	UNHF
Seven-mile elevated 1	7.2%	3.5%	2.9%	5.6%	1.9%	0%	0%	0%	0%	0%
Seven-mile elevated 2	6.3%	7.0%	5.2%	8.8%	4.9%	0%	0%	0%	0%	2.9%
Seven-mile lower 1	7.2%	9.0%	13.3%	8.7%	14.1%	11.1%	0%	0%	20%	29.4%
Seven-mile lower 2	18.0%	10%	12.7%	9.7%	12.0%	11.1%	0%	100%	10%	17.6%
Three-mile lower 1	20.7%	6.6%	11.6%	11.3%	12.5%	0%	0%	0%	0%	17.6%
Three-mile lower 2	17.1%	7.0%	12.7%	9.3%	12.0%	22.2%	0%	0%	0%	14.7%
Crib elevated 1	0%	0.1%	0.2%	1.3%	0.2%	0%	0%	0%	0%	0%
Crib elevated 2	0%	0.1%	0.3%	1.5%	0.3%	0%	0%	0%	0%	0%
Crib lower 1	4.5%	33.7%	21.3%	23.1%	21.5%	0%	33.3%	0%	40%	8.8%
Crib lower 2	18.9%	23.0%	19.9%	20.8%	20.7%	55.6%	66.7%	0%	30%	8.8%
Total Lower	86.5%	89.2%	91.4%	82.8%	92.7%	100%	100%	100%	100%	97.1%
Total Elevated	13.5%	10.8%	8.6%	17.2%	7.3%	0%	0%	0%	0%	2.9%
Total[2]	1.8%	11.8%	49.2%	21.5%	10.3%	0.1%	0.1%	<0.1%	0.2%	0.6%

[1] Calculated by taking the number of species bat passes recorded at a detector or station type divided by the total number of species bat pass[illegible]

[2] Calculated by taking the number of species bat passes recorded divided by the all bats total number of bat passes recorded at the IWP.

In addition to the analysis of bat acoustic recordings described above, WEST also performed a statistical analysis of the correlation between the seven-mile lower and seven-mile elevated detector bat activity levels. This analysis was specifically requested by the IWP team based on discussions with ODNR, who requested that this additional analysis be performed to address the question of whether the data being gathered at these two recording stations was truly additive, as would be the case if the two data streams were found to be uncorrelated, or largely redundant, or if the two data streams were highly correlated. The results of this analysis showed bat activity at lower and elevated stations were highly correlated. The analysis was presented in a separate report provided by WEST to the IWP team, dated October 31, 2017. This report was submitted to ODNR on November 1, 2017, revised in response to ODNR comments on the initial draft, and the revised draft is attached as Appendix A.

DISCUSSION

The MOU signed by IWP and ODNR describes the goals of bat monitoring as 1) to document existing conditions and patterns of use by species of concern at the Project site; 2) to document changing conditions and patterns of use by species of concern and their associated habitats as a result of Project construction and operations at the Project site; 3) to develop and implement effective mitigation and adaptive management strategies to minimize avian and bat resource impacts; 4) to evaluate the feasibility of various monitoring protocols in an offshore setting; and 5) to better understand how offshore wind projects in Lake Erie or the Great Lakes may affect birds and bats. The bat monitoring completed in 2010 by Tetra Tech and 2017 by WEST measured patterns of use within and outside the Project site, and provides a baseline to which use can be compared after construction.

Offshore monitoring of bats provides unique challenges that on-shore facilities do not face. Humid conditions and harsh weather can cause bat detectors to malfunction more often than desired; despite the harsh conditions, detector success rates exceeded the 80% goal desired by ODNR, and met the intentions of the MOU. Use of redundant detectors at stations and regular checks of equipment by LimnoTech increased the success rate. The ability of SM4/3 detectors to handle moist conditions also increased the success rate relative to other detectors typically used collect bat activity at wind-energy projects, such as Anabat.

ODNR requested a detector be raised as high as possible within the Project site to better assess bat use closer to the rotor swept zone of turbines; in response, LimnoTech deployed an experimental offshore buoy with a 10-m carbon fiber pole attached to the buoy. The detector was placed near the buoy and the microphone was elevated to the top of the 10-m pole. The detector operated successfully until the bolts connecting the pole to the buoy failed and the pole broke off from the buoy. The failure of the bolts was likely due to high winds and large waves, illustrating the logistical challenges associated with monitoring bat activity in offshore environments. As described in Appendix A, attached, data collected from the 10-m detector was highly correlated with data collected at a nearby detector located near water level, suggesting that both detectors recorded bat calls within similar airspaces. Wave action and harsh weather associated with offshore environments make it impractical to collect acoustic bat data at heights greater than approximately 10-m for the majority of the active bat season. Collecting this additional data from elevated buoys is unlikely to provide additional insight into the existing conditions and patterns of use by bats at the Project site.

Previous Study Results

Acoustic studies using ultrasonic bat detectors provide a way to sample bats in locations, such as open water, that would not be able to be sampled using traditional bat capture methods. A wide variety of bat detectors exist on the market; however, different detector models use different technology and microphones to record bat echolocation calls (Downes 1982 and Fenton 2000). A study by Adams et al. (2012) compared five different bat detector models, and found that there is significant variation in detection ability of different bat detectors. Different detector models use different microphone types, such as directional and omnidirectional microphones. Omnidirectional microphones have a greater chance of recording bat echolocation calls than a directional microphone (Limpens and McCraken 2004). Direct comparison between studies that used different recording methods and technology should be made with caution, understanding that there are innate differences in the ability of different bat detectors to detect and record bat echolocation calls. Adams et al. (2012) showed Anabat detectors to consistently record fewer calls than four other detector types, including Wildlife Acoustics SM2 detectors. For example, Anabat units recorded approximately 5 synthetic bat calls played at 10-m from detectors at 25Khz compared to approximately 15 calls recorded by the SM2 detector.

Tetra Tech conducted a bat activity study (Svedlow et al. 2012) using some stations that were also monitored WEST in 2017. Svedlow et al. (2012) found different, generally lower, bat activity rates than the study by WEST. Different bat detectors were deployed in the two studies. In 2010, Anabat SD1 bat detectors were deployed and, in 2017, SM4/SM3 bat detectors were deployed. SD1 bat detectors use a directional microphone that is not waterproof (requires additional housing to protect the microphone); whereas the SM4 bat detectors use an omnidirectional waterproof microphone that is better suited for off-shore bat activity monitoring. SM4/SM3 microphones are more sensitive and record more bat calls than Anabat detectors. The differences in detector type preclude direct comparison of the number of bat passes recorded in 2017 to Svedlow et al. (2012) or most land-based wind-energy projects that used Anabat detectors. Generally, both the WEST study and Svedlow et al. (2012) found a similar species composition, along with seasonal activity trends (higher activity in the summer and fall) at the recording locations. Both WEST and Svedlow et al. (2012) documented significantly more bat activity at the lower detector on the crib compared to other detectors. Svedlow et al. (2012) suggested the reason for the increase activity was that bats were attracted to the crib, the reasons for which were unclear but could be related to insects congregating around lights on the crib.

CONCLUSIONS

The results of this study provide a valuable baseline to which use and mortality can be compared post-construction. For example, the bat species recorded, and the timing of bat activity was similar to patterns of mortality at on-shore wind-energy facilities (Arnett et al. 2008); post-construction monitoring can be used to determine if bat mortality off-shore at the Project also follows patterns observed at on-shore facilities. While it is tempting to use activity rates recorded during this study to precisely predict post-construction mortality rates by comparing our results to Svedlow et al. (2012) or projects located on-shore, the ability of SM detectors to record significantly more bat calls than Anabats makes these comparisons inappropriate. Most existing studies of on-shore wind-energy facilities Ohio and elsewhere have utilized Anabat detectors to characterize bat activity, which record significantly fewer bat passes.

The lack of empirical relationships between pre-construction bat activity and post-construction bat mortality rates also precludes precise predictions of bat mortality rates. Research completed to date has not shown a strong correlation between pre-construction bat activity rates and post-construction bat mortality rates. Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m and fatality rates for hoary and silver-haired bats across five on-shore wind projects in southern Alberta; however, only 31% of the variation in activity and mortality was explained during their study. Hein et al. (2013) were unable to find a significant relationship between bat activity and mortality in a review of 12 wind projects in the US with adequate pre-construction activity data and post-construction mortality data, and similar to Baerwald and Barclay (2009), a small portion of variation in fatalities (21.8%) was explained by bat activity. Differences in survey methodologies could partially explain the lack of correlation; however the propensity for bats to be attracted to turbines is the more likely explanation for the lack of strong correlation between pre-construction bat activity estimates and post-construction bat mortality rates (Jameson and Willis 2014, Cryan et al. 2014).

Gordon and Erickson (2016) assessed risk to bats from the Project based on available data, and predicted that bat fatality rates would be within the broad range of mortality recorded at on-shore wind-energy facilities, and there was a low potential for collision risk of species protected under the endangered species act. The results of this study are consistent with the conclusions of Gordon and Erickson (2016).

REFERENCES

Adams, A.M., M.K. Jantzen, R.M. Hamilton, and M.B. Fenton. 2012. Do you hear what I hear? Implications of detector selection for acoustic monitoring of bats. Methods in Ecology and Evolution, 3 (6) 992-998.

Arnett, E.B., K. Brown, W.P. Erickson, J. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersley, Jr. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. Journal of Wildlife Management 72(1): 61-78.

Arnett, E.B. and E.F. Baerwald. 2013. Impacts of Wind Energy Development on Bats: Implications for Conservation. Chapter 21. Pp. 435-456. In: R.A. Adams and S.C. Pederson, eds. Bat Ecology, Evolution and Conservation. Springer Science Press, New York.

Baerwald, E.F. and R.M.R. Barclay. 2009. Geographic Variation in Activity and Fatality of Migratory Bats at Wind Energy Facilities. Journal of Mammalogy 90(6): 1341–1349.

Bat Conservation International (BCI). 2017. Bat Species: Us Bats. BCI, Inc., Austin, Texas. Information available at: http://www.batcon.org and http://www.batcon.org/resources/media-education/species-profiles . Accessed December 2016.

Britzke, E.R., B.A. Slack, M.P. Armstrong, and S.C. Loeb. 2010. Effects of orientation and weatherproofing on the detection of bat echolocation calls. Journal of Fish and Wildlife Management, 1, 136–141.

Cryan, P.M. 2008. Mating Behavior as a Possible Cause of Bat Fatalities at Wind Turbines. Journal of Wildlife Management 72(3): 845-849. doi: 10.2193/2007-371.

Cryan, P.M. and R.M.R. Barclay. 2009. Causes of Bat Fatalities at Wind Turbines: Hypotheses and Predictions. Journal of Mammalogy 90(6): 1330-1340.

Cryan, P.M., P. Marcos Gorresen, C.D. Hein, M.R. Schirmacher, R.H. Diehl, M.M. Huso, D.T.S. Hayman, P.D. Fricker, F.J. Bonaccorso, D.H. Johnson, K. Heist, and D.C. Dalton. 2014. Behavior of Bats at Wind Turbines. Proceedings of the National Academy of Sciences 111(42): 15126-15131. doi: 10.1073/pnas.1406672111.

Downes, C.M. 1982. A comparison of sensitivities of three bat detectors. Journal of Mammalogy, 63, 343–345.

Fenton, M.B. 1980. Adaptiveness and Ecology of Echolocation in Terrestrial (Aerial) Systems. Pp. 427-446. In: R.G. Busnel and J.F. Fish, eds. Animal Sonar Systems. Plenum Press, New York.

Hein, C.D., J. Gruver, and E.B. Arnett. 2013. Relating Pre-Construction Bat Activity and Post-Construction Bat Fatality to Predict Risk at Wind Energy Facilities: A Synthesis. A report submitted to the National Renewable Energy Laboratory (NREL), Golden Colorado. Bat Conservation International (BCI), Austin, Texas. March 2013. Available online: http://batsandwind.org/pdf/Pre-%20Post-construction%20Synthesis_FINAL%20REPORT.pdf

Fenton, M.B. 2000. Choosing the 'correct' bat detector. Acta Chiropterologica, 2, 215–224.

Gordon, C., and W.P. Erickson. 2016. Icebreaker Wind: Summary of Risks to Birds and Bats. Prepared for Lake Erie Development Corporation (LEEDCo). Prepared by Western EcoSystems Technology, Inc, Cheyenne, Wyoming. November 29, 2016.

Jameson, J.W. and C.K.R. Willis. 2014. Activity of tree bats at anthropogenic tall structures: implications for mortality of bats at wind turbines. Animal Behaviour 97: 145-152.

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological Impacts of Wind Energy Development on Bats: Questions, Research Needs, and Hypotheses. Frontiers in Ecology and the Environment 5(6): 315-324. Available online: https://www.bu.edu/cecb/files/2009/12/kunzbats-wind07.pdf

Limpens, H.J.G.A. and G.F. McCracken. 2004. Choosing a bat detector: theoretical and practical aspects. Bat Echolocation Research: Tools, Techniques, and Analysis (eds R.M. Brigham, E.K.V. Kalko, G. Jones, S. Parsons & H.J.G.A. Limpens), pp. 28–37, Bat Conservation International, Austin, TX.

North American Datum (NAD). 1983. NAD83 Geodetic Datum.

Ohio Department of Natural Resources (ODNR). State Listed Wildlife Species. Available online: http://wildlife.ohiodnr.gov/species-and-habitats/state-listed-species

Svedlow, A., L. Gilpatrick, and D. McIlvain. 2012. Spring-Fall 2010 Avian and Bat Studies Report: Lake Erie Wind Power Study. Prepared by Tetra Tech for the Cuyahoga County Department of Development.

US Department of Agriculture (USDA). 2012. Imagery Programs - National Agriculture Imagery Program (NAIP). USDA - Farm Service Agency (FSA). Aerial Photography Field Office (APFO), Salt Lake City, Utah. Last updated July 3, 2012. http://www.fsa.usda.gov/FSA/apfoapp?area=home &subject=landing&topic=landing

US Fish and Wildlife Service (USFWS). 2007. Candidate Conservation. Candidate Species Factsheet: Section 4 of the Endangered Species Act. February 2007. USFWS Endangered Species Program Homepage: http://www.fws.gov/endangered/ Candidate Conservation: http://www.fws.gov/endangered/candidates/index.html Candidate Species Factsheet http://www.fws.gov/endangered/factsheets/candidate_species.pdf

US Geological Survey (USGS). 2017. USGS Topographic Maps. Last updated January 17, 2017. Homepage available at: https://nationalmap.gov/ustopo/index.html

Appendix A: Memorandum RE Analysis of the Correlation Between Low and High Microphones in the Daily Patterns of Bat Acoustic Activity Recorded at the Buoys at the Icebreaker Wind Project Site During Summer, 2017 (Revised December 30, 2017)

WEST Inc.

ENVIRONMENTAL & STATISTICAL CONSULTANTS

2990 Richmond Avenue, Suite 510
Houston, TX 77098 (512) 229-8399

December 30, 2017

Beth Nagusky
Icebreaker Wind, Inc.
1938 Euclid Avenue, Suite 200
Cleveland, OH 44114

RE: Analysis of the correlation between low and high microphones in the daily patterns of bat acoustic activity recorded at buoys located at the Icebreaker Wind Project site during summer, 2017

Dear Ms. Nagusky,

Icebreaker Wind, Inc. (IWI) requested that Western EcoSystems Technology, Inc. (WEST) prepare a data summary including a quantitative analysis of the strength of the correlation between high (10 meters above water surface) and low (2 meters above water surface) microphones located on buoys within the Icebreaker Project site, in the daily patterns of bat acoustical activity detected at these microphones during the period of time during which data was gathered at both high and low microphones (July 11 – August 30, 2017). This memorandum presents our findings with regard to this request.

Please let me know if you have any questions regarding the data or analysis presented herein.

Sincerely,

Caleb Gordon, Ph. D.
WEST, Inc.
512-229-8399
cgordon@west-inc.com

Field Sampling

The data analyzed in this memorandum are bat acoustic data gathered with four SM4 bat acoustic detectors deployed on two buoys deployed roughly 300m from one another within the Icebreaker Wind Project site, roughly 9 miles from the shore of Cleveland, Ohio. Two detectors were deployed on each buoy. On one buoy, both detectors were deployed at an elevation roughly 2 meters above the water's surface. These are referred to herein as the "low" detectors. On the other buoy, the microphones for the detectors were deployed atop a carbon fiber pole, such that they were located at an elevation roughly 10 meters above the water's surface. These are referred to herein as the "high" detectors. Further details regarding these deployments, the buoys, the detectors, and the acoustic data processing and analysis methods is provided in the MOU signed between IWI and the Ohio Department of Natural Resources[1] and the first quarterly report on bat acoustic monitoring prepared by WEST[2].

Analysis Methods

The objective of the present analysis was to examine the strength of the correlation between the high and the low detectors in the patterns of nightly variation in bat acoustic activity, or "calls," recorded at each of these locations during the period where simultaneous recordings were gathered at both high and low detectors, extending from 11 July through 30 August, 2017.

To this end, we performed a two-tiered analysis. The first comprised a simple investigation of correlation involving dates for which all four detectors successfully obtained data. The second comprised a more involved analysis incorporating data from detectors on days for which at least one detector type's data of bat calls was available. Table 1 describes the temporal ranges during which different detectors successfully collected data.

Prior to analysis, nightly call-count data were first normalized by adding one, and then transformed via the log function. The variable used for this analysis was nightly total bat call counts. Thus, there is no analysis of patterns over hourly time within nights. Only the pattern of night to night variation in total nightly calls was analyzed.

---

[1] Icebreaker Windpower Inc., 2017. Response and Application Second Supplement. Avian and Bat MOU. Memorandum of Understanding between the Ohio Department of Natural Resources and Icebreaker Windpower, Inc. in the matter of the Application of Fred Olsen Renewables USA LLC/Icebreaker Windpower Inc. for a Certificate to construct a wind-powered electric generation facility. Case # 16-1871-EL-BGN. Filed July 20, 2017.

[2] Matteson, A., B. Hale, C. Gordon, and R. E. Good, 2017. Icebreaker Wind Bat Monitoring, Lake Erie, Ohio. Interim report March 21-August 14, 2017. Prepared for Icebreaker Wind, Inc. by Western EcoSystems Technology, Inc.

Table 1: Date ranges of data included in both analysis strategies, with respect to each of the four detectors. For a date to be included in the Correlation analysis, data must have been recorded at all four detectors. For inclusion in the Analysis of Covariance, data need only have been recorded at one of the two Detectors of a particular Altitude. Column N describes the number of nights of data from that Detector contributing to that analysis strategy

Altitude	Detector	Correlation Date Range	N	Analysis of Covariance Date Range	N
High	1	Jul 19 – Aug 14	27	Jul 11 – Aug 14	35
	2	Jul 19 – Aug 14	27	Jul 19 – Aug 30	43
Low	1	Jul 19 – Aug 14	27	Jul 11 – Aug 30	51
	2	Jul 19 – Aug 14	27	Jul 11 – Aug 30	51

Correlation

In order to obtain an initial simple snapshot of the underlying data, correlation patterns between the log-call counts recorded via the high detectors were compared with the same from the low. Generally speaking, correlation analyses investigate the relative strength of the correlation between two variables by pairing each value of the first variable with a corresponding value in the second.

To ensure an appropriate comparison between the high- and low-altitudes, the nightly data recorded at both detectors, for each altitude, were averaged. Thus, for any one day, the two available data points of that altitude type were reduced to one data point. Dates for which one of the detector data points were missing for an altitude were removed from consideration. In this way, 27 paired observations covering the temporal range from Jul 19 – Aug 14, inclusive, were obtained for initial correlation investigations, with one variable describing average low logged call-counts, and the other high.

To estimate the correlation between the log-count data recorded from both altitudes, standardized high-altitude calls were regressed against the same of low-altitude calls via simple linear regression. When performed in this way, the slope estimate from the resulting model equals the correlation r between the regressor and outcome. Squaring of the slope estimate, in this case the correlation, provides the coefficient of determination r^2. The coefficient of determination identifies the proportion of variance of log-scale high-altitude calls explained by the variability in log-scale low-altitude calls.

The same log-scale simple linear regression was then repeated, but with non-standardized original values. From this regression of high-altitude log-counts against low-altitude log-counts, the values of the intercept and slope were obtained and assessed. Data exhibiting high correlation between high-altitude log-counts and low-altitude log-counts should have estimated regression intercepts close to zero, and estimated slopes close to one. In this case, this means that high-altitude log-counts can be accurately predicted via low-altitude log-counts alone, or vice versa.

Analysis of Covariance

The correlation analysis described above only incorporates data on dates for which all four detectors were functioning. However, different detectors were functioning on different days (Table 1). Use of all the available data, including those dates on which at least one detector of an altitude was non-functioning, requires a different analysis.

Analysis of covariance is a statistical technique that combines regression with analysis of variance. Statistical regression, as applied here, allows for the trending of bat calls against time. Analysis of variance identifies statistical differences between categorical groups, or in this case, the mean number of bat calls recorded at discrete detector altitudes. Here then, an analysis-of-covariance model allows for the evaluation of trends in bat calls over time over categorical detector altitude ("high" or "low"), along with nuisance parameters (replicated detector), in one modeling framework.

Via its regression-like structure, analysis of covariance allows for the control of possible confounding variables which could influence the accuracy of simple correlation, as described above. It also allows for the use of all data, even on days for which only one of the four detectors was functioning. Finally, it also permits more complicated covariance structures.

To identify important predictors of log call-counts recorded over time, an initial analysis-of-covariance model was fit. The initial model considered categorical detector altitude, time, their interaction, and replicated detector. Consideration of an interaction allows for independent trending of detector-altitude bat-call time series, within one modeling framework. As applied here, the presence of an interaction of log call-counts against time, with respect to high and low detectors, would graphically result in the two temporal high- and low-trends not being parallel.

However, prior to the investigation and possible removal of individual variables, possible call-count lag-1 autocorrelation was assessed via examination of four autocovariance plots for each of the two detectors at each of the high and low altitudes. Lag-1 autocorrelation is the tendency for the call-count at a detector on any one night to correlate with values from the previous night. Lag-1 autocorrelation, a type of covariance structure, was assessed by fitting the initial-model analyses of covariance models described above, in restricted maximum-likelihood models with and without an overall lag-1 autocorrelation variance structure. Statistical significance of the overall autocorrelation was then assessed via a likelihood-ratio test.

After the initial assessment of lag-1 autocorrelation, and assuming its removal, analysis of covariance was then run in a sequential manner to assess for the significance of individual model covariates. Modeling followed a backwards regression fitting procedure, in which more complicated models were considered first. Variables were removed, one-by-one, if the use of a one-degree-of-freedom likelihood ratio test exhibited a p-value greater than 0.05. In this case, we concluded that this variable did not contribute significantly to the explanatory value of the model, and it was removed. The procedure was then repeated with the newly simplified model. The procedure was stopped when all included variables exhibited sufficiently low p-values. In these subsequent tests involving only fixed effects, maximum likelihood was used.

The models were first assessed for significance of replicated detector. Next, the interaction was evaluated, followed by detector height. The time trend was the final covariate evaluated. In all cases, evaluation of the next covariate only proceeded if the likelihood-ratio test of the previous covariate was not significant (thereby ensuring its previous removal).

Results

Correlation

The first-look of correlation between low- and high-altitude log call-counts, following the averaging of non-missing nightly detector data, was $r = 0.8744$, 90% CI: (0.8442, 0.8991), with a coefficient of determination $r^2 = 76.46\%$.

The regression of nightly averaged log-counts of high versus low led to an intercept estimate of 0.3606, 90% CI: (0.0827, 0.6385) and slope estimate of 0.8440, 90% CI: (0.6910, 0.9970).

Figure 1 depicts the 27 nightly counts of bat-calls, averaged over detector, for each of the high and low altitudes utilized in the correlation analysis.

Analysis of Covariance

Examination of autocovariance plots suggested no significant autocorrelation. Further, results from the first likelihood-ratio test examining lag-1 autocorrelation were non-significant ($p=0.3629$). Analysis-of-covariance model fitting suggested removal of the following covariates due to low explanatory value: replicated detector ($p=0.7735$), time-altitude interaction ($p=0.8207$), and altitude ($p=0.3666$). Nonetheless, because of the interest in altitude as a potential explanatory factor, we present data from a model that included altitude as an explanatory factor (the second-to-last model), as well as a final model, which retained only date and an intercept as factors governing the night-to-night variation in total bat calls.

Figure 2 illustrates all four time series (two high detectors and two low detectors). All four time series exhibit similar patterns. Figure 2 also includes a model fit for each of the detectors from the second-to-last model (the one that retained altitude as an explanatory factor, even though the model selection process showed that altitude did not explain a significant amount of variation in nightly bat calls).

Conclusion/Discussion

Our initial simple correlation analysis, using dates for which data were available from all four detectors, led to the conclusion that the patterns of daily variation in bat call activity are highly correlated between the high-altitude and low-altitude detectors. This suggests that either one of the altitudes alone could be used to assess the temporal trend of bat calls at the Icebreaker Wind Project site, within altitudes sampled by detectors placed between 2m and 10m altitude.

The plot of high-altitude vs low-altitude counts of calls shows a preponderance of nights with very low numbers of calls, and a greater number of points above the light-gray line of perfect fit on such nights (Figure 1). To explore the effect of this pattern on the correlation, we repeated the regression of nightly averaged high-altitude log-counts versus low-altitude log-counts with regression forced through the origin. Regressing in this way led to a slope estimate of 1.0487, 90% CI: (0.9506, 1.1468). This strong value very near one aligns with the strong correlation result discussed earlier, and indicates that the result of high correlation between high and low altitude detectors is stable when the intercept is stabilized at the origin.

The correlation reported here of $r = 0.8744$, after averaging nightly detector data, is incredibly strong. Similarly, the strong slope estimate of 1.0487 following a forced fitting through the origin, suggests that for the period covered by the correlation analysis (July 19 through August 14), the nightly call totals for high and low detectors were statistically the same.

An expanded statistical effort, designed to use all the data, even on nights when at least one detector was not operational, found similar evidence of sameness in the high and low log call-count patterns. This expanded analysis-of-covariance effort, which incorporated more data, considered possible autocorrelation, and tested for possible confounders, led to a similar "sameness" result. That result indicated no statistically significant difference between detector altitudes at the alpha = 0.05 level. Thus, the analysis-of-covariance analysis echoes the conclusion of sameness suggested from the correlation analysis.

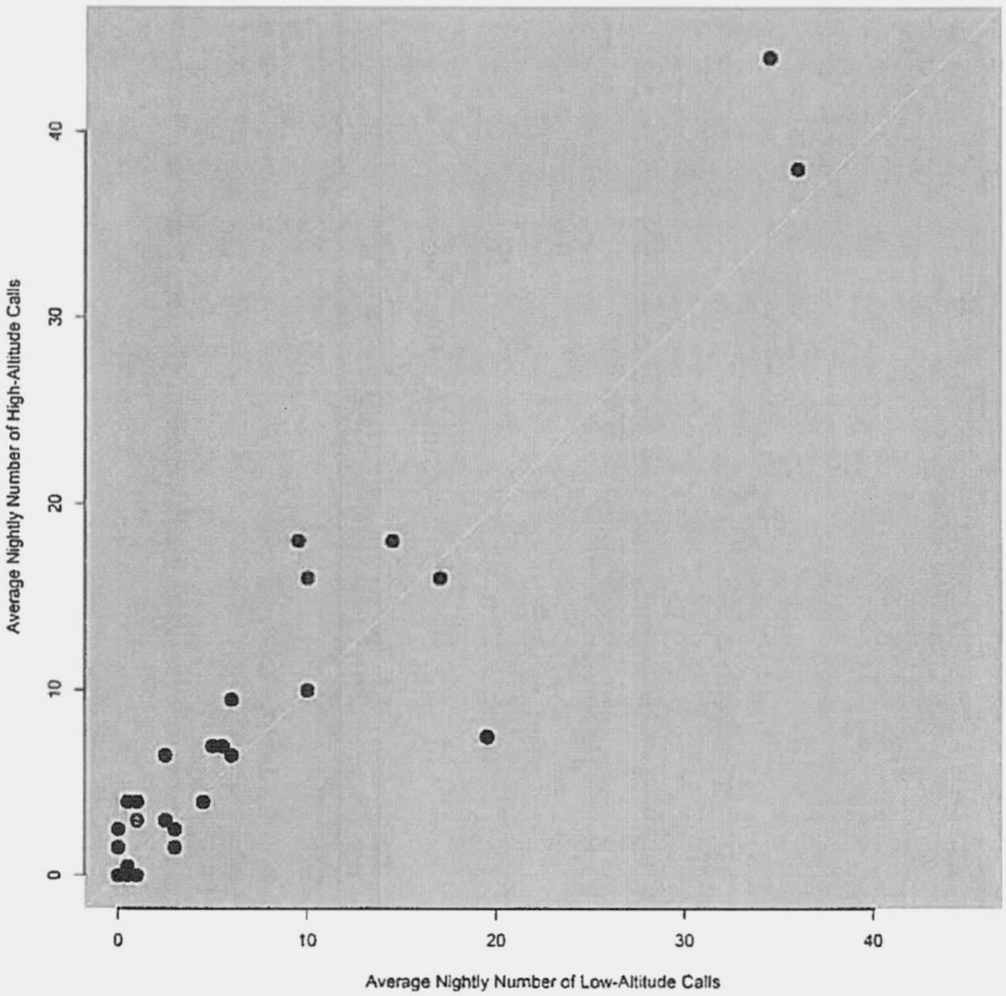


Figure 1: Number of High- vs. Low-Altitude Calls. Each data point represents one night. Each point's coordinate reflects the nightly average value for each altitude. Note that the only nights included in this analysis were nights for which data was gathered from all four detectors (July 19-August 14). One data point that was identical for two nights is labeled "2". The light gray zero-intercept and slope-one line of perfect fit are highlighted.

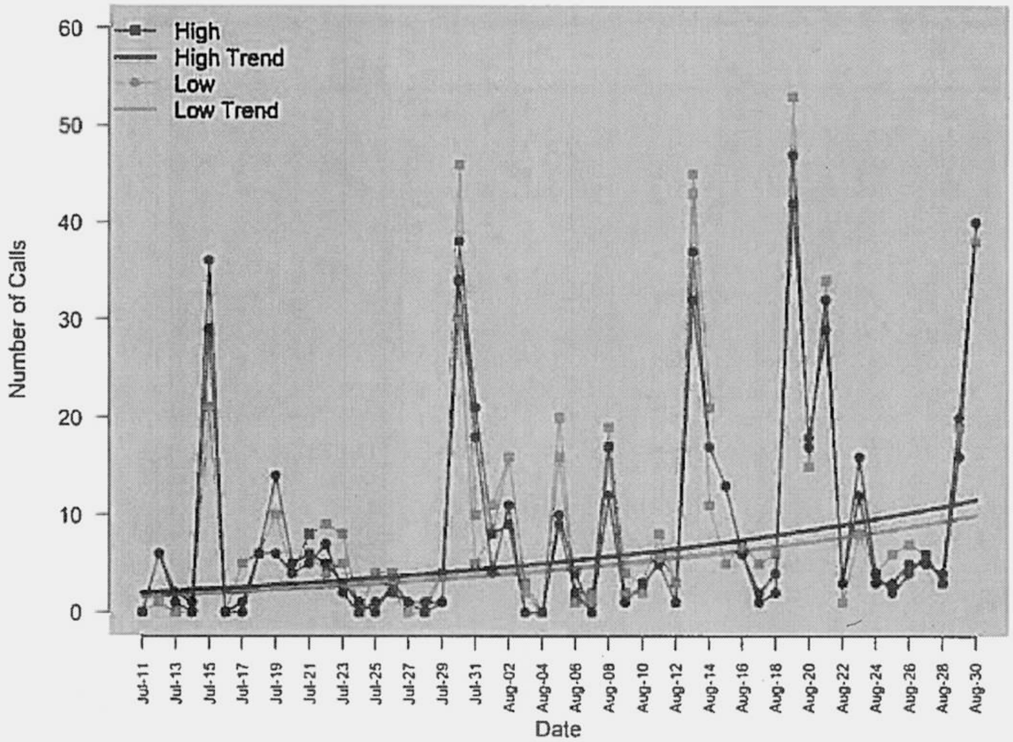


Figure 2: Number of Calls versus Date for High and Low Altitudes at Each of Two Detectors. Each night records the number of bat calls up to four distinct points, with two detector points for High Altitude and two for Low Altitude. The trend lines depict the temporal trends for each altitude, using the model from the covariance analysis that retained altitude, as well as date (the "second-to-last" model, see text).

Appendix B

Aerial Waterfowl and Waterbird Survey Interim Report for the Proposed Icebreaker Wind Project Cuyahoga County, Ohio

LeedCo Icebreaker Pre-construction and Post-construction Monitoring Survey Protocol

U.S. Fish and Wildlife Service and Ohio Department of Natural Resources Division of Wildlife

Comments

Feb. 28, 2017

The below comments represent U.S. Fish and Wildlife Service and Ohio Department of Natural Resources Division of Wildlife recommendations relative to the matrix of pre- and post-construction monitoring options provided by LeedCo via e-mail on January 5, 2017.

1. Bat acoustic monitoring
    a. Pre-construction
        i. On 10 mile large buoy—high (~50 m or as high as possible) and low (~water level) detectors. If the "high" and "low" detectors are separated by at least 40 m, add a "middle" (~30 m) detector too.
        ii. On 3 and 7 mile buoys—low detector
        iii. On Cleveland crib—high (~50 m) and low (close to water surface) detectors
        iv. Per ODNR protocol, use AnaBat detectors (either SD1 or those equipped with CF ZCAIMS), with sensitivity adjusted to detect a calibration tone3 at 20 meters.
        v. March 15-November 15, half hour before sunset until half hour after sunrise; all monitors running concurrently for the entire season.
    b. Post-construction
        i. On 3 turbines (at least one on an end)—high (nacelle), medium (~ 30 m), and low (~10 m)detectors
        ii. On crib—high, low detectors
        iii. On 10 mile buoy –high and low detectors
    c. Rationale
        i. Provides bat species composition at various altitudes, index of bat activity overall and at various heights, seasonal patterns of movements. Allows comparison between site-specific data and crib data, assuming that site-specific data may not be as high as can be obtained from crib.
    d. Successful performance criteria
        i. 80% of nights per detector recorded during active period (March 15-Nov 15)
2. Waterfowl aerial surveys—with observer
    a. Pre-construction, *see attached protocol*
        i. Focus on waterfowl (esp. red-breasted mergansers that are easily spooked), bald eagles, ice relative to location of birds
        ii. Survey transects should run parallel to the turbine string.
        iii. Dates: mid-October - end of May
        iv. Frequency: Every 2 weeks

EXHIBIT
PENGAD 800-631-6989
Bratenahl Residents
7

v. **Transect** spacing: Transects should be close enough to the turbines to observe birds between the turbines, but need to be a safe distance from the blades.
vi. Flight heights: 76-100 m in order to detect small waterbirds.
vii. Flight speeds: 150-200 km/h (unless constrained by local flying restrictions)
viii. Weather conditions: 4 or below on the Beaufort scale, winds approximately 37 km/h or less. Minimum of 3.2 km of visibility (or pilot's discretion).
ix. GPS location for each bird or flock should be recorded.

b. Post-construction
   i. Similar transect protocol as pre-construction
   ii. Year 1 after construction, year 4 after construction

c. Rationale
   i. Species numbers, distribution, use of project area seasonal patterns; eagles; ice; avoidance/attraction/displacement

d. Successful performance criteria
   i. Bi-weekly surveys during designated timeframe in appropriate weather conditions.

3. Radar
   a. **Boat** based radar is not technologically there yet, nor cost advantageous, and it focuses on waterfowl, but we have other methods outlined to address waterfowl. NEXRAD data is not useful for assessing bird/bat behavior within rotor swept zone, which is the data we need. Thus we suggest these approaches should not be considered further.
   b. Pre-construction
      i. We strongly recommend S-band radar, *see attached protocol.*
      ii. Preferred is radar data from project area—FWS and ODNR have been requesting this information since 2008. We still advocate for a single radar, on its own platform, within project area for spring and fall season of pre-construction monitoring as the preferred option.
      iii. Our second choice is to install one or all turbine bases prior to fall (2017), put a radar on one of the turbine bases for fall 2017-spring 2018, then install turbines after spring 2018.
      iv. Our third choice is to install one or all turbine bases prior to fall. Once the first turbine base is installed at the furthest point from shore, place radar unit on it and begin collecting data on fall migration as other bases are being installed. Install towers, with radar on platform collecting data until last tower is erected. (Assumes data collected for 6-8 weeks over fall migration period, which is key focus). Additionally, install radar on Cleveland crib with elevated antenna for spring and fall.
         1. Limitations of this approach: We are only getting fall data (we believe that fall is the most important season due to high bat mortality in fall migration), no information on spring risk. We would use the comparison between crib data and onsite data in fall to extrapolate what may be occurring onsite in spring. This is not ideal, but we think it is workable.

Construction activities may cause "clutter" on the radar map and may alter bird activity within the project area.

v. Site specific radar data is critical to our analysis. If none of the above options can be implemented, we will work with the applicant to evaluate other methods of obtaining site specific radar data.

c. Post-construction
   i. Preferred is single radar, on its own platform, within project area, in years 1, 3, and 5, from spring-fall.
   ii. Our second choice is 2 radars mounted on turbine platforms, in years 1, 3, and 5, from spring-fall.

d. Rationale
   i. Site specific data on night migration of birds and bats. Altitude data of bird and bat targets within rotor swept zone, counts of targets, peak dates of migration, seasonal patterns. Avoidance/attraction/displacement.
   ii. Because this is a pilot project the intent is to study and understand the impact of the project on various resources. Without project-specific radar information we cannot get key information needed to understand that impact.

e. Successful performance criteria
   i. Site-specific data; radars operating and collecting data over at least 80% of nights during spring/fall migration period.

4. Carcass monitoring
   a. Pre-construction—proof of concept development
      i. Bat nets—We believe this concept could have merit, but we would like to see a more fleshed-out conceptual proposal first. Please draft a detailed proposal and plans, and a land-based test concept and submit to FWS and ODNR for review. Be sure to consider carcass distribution of bats relative to distance from turbine. Net should be designed to collect at least 30% of bat carcasses and carcasses should be recoverable from the nets.
      ii. "Thunk" detection—We believe this concept could have merit. We request follow-up with the technology developer to ensure the technology could be ready to deploy within the project timeframe (testing in year 1, deployment in 2018-2019, etc.). Please draft a detailed proposal and plans, and a land-based test concept and submit to FWS and ODNR for review.
      iii. Identiflight—The original application for this technology (detecting golden eagles during daylight and shutting down turbines) is very different that the application needed for this project (detecting small nocturnal animals striking turbines). We think that the other options are more applicable and closer to being ready than this option. We suggest not using this option at this time.
   b. Post-construction
      i. Bat nets— If proof-of-concept test works, then install on 3 turbines during years 1, 3, and 5, and through the lifespan of the technology.

ii. "Thunk detection"—if proof-of-concept test works, then install on 3 turbines during years 1, 3, and 5, and beyond, through the lifespan of the technology.

iii. Live observers—do not recommend this for carcass monitoring, as most mortality is expected to occur at night and could not be observed. Do not recommend this for waterfowl displacement study because aerial flights and radar would be better to address displacement.

c. Rationale—to detect collisions of birds/bats, identify carcasses at least to guild

d. Successful performance criteria—ability to detect bird/bat collisions. Generate a reasonable estimate of collisions/MW/year. Set up an adaptive management program to address potential performance issues with new technology.