TO: Readers of USFWS Wind Turbine Guidelines Advisory Committee Public Packet

FR: USFWS Wind Turbine Guidelines Advisory Committee Synthesis Workgroup, or Drafting Subcommittee

RE: Background and Explanation of Draft v.4

DT: August 19, 2009

The attached *Draft v.4* contains the current state of the Wind Turbine Guidelines Advisory Committee's work over the last year and a half. Draft v.4 is a draft to be discussed by the Committee and then modified. This is not a consensus draft. Important policy and technical issues for discussion with the FAC are noted in comments in the margins of the draft. Sections of text that are under revision but were included for FAC discussion are highlighted in gray. After the Committee discusses Draft v.4 at the September 1 - 3, 2009 meeting, it will be edited based on Committee direction.

Comments on Draft v.4
We will discuss Draft v.4 at the September 1 – 3 FAC meeting. Please to come to the meeting prepared with a list of the items you cannot live with, and why. We will work through these items in the time we have. Please send the list to Elana in advance of the meeting if possible, noting the page and line number and proposed alternative language. We will not have time to address editorial comments - only major policy issues that need to be addressed.

Editorial Changes to Draft v.4
PLEASE READ DRAFT V.4 IN ITS ENTIRETY. A professional editor has revised the organization of the document, and edited the text for correct grammar. She paid special attention to retaining the meaning of the text.

The following sections were drafted based on FAC direction and incorporated into Draft v.4:

- **Chapter Three has been edited by the technical subgroup based on comments received to Chapter Three.**

- **Decisions to move from tier to tier:** new language was drafted to describe how decisions are made when moving from tier to tier, and how these decisions are evaluated to confirm adherence with the Guidelines (pages 18-19). This language is highlighted in gray to indicate that it will be edited after the draft Implementation Chapter is complete.

- **Tier 3, Question 2:** new language was drafted to address habitat fragmentation analysis (page 26-27). Additional language is under revision and will be presented to the FAC at the September 1 – 3 FAC Meeting as a separate handout.

- **Level of detail in methods and metrics:** The Synthesis Workgroup considered the option, raised at the June 30 – July 2 FAC Meeting, of moving the methods and metrics into an appendix. To address the concerns raised by the FAC, the level of detail in Tier 3 (pages 22 – 36) was revised to match the detail in the rest of the tiers. The FAC should review this and make a decision on 1) whether the level of detail in Tier 3 is appropriate, and 2) whether it should stay in the text of the Guidelines or be moved into an appendix.

- **Chapter Four, Mitigation:** a subgroup edited the chapter on mitigation and the Synthesis Workgroup reviewed and approved it (pages 52-54).

- **Chapters Five – Seven (page 54):** The Implementation Subcommittee proposes moving the text of Chapters Five – Seven of the previous iteration of the One-Text, Draft v.3, into the draft Implementation Chapter. The draft Implementation Chapter was still under revision at the date of Draft v.4's release, and will be presented to the FAC at the September 1 - 3 meeting in a separate handout. Although some of the sections in former Chapters Five - Seven were already reviewed by the FAC and/or by the Synthesis Workgroup in previous drafts of the One-Text, the decision was made to move this text out of Draft v.4 to allow the FAC to view the text from Chapters Five – Seven as it would appear in the new Implementation Chapter.

- **Research:** This section was revised, and its placement in the draft is still under review (pages 54-55).

- **Appendices**: At the January 27 – 29, 2009 meeting, the Committee agreed to make all appendices part of the final consensus Draft. A draft set of appendices will be provided as a separate handout for the FAC to review before the September 1 – 3 FAC Meeting. Time will be set aside at the FAC meeting to discuss the appendices.

As noted above, the following sections will be distributed as soon as completed. We will also discuss these at the September 1 – 3 FAC Meeting

- Draft Habitat Fragmentation section for Chapter Three
- Draft Implementation Chapter
- Draft Appendices

Preamble to the Committee Recommendations

A. Establishment of Wind Turbine Guidelines Advisory Committee

In response to interest in the development of wind power in the United States, the U.S. Fish and Wildlife Service (USFWS) released in July 2003 for public comment a set of voluntary, interim guidelines for developing wind power projects. After USFWS reviewed the public comments, the Secretary of the Interior (Secretary) established a Federal Advisory Committee to provide recommendations to avoid or minimize impacts to wildlife and their habitats related to land-based wind energy facilities. In March of 2007, USFWS announced the establishment of the Wind Turbine Guidelines Advisory Committee (the Committee) in the *Federal Register*.

Pursuant to the requirements of the Federal Advisory Committee Act (FACA), the Committee Charter was signed by the Secretary on October 26, 2007, effective for two years. The Charter states the Committee's scope and objective:

> *"The Committee will provide advice and recommendations to the Secretary of the Interior (Secretary) on developing effective measures to avoid or minimize impacts to wildlife and their habitats related to land-based wind energy facilities."*

The attached Recommended Guidelines (Guidelines) are the result of two years of deliberation by the Committee.

Committee Members

Committee Members were carefully selected by the Secretary from a large pool of candidates to represent a balance of stakeholder groups with the necessary policy, technical, and scientific expertise to address minimization of wildlife impacts associated with the development of the Nation's wind power potential:

Taber Allison, Massachusetts Audubon Society
Ed Arnett, Bat Conservation International
Michael Azeka, AES Wind Generation
Kathy Boydston, Texas Parks and Wildlife Department
René Braud, Horizon Wind Energy
Scott Darling, Vermont Fish & Wildlife Department
Mike Daulton, National Audubon Society
Aimee Delach, Defenders of Wildlife
Karen Douglas, California Energy Commission
Greg Hueckel, Washington Department of Fish & Wildlife
Jeri Lawrence, Blackfeet Nation
Steve Lindenberg, U.S. Department of Energy
Andrew Linehan, Iberdrola Renewables
Rob Manes, The Nature Conservancy, Kansas
Winifred Perkins, Next Era Energy

Steve Quarles, Crowell & Moring, LLP
Rich Rayhill, Ridgeline Energy, LLC
Robert Robel, Kansas State University
Keith Sexson, Kansas Department of Wildlife & Parks
Mark Sinclair, Clean Energy Group
Dave Stout, U.S. Fish & Wildlife Service
Patrick Traylor, Hogan & Hartson, LLP

B. Background on Context and Need for the Recommended Guidelines

Wind development in the United States increased by 46%[1] in 2007, and at the end of 2007 the U.S. had the second highest cumulative wind capacity globally. This rate of development is expected to continue, and perhaps to accelerate, as United States energy policy emphasizes independence from foreign oil and reduction of carbon emissions. USFWS and the Committee Members recognize that wind-generated electrical energy is renewable, and is considered to be a generally environmentally-friendly technology.

Wind energy produces electricity without air pollution, greenhouse gas emissions, water consumption, mining, drilling, refining, waste storage and other problems associated with many traditional forms of energy generation. Wind power has recently received increased attention because it is a domestic source of energy, and because carbon dioxide emissions from fossil fuel combustion is the leading cause of anthropogenic climate change, which is likely to have serious negative impacts on ecosystems and wildlife.[2] The U.S. Department of Energy (DOE) estimates that a single 1.5 MW wind turbine displaces 2700 metric tons of CO_2 per year compared with the current U.S. average utility fuel mix.[3] In some locations, wind prevents urban and suburban encroachment into traditional greenbelts. Given these advantages, wind is expected to play an increasingly important role in meeting the nation's energy goals in the coming years.

Nevertheless, as the U.S. moves to expand wind energy production, it also must maintain and protect the nation's wildlife and habitats, which wind energy production can negatively affect. As with all responsible energy development, wind power facilities should adhere to high standards for environmental protection. With proper diligence to siting, operations and management, it is possible for wind energy facilities to avoid, minimize and mitigate adverse impacts on wildlife and habitats.

C. Committee Premises and Guiding Principles

Committee Premises

1. The Committee acknowledges the USFWS definition of wildlife (see glossary). The Committee recognizes that different species and species groups have different levels of protection under tribes, federal and state wildlife statutes. (See Legal White Paper).

[1] (20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply. (2008).248 pp; NREL Report No. TP-500-41869; DOE/GO-102008-2567).
[2] Intergovernmental Panel on Climate Change 2007
[3] 20% Wind Energy by 2030 2008).

It is the Committee's intention to identify, evaluate and recommend approaches to assessing risk and impacts to wildlife associated with wind energy development that are useful regardless of the regulatory status of any particular species, and that are particularly focused on those species most likely to be affected by wind energy development.

2. The Committee recognizes that, among different wind energy projects, there will be varying degrees of potential impact to wildlife as well as varying degrees of certainty associated with the assessments of that potential impact. Thus varying levels of effort will be appropriate in assessing the risk of potential projects and determining how or whether the projects are developed.

3. The Committee recognizes that it is possible and essential to avoid, minimize, and, if necessary, mitigate negative impacts on wildlife populations and habitats while balancing expected impacts with the costs of undertaking necessary studies and monitoring.

Guiding Principles

The Guidelines should:

1. Provide a consistent methodology for conducting pre-construction risk assessments and post-construction impact assessments to guide siting decisions by developers and agencies.

2. Encourage communication and coordination between the developer and relevant state and federal agencies during all phases of wind energy project development.

3. Provide mechanisms to encourage the adoption and use of the Guidelines by all federal agencies, as well as the wind energy industry, while recognizing the primary role of the lead agency in coordinating specific project assessments.

4. Complement state and tribal efforts to address wind/wildlife interactions and provide a voluntary means for these entities to coordinate and standardize review of wind projects with the USFWS.

5. Provide a clear and consistent approach that increases predictability and reduces the risk of liability exposure under federal wildlife laws.

6. Provide sufficient flexibility to accommodate the diverse geographic and habitat features of different wind development sites.

7. Present mechanisms for determining compensatory mitigation, when appropriate, in the event of unforeseen impacts to wildlife during construction or operation of a wind energy project.

8. Define scientifically rigorous and cost-effective study designs that improve the ability to predict direct and indirect wildlife impacts locally and regionally.

9. Include a formal mechanism for revision in order to incorporate experience, technological improvements, and scientific advances that reduce uncertainty in the interactions between wind energy and wildlife.

Committee Policy Recommendations

A. Adoption and Use of the Guidelines

Adopt, promulgate, and consistently implement the voluntary Guidelines recommended in this document. The Committee gave considerable attention to the production of a suggested protocol for wildlife assessment and siting decisions at wind power facilities. This protocol, described in detail in Chapter 3 of this document, uses a tiered approach to evaluate, predict, and minimize the risk of potential wind projects to wildlife and habitat, and to assess and mitigate impacts post-construction. The Committee believes that the final product reflects a comprehensive and user-friendly risk assessment and decision-making tool that supports Department of the Interior (DOI) priorities with respect to renewable energy development, federal and state trust responsibilities, developer cost and confidentiality concerns, and the needs of sensitive wildlife and habitats, without creating new regulations. The Committee recommends that the Secretary direct USFWS to promptly adopt the recommended voluntary Guidelines developed by the Committee.

In adopting and implementing the Guidelines, use the premises and principles adopted by the Committee, as set forth above.

B. Tools and Support for Implementation

Develop landscape tools and provide analysis to assist in implementation of the Guidelines. The Committee recommends that the Secretary instruct USFWS, in consultation with the U.S. Geological Survey (USGS) and state agencies, to assemble and maintain a comprehensive national scale landscape database based on scientifically credible sources. This database will assist in identifying and assessing development risks to ecosystems, large-scale habitats, and migratory and resident species that rely on large-landscape or specialized habitats. In developing this database, the USFWS should consult and assess existing and on-going landscape analysis and mapping efforts focused on renewable energy, including, but not limited to: the California Renewable Energy Transmission Initiative (RETI), Western Governors' Association Wildlife Habitat Council, The Nature Conservancy, National Audubon Society, and American Wind and Wildlife Institute activities. Such a database should have broad applicability to help guide decisions regarding other types of development, including other energy sources. However, the Committee stresses that the lack of landscape level tools should not in any way delay the use and application of the recommended Guidelines.

Provide and/or support adequate, meaningful incentives for industry's voluntary adoption of the Guidelines. The Committee has explored a suite of legal and financial incentives to encourage universal adoption of the recommended voluntary guidelines. The results of these investigations are described in detail in Chapter 5 of the Guidelines. The Committee recommends that DOI implement incentives within DOI's purview simultaneously with promulgation of the Guidelines. The Committee also recommends that DOI engage constructively to support potential incentives that are outside the purview of DOI (for instance those that would require statutory changes) and encourage their timely adoption and implementation.

Advance the use, cooperation, and effective implementation of the Guidelines. Coordinate within DOI and with other federal agencies, tribes, states, wind developers and other stakeholders to maximize the use and effectiveness of the Guidelines. In order to do this, the Committee recommends the Secretary consider the following:

- Encourage collaboration and coordination with other federal and state agencies and tribes to ensure timely and consistent review of wind energy projects and resolve conflicts among and within agencies.
- Develop best management practices based on the Guidelines.
- Promote use of the Guidelines by federal and state agencies, as well as by the private sector.
- Provide training to USFWS and other federal agency field personnel on effective use of the Guidelines.
- Advance the involvement and cooperation of non-governmental organizations with an interest in improving siting and compensatory mitigation for wind projects.

Assure that the USFWS has an adequate budget and staff resources to implement the Guidelines as necessary, including training of Regional and Field staff and other interested stakeholders.

When making policy decisions, address both the threat to birds and other wildlife from climate change, and the effects of other stressors. When conducting its review of wind energy development pursuant to the Guidelines, the Secretary is encouraged to make management, policy, project-specific assessment, siting, and mitigation decisions with appropriate consideration of wind energy's air pollution, greenhouse gas, water consumption, and other benefits. According to the USFWS Climate Change Strategic Plan (Strategic Plan), "Climate change is the greatest challenge the Service has ever faced in conserving fish, wildlife and their habitats." The Strategic Plan outlines a joint commitment to *mitigation*[4] (reducing the sources or enhancing the sinks or carbon dioxide) and *adaptation*[4] (management to reduce the impacts of climate change on fish, wildlife and habitats). The Committee urges the Secretary to hold both of these commitments in mind when making management decisions related to wind development: recognizing both the important role that wind power, as a carbon-free energy source, will play in climate change *mitigation*[4], while also delivering wind on the landscape in a manner that supports wildlife *adaptation*[4] to climate change, namely by minimizing wind's potential to itself be a non-climate stressor.

[4] As defined by the Intergovernmental Panel on Climate Change (IPCC).

C. Future Application

Work with other federal agencies, stakeholders, and states to develop a national research plan that identifies and implements research priorities to reduce impacts to wildlife resources while allowing wind energy development. Research should be conducted collaboratively, wherever possible, and should include appropriate stakeholders and peer review.

Revise the Guidelines. Review and revise the Guidelines, as justified, at least once every five years to incorporate new knowledge on wildlife interactions with wind energy and the rapidly advancing technology of commercialized wind energy production. The Secretary should use the Committee's premises and principles to assist in revisions of the Guidelines.

DOI should improve its capability to assess cumulative impacts by working with the USFWS Regions to:

- Review the range of development-related significant adverse impacts.
- Review indicator species and/or their habitats within the landscape at the most risk of significant impacts from wind development, in conjunction with other reasonably foreseeable significant adverse impacts.
- Develop data that can be used to conduct regional or landscape level analysis.

The product of regional analyses of cumulative impacts should be available to inform Tier 1 preliminary site assessment or Tier 2 site characterization and may be useful for designing Tier 3 wildlife surveys. However, the Committee stresses that the lack of tools for cumulative impact analysis should not in any way delay the use and application of the recommended Guidelines.[5]

[5] The Committee also recommends that in developing the scope of this cumulative effects analysis, the USFWS review the conclusions of the white paper on cumulative effects analysis developed by the USFWS, Oregon Department of Fish and Wildlife, and other stakeholders during the development of the Oregon Columbia Ecoregion Wind Energy Siting and Permitting Guidelines (September 29, 2008). The white paper reviewed multistate cumulative effects analyses prepared by WEST, Inc. in the Pacific Northwest and made recommendations on how such analyses could be more effective. Recommendations included:

- Collaborative funding and management of regional cumulative effects analysis
- Focus on a limited number of key regional indicator species and habitats most likely to be affected by wind energy
- Studies to better understand the population dynamics of the key indicator species and to develop "impact levels of concern"
- Development of an action plan for impacts to key species and habitats that are above "threshold of concern" levels

U.S. Fish and Wildlife Service
Wind Turbine Guidelines Advisory Committee

Draft Recommended Guidelines

Submitted to the Secretary of the Interior
(Date)

By the Wind Turbine Guidelines Advisory Committee

U.S. Fish and Wildlife Service
Wind Turbine Guidelines Advisory Committee

Draft Recommended Guidelines

Draft Table of Contents

Comment [ejk1]: The Synthesis Workgroup recommends removing Appendix F and G from the Appendices packet.

Draft Recommended Guidelines

Executive Summary, *to be inserted*

Chapter One: Introduction

A. Background

In response to the United States' growing demand for production of electricity by wind power and in recognition of the U.S. Fish and Wildlife Service (USFWS) mission "Working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people," the Secretary of the Interior (Secretary) authorized USFWS to charter the Wind Turbine Guidelines Advisory Committee (Committee) to recommend effective measures to avoid or minimize impacts to wildlife and their habitats related to land-based wind energy facilities.

Herein are the Committee's Recommended Guidelines (Guidelines). They are based on two years of deliberations and judgments regarding the siting and operation of large wind developments while minimizing impacts to wildlife and their habitat. The Committee is composed of a broad array of representatives, among the most informed in the country, selected for their outstanding experience on these issues. These Guidelines are the Committee's best attempt to present the most effective, feasible, and appropriate approaches that are available to the Department of the Interior (DOI), tribes, states, local jurisdictions, and the wind industry to address USFWS responsibilities to protect wildlife resources while encouraging responsible siting and operation of wind energy projects.

B. Premises and Guiding Principles

In its development of these Guidelines, the Committee accepted by consensus[6] the following premises and principles and recommends these be incorporated into the final guidance published by the USFWS.

Premises

1. The Committee acknowledges the USFWS definition of wildlife (see Glossary). The Committee recognizes that different species and species groups have different levels of protection under tribes, federal and state wildlife statutes. (See Legal White Paper).

   It is the Committee's intention to identify, evaluate and recommend approaches to assessing risk and impacts to wildlife associated with wind energy development that are useful regardless of the regulatory status of any particular species, and that are particularly focused on those species most likely to be affected by wind energy development.

[6] March 26, 2009

2. The Committee recognizes that, among different wind energy projects, there will be varying degrees of potential impact to wildlife as well as varying degrees of certainty associated with the assessments of that potential impact. Thus varying levels of effort will be appropriate in assessing the risk of potential projects and determining how or whether the projects are developed.

3. The Committee recognizes that it is possible and essential to avoid, minimize, and, if necessary, mitigate negative impacts on wildlife populations and habitats while balancing expected impacts with the costs of undertaking necessary studies and monitoring.

Principles

The Guidelines should:

1. Provide a consistent methodology for conducting pre-construction risk assessments and post-construction impact assessments to guide siting decisions by developers and agencies.

2. Encourage communication and coordination between the developer and relevant state and federal agencies during all phases of wind energy project development.

3. Provide mechanisms to encourage the adoption and use of the Guidelines by all federal agencies, as well as the wind energy industry, while recognizing the primary role of the lead agency in coordinating specific project assessments.

4. Complement state and tribal efforts to address wind/wildlife interactions and provide a voluntary means for these entities to coordinate and standardize review of wind projects with the USFWS.

5. Provide a clear and consistent approach that increases predictability and reduces the risk of liability exposure under federal wildlife laws.

6. Provide sufficient flexibility to accommodate the diverse geographic and habitat features of different wind development sites.

7. Present mechanisms for determining compensatory mitigation, when appropriate, in the event of unforeseen impacts to wildlife during construction or operation of a wind energy project.

8. Define scientifically rigorous and cost-effective study designs that improve the ability to predict direct and indirect wildlife impacts locally and regionally.

9. Include a formal mechanism for revision in order to incorporate experience, technological improvements, and scientific advances that reduce uncertainty in the interactions between wind energy and wildlife.

C. Purpose of the Guidelines

The primary purpose of these Guidelines is to describe the information typically needed to identify, assess, and monitor the potential adverse effects of wind energy projects on wildlife and their habitat, especially migratory birds, bats and species at risk, in order to:

- Guide the wind energy industry to make the best possible choices on the location, design and operation of wind energy installations to avoid and minimize the risks to wildlife and their habitat.
- Ensure that the responsible regulatory agency or advisory agency for any wind energy installation is aware of and considers the appropriate factors that present risks to wildlife and their habitat and the full range of options to avoid, minimize and, if needed, provide compensatory mitigation.
- Specify the types and amount of baseline information that are required for adequate review of a wind project; and describe the likely extent of follow-up that would be necessary after construction.

Additional purposes of the Guidelines are to:

- Promote responsible development of wind facilities across the country.
- Enable states, tribes, USFWS, developers and stakeholders to share information and data regarding avian and bat studies, compensatory mitigation options, siting practices, and monitoring of habitat/species impacts, to increase understanding of risks and the effectiveness of siting and operating decision-making.
- Develop effective, consistent and cost-effective methods and protocols to guide project-specific studies, to improve assessment of risk and impacts by producing comparable data.
- Allow for comparison among field studies from around the country.

D. Benefits of Using the Guidelines

As the U.S. moves to achieve its renewable energy commitments, it must also maintain and protect its wildlife resources. The Committee's Guidelines will facilitate wind energy development while protecting wildlife and their habitat. The Guidelines will provide best management practices for wind energy-wildlife interactions and result in greater regulatory certainty for the wind developer, resulting in the following four types of benefits.

1. Reduced Ecological Impacts

The Guidelines offer a science-based reference for use by industry, federal, state, tribal and local agencies, and other stakeholders in the siting and permitting of wind projects. The Guidelines describe the kind of information needed to adequately identify, assess, minimize, mitigate, and monitor the wind-wildlife impacts when developing new wind energy projects and repowering existing facilities. The Guidelines will promote scientifically sound, cost-effective study designs; produce comparable data among studies throughout the country; allow for analyses of trends and patterns of impacts at multiple sites; and ultimately improve the ability to estimate and resolve impacts to wildlife and habitats locally and regionally.

2. Increased Compliance and Reduced Regulatory Risk

The Guidelines are a tool for facilitating compliance with relevant laws and regulations by recommending methods for conducting site-specific, scientifically sound biological evaluations. Following the guidelines is consistent with NEPA, namely to provide full and fair discussion of significant environmental impacts of wind development upon wildlife arising from potential federal actions. The guidelines are consistent with the intent of NEPA, including promoting efforts that will prevent or eliminate damage to the environment. The guidelines also facilitate achieving the NEPA objective of ensuring that environmental resources are given appropriate consideration in planning and decision-making processes. Using the methods described in the Guidelines will provide information for impact assessment and minimization, and for compensatory mitigation (if needed) for the application of wildlife protection laws. It also demonstrates a good faith effort to develop and operate wind projects consistent with the intent of local, state, and federal laws.

3. Improved Predictability of Wildlife and Habitat Impact

The goal of the Guidelines is to provide a consistent, predictable approach to assessing impacts to wildlife and habitats from wind energy projects, while providing flexibility to accommodate the unique circumstances of each project. As comparable information from projects using consistent and standardized methods and protocols becomes available from projects around the nation, meta-analysis will continue to provide information that allows better predictive modeling. The growing body of information will assist in providing valuable information on “use” of wind energy sites by and potential impacts to wildlife. Over time the growing knowledge base should decrease the need for some monitoring studies.

4. Cost Savings

The Guidelines will promote scientifically sound, cost-effective study designs that are proportionate to the risk to wildlife and their habitats; produce comparable data among studies within the nation; allow for analyses of trends and patterns of impacts at multiple sites; and ultimately improve the ability to predict and resolve impacts locally, regionally and nationally. This will reduce the need for some studies, thereby reducing project costs. Initiating pre-construction surveys early will help to avoid unnecessary and costly delays during permitting. The Guidelines advise that the costs and the resulting benefits be considered when developing the monitoring efforts needed for each project site. Some monitoring methods and/or technologies are expensive and should be recommended only when necessary.

Chapter Two: Summary of the Guidelines and General Considerations

A. Intended Use of the Guidelines

These Guidelines are intended to be voluntary. Although voluntary, the Guidelines described in this report are designed to be used by all prospective developers of wind energy projects and USFWS field staff reviewing such projects. The Guidelines also are intended to suggest a useful approach for local, state and tribal officials, and other interested stakeholders.

The Committee wrote the Guidelines to be as specific as possible with regard to the expectations, recommendations, and appropriate assessments for developing a wind energy project. They must, however, apply to a large diversity of projects in many different habitats. The Guidelines are intended to provide flexibility in their application, in consideration of project-specific factors, and not be rigidly applied in every situation. The Guidelines are designed to address current commercial technology.

Project Scale and Location

The tiered approach is designed to lead to the appropriate amount of research in proportion to the anticipated level of risk that the development may pose to wildlife 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 adverse effects on wildlife and corresponding habitat. In particular, the risk of adverse impacts to wildlife and their habitats tends to be a function of site location, not necessarily the size of the project. A small project may pose greater risk to wildlife than a larger site in a less sensitive location, and would therefore require more pre- and post-construction studies than the larger site. 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 should be tailored to the relative scale, location and potential for adverse impacts of the proposed site.

Project Interconnection Lines

The Guidelines are designed to address all elements of a wind power facility, including the turbine string or array, access roads, ancillary building, and the above- and below-ground electrical lines which connect a project to the transmission system. The project evaluation should include consideration of the wildlife- and habitat-related impacts of these lines. The developer would include measures to reduce impacts of these electrical lines, such as those outlined in the Avian Powerline Interaction Committee (APLIC) Suggested Practices (APLIC (Avian Power Line Interaction Committee). 2006. *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006*. Edison Electric Institute. Washington D.C.). 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. This recommendation does not supercede existing policies.

B. Introduction to the Decision Framework Using a Tiered Approach

The Committee recommends using a tiered approach to evaluate and minimize the risk of potential wind projects to wildlife. The tiered approach is 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 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. 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.

Application of the tiered approach and possible outcomes

The tiered approach follows an iterative process for quantifying the risks to wildlife of a potential wind energy project. The tiers are listed as follows (see flow chart below, "General Framework for Minimizing Impacts of Wind Development on Wildlife in the Context of the Siting and Development of Wind Power"):

- Tier 1 - Preliminary evaluation or screening of potential sites
- Tier 2 - Site characterization
- Tier 3 – Field studies to document site wildlife conditions and predict project impacts
- Tier 4 – Post-construction fatality studies
- Tier 5 – Other Post-construction Studies

At each tier, potential problems associated with developing or operating a project are identified and questions formulated to guide the decision process. Chapter 3 outlines the questions to be posed at each tier, and describes recommended methods and metrics for gathering the data needed to answer those questions.

If sufficient data are available at a particular tier, the following outcomes are possible based on analysis of the information gathered:

The project is abandoned because the risk is considered unacceptable

The project proceeds in the development process without additional data collection, or

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

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 abandon the project, modify the project, or proceed and expand the project.

Applicability of Adaptive Management

Adaptive management (AM) can be categorized into two types: "passive" and "active" (Walters and Holling 1990, Murray and Marmorek 2003). In passive AM, alternatives are assessed and the management action deemed best is designed and implemented. Monitoring and evaluation then lead to adjustments as necessary. In active AM, managers explicitly recognize that they do not know which management approaches are best, so they select several alternative management approaches to design and implement.[7] Active AM, if necessary, should be explored and applied only when substantial uncertainty exists regarding the approaches to avoiding or minimizing impacts. With the possible exception of evaluating project specific mitigation measures, these Guidelines do not recommend that active AM be implemented at wind energy projects. Active AM may be appropriate if there is a specific research objective that is probably applicable to multiple wind projects, and these Guidelines recognize that accomplishing those objectives is outside the decision framework and would involve multiple stakeholders and funding sources.

Adaptive management, whether active or passive, is not typically applied to wind projects because in the majority of instances the impacts and the level of uncertainty do not warrant its use. Nevertheless, the tiered approach is designed to accommodate AM if warranted. In the pre-construction environment, analysis and interpretation of information gathered at a particular tier influences the decision to proceed further with the project or the project assessment. If the project is constructed, information gathered in the pre-construction assessment guides possible project modifications, or the need for and design of post-construction studies. Analysis of the results of post construction studies can test design modifications and operational activities to determine their effectiveness in avoiding and minimizing impacts. When there is considerable uncertainty over the appropriate mitigation for a project active adaptive management is the preferred approach to testing the effectiveness of alternative approaches.

For AM to work, there must be agreement to adjust management and/or mitigation measures if monitoring indicates that goals are not met. The agreement 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.

Passive and active AM as described above are similar to the process described in the DOI Adaptive Management Technical Guide (Williams et al 2007). As described in the Technical Guide, AM includes five key elements in its application: stakeholder involvement, management objectives, management alternatives, predictions of the effects of potential management actions, and monitoring protocols and plans. These elements are folded into the structured process of decision making, monitoring, and assessment. Passive AM, and its use in the tiered approach, is consistent with the technique outlined in the Technical Guide.

[7] In active adaptive management, monitoring and evaluation of each alternative helps in deciding which alternative is more effective in meeting objectives, and adjustments to the next round of management decisions can be made based on those lessons.

C. Other Elements of the Guidelines

Use of Mitigation Policies and Principles

These Guidelines contain scientifically valid, economic, and technically feasible and effective methods and metrics intended to evaluate risk and estimate impacts to wildlife, inform permitting decisions, and satisfy environmental assessment processes. The objective is to avoid or minimize impacts to fish, wildlife and their habitats, and to provide compensatory mitigation for those impacts not avoided or minimized. Wind project developers should consider the use of the USFWS Mitigation Policy (USFWS Mitigation Policy, 46 FR 7656 (1981)) whenever it is not possible or feasible to avoid and minimize impacts to wildlife habitats. The USFWS policy provides a common basis for determining how and when to use different compensatory mitigation strategies, and facilitates earlier consideration of wildlife values in wind project planning. The fundamental principles that will guide the use of compensatory mitigation and recommendations by the USFWS are reflected in Chapter 4 of these Guidelines. Wind developers also should consult with appropriate state agencies to ensure compliance with state compensatory mitigation requirements.

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 the project with the public and competitors. Any consultation or coordination with agencies at this stage may include confidentiality agreements.

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. Consideration of cumulative impacts should be incorporated into the wind energy planning process as early as possible to improve decisions. To achieve that goal, it is important that agencies and organizations take the following actions to improve cumulative impacts analyses: review the range of development-related significant adverse impacts; determine indicator species and/or their habitats within the landscape most at risk of significant 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 effect on a resource depends on whether the cumulative impacts exceed the capacity for resource sustainability and productivity.

Federal agencies are required to include a cumulative impacts analysis in their NEPA review, including any energy projects that require a federal permit or that have any other federal nexus. The federal action agency coordinates with the developer to obtain necessary information for the NEPA review and cumulative impacts analysis. In order 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 effects on wildlife and habitats. Developers are encouraged to coordinate with federal and state agencies early in the project planning process to access any existing information on the cumulative impacts of individual wind projects on species and habitats at risk and to incorporate it into project development and any necessary wildlife studies.

Research Questions

Much uncertainty remains about predicting risk and estimating impacts of wind energy development on wildlife. It is in the interests of wind developers and wildlife agencies to improve these assessments to better avoid and minimize the wildlife impacts of wind energy development. The Committee recommends that research that improves predictions of pre-construction risk and estimates of post-construction impacts be a high priority. 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 effects of multiple wind projects, or comparisons of different methods for assessing avian and bat activity relevant to predicting risk. 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.

Chapter Three: The Tiered Approach for Wildlife Assessment and Siting Decisions

This chapter describes in detail the suggested process for each stage of the tiered approach, with additional sections outlining best practices during site construction, retrofitting, repowering and decommissioning phases of a project.

The first three tiers correspond to the pre-construction evaluation phase of wind energy development. At each of the three tiers the Guidelines provide a set of questions that the Committee recommends developers attempt to 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 federally 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 federally or state-listed species).

The decision to proceed to the next tier is usually made by the developer in cooperation with federal, state and tribal representatives after meeting to discuss the progress to date and any outstanding issues. The decision is based on whether all questions identified in the tier have been adequately answered and agreeing that the methods for arriving at the answers were consistent and appropriate for the site selected and the risk posed to species and their habitats. The developer is encouraged to coordinate with federal, state and tribal representatives to verify that they are satisfied with the level of effort and results received prior to deciding to proceed to the next tier.

Comment [ejk2]: Note to FAC: These two paragraphs in gray should be revised after the Implementation Chapter is completed.

USFWS and states will decide whether the developer has adhered to the Guidelines. That decision will be based on what questions were identified, whether those questions were adequately addressed, and that the conclusions reached are consistent with the study findings. These elements should be included in the Conservation Plan. The decision about whether a company has adhered to the guidelines may be made at different times during the tiered approach. The first time it might be made is at the conclusion of Tier 3, when all pre-construction components have been completed and Tier 4 and 5 elements are identified. The decision also may be made after Tier 4 or 5, depending on the results of the post-construction mortality studies and any additional research. These decision points also should be included in the Conservation Plan.

A. Tier 1: Preliminary Evaluation or Screening of Potential Sites

For developers taking a first look at a broad geographic area, a useful first stage can be a preliminary evaluation of a general ecological context of a potential site or sites. If it is conducted, this is an internal process conducted by developers in preparation for coordination with the federal, state, tribal, and/or local agencies, This process begins to identify geographic areas of high wildlife sensitivity due to 1) the presence of large blocks of intact native landscapes, 2) intact ecological communities, 3) fragmentation-sensitive species' habitats, or 4) other important landscape-scale wildlife values. It is anticipated that developers who choose to conduct Tier 1 investigations will probably 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 developer's or consultant's own information. The Committee has made a policy recommendation to DOI that USFWS facilitate or participate in the development of a comprehensive landscape database on a national scale for the purpose of identifying and assessing development risks and cumulative impacts to ecosystems and large-scale habitats.

Comment [ejk3]: FAC review: consider whether to incorporate language into Tier 1 similar to what is already included in Tier 2 (see lines 814-815) -- that if developer does not conduct Tier 1, they will answer Tier 1 questions in Tier 2.

Tier 1 may be used in any of three ways:

1. To identify regions where wind energy development poses substantial risks to wildlife or habitats, including the fragmentation of large-scale habitats and threats to regional populations of sensitive species
2. To “screen” an landscape or set of multiple potential sites in order to avoid those that have the highest habitat values
3. To begin to determine if a single identified potential site poses serious wildlife or habitat concerns

Tier 1 can offer early guidance about the sensitivity of the site within a larger landscape context, it can help direct development away from sites that will be associated with higher study, mitigation costs, and uncertainty. 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. In other cases it will raise questions or uncertainties that will guide investigations in further tiers, particularly if the necessary habitat data is deficient or outdated.

Tier 1 Questions

Suggested questions to be considered in Tier 1 include:

1. Are there known threatened, endangered, federal "sensitive", state-listed, or other species of concern present on the proposed site, and/or is habitat (including designated critical habitat) present for these species?
2. Does the landscape contain any areas of special designation, including, but not limited to, ‘area of scientific importance’; ‘of significant value’; federally-designated critical habitat; high-priority conservation areas for non-government organizations; or other local, state, regional, federal, tribal, or international categorization that may preclude wind energy development?
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 with needs for large contiguous blocks of habitat?

Tier 1 Methods and Metrics

Answers to the above questions may determine whether suitable sites are available in the region where development is being considered and developers can then decide whether to proceed to further tiers (See Tiers 2-5 below) as they plan for development of those sites. Developers should conduct a systematic and comprehensive review of the publicly available data, and 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. Currently available data sources useful for this analysis are listed in Appendix D. Check with the USFWS field office for data specific to wind and wildlife.

Tier 1 Decision Point

The purpose of Tier 1 activities is to assist the developer in identifying wind energy development sites with few if any potential conflicts with wildlife. A developer may decide to proceed with further review of a potential site for which one or more of the above questions has been answered “yes.” However, this decision will entail more detailed studies in Tier 2 and Tier 3 for species considered at risk from the development. “Yes” answers may also result in stronger scrutiny during Tiers 2 and 3 from those state, federal, and tribal agencies that have responsibility for protecting wildlife resources. However, a “Yes” answer to any of the questions does not in and of itself indicate that a project should not go forward.

While the answer of “no” to the questions where data exists may be encouraging to a developer, an answer of “no” in the absence of data does not necessarily indicate an absence of wildlife conflicts. If a site is selected for further analysis in the absence of data adequate to definitively answer the questions, the developer should attempt to locate the data necessary to answer the questions posed in Tier 2.

B. 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 wildlife and habitat. 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 a set of questions similar to those asked in Tier 1; however, a distinguishing feature of Tier 2 studies is that they focus on site-specific information and should include at least one visit to each of 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).

Comment [ejk4]: Note to FAC: should this language also be included in Tier 1?

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/or local agencies that have jurisdiction and/or management authority and responsibility over the potential project.

1. Are threatened, endangered, federal "sensitive", state listed species, or other species of concern present on or likely to use the proposed site(s)?
2. Are there rare or unusual plant communities present or likely to be present at the site(s), or plant communities that otherwise have a special designation?
3. Which species of birds and bats, especially those known to be at risk caused by wind energy facilities are likely to use a proposed site based on an assessment of site attributes?
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 associated with the proposed site(s)?
5. Are there large areas of intact habitat with the potential for fragmentation, with respect to species with needs for large contiguous blocks of habitat?

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. It is recommended that the developer will make contact with federal, state, tribal, and/or local agencies that have jurisdiction and/or management authority over the project or information about the potentially affected resources. In addition, because key non-governmental organizations (NGOs) and relevant local groups are often valuable sources of relevant local environmental information, it is recommended that developers contact key NGOs, even if the developer is not able to identify specific project location information at this stage due to confidentiality concerns. These contacts also provide an opportunity to identify other potential issues and data not already identified by the developer.

Site visit(s) will normally be conducted to confirm the presence of habitat suitable for species of special interest (e.g., Federal and state listed species, species of conservation concern, species considered at high risk to collisions, etc.), the quality of the habitat, the presence of unique topographic or botanical features and an early indication of the potential for avoidance or mitigation of unavoidable impacts.

Tier 2 Decision Point

"Yes" answers to any or all of the above questions would indicate potential wildlife conflicts that might preclude or substantially increase the difficulty of wind energy development. Developers should also evaluate whether the data collected from a more detailed site characterization are adequate to evaluate risks to wildlife resulting from the potential wind energy development. For example, do the available data adequately characterize the presence and abundance of wildlife species of concern and their habitat? Furthermore, does information exist that allows the evaluation of risk to the same or similar species? A good source of this information is impact assessments from existing wind facilities operating in similar landscape types.

A developer may decide to abandon the project after Tier 2 analysis, or s/he may decide that potential conflicts can be easily avoided or minimized by the project design. Alternatively, the available data may not be sufficient to characterize the site and/or evaluate risk. If the developer wishes to pursue the potential development of the site then s/he should proceed to the more detailed field studies in Tier 3. The results of the Tier 2 analysis also could indicate, in unique circumstances where wildlife conflicts are low risk, that further studies are unnecessary and the developer can proceed to developing the site.

C. Tier 3: Field Studies to Document Site Wildlife Conditions and Predict Project Impacts

Tier 3 is the first tier in which quantitative and scientifically rigorous studies will be conducted to assess the potential risk of the proposed project. Specifically, these studies will provide pre-construction information to:

- Further evaluate a site for determining whether the project should be developed or be abandoned
- Design and operate a site to avoid or minimize impacts if a decision is made to develop;
- Design of mitigation measures if significant impacts cannot be acceptably avoided or minimized;
- Determine if post-construction studies are necessary; and,
- Provide the pre-construction component of Tier 5 studies necessary to estimate impacts.

Tier 3 Questions

Tier 3 begins as the other tiers do, with problem formulation: what additional studies are required 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: 1) design a project to avoid or minimize predicted risk; 2) evaluate predictions of impact and risk through post-construction comparisons of estimated impacts (i.e., Tier 4 and 5 studies); and 3) identify the need for and the development of mitigation measures to offset unavoidable impacts.

The decision to conduct a Tier 3 study depends on whether or not additional data are necessary to answer the questions listed below. For example, if adequate data are available from nearby sources and/or from studies of the site being evaluated, then additional studies may be unnecessary. Additionally, a reduced level of survey effort may be warranted for certain projects, such as infill development, small-scale projects with low potential risk for impacts, some repowering projects, or projects contiguous to existing low-impact wind facilities provided these projects have sufficient credible information regarding impacts.

The problem formulation stage for Tier 3 also will include an assessment of which of the 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 site visit(s) in Tier 2, and 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 it 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 impact is unlikely or of minor significance.

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

1. Do field studies indicate that federally listed threatened, endangered, federal "sensitive", state listed species, or other species of concern are present on or likely to use the proposed site?
2. Do field studies indicate that there are large blocks of habitat used by species that need large contiguous blocks of habitat and who are likely to be affected by wind energy?
3. What is the distribution, relative abundance, behavior, and site use of wildlife determined to be of interest in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind power project? Do these species exhibit behavior that puts them at risk from the proposed wind project?
4. What are the potential risks of impacts of the proposed wind energy project to individuals and local populations?
5. If significant impacts are predicted, especially to wildlife of interest, can these impacts be avoided, minimized, or mitigated?
6. Are there studies that should be initiated at this stage that would be continued in either Tier 4 or Tier 5?

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 sufficient data to enable analysis to answer Tier 3 questions 4-6.

Tier 3 Methods and Metrics

If Tier 3 studies are warranted the Committee encourages the use of common methods and metrics for measuring wildlife activity and habitat features. Standard 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. Varying from the standard methods should be carefully considered, scientifically justifiable and vetted with the USFWS, the permitting agency, state wildlife agencies, and tribes where they have jurisdiction. It may be useful to consult other scientifically credible information sources.

The Committee recognizes that Tier 3 studies will be designed to accommodate local and regional characteristics. The specific protocols by which standard methods and metrics are implemented in Tier 3 studies depends 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, species of concern, or those of special interest, and their habitats, often will 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.

A single method will not adequately assess potential collision risk or habitat impact. For example, when there are moderate to high levels of concern of risk to nocturnally active species, such as migrating passerines and local and migrating bats, a combination of remote sensing tools such as marine or NEXRAD radar, 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 a wide ranging species such as prairie grouse may require more time consuming surveys, perhaps including telemetry.

Because of the points raised above and the need for flexibility in application, the Committee does not make specific recommendations on protocol elements for Tier 3 studies. The peer-reviewed scientific literature (such as those articles cited below) contains numerous recently published reviews of methods for assessing avian and bat activity, two areas of principal concern and tools for assessing habitat and landscape level risk are also available. In addition, a revised Methods and Metrics manual, prepared under the auspices of the National Wind Coordinating Collaborative, is in review [8]. This Committee has not reviewed the latter document and therefore cannot endorse its content, but it is expected that the new Methods and Metrics document will be widely consulted by the industry and wildlife agencies. Thus, details on specific methods and protocols for recommended studies are or will be widely available and should be consulted by industry and agency professionals.

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[8] 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. 2009. Studying Wind Energy/Wildlife Interactions: a Guidance Document. Prepared for the National Wind Coordinating Collaborative, Washington, D.C., USA.

Many methods for assessing risk are areas of active research and involving collaborative efforts of public-private research partnerships with federal and state agencies, wind energy developers and non-governmental organizations interested in wind-wildlife interactions (e.g., Bats and Wind Energy Cooperative; www.batsandwind.org and the Grassland Shrub Steppe Species Cooperative; www.nationalwind.org). Thus, while recognizing the value of utilizing standard methods the Committee also recognizes the need to integrate the results of research that improves existing methods or describes new methodological developments.

The remainder of this section outlines the methods and metrics which may be appropriate for gathering data to answer Tier 3 questions. Each question is considered in turn, followed by a discussion of the methods and their applicability.

1. Do field studies indicate that threatened, endangered, federal "sensitive", state listed species, or other 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 are not required, and protocol development will 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 (i.e., every year). In the event a species of concern is very rare and only occasionally visits a site (e.g., whooping crane) 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 and Federal agencies often require specific protocols be followed when listed and special-status species are potentially present on a site. The methods and protocols for determining presence of threatened, endangered, and other special status bird species at a site are normally established for each species and required by federal and state resource agencies. Estimates of bird use (see question 3 below) will provide presence/absence information as a byproduct. 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.

Acoustic monitoring can be a practical method for determining the presence of threatened, endangered or otherwise rare species of bats throughout a proposed wind energy facility (Kunz et al. 2007). There are two general types of acoustic detectors that are 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 (e.g., Pettersson and Binary Acoustic Technology detectors) provide nearly complete species discrimination, while zero-crossing detectors (i.e., Anabat detectors) provide reliable and cost-effective estimates of total bat use at a site and provide some species discrimination; Myotis species can be especially difficult to

Comment [ejk5]: FAC review: can we identify which bat species trigger study needs - is it all bats?

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 multiple sampling stations to account for temporal and spatial variability.

While **mist-netting** bats is required in some situations by state agencies and the USFWS to determine the presence of threatened, endangered or otherwise rare species, these Guidelines generally do not recommend mist-netting as a standard method for assessing risk of wind 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 built; and 3) mist-netting isn't feasible at the heights of the rotor-swept zone and captures below that zone may not adequately reflect risk of fatality.

Determining the presence of diurnally or nocturnally active mammals, reptiles, amphibians, and other species of special interest will typically be accomplished by following agency-required protocols. Most listed species have standard protocols for detection (e.g., black-footed ferret). State 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).

2. Do field studies indicate that there are large blocks of habitat needed by species of special interest?

Comment [ejk6]: FAC review this concept: It should be noted that some areas are inappropriate for wind energy development, based solely on their rarity and the intactness of the ecological community, *independent of the presence of any species of concern.*

Answering this question requires an analysis of **habitat fragmentation**, 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. Particulars of the analysis will depend on the species of concern and how fragmentation is defined for the ecology of that species, the likelihood that the wind project will adversely affect the species, and the importance of intact expanses of vegetative communities such as wetland and riparian areas.

Site clearing, access roads, transmission lines and turbine tower arrays affect birds and other wildlife by fragmenting continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when area-sensitive species are present at a project site, or in the broader area affected by a project. Some area-sensitive species require large expanses of habitat for activities such as breeding and foraging. Consequences of isolating area-sensitive 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. Development of wind energy infrastructure may result in a suite of "edge effects" that can extend a mile or more into remaining fragments. Habitat fragmentation also leads to greater susceptibility of habitat areas to colonization by invasive species.

Comment [ejk7]: This section is still under revision and additional language is being considered.

To evaluate habitat fragmentation in a site or area of interest, developers should evaluate landscape characteristics of potential sites within the area prior to construction and determine the degree to which the interior habitat integrity will be altered by the presence of a wind energy facility. When the characteristics of habitat for a species are well known, the habitat can be mapped using existing information (e.g., data, maps, GIS layers, aerial photography) including vegetation, topography, unique habitat features, land use, and species distribution (both existing and historic).The impacts of this change in habitat character should be evaluated for species of conservation concern, including in particular area-sensitive species, species that rely on interior habitat, and species of limited distribution or abundance.

3. What is the distribution, relative abundance, behavior, and site use of wildlife determined to be of interest in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind power project?

For those species of concern that are considered at risk of collisions or habitat impacts (e.g., displacement) the questions to be answered in Tier 3 include: where they are likely to occur (i.e., where their habitat is) within a project site, when they might 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. 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, the absolute risk when compared to existing wind facilities where similar information exists, and for use 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 and abundance may vary with the species and its ecology. Spatial distribution is determined by applying presence/absence or use surveys in a probabilistic manner over the entire area of interest.

Bird Distribution, Abundance, Behavior and Site Use

Diurnal Avian Activity Surveys

The standardized 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) or along transects (transect surveys). 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. Surveys for raptor and other large bird use should be done using point counts. Depending on the characteristics of the area of interest and the bird species potentially affected by the project, additional pre-permitting 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 WRA by habitat, determine the presence of sensitive species, and to provide a baseline for assessing displacement effects and habitat loss. Point counts for large birds (e.g., raptors) follows the same point count method described by Reynolds et al. (1980).

Point count plots or transects 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 meteorological towers are proposed or are 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 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 area. 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 for 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., Dettmer et al. 1999). If a more precise estimate of density is required for a particular species (for example, 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 the point counts but if potential impacts to breeding raptors are a concern on a project, raptor nest searches are also necessary. These surveys provide information to predict risk to the local breeding population of raptors, for micro-siting decisions, and for developing an appropriately sized non-disturbance buffer around nests. Surveys also provide baseline data for estimating impacts and to determine compensatory mitigation requirements.

Searches for raptor nests or raptor breeding territories on projects with potential for impacts to raptors should be conducted in suitable habitat for the species of concern 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 project footprint should locate most raptor nests potentially affected by the development.

Methods for these surveys are fairly standard and will vary with the species, terrain, and vegetation within the survey area. Draft protocols should be discussed with biologists from the lead agency, USFWS, 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, the appropriate search protocol for each site, including timing and number of surveys needed, search area, and search techniques.

Prairie Grouse Male Breeding Area (Lek) Counts

Much of the native habitat important to prairie grouse has been lost to changes in land use practices. Because these species are known to avoid tall anthropogenic structures (Robel et al. 2004?, Pruett et al. 2009) and the remaining habitat for these species frequently coincides with excellent wind resources, there is a great deal of concern about the potential impact of wind development on these birds.

It is generally agreed that breeding populations of prairie grouse should be 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 new leks, followed by repeated visits to active leks to estimate the number of grouse using the leks.

The extent of the impact of wind energy development on lekking activity and the associated impacts on breeding populations (e.g., nesting and brood rearing habitat) is poorly understood (Arnett et al. 2007; NRC 2007; Manville 2004; Pruett et al. 2009; Pitman et al. 2005) and is an area of much needed research. These effects should be addressed through Tier 5 studies on projects which proceed to construction that are within one mile for lesser and greater prairie chicken leks. There is a great deal of uncertainty regarding avoidance distances for other prairie grouse species.

Comment [ma8]: Dr. Robel may provide additional information to the FAC.

Prairie Grouse Brood Surveys

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

Mist-Netting for Birds

Mist-netting is not recommended as a standard method for assessing risk of wind development. 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 isn't feasible at the heights of the rotor-swept zone and captures below that zone may not adequately reflect risk. Operating mist-nets is expensive and 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 facility. If mist-netting is to be used, follow procedures for operating nets and collecting data in accordance with Ralph et al. (1993).

Nocturnal Bird Survey Methods

Additional studies using different methods will be required if characteristics of the project site and surrounding areas potentially pose a high risk of collision to night migrating songbirds and other nocturnally active 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, 2004).

In general, pre-permitting 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 wind energy 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, special-status bird species (for example, marbled murrelet, northern spotted owl, Hawaiian petrel, Newell's shearwater), surveyors should use species-specific protocols recommended by state wildlife agencies or USFWS 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 required 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

Acoustic Monitoring

When bat fatalities are of concern, acoustic monitoring should be used at sites to estimate seasonal use at proposed wind facility sites. Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species composition and use, but does not measure the number of individual bats or population density. Passive acoustic surveys can provide baseline patterns of seasonal bat activity at proposed wind energy sites, but researchers should be aware that with the current state of knowledge about bat-wind turbine interactions, a fundamental gap exists regarding links between pre-permitting assessments and operations fatalities. The ability to predict fatalities, and thus risk, from acoustic data has not yet been established, and acoustic data gathered in Tier 3 should be linked with Tier 4 post-construction fatality data from multiple facilities. Discussions with experts, state wildlife trustee agencies, and USFWS will be needed to determine whether acoustic monitoring is warranted at a proposed wind energy 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 species. Monitoring for a full year is recommended in areas where there is year-round bat activity because little is known about the timing of bat activity in many parts of the country, and some bat species can be active throughout the year. Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so these weather data can be correlated with bat activity levels.

The number and distribution of sampling stations has not been well established, but multiple sampling stations will provide an estimate of spatial variability in bat activity. If variation among sampling stations is low (e.g., Weller 2007) then fewer stations will be needed, whereas the opposite is true for sites with high variability among sampling stations (e.g., Arnett et al. 2006, E.B. Arnett, Bat Conservation International, unpublished data). At sites where high variability in bat calls is expected, or those sites where no data occur to evaluate site-to-site variability, it is recommended that a sample of existing met towers distributed approximately every two kilometers across the site where turbines are expected to be sited, be equipped with detectors.

Acoustic detector systems should be placed at low positions (near ground) on each meteorological tower included in the sample. A subsample of sampled met towers should also have a detector installed at or near the top of the tower. Sampling at both high and low positions on a subset of sampled towers would be treated as a “double sample” allowing a more cost effective estimate of bat activity at both positions. At potential development sites where potential risk to bats is identified early in the development process developers should evaluate whether it would be cost effective to install detectors when meteorological 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.

Other Bat Survey Techniques

Other research tools are available to complement the information from acoustic surveys. These methods are not necessarily needed for every project, but may be required to answer particular questions about colony size, species composition, behavior, and patterns of roost use or to further investigate habitat features that might attract bats. Kunz et al. (2007) provides a comprehensive description of bat survey techniques in relation to wind facilities.

Exit Counts / Roost Searches

Pre-permitting survey efforts should determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the area of interest. For most projects, the area of interest is the area where wind turbines and meteorological towers are proposed or are expected to be sited. Tier 2 collection of existing information will identify most of these sites in or near the area being considered for development. However, field surveys should be conducted throughout the proposed wind turbine area to ensure all roosts within the area are identified. If active roosts are detected exit surveys should be conducted. Potential exit surveys include exit counts and roost searches to assess the size, species composition, and activity patterns for any bat-occupied features near areas of interest and acoustic surveys and radar to assess the spatial distribution of direction of movement as bats leave roosts. Rainey (1995) provides a guide to options for exit counts and Kunz et al (2007) describe the use of acoustics and radar.

Roost searches should be performed cautiously because roosting bats are sensitive to human disturbance (Kunz et al., 1996). Known maternity roosts should not be entered or otherwise disturbed. Searches of abandoned mines or caves can be dangerous and should only be conducted by experienced researchers. For mine survey protocol and guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999). Multiple surveys will be required to determine presence of bats in caves and mines (up to 12 or more surveys in some regions; see Sherwin et al. [2003]).

Mist-Netting for Bats

As discussed in detail above, mist-netting is not recommend as a standard method for assessing risk of wind development. If mist-netting is required by agencies, for example, to determine the presence of threatened or endangered species or where other methods are not practical, it is best used in combination with acoustic monitoring to inventory the species of bats present at a site efforts should concentrate on potential commuting, foraging, drinking, and roosting sites (Kuenzi and Morrison 1998, O'Farrell et al., 1999).

Biologists with training in bat identification, equipment use, and data analysis and interpretation should design and conduct all studies discussed below. Mist-netting and other activities that involve capturing and handling bats may require permits from state and/or federal agencies.

Other Wildlife

While the above guidance emphasizes the evaluation of potential impacts to birds and bats, Tier 1 and 2 evaluations may identify other wildlife species of concern. Developers are encouraged to assess impacts potentially caused by wind development for those species most likely to be negatively affected by such development. Impacts to other species are primarily derived from potential habitat loss and/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. Nevertheless, most methods and metrics will be species specific and should be worked out with the state and federal agencies during problem formulation for Tier 3.

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

Risk is defined as the likelihood that adverse effects may occur to individual animals or populations of wildlife, as a result of the ecological stress caused by wind power generation. In the context of wind energy development, risk can be defined for individuals of a species as the risk of collision fatality, calculated by dividing the number of fatalities (impact) by the number of birds in the zone of risk (exposure). Risk can also be defined in the context of populations, but the 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 other survivorship**,** either for local populations, metapopulations, or entire species. Impacts to populations could result from individual collision fatalities, habitat loss, habitat fragmentation, and reduction in reproduction and survival of individuals in the population.

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 facilities with similar characteristics (e.g., similar technology, landscape, and weather conditions). Models provide an additional tool for estimating fatalities, and have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the U.S. (Madders and Whitfield 2006). As with other prediction tools, model predictions must be evaluated and compared with post-construction fatality data to validate the models. Models should be used as a subcomponent of a more comprehensive evaluation of risk. 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. (In review).

Collision risk to individual birds and bats at a particular wind 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 zone of risk. If individuals (e.g. ravens) frequently occupy the zone of risk, but effectively avoid collisions then they are also at low risk of collision with a turbine. Alternatively, if the behavior of individuals frequently places them in the zone of risk, and they do not actively avoid turbine blade strikes, then 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 relatively the same. The risk to a population increases as the proportion of individuals in the population at risk to collision increases.

Bat fatalities typically are higher than bird fatalities at wind facilities, but little is known about the exposure risk of bats at turbines. The issue is further complicated by the fact that bats may be attracted to turbines (Horn et al. 2008, Cryan 2008). Research is required to determine whether this increased individual risk translates into higher population-level risk for bats.

The estimation of displacement risk (see below) requires an understanding of animal behavior in response to a wind facility 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 facility. The amount of habitat that is lost to displacement will be a function of the sensitivity of individuals to the facility and to the activity levels associated with the project's operations. The population-level significance of this habitat loss will depend on the amount of habitat available to the affected population. If the loss of habitat results in habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased. Quantifying cause and effect may be very difficult, however.

5. If significant impacts are predicted with respect to wildlife and their habitats, what avoidance, minimization, or mitigation strategies are identifiable?

Comment [ejk9]: FAC review this comment: this section should not contemplate adherence to the guidelines if a "project developer…proceeds with construction" in circumstances where there will be "significant adverse impacts".

Results of Tier 3 studies provide a basis for identifying measures for avoiding, minimizing, or providing compensatory mitigation for those impacts. Information on wildlife use of the proposed area is most useful when designing a project to avoid or minimize impacts. For example, in baseline studies of the proposed Wyoming Wind Energy Project, field observations demonstrated that most raptor use of the site was within 50 meters of the edge of the mesa where the project was to be sited (Johnson et al. 2000). Based on this information the developer chose to modify the site development plan to reduce the risk of raptor fatalities. Turbines were sited so as to avoid this zone of high raptor use. Such avoidance buffers can be placed around other wildlife concentration areas such as breeding display areas (e.g., sage grouse leks), raptor nests, bat hibernacula, and other areas of concentrated use by species of concern.

Avoidance buffers require detailed information on animal behavior in relation to wind energy facilities and their components. Impact avoidance, minimization and mitigation are areas of much needed research (NRC 2007). The technical feasibility and cost of impact avoidance, minimization and mitigation are important factors for companies to consider when evaluating a potential site for development.

When significant adverse ecological impacts cannot be fully avoided or adequately minimized, some impacts will need to be replaced through compensatory mitigation. For example, it may be possible to mitigate habitat loss or degradation for a species of concern by replacing or restoring nearby habitat comparable to that potentially influenced by the wind project. More detail is provided on this topic in Chapter 4.

6. Are there studies that should be initiated at this stage that would be continued in either Tier 4 or Tier 5?

During Tier 3 problem formulation it is necessary to identify the studies needed to address the Tier 3 questions. These studies must also consider how the resulting data may be used in conjunction with post-constriction Tier 4 and 5 studies. If estimation of post-construction impact and/or success of mitigation is necessary, then the design for these studies should be determined based on the specific impact questions being addressed. Tier 3 predictions of fatalities will be evaluated using data from Tier 4 studies designed to estimate fatalities. Tier 3 studies may demonstrate the need for avoidance, minimization and/or mitigation of habitat impacts and/or demographic impacts to local populations. Where habitat impacts are of major concern, Tier 5 studies will provide data that evaluate the predicted impacts and the effectiveness of avoidance, minimization, and mitigation measures. Evaluation of the impact of a wind facility on demographic parameters of local populations, habitat use, or some other parameter(s), typically will require data on these parameters prior to and after construction of a wind facility.

Confirming the relationship between pre- and post-construction parameters so that these relationships can be generalized with confidence to other proposed facilities will require that studies at multiple facilities be combined to determine if there are consistent and predictable patterns. Such meta-analysis utilizing results from multiple sites to confirm these relationships is beyond the scope of an individual project and should be a collaborative effort among several projects and other stakeholders. These studies are critical for examining methods and the predictability of fatalities for future risk assessments, and will benefit both wildlife conservation and the wind energy industry.

Not all Tier 3 studies will continue into Tiers 4 or 5. For example, surveys conducted in Tier 3 for a threatened, endangered, or species of concern may indicate the species is not present at the proposed site, or siting decisions could be made in Tier 3 that remove identified concerns; thus obviating the need for continued efforts in later tiers. Additional detail on the design of Tier 5 studies that begin in Tier 3 is provided in the discussion of methods and metrics in Tier 5.

Tier 3 Decision Point

At the end of Tier 3 the developer, and potentially 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:

1. Development of the site has a high probability of unacceptable environmental impact that cannot satisfactorily be avoided, minimized or mitigated. Development is delayed or abandoned in favor of sites with less potential for environmental impact or evaluation of other sites or landscapes in search for more acceptable sites to develop.

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

3. Development of the site has a relatively high probability of unacceptable impacts without proper measures being taken to avoid, minimize, or mitigate those impacts. However, there is uncertainty regarding how to develop the site to adequately avoid, minimize, or

mitigate impacts, or the permitting process requires additional information on potential wildlife impacts before permitting future phases of the project. A decision to develop the site is made conditional on the proper avoidance, minimization and/or mitigation measures being taken and with follow up post-construction studies (Tier 4 and 5).

D. Site Construction: Site Development and Construction Best Management Practices

During site planning and development, significant attention should be given to reducing risk of adverse impacts to wildlife from turbines and associated infrastructure through careful site selection and facility design. The following best management practices (BMPs) can assist a developer in the planning process to reduce potential wildlife impacts. Use of these BMPs should ensure that the potential adverse impacts to most wildlife and habitat present at many wind development sites would be reduced, although additional compensatory mitigation may be required at a project level to address significant site-specific concerns and pre-construction study results.

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 facilities. USFWS will work with the industry, stakeholders and the states to evaluate, revise and update these BMPs on a continual basis, and the USFWS will 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 turbines in areas identified as having potentially high risk to birds and bats
3. Avoid using or degrading high value or large intact habitat areas, as identified in state wildlife action plans, or by other published data sources, including natural heritage and non-government organization data bases and documents.
4. 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.
5. Use native species when seeding or planting during 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 (i.e., where shallow bedrock exists) or where greater impacts to biological resources would result.
    a. Overhead lines may be acceptable if sited away from high bird crossing locations, such as between roosting and feeding areas or between lakes, rivers, prairie grouse leks, and nesting habitats.
    b. Overhead lines may be used when they 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 comply with the 2006 or most recent Avian Power Line Interaction Committee (APLIC) "Suggested Practices for Avian Protection on Power Lines."

7. Communication towers and permanent meteorological towers should not be guyed at turbine sites, and should be built < 61 m above ground level (200 ft. AGL) to avoid use of pilot warning lights when possible (Gehring et al. 2009a; Gehring et al. 2009b MS to J. Wildlife Manage.) If guy wires are necessary, bird flight diverters or high visibility marking devices should be used.

8. Use construction and management practices to minimize activities that may attract prey and predators to the wind turbine site.

9. 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, only a portion of the turbines within the wind facility should be lighted, and all pilot warning lights should fire synchronously.

10. 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.

11. Establish non-disturbance buffer zones to protect raptor nests, bat roosts, areas of high bird or bat use, or specials-status species habitat identified in pre-construction studies. Determine the extent of the buffer zone in consultation with USFWS and state, local and tribal wildlife biologists, and land management agencies (e.g., BLM and USFS).

12. Locate turbines to avoid separating birds and bats from their daily roosting, feeding, or nesting sites if documented that the turbines' presence poses a risk to species.

13. Avoid impacts to hydrology and stream morphology, especially where sensitive aquatic or riparian species may be involved.

14. Although it is unclear whether tubular or lattice towers reduce risk of collision, when practical use tubular towers or best available technology to reduce ability of birds to perch and to reduce risk of collision.

15. Minimize the number and length of access roads, use existing roads when feasible.

E. Tier 4: Post-Construction Fatality Studies

Tier 4 studies focus specifically on post-construction fatality monitoring. Activities involve searching for bird and bat carcasses beneath turbines to determine overall fatality rates, and to answer other questions regarding species composition of fatalities, relationships with site characteristics, comparison of fatalities among facilities, comparison of actual and predicted fatality rates estimated in previous tiers, and determining if fatality rates warrant corrective management or mitigation measures.

The level of effort and seasonality of studies may vary depending on several factors, including site sensitivity and risk level, amount and quality of existing data from nearby sites, seasons of occupancy, and variability within and between seasons and years, and affected species of concern. Fatality studies should be conducted for a minimum of one year post construction for all projects. Fatality studies should be conducted for at least two years post construction when little is known about fatality rates in a particular landscape or when fatality data from a new facility in a particular landscape is substantively higher than data for existing facilities. The number of years of monitoring can be adjusted if appropriate, following discussions with the USFWS, state wildlife agency, permitting agency and other stakeholders. For example, if a site had been determined to be low-risk, and first-year Tier 4 studies indicate that impacts are low, suspension of monitoring may be appropriate. Fatality studies should occur over all seasons of occupancy for the species of interest. All fatality studies should include estimates of carcass removal and carcass detection rates for all seasons and all conditions likely to influence those rates. Operators of facilities are encouraged to develop a long-term program for reporting fatalities by their personnel after studies are terminated.

Tier 4 Questions

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

1. What is the bird and bat fatality rate for the project?

   What are the fatality rates of those species determined to be of special interest?

   How do the estimated fatality rates compare to the predicted fatality rates?

   Do bird and bat fatalities vary within the facility in relation to site characteristics?

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

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

   Do fatality data suggest the need for mitigation measures to reduce risk?

Fatality monitoring results should be of sufficient statistical validity to answer Tier 4 questions, to allow comparisons with pre-construction impact predictions and comparisons with other sites, and to provide a basis for determining if corrective management or mitigation measures at the site are appropriate.

Tier 4 Protocol Design Issues

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 included methods for adequately accounting for sampling biases (search efficiency and scavenger removal). However, some situations warrant exceptions to standardized protocol, and the responsibility of demonstrating that an exception is appropriate and applicable should be on the stakeholder attempting to justify increasing or decreasing the duration or intensity of operations monitoring.

Some general guidance is given below with regard to the following fatality search 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; and
- Estimators of fatality.

More detailed descriptions and methods of fatality search protocols and can be found in the California (California Energy Commission 2007) and Pennsylvania (PGC 2007) state guidelines and the following publications: Kunz et al. (2007), Smallwood (2007), and the revised methods and metrics document (Strickland et al., In review)).

Duration and frequency of monitoring

Duration and frequency of fatality searches within a year will vary depending on the questions to be answered, the species of concern, their peak periods of migration, season of searching, and estimated carcass removal rates.

As a general rule protocols should be designed to minimize adjustments required due to the biases described below. A search interval of 7 days is typically adequate to answer Tier 4 questions. It should be noted that search interval is the interval between searches of individual turbines and protocols should be designed such that some turbines are sampled most days each week of the study. Notwithstanding, larger or smaller search intervals may be justified. If the primary objective is fatalities of large raptors and carcass removal is low, then a longer interval between searches (e.g., 14-28 days) and larger subplots (3-5 meters radius) are sufficient. However, if the focus is fatalities of bats and small birds and carcass removal is high, then a search interval of less than 7 days will be necessary. For example, if the mean removal rate established by carcass removal trials is 2 days, then the search interval should be no more than 4 days and subplots should be smaller (e.g., 1.5-3 m).

There are situations in which studies of higher intensity (e.g., daily searches at individual turbines within the sample) may be appropriate in the first year of post-construction monitoring. These would be considered Tier 5 studies because of the greater complexity and level of effort. These Tier 5 studies could include evaluation of specific measures that have been implemented to mitigate potential impacts to threatened or endangered species, or species of particular concern identified during pre-construction studies.

Number of turbines to monitor

Data on variability among turbines from existing facilities in similar conditions within the same region should be used, if available, to determine needed sample size (see Strickland et al., In review). If data are not available, then a sufficient number of turbines should be selected via a systematic sample with a random start point. Sampling plans can be varied (e.g., rotating panels [Strickland et al., In review]) to increase efficiency as long as a probability sampling approach is used. If the project contains fewer than 10 turbines, all turbines in the area of interest should be searched unless otherwise agreed to by the regulating agencies. When selecting turbines, it is recommended that a systematic sample with a random start be used when selecting search plots to ensure interspersion among turbines. Stratification among different habitat types also is recommended to account for differences in fatality rates among different 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% of bat fatalities fall within half the maximum distance of turbine height to ground (Erickson 2003 a, b), and a minimum plot radius of 60 m from the turbine should be established at sample turbines. Plots will need to be larger for birds, with a radius of the maximum distance of turbine height to ground. Decisions regarding search plot size should be made in discussions with the USFWS, state wildlife agency, permitting agency and tribes where they have jurisdiction. It may be useful to consult other scientifically credible information sources.

It is recommended 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 radius of 3 meters should be adequate. Notwithstanding, search radii may vary from 1.5-5 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 radius; thus, the searchable area of each turbine must be delineated and mapped to adjust fatality estimates based on the actual area searched. If needed, habitat visibility classes should be established in each plot to account for differential detectability. It may be necessary 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 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 radius of the search plot.

General search protocol guidance

Trained searchers should look for bird and bat carcasses along transects or subplots within each plot and record and collect all carcasses located in the searchable areas. A complete search of the area should be accomplished and subplot size (e.g., transect width) should be adjusted to compensate for 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), a digital photograph of the carcass should be taken), and estimated time of death (e.g., $\leq$1 day, 2 days). Rubber gloves should be used to handle all carcasses to eliminate possible transmission of rabies of 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. 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

It has long been recognized that during searches conducted at wind turbines, actual fatality is incompletely observed and that carcass counts must be adjusted by some factor that accounts for imperfect detectability. 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 bats that may land or move outside search plots.

To address bias sources 2-4 above, all fatality studies must conduct carcass removal and searcher efficiency trials using accepted methods discussed in the revised methods and metrics document (Strickland et al., In review). 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.

Prior to a study's inception, a list of random turbine numbers and random azimuths and distances (m) 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 have its location recorded. There is no agreed upon sample size for bias trials, though some state guidelines recommend from 50 - 200 carcasses. Most researchers agree that sample size of carcasses used for bias trials should be maximized to the greatest extent practical.

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

Carcasses or injured individuals may land or move outside the search plots, error number 5 above. This potential sampling error could be estimated by sampling outside the standard search plot for a subsample of turbines, but it is unlikely that this error will ever be accurately estimated. Additionally, based on the distribution of carcasses in plots this error is considered to be small and studies that expand the standard search plot could be used to evaluate the magnitude of the error.

Estimators of Fatality

If there were a direct relationship between the number of carcasses observed and the number that were 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. 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. Only the most contemporary equations for estimating fatality should be used, as some original versions are now known to be extremely biased under many commonly encountered field conditions; the revised methods and metrics document should be used as a current source for estimators of fatality (Strickland et al., In review).

Tier 4 Objectives and Metrics

In addition to the monitoring protocol, the metrics used to estimate fatality rates must be selected with the Tier 4 questions and objectives in mind. Metrics considerations for each of the Tier 4 questions are discussed briefly below.

1. What is the bird and bat fatality rate for the project?

The primary objective of fatality searches is to determine the overall estimated fatality rate 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. Nevertheless, the size of the rotor swept area may vary among manufacturers for the same nameplate capacity, and each site has a unique capacity factor (the average operating capacity). Fatalities "per rotor swept hour" and "per MW of produced power" would be superior to the other metrics, but require data that are usually unavailable. Unless better metrics are available, fatality rates should be expressed on a per turbine and per nameplate MW basis.

2. What are the fatality rates of those species determined to be of special interest?

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 MW basis if comparing species fatality rates among facilities.

3. How do the estimated fatality rates compare to the predicted fatality rates?

There are a several ways that predictions can be assigned and later evaluated with actual fatality data. During the planning stages in Tier 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 facility – could be used in conjunction with use and fatality estimates from existing facilities to develop a model for predicting fatalities at the proposed facility. 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.

Several statistical methods can be found in the revised Strickland et al. (In review) and used to evaluate fatality predictions. Metrics derived from Tier 3 pre-construction assessments may be correlated with fatality rates, and (using the facility 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. How do the fatality rates compare to the fatality rates from existing facilities in similar landscapes with similar species composition and use?

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

5. Do bird and bat fatalities vary within the facility in relation to site characteristics?

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 facility.

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 (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 the assessment of potential population effects. More detailed investigations using stable isotope and genetic analyses may be conducted in Tier 5.

7. Do fatality data suggest the need for mitigation measures to reduce risk?

Fatality rates that trigger specific mitigation measures have not yet been established, but could be established if there is a likely effect on local populations, or within broad landscape types with similar risk levels (e.g., forested ridges). Evaluation of mitigation methods would occur in Tier 5, if there was uncertainty about whether the mitigation measure would meet the objective of reducing risk of fatalities.

F. Tier 5: Other Post-construction Studies

Tier 5 studies are intended to assess both direct and indirect project-specific impacts, and may include:

- Estimating the direct and indirect effects (e.g., displacement) of habitat alteration, habitat loss, or habitat fragmentation on species of special interest, including birds, bats, and Federal or state-listed species
- Analyzing factors associated with impacts, particularly direct impacts, in those cases in which impacts significantly exceed pre-construction predictions
- Determining whether the avoidance, minimization, and mitigation measures implemented for a project were adequate or whether additional action is warranted
- Assessing demographic effects on local populations of species of special interest, including birds, bats, and Federal or state-listed species.

Studies to assess direct 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. Indirect impacts may include two important components. The first involves indirect effects to wildlife resulting from displacement, due to disturbance, habitat fragmentation, loss, and alteration. The second involves demographic effects that may occur at the local, regional or population-wide levels. Such demographic effects may result from reduced nesting and breeding densities, loss of population vigor and/or decline in population density, habitat and site abandonment, increased isolation of species between habitat patches, loss of refugia for wildlife, attraction to modified habitats, effects on behavior (e.g., stress, interruption, and modification), disturbance, site avoidance, and displacement of species, and habitat unsuitability. 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 2008, Robel et al. 2004?, Pruett et al. 2009).

Tier 5 studies may also be used by a developer to evaluate the effectiveness of a risk reduction measure (e.g., changes in turbine cut-in speed) and the effectiveness of blade "feathering" experiments) before deciding to continue the measure permanently and/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 to reduce impacts to species are necessary.

Tier 5 studies may be proposed to test additional design and operation adjustments when project design modifications or operational activities fail to meet impact avoidance, minimization or mitigation goals. For example, if Tier 4 fatality studies document that a particular turbine or set of turbines exhibits greater bird or bat collision mortality than originally predicted, adaptive management (as defined in Chapter 2B) may be useful in evaluating alternative mitigation measures to avoid or minimize future take at that turbine/turbine string. In this example, the decision to implement mitigation measures would be based on the likelihood of success in reducing mortality, the availability of alternative more cost-effective measures, and the magnitude of concern over the increased level of fatalities.

Tier 5 Study Designs

A variety of designs may be utilized in Tier 5 studies, and the specific designs will depend on the types of questions and the specific project. Many Tier 5 studies will be a continuation of studies begun in Tier 3, and the decision to continue these studies in Tier 5 will reflect an assessment of the results of these Tier 3 studies. Like Tier 4 studies, results from Tier 5 studies should also lead to improved predictability and reduced cost of pre-construction risk assessment for future projects.

In the context of wind energy development, a potential design for assessing displacement and/or other habitat-related impacts involves pre- and post-construction data collection on both areas of interest and reference areas. Referred to as the Before-After-Control-Impact (BACI), this design is most like the classic manipulative experiment.[9] The Impact Gradient Design is a modification of the classic BACI design (Morrison et al. 2008). The BACI, and perhaps the Impact Gradient Design, are initiated in Tier 3 and allow the strongest test of the impact of the wind project on the

[9] 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.

wildlife variables of interest, such as species displacement as a result of the project construction. Under the assumption that habitat and species use are homogenous in the assessment area prior to development, the Impact Gradient Design can provide an alternative to the BACI when "before" data are lacking. Such designs will allow stronger inferences if multiple years of data collection occur both pre- and post-construction, and as a consequence post-construction studies utilizing these alternate designs will be the most expensive types of study.

In some cases project impacts occur unexpectedly. Studies intended to explain these unexpected impacts would utilize designs other than the BACI because relevant pre-construction data and/or reference areas may not be available. The use of the BACI study design is recommended mainly when there is little information available from wind projects in similar landscapes, and there is a high level of suspected impact to species of concern. Study designs other than BACI may be sufficient if there is post-construction data available from other sites involving similar landscapes and species.

Tier 5 Questions

Tier 5 questions are primarily geared towards evaluating impact predictions developed during the pre-construction risk assessment. For example, pre-construction studies focus on estimating the potential impacts of a wind project on wildlife, especially to species that are of special concern (e.g., state or Federally listed species), or to species that are known to be at risk from wind development and are found to be present in the proposed area of interest. Such pre-construction studies may lead to design modifications and mitigation measures. A goal of Tier 5 studies would be to determine whether those modifications and measures have been effective in reducing predicted impacts, or whether estimated impacts exceed predictions, requiring further mitigation and study.

Tier 5 questions typically fall in three major categories:

1. Do post-construction impacts equal or exceed pre-construction predictions for direct and indirect impacts on wildlife and their habitat determined to be of interest in Tier 3?

   In the Tier 3 risk assessment, predictions of collision fatalities and habitat impacts (direct and indirect) are developed. Post-construction studies in Tiers 4 and 5 evaluate the accuracy of those predictions by estimating impacts.

2. Have avoidance, minimization and /or mitigation measures implemented as part of the project to avoid unacceptably high direct and indirect habitat and fatality impacts been effective?

   One objective of Tier 4 studies is to assess the effectiveness of fatality mitigation measures implemented as part of the project and to identify such alternative or additional measures as are necessary. If Tier 4 studies indicate that collision fatalities and habitat impacts exceed predictions, or they are unacceptably high, there may be additional or alternative avoidance, minimization or mitigation measures which should be explored. The effectiveness of these additional measures would be evaluated using Tier 5 studies.

3. Are the estimated impacts of the proposed wind energy project likely to lead to local population declines in species of interest, and for selected species (e.g., rare and/or endangered species) to entire species and their habitats?

   For species of concern identified in Tier 3 studies it is important to determine whether the estimated impacts of the wind project have population-level effects, typically measured as resulting in a population decline (lambda (λ) of less than 1). In most projects, this will be difficult to do beyond the local population, but in some cases, especially for listed species, the assessment of impact should include impact assessments for the entire species.

Tier 5 Methods

The specific Tier 5 questions and methods for addressing them will depend on the individual project and the concerns raised during pre-construction studies and during operational phases. Because many of the Tier 5 studies are continuations of Tier 3 studies, the same techniques will be utilized as those described above in Tier 3 (e.g., avian use surveys). The case studies listed below provide examples of studies that have attempted to answer Tier 5 questions. Some of these examples are drawn from the Strickland et al. (In review) which includes more detailed discussion and case studies of alternative designs.

1. Indirect Impacts - Displacement Studies

Displacement from suitable habitat represents one type of risk associated with wind energy development. Displacement refers to the indirect loss of habitat if birds avoid otherwise suitable habitat due to tower presence, infrastructure, turbine operation and maintenance/visitor disturbance. Displacement can also result from fragmentation of habitat when birds are deterred from using normal routes to feeding or roosting grounds, or large blocks of suitable habitat are broken into smaller blocks of less suitable habitat, or where habitat fragmentation reduces reproductive success or survival of a wildlife species of special concern.

While displacement studies normally do not occur at wind facilities, displacement is considered a potentially significant impact to prairie species, such as prairie grouse (prairie chickens, sharp-tailed grouse, and sage grouse), and displacement studies may be necessary to determine the extent of these impacts and the need for mitigation. Displacement studies occur during Tier 5 studies, but components of the study may need to be conducted during pre-construction (Tier 3). The most scientifically robust study designs to estimate displacement effects are before-after/control-impact (BACI), resource selection function (RSF), and impact gradient. RSF and impact gradient designs may not require specialized data gathering during Tier 3.

BACI designs use data collected from the project site and from one or more reference site both before and after the construction of a wind project using exactly the same protocol. Anderson et al. (1999) and Strickland et al. (In review) provide a thorough discussion of the design, implementation, and analysis of these kinds of field studies and should be consulted when designing the BACI study. A BACI study design is not always possible, because locating appropriate reference areas that are not already planned for wind energy development may be difficult and wind project development schedules commonly preclude the collection of sufficiently rigorous pre-treatment data for such a design. Furthermore, alterations in land use or disturbance over the course of a multi-year BACI study may complicate the analysis of study results.

An alternative approach either with or without pre-construction and reference data that is effective in demonstrating displacement is the resource selection function (RSF) study design (see Anderson et al 1999; Strickland et al. In review). 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 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 a response to mitigation measures designed to reduce displacement even without these additional data.

In certain situations, such as for a proposed wind development site that is relatively small and in a more or less homogeneous landscape, an impact gradient design may be a more appropriate means to assess impacts of wind turbines on resident populations (Strickland et al., 2002). For example, a project located in homogeneous grasslands might use impact gradient analysis to assess project impacts to resident songbirds. Data are 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 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 for example involve measuring the number of breeding grassland birds counted at point count plots as a function of distance from the wind turbines.

The most appropriate design for a particular study will depend on a number of practical considerations including the area being studied, the time period of interest, species of concern, potentially confounding variables, time available to conduct studies, budget, and the magnitude of the anticipated impact (see Morrison et al 2008 for detailed study designs).

There is a great deal of concern and uncertainty over the displacement effects of wind energy development on prairie grouse and the potential population consequences of these impacts. Nevertheless, possible avoidance, minimization and/or mitigation for potential lost habitat for these species should be factored into the project early in its design. BACI studies involving telemetry are currently the most scientifically robust approach to quantify the impacts of the project on prairie grouse in different environments (tallgrass, mixed grass, sandsage, sagebrush, etc.). Telemetry studies that measure impacts of the project development on displacement, nesting, nest success, and survival of prairie grouse will require spatial and temporal replication, undisturbed reference sites, large sample sizes covering large areas and will be expensive. Examples of study designs and analyses are presented in Holloran et al. (2005), Pittman et al. 2005 and Robel et al. (2004).

2. Operational Modifications to Reduce Collision Mortality

Tier 5 studies may include more intensive post-construction mortality studies to determine, for example, relationships between fatalities and weather (e.g., wind speed) or turbine (revolutions-per-minute) 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 operational modifications to reduce collision fatality.

Other studies may use tools such as thermal imaging (Horn et al. 2008) or acoustic detectors (Kunz et al. 2007) to quantify post-construction bat activity in relation to weather and turbine characteristics for improving operational mitigation efforts. For example, at the Mountaineer project in 2003, Tier 4 studies (weekly searches at every turbine) demonstrated unanticipated and high levels of bat mortality (Kerns and Kerlinger 2004). Daily searches were instituted in 2004 and revealed that mortality was strongly associated with low-average-wind-speed nights, thus providing a basis for testing operational modifications (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). These studies at Mountaineer and at a Pennsylvania site confirmed that wind projects located on Mid-Atlantic ridge-top could reasonably be expected to experience significant bat mortality (Arnett 2005). As a result, the Pennsylvania Game Commission has recommended more frequent carcass searches characteristic of Tier 5 studies (see PGC 2007).

Findings from intensive post-construction fatality studies can be used to determine optimal periods to implement operational modifications such as changes in turbine cut-in speed or real-time shutdowns to reduce collision fatalities. For example, 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.

Iberdrola Renewables' Penascal project and Babcock & Brown's Gulf Wind project, both in Kennedy County, Texas, are collaboratively refining and testing a real-time curtailment protocol. The projects use a MERLIN 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. Feathering (real-time curtailment) experiments are underway in Tehuantepec, Mexico, where raptor migration through a mountain pass is extensive.

3. Assessment of Population-level Impacts

The Altamont Pass Wind Resource Area (APWRA) has been the subject of intensive scrutiny because of high avian mortality, especially for raptors, in an area encompassing more than 5,000 wind turbines (e.g., Orloff and Flannery 1992; Smallwood and Thelander 2004, 2005). With an APWRA settlement agreement about to enter year 3, efforts to reduce avian mortality by 50%

have as yet not been attained. Given the high mortality of certain long-lived raptors such as Golden Eagle, concern has focused on the population-level impacts of this consistently high number of fatalities. To assess population-level effects, Hunt (2002) completed a four-year telemetry study of golden eagles at the APWRA and concluded that while the population is self-sustaining, fatalities resulting from wind-energy production were of concern because the population apparently depends on floaters from the local population and/or immigration of eagles from other subpopulations to fill vacant territories. Hunt conducted follow-up surveys in 2005 (Hunt and Hunt 2006) and determined that all 58 territories occupied by eagle pairs in 2000 were also occupied in 2005. Hunt (2002) hypothesized that this could be a sink population.

4. Displacement and Demographic Studies in Prairie Chickens

Researchers at Kansas State University, as part of the NWCC Grassland Shrub Steppe Species Collaborative (GS3C), have begun a multi-year telemetry study to evaluate effects of three proposed wind energy facilities on displacement and demographic parameters (survival, nest success, brood success, fecundity) of greater prairie chickens (*Tympanuchus cupido*) in Kansas. Studies are intended to evaluate whether: 1) lek attendance is affected by wind-power development; 2) greater prairie-chickens avoid wind-towers and/or other anthropogenic features; and 3) wind energy development reduces nest success or chick survival. The study combines use of data collected at three proposed wind energy facilities and reference areas so that the BACI design can be used to assess effects on demographic parameters. Several hundred birds have been radio marked on all sites combined to obtain baseline data on both the reference areas and wind energy facilities. Birds are located frequently to determine home ranges and habitat use prior to wind energy developments so that displacement can be measured once the facilities are constructed. In addition, data are collected on survival of radio marked birds as well as nest success, fledgling success, and fecundity (the number of female offspring produced per adult female). The first post-construction data will be collected in 2009. Similar studies are being initiated to evaluate effects of wind energy development on greater sage-grouse in Wyoming.

Comment [ejk10]: It was suggested that we delete scientific names from the text, but include them in an appendix

G. Retrofitting, Repowering, and Decommissioning Phases

As with project construction, these Guidelines offer best management practices (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. 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.

Remove wind turbines when they are no longer cost effective to retrofit so they cannot present a collision hazard to birds and bats.

Repowering Existing Wind Projects

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.

Roads and facilities that are no longer needed should be 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.

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

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.

Above-ground low and medium voltage lines, transformers and conductors should comply with the 2006 or most recent Avian Power Line Interaction Committee (APLIC) "Suggested Practices for Avian Protection on Power Lines."

Guyed structures should be avoided unless guy wires are treated with bird flight diverters or high visibility marking devices, or are located where known low bird use will occur.

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.

Keep lighting at both operation and maintenance facilities and substations located within ½ 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.

Decommissioning

Decommissioning is the cessation of wind power operations and removal of 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 depth of two feet below surrounding grade, and covered with soil to allow adequate root penetration for native plants and so that subsurface structures don't substantially disrupt ground water movements.
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.
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, per landowner requirements and commitments.
5. Surface flows should be restored to pre-disturbance conditions, including removal of stream crossings, roads, and pads.

   Surveys should be conducted by qualified experts to detect invasive plants, and comprehensive approaches to controlling any detected plants should be implemented and maintained as long as necessary.
6. Overhead pole lines that are no longer needed should be removed.
7. After decommissioning, erosion control measures should be installed in all disturbance areas where potential for erosion exists.
8. Fencing should be removed unless the land owner will be utilizing the fence
9. Petroleum product leaks and chemical releases that constitute a Recognized Environmental Condition should be remediated prior to completion of decommissioning.

Comment [ejk11]: FAC review: comment to delete "per landowner requirement and commitments."

Chapter Four: Mitigation

During the coordination process between the project developer and USFWS, USFWS will identify important species and habitats that may occur in the area of interest which might be impacted by project development. All recommendations regarding avoidance, minimization and compensatory mitigation are voluntary on the part of the project proponent. However, it is the expectation that the project proponent will work with the USFWS to agree on mitigation recommendations [in order to receive any incentives for voluntarily following the guidelines]. It is in the best interest of all parties to work together during the project development process to identify where mitigation may be appropriate and feasible. This will avoid unnecessary project delays and allows for incorporation of the mitigation into the project design.

Comment [ejk12]: Note to FAC: This is dependent upon what occurs later (with incentives)

If impacts to habitat or species cannot be avoided, then opportunities to minimize impacts to the fullest extent practicable are pursued. For example, it may not be possible to avoid removing some forested habitat for a turbine string, but it may be possible to reduce the total amount of forest habitat removed through alternative placement of access roads and support structures. In addition, anticipated direct mortalities may be reduced by the application of operational adjustments.

In some cases, impacts may still occur that can't be avoided or minimized. In those cases, it may be possible to offset all, or a portion, of these impacts through additional minimization strategies or compensatory mitigation. The USFWS Mitigation Policy describes these steps for addressing habitat loss in detail and includes information on Resource Categories (http://www.fws.gov/policy/501fw2.html) to assist in considering type and amount of compensatory mitigation to offset losses of habitat.

The resource goals for the resource categories are as follows:

Resource Category 1: Avoid habitat loss
Resource Category 2: No net loss of in-kind habitat value
Resource Category 3: No net loss of out-of-kind habitat value
Resource Category 4: Minimize loss of habitat value

Recommended measures may include on- or off-site habitat improvement, and may be in-kind or out-of-kind. Compensatory measures may be project-specific or may be part of a mitigation banking scenario.

An example of such an initiative is the 2008 Meridian Way Conservation Project, in central Kansas, under which Horizon Wind, The Nature Conservancy, the Ranchland Trust of Kansas, and state and federal wildlife agencies are cooperating voluntarily to restore and protect grassland landscape to offset prairie ecosystem detriments resulting from Horizon's nearby wind farm. Another example is an agreement through which Oklahoma Gas & Electric will provide funding to the Oklahoma Department of Wildlife Conservation to voluntarily offset impacts to lesser prairie chicken habitat in northwest Oklahoma. The ODWC intends to leverage OG&E's investment with matching funds from multiple federal, foundation and NGO partners, creating the Southern Plains' largest voluntary conservation project for lesser prairie chicken. In both cases, the associated wind energy projects were deemed to have significant, but mitigatable impacts, which are being addressed, in large part, by habitat improvements and long-term protection which are financially supported by the wind energy developers.

It may be possible to offset direct impacts of habitat loss to individuals, but this does not apply to federally listed threatened and endangered species. If a federal nexus exists, or if a project proponent chooses to seek an Incidental Take Permit (ITP), then impacts to listed species should be evaluated through the processes of Section 7 or 10 of the ESA.

Additional mitigation for impacts from operations should be requested and implemented only if the level of impact at a project site was unanticipated, and existing measures implemented are inadequate to address levels of impacts not originally considered in the Conservation Plan. Because in certain circumstances a project's impacts cannot be forecast with precision, the project proponent and the agencies may be unable to make some mitigation decisions until post-construction data have been collected. Compensatory 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. Mitigation beyond that implemented at project approval should be well defined, bounded, and technically feasible, and commensurate with the project impacts.

Comment [ejk13]: Review this phrase further.

It is anticipated that project proponents will take steps to avoid and minimize impacts to wildlife and their habitats to the greatest extent practicable for that project. It is generally the case that project-impact assessment is a cooperative effort involving the developer, USFWS and the state (and tribe when appropriate) and therefore, recommended mitigation measures will be consensus measures, and will not be additive. The State and the USFWS may have different species or habitats of concern, however, according to their responsibilities and statutory authorities.

Chapter Five: Advancing Use, Cooperation, and Effective Implementation of the Guidelines

NOTE: The Implementation Subcommittee proposes moving the text of Chapters Five – Seven of the previous iteration of the One-Text, Draft v.3, into the draft Implementation Chapter. The draft Implementation Chapter was still under revision at the date of Draft v.4's release, and will be presented to the FAC at the September 1 - 3 meeting in a separate handout. Although some of the sections in former Chapters Five - *Seven were already reviewed by the FAC and/or by the Synthesis Workgroup in previous drafts of the One-Text, the decision was made to move this text out of Draft v.4 to allow the FAC to view the text from Chapters Five – Seven as it would appear in the new Implementation Chapter.*

Research

Comment [ejk14]: Placement of this section needs to be reviewed.

There is an immediate need for additional research to develop a solid scientific basis for decision-making when siting wind facilities, evaluating their impacts on wildlife and habitats, and testing 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. Monitoring and research should be designed and conducted to ensure unbiased data collection that meets legal standards and technical standards such as those used in peer review (Kunz et al. 2007a). Research partnerships (e.g., Bats and Wind Energy Cooperative [www.batsandwind.org], Grassland and Shrub Steppe Species Cooperative [www.nwcc.org]) among 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, the American Wind Wildlife Institute, and the California Energy Commission's Public Interest Energy Research Program all support research in this area. Study sites and access will be required to design and implement research, and developers are encouraged to participate in these research efforts when possible. Subject to appropriations, the USFWS also should fund priority research and promote collaboration and information sharing among research efforts to advance science on wind/wildlife interactions and improve these guidelines.

(Appendices are in a separate handout for FAC review)

Wind Turbine Guidelines Advisory Committee
Draft Appendices
For Synthesis Workgroup Draft v.4 of the One-Text of Recommended Guidelines

Appendix A: Draft Glossary
Appendix B: USFWS Mitigation Policy
Appendix C: Legal White Paper *(presented and adopted at October 21-23, 2008 FAC Meeting)*
Appendix D: Mapping Tools Case Studies, from the Landscape/Habitat Subcommittee *(presented at October 21-23, 2008 FAC Meeting)*
Appendix E: Summary of Metadata for Data Layers Mapped, from the Landscape/Habitat Subcommittee *(presented at October 21-23, 2008 FAC Meeting; updated August 7, 2009)*
Appendix F: Existing Guidelines Subcommittee Recommendations *(presented at October 21-23, 2008 FAC Meeting)*
Appendix G: Other Models Subcommittee Matrix *(presented at October 21-23, 2008 FAC Meeting)*

Comment [ejk15]: The Synthesis Workgroup recommends removing Appendix F and G from the Appendices packet.