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

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

Service Review Period

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

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

Introduction to the Decision Framework Using a Tiered Approach

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

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

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

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

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

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

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

Wind turbines in California. Credit: Rachel London, USFWS

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

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

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

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

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

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

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

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

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

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

Figure 1. General Framework of Tiered Approach

TIER 1

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

TIER 2

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

TIER 3

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

TIER 4a (See Table 2, pg 39)

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

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

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

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

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

Considering Risk in the Tiered Approach

In the context of these Guidelines, risk refers to the likelihood that adverse impacts will occur to individuals or populations of species of concern as a result of wind energy development and operation. Estimates of fatality risk can be used in a relative sense, allowing comparisons among projects, alternative development designs, and in the evaluation of potential risk to populations. Because there are relatively few methods available for direct estimation of risk, a weight-of-evidence approach is often used (Anderson et al. 1999). Until such time that reliable risk predictive models are developed regarding avian and bat fatality and wind energy projects, estimates of risk would typically be qualitative, but should be based upon quantitative site information.

For the purposes of these Guidelines, risk can also be defined in the context of populations, but that calculation is more complicated as it could involve estimating the reduction in population viability as indicated by demographic metrics such as growth rate, size of the population, or survivorship, either for local populations, metapopulations, or entire species. For most populations, risk cannot easily be reduced to a strict metric, especially in the absence of population viability models for most species. Consequently, estimating the quantitative risk to populations is usually beyond the scope of project studies due to the difficulties in evaluating these metrics, and therefore risk assessment will be qualitative.

Risk to habitat is a component of the evaluation of population risk. In this context, the estimated loss of habitat is evaluated in terms of the potential for population level effects (e.g., reduced survival or reproduction).

The assessment of risk should synthesize sufficient data collected at a project to estimate exposure and predict impact for individuals and their habitats for the species of concern, with what is known about the population status of these species, and in communication with the relevant wildlife agency and industry wildlife experts. Predicted risk of these impacts could provide useful information for determining appropriate mitigation measures if determined to be necessary. In practice in the tiered approach, risk assessments conducted in Tiers 1 and 2 require less information to reach a risk-based decision than those conducted at higher tiers.

Cumulative Impacts of Project Development

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

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

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

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

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

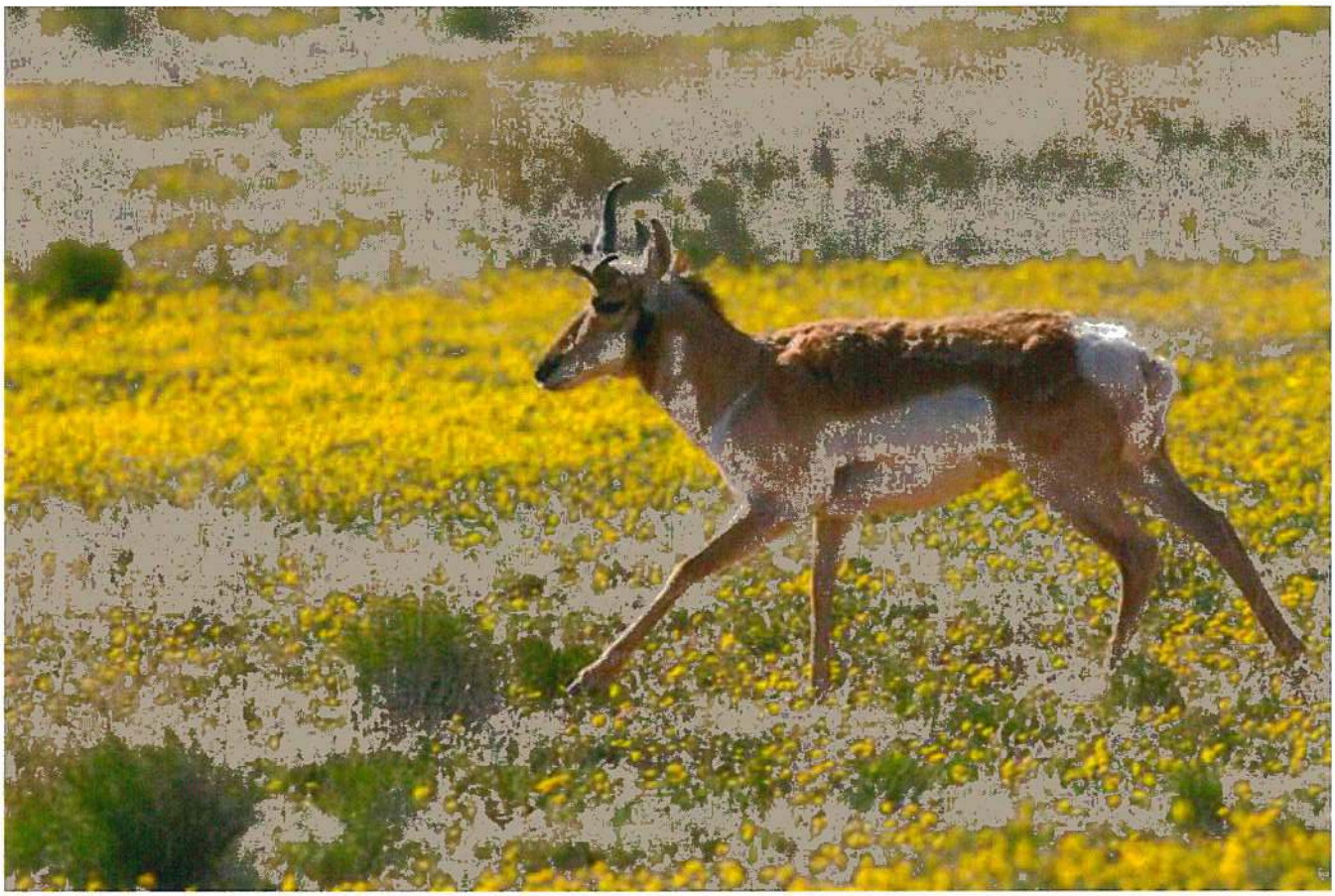
Other Federal Agencies

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

resources, wind energy developers should work closely with appropriate State agencies.

Relationship to Other Guidelines

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



Pronghorn Antelope. Credit: Steve Hillebrand, USFWS

Chapter 2: Tier 1 – Preliminary Site Evaluation

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

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

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

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

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

Tier 1 can offer early guidance about the sensitivity of the site within a larger landscape context; it can help direct development away from sites that will be associated with additional study need, greater mitigation requirements, and uncertainty; or it can identify those sensitive resources that will need to be studied further to determine if the site can be developed without significant adverse impacts to the species of concern or local population(s). This may facilitate discussions with the federal, state, tribal, and/or local agencies in a region being considered for development. In some cases, Tier 1 studies could reveal serious concerns indicating that a site should not be developed.

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

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

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

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

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

Tier 1 Questions

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

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

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

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

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

Tier 1 Methods and Metrics

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

Tier 1 Decision Points

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

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

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

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

Chapter 3: Tier 2 – Site Characterization

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

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

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

Tier 2 Questions

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

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

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

Open landscape with wind turbines. Credit: NREL

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

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

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

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

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

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

Tier 2 Methods and Metrics

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

1. A review of existing information, including existing published or available literature and databases and maps of topography, land use and land cover, potential wetlands, wildlife, habitat, and sensitive plant distribution. If agencies have documented potential habitat for species of habitat fragmentation concern, this information can help with the analysis.

2. Contact with agencies and organizations that have relevant scientific information to further help identify if there are bird, bat or other wildlife issues. The Service recommends that the developer make contact with federal, state, tribal, and local agencies that have jurisdiction or management authority over the project or information about the potentially affected resources. In addition, because key NGOs and relevant local groups are often valuable sources of relevant local environmental information, the Service recommends that developers contact key NGOs, even if confidentiality concerns preclude the developer from identifying specific project location information at this stage. These contacts also provide an opportunity to identify other potential issues and data not already identified by the developer.

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

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

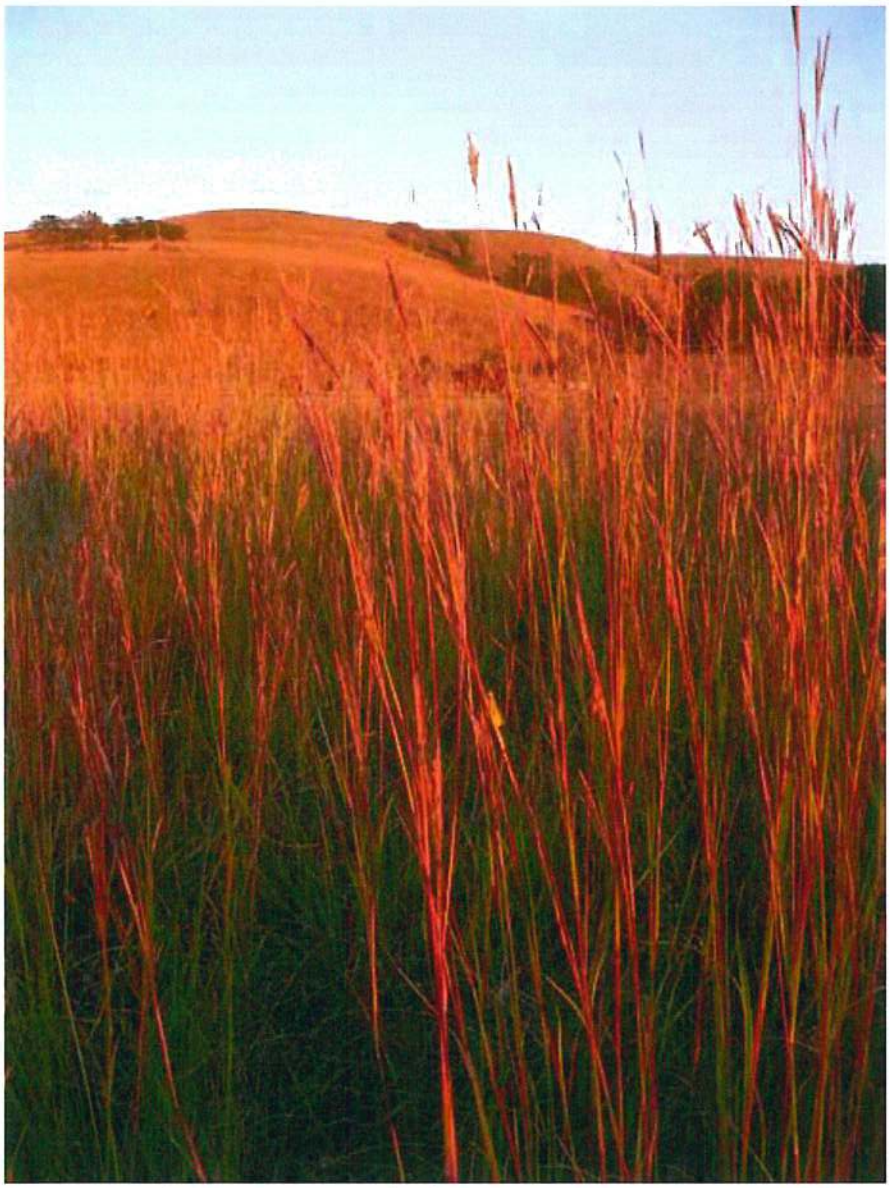
1. **Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?**

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

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

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

   Information review and agency contact such as: maps of political and administrative boundaries; National Wetland Inventory data files; USGS National Land Cover data maps; state, federal and tribal agency data on areas that have been designated to preclude development, including wind energy development; State Wildlife Action Plans; State Land and Water Resource Plans; Natural Heritage databases; scientifically credible information provided by NGO and local



Tall grass prairie. Credit: Amy Thornburg, USFWS

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

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

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

Information review and agency contact such as: Natural Heritage Data of state rankings (S1, S2, S3) or globally (G1, G2, G3) ranked rare plant communities.

Site Visit: To the extent practicable, the site visit should evaluate the topography, physiographic features and uniqueness of the site vegetation in relation to the surrounding region. If plant communities of concern are present, developers should also assess in Tier 3 whether the proposed project poses risk of significant adverse impacts and opportunities for mitigation.

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

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

Site Visit: To the extent practicable, the site visit should, during appropriate times to adequately assess these issues for prospective site(s), evaluate the topography, physiographic features and uniqueness of the site in relation to the surrounding region to assess the potential for the project area to concentrate resident or migratory birds and bats.

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

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

Habitat fragmentation is defined as the separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments is reduced; and risk, in this case, is defined as the probability that this fragmentation will occur as a result of the project. Site clearing, access roads, transmission lines and turbine tower arrays remove habitat and displace some species

of wildlife, and may fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding and foraging.

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

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

<u>General Framework for Evaluating Habitat Fragmentation at a Project Site (Tier 2)</u>

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

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

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

   ii. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:

   - High quality: little or no apparent fragmentation of intact habitat
   - Medium quality: intact habitat exhibiting some recent disturbance activity
   - Low quality: Extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

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

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

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

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

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

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

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

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

Tier 2 Decision Points

Possible outcomes of Tier 2 include the following:

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

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

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

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

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

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

Greater sage grouse, Credit: Stephen Ting, USFWS

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

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

- Further evaluate a site for determining whether the wind energy project should be developed or abandoned
- Design and operate a site to avoid or minimize significant adverse impacts if a decision is made to develop
- Design compensatory mitigation measures if significant adverse habitat impacts cannot acceptably be avoided or minimized
- Determine duration and level of effort of post-construction monitoring. If warranted, provide the pre-construction component of post-construction studies necessary to estimate and evaluate impacts

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

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

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

Tier 3 Questions

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

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

The problem formulation stage for Tier 3 also will include an assessment of which species identified in Tier 1 and/or Tier 2 will be studied further in the site risk assessment. This determination is based on analysis of existing data from Tier 1 and existing site-specific data and Project Site (see Glossary in Appendix A) visit(s) in Tier 2, and on the likelihood of presence and the degree of adverse impact to species or their habitat. If the habitat is suitable for a species needing further study and the site occurs within the historical range of the species, or is near the existing range of the species but presence has not been documented, additional field studies may be appropriate. Additional analyses should not be necessary if a species is unlikely to be present or is present but adverse impact is unlikely or of minor significance.

Tier 3 studies address many of the questions identified for Tiers 1 and 2, but Tier 3 studies differ because they attempt to quantify

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Avian Radar

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

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

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

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

State, federal and tribal agencies often require specific protocols be followed when species of concern are potentially present on a site. The methods and protocols for determining presence of species of concern at a site are normally established for each species and required by federal, state and tribal resource agencies. Surveys should sample the wind turbine sites and applicable disturbance area during seasons when species are most likely present. Normally, the methods and protocols by which they are applied also will include an estimate of relative abundance. Most presence/absence surveys should be done following a probabilistic sampling protocol to allow statistical extrapolation to the area and time of interest.

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

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

If Tier 2 studies indicate the presence of species of habitat fragmentation concern, but existing information did not allow for a complete analysis of potential impacts and decision-making, then additional studies and analyses should take place in Tier 3.

As in Tier 2, the particulars of the analysis will depend on the species of habitat fragmentation concern and how habitat block size and fragmentation are defined for the life cycles of that species, the likelihood that the project will adversely affect a local population of the species and the significance of these impacts to the viability of that population.

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

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

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

For those species of concern that are considered at risk of collisions or habitat impacts, the questions to be answered in Tier 3 include: where are they likely to occur (i.e., where is their habitat) within a project site or vicinity, when might they occur, and in what abundance. The spatial distribution of species at risk of collision can influence how a site is developed. This distribution should include the airspace for flying species with respect to the rotor-

swept zone. The abundance of a species and the spatial distribution of its habitat can be used to determine the relative risk of impact to species using the sites, and the absolute risk when compared to existing projects where similar information exists. Species abundance and habitat distribution can also be used in modeling risk factors.

Surveys for spatial distribution and relative abundance require coverage of the wind turbine sites and applicable site disturbance area, or a sample of the area using observational methods for the species of concern during the seasons of interest. As with presence/absence (see Tier 3, question 1, above) the methods used to determine distribution, abundance, and behavior may vary with the species and its ecology. Spatial distribution is determined by applying presence/absence or using surveys in a probabilistic manner over the entire area of interest. Suggested survey protocols for birds, bats, and other wildlife are found in the Technical Resources section on page 26.

Whooping crane. Credit: Ryan Hagerty, USFWS

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

Methods used for estimating risk will vary with the species of concern. For example, estimating potential bird fatalities in Tier 3 may be accomplished by comparing exposure estimates (described earlier in estimates of bird use) at the proposed site with exposure estimates and fatalities at existing projects with similar characteristics (e.g., similar technology, landscape, and weather conditions). If models are used, they may provide an additional tool for estimating fatalities, and have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the United States (Madders and Whitfield 2006). As with other prediction tools, model predictions should be evaluated and compared with post-construction fatality data to validate the models. Models should be used as a subcomponent of a risk assessment based on the best available empirical data. A statistical model based on the relationship of pre-construction estimates of raptor abundance and post-construction raptor fatalities is described in Strickland et al. (2011) and promises to be a useful tool for risk assessment.

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

At some projects, bat fatalities are higher than bird fatalities, but the exposure risk of bats at these facilities is not fully understood (National Research Council (NRC) 2007). Horn et al. (2008) and Cryan (2008) hypothesize that bats are attracted to turbines, which, if true, would further complicate estimation

of exposure. Further research is required to determine if bats are attracted to turbines and if so, to evaluate 1) the influence on Tier 2 methods and predictions, and 2) if this increased individual risk translates into higher population-level impacts for bats.

The estimation of indirect impact risk requires an understanding of animal behavior in response to a project and its infrastructure, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid areas in proximity to turbines, roads and other components of the project. The amount of habitat that is lost to indirect impacts will be a function of the sensitivity of individuals to the project and to the activity levels associated with the project's operations. The population-level significance of this indirect impact will depend on the amount of habitat available to the affected population. If the indirect impacts include habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased. Quantifying cause and effect may be very difficult, however.

5. How can developers mitigate identified significant adverse impacts?

Results of Tier 3 studies should provide a basis for identifying measures to mitigate significant adverse impacts predicted for species of concern. Information on wildlife use of the proposed area is most useful when designing a project to avoid or minimize significant adverse impacts. In cases of uncertainty with regard to impacts to species of concern, additional studies may be necessary to quantify significant adverse impacts and determine the need for mitigation of those impacts.

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

The following discussion of prairie grouse and sage grouse as species of concern illustrates the uncertainty mentioned above by describing the present state of scientific knowledge relative to these species, which should be considered when designing mitigation measures. The extent of the impact of wind energy development on prairie grouse and sage grouse lekking activity (e.g., social structure, mating success, persistence) and the associated impacts on productivity (e.g., nesting, nest success, chick survival) is poorly understood (Arnett et al. 2007, NRC 2007, Manville 2004). However, recent published research documents that anthropogenic features (e.g., tall structures, buildings, roads, transmission lines) can adversely impact vital rates (e.g., nesting, nest success, lekking behavior) of lesser prairie-chickens (Pruett et al. 2009, Pitman et al. 2005, Hagen et al. 2009, Hagen et al. 2011) and greater prairie-chickens over long distances. Pitman et al. (2005) found that transmission lines reduced nesting of lesser prairie chicken by 90 percent out to a distance of 0.25 miles, improved roads at a distance of 0.25 miles, a house at 0.3 miles, and a power plant at >0.6 miles. Reduced nesting activity of lesser prairie chickens may extend farther, but Pitman et al. (2005) did not analyze their data for lower impacts (less than 90 percent reduction in nesting) of those anthropogenic features on lesser prairie chicken nesting activities at greater distances. Hagen et al. (2011) suggested that development within 1 to 1 ½ miles of active leks of prairie grouse may have significant adverse impacts on the affected grouse population. It is not unreasonable to infer that impacts from wind energy facilities may be similar to those from these other anthropogenic structures. Kansas State University, as part of the National Wind Coordinating Collaborative's Grassland and Shrub Steppe Species Subgroup, is undertaking a multi-year telemetry study to evaluate the effects of a proposed wind-energy facility on displacement and demographic parameters (e.g., survival, nest success, brood success, fecundity) of greater prairie-chickens in Kansas.[5]

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

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

[5] www.nationalwind.org

appropriate to address the loss of habitat value. For example, it may be possible to mitigate habitat loss or degradation for a species of concern by enhancing or restoring nearby habitat value comparable to that potentially influenced by the project.

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

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

Rows of wind turbines. Credit: Joshua Winchell, USFWS

Tier 3 Study Design Considerations

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

Assessing Presence

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

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

Assessing Site Use/Behavior

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

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

Duration/Intensity of Studies

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

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

Assessing Risk to Species of Concern

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

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

Collision

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

Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher likelihood of collisions with turbines regardless of abundance. Some species, even at lower abundance, may have a higher collision rate than similar species due to subtle differences in their ecology and behavior.

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

Habitat Loss and Degradation

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

Habitat Fragmentation

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

Habitat fragmentation can result in increases in "edge" resulting in direct effects of barriers

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

Displacement and Behavioral Changes

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

Indirect Effects

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

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

Virginia big-eared bat. Credit: USFWS

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

Tier 3 Technical Resources

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

Tier 3, Question 1

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

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

multiple sampling stations to account for temporal and spatial variability.

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

Tier 3, Question 2

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

1. Define the study area. The study area for the site should include the "footprint" for the proposed facility plus an appropriate surrounding area. The extent of the study area should be based on the area where there is potential for significant adverse habitat impacts, including indirect impacts, within the distribution of habitat for the species of habitat fragmentation concern.

2. Determine the potential for occupancy of the study area based on the guidance provided for the species of habitat fragmentation concern described above in Question 1.

3. Analyze current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.

   a. Use recent aerial or remote imagery to determine distinct habitat patches or boundaries within the study area, and the extent of existing habitat fragmenting features.

      i. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:

         - High quality: little or no apparent fragmentation of intact habitat
         - Medium quality: intact habitat exhibiting some recent disturbance activity
         - Low quality: extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

      ii. Determine edge and interior habitat metrics of the study area:

         - Identify habitat, non-habitat landscape features and existing fragmenting features relative to the species of habitat fragmentation concern, to estimate existing edge
         - Calculate area and acres of edge
         - Calculate area of intact patches of habitat and compare to needs of species of habitat fragmentation concern

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

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

      ii. Assess the expected future size and quality of habitat patches for the species of habitat fragmentation concern and the additional fragmenting features, and categorize into three classes as described above

      iii. Determine expected future acreages of edge and interior habitats

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

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

      i. Determine the area of intact habitat lost (to the displacement footprint or by alteration due to the edge effect)

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

4. Assess the likelihood of a significant reduction in the demographic and genetic viability of the local population of the species of habitat fragmentation concern using the habitat fragmentation information collected under item 3 above and any currently available demographic and genetic data. Based on this assessment, the developer makes the finding whether or not there is significant reduction. The developer should share the finding with the relevant agencies. If the developer finds the likelihood of a significant reduction, the developer should

consider items a, b or c below:

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

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

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

Tier 3, Question 3

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

Bird distribution, abundance, behavior and site use

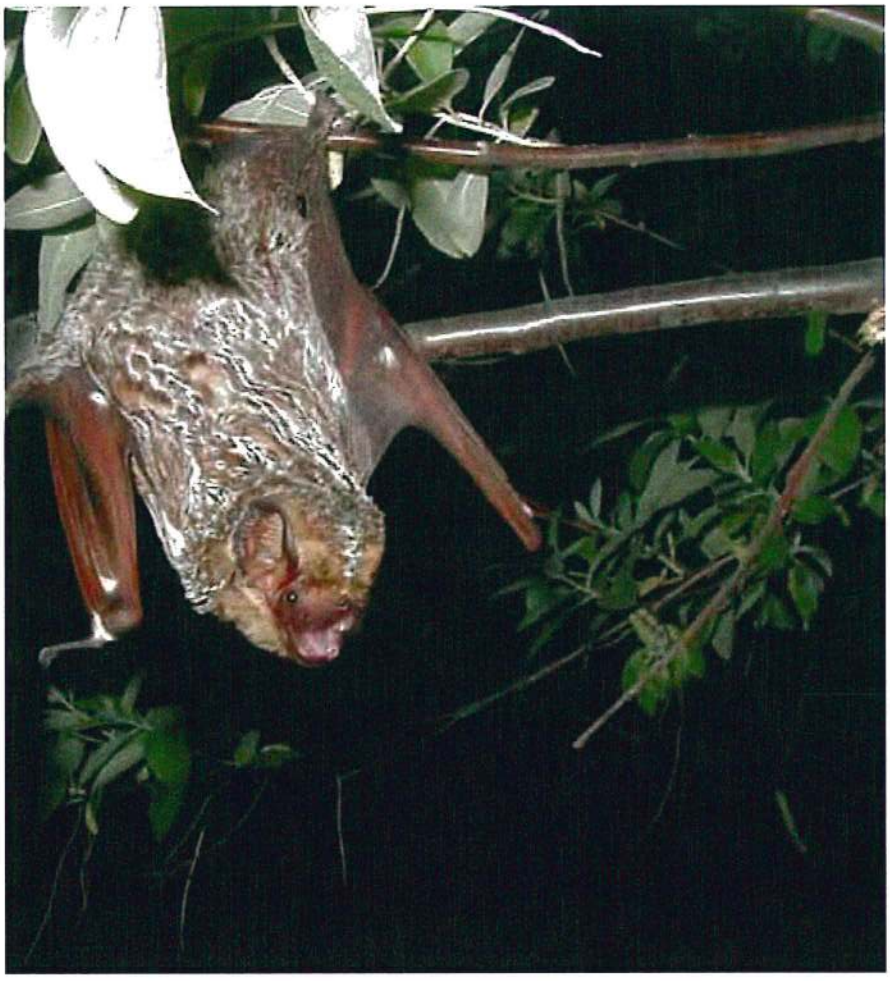
Diurnal Avian Activity Surveys

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

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

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

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



Hoary bat. Credit: Paul Cryan, USGS

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

The use of comparable methods and metrics should allow data comparison from plot to plot within the area of interest and from site to site where similar data exist. The data should be collected so that avian activity can be estimated within the rotor-swept zone. Relating use to site characteristics requires that samples of use also measure site characteristics thought to influence use (i.e., covariates such as vegetation and topography) in relation to the location of use. The statistical relationship of use to these covariates can be used to predict occurrence in unsurveyed areas during the survey period and for the same areas in the future.

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

Raptor Nest Searches

An estimate of raptor use of the project site is obtained through appropriate surveys, but if potential impacts to breeding raptors are a concern on a project, raptor nest searches are also recommended. These surveys provide information to predict risk to the local breeding population of raptors, for micro-siting decisions, and for developing an appropriate-sized non-disturbance buffer around nests. Surveys also provide baseline data for estimating impacts and determining mitigation

Red-tailed hawk. Credit: Dave Menke, USFWS

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

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

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

Prairie Grouse and Sage Grouse Population Assessments

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

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

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

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

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

Recent research indicates that viable prairie grouse and sage grouse populations are dependent on suitable nesting and brood-rearing habitat (Connelly et al. 2000, Hagen et al. 2009). These habitats generally are associated with leks. Leks are the approximate centers of nesting and brood-rearing habitats (Connelly et al. 2000, but see Connelly et al. 1988 and Becker et al. 2009). High quality nesting and

brood rearing habitats surrounding leks are critical to sustaining viable prairie grouse and sage grouse populations (Giesen and Connelly 1993, Hagen et al. 2004, Connelly et al. 2000). A population assessment study area should include nesting and brood rearing habitats that may extend several miles from leks. For example, greater and lesser prairie-chickens generally nest in suitable habitats within one to two miles of active leks (Hagen et al. 2004), whereas the average distances from nests to active leks of non-migratory sage grouse range from 0.7 to four miles (Connelly et al. 2000), and potentially much more for migratory populations (Connelly et al. 1988).

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

Mist-Netting for Birds

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

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

Nocturnal and Crepuscular Bird Survey Methods

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

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

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

Bat survey methods

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

Acoustic Monitoring

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

Tri-colored bat. Credit: USFWS

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

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

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

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

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

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

Other bat survey techniques

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

Roost Searches and Exit Counts

Pre-construction survey efforts may be recommended to determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the project vicinity, and to confirm whether known or likely bat roosts are present and occupied by bats. If active roosts are detected, it may be appropriate to address questions about colony size and species composition of roosts. Exit counts and roost searches are two approaches to answering these questions, and Rainey (1995), Kunz and Parsons (2009), and Sherwin et al. (2009) are resources that describe options and approaches for these techniques. Roost searches should be performed cautiously because roosting bats are sensitive to human disturbance (Kunz et al. 1996). Known maternity and hibernation roosts should not be entered or otherwise disturbed unless authorized by state and/or federal wildlife agencies. Internal searches of abandoned mines or caves can be dangerous and should only be conducted by trained researchers. For mine survey protocol and

guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999). Exit surveys at known roosts generally should be limited to non-invasive observation using low-light binoculars and infrared video cameras.

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

Activity Patterns

If active roosts are detected, it may be necessary to answer questions about behavior, movement patterns, and patterns of roost use for bat species of concern, or to further investigate habitat features that might attract bats and pose fatality risk. For some bat species, typically threatened, endangered, or state-listed species, radio telemetry or radar may be recommended to assess both the direction of movement as bats leave roosts, and the bats' use of the area being considered for development. Kunz et al. (2007) describe the use of telemetry, radar and other tools to evaluate use of roosts, activity patterns, and flight direction from roosts.

Mist-Netting for Bats

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

White-Nose Syndrome

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

Mule deer. Credit: Tupper Ansel Blake, USFWS

Other wildlife

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