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Forest Service Handbook 2609.13 – Wildlife and Fisheries Program Management Handbook
Chapter 80 - Wildlife Monitoring At Wind Energy Sites

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Superseded Document(s):

Digest: Following is an explanation of the changes throughout the directive by section.

80: Establishes new chapter and title, "Wildlife Monitoring at Wind Energy Sites" and sets forth direction on responsibilities, definitions, and references for wildlife monitoring at sites that have been identified for potential wind energy development.

81: Establishes code and caption "Monitoring Plans" and sets forth direction defining elements of a monitoring plan.

82: Establishes code and caption "Monitoring Objectives" and sets forth direction identifying specific objectives to be included in a monitoring plan.

82.1: Establishes code and caption "Monitoring Wildlife Presence or Abundance" and sets forth direction defining the objective of monitoring wildlife presence.

82.2: Establishes code and caption "Monitoring Mortality" and sets forth direction defining monitoring requirements.

82.3: Establishes code and caption "Other Monitoring" and sets forth direction establishing the need to monitor impacts to wildlife in ways other than mortality.

83: Establishes code and caption "Monitoring Tools" and sets forth direction to identify and evaluate the tools most appropriate for monitoring.

84: Establishes code and caption "Adaptive Management" and sets forth direction defining adaptive management and how to apply when monitoring.

85: Establishes code and caption "Exhibits." Displays exhibits that describe various techniques to utilize or consider in performing wildlife surveys at wind energy facilities.

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This chapter provides direction for monitoring wildlife in relation to wind energy development, both pre-construction (coinciding with the application process for a construction and operation permit) and after the development is operational. Direction regarding the authorization, administration, and management of wind energy sites, including wildlife surveys associated with site testing and feasibility may be found in Forest Service Manual 2726.21 and in Forest Service Handbook 2709.11, chapter 70.

80.4 – Responsibilities

The authorized officer shall:

1. Identify the scope and sequence of all elements of the monitoring plan.

2. Ensure that the monitoring plan has had adequate review by the U.S. Fish and Wildlife Service and by the State wildlife agency where the wind facility is located, commensurate with the level of concern regarding wildlife issues.

3. Ensure that all elements of the monitoring plan are implemented and that monitoring results are considered when updating the annual operating plan.

4. Establish a reporting schedule for implementing the monitoring plan.

5. Ensure that the appropriate legal instruments are in place, in accordance with cost recovery regulations Title 36, Code of Federal Regulations, part 251, that allow for:

   a. The applicant for a construction and operation permit to cover expenses for pre-construction wildlife monitoring, and

   b. The permit holder to cover expenses related to post-construction wildlife monitoring.

6. Ensure that the responsible party for implementing the monitoring plan has experience in wildlife monitoring at wind energy or similar developments and in writing technical documents, as well as the ability to thoroughly describe the direct, indirect, and cumulative effects on wildlife from the construction and operation of the facility.

7. Review the selection of any third party monitoring contractor.

8. Ensure that the selected third party for monitoring:

   a. Is qualified to carry out the required monitoring as documented by experience, credentials, and training;

   b. Implements the monitoring plan;

   c. Performs fully all of the objectives and specific analytical tasks associated with successful completion of the monitoring and analyses;

d. Consults and adheres to peer-reviewed monitoring guidelines and recommendations (such as the Fish and Wildlife Service guidelines, Anderson et al. 1999, Kunz et al. 2007, and various wind energy guidelines developed or adopted by States);

e. Provides verbal and/or written progress reports to the authorized officer, at the intervals specified in the monitoring plan.

9. Ensure that all monitoring data related to the natural resource management is given to the authorized officer to be made available to the public upon request. This does not generally include information about wind, which is usually proprietary from the standpoint of planning a wind energy facility.

80.5 – Definitions

For definitions related to wind energy development, see FSH 2709.11, section 70.5.

80.6 – References

The following references contain relevant information and have been cited in this chapter.

1. Arnett, Edward B. 2006. A Preliminary Evaluation on the Use of Dogs to Recover Bat Fatalities at Wind Energy Facilities. Wildlife Society Bulletin 34(5):1440-1445.

2. American Wind Energy Association. 2008. Wind energy siting handbook. http://www.awea.org/sitinghandbook/.

3. Anderson, Richard; Morrison, Michael; Sinclair, Karin; Strickland, Dale. 1999. Studying Wind Energy/Bird Interactions: A Guidance Document. Washington DC: National Wind Coordinating Committee. 88 p.

4. Kerns, Jessica; Kerlinger, Paul. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Technical report prepared by Curry and Kerlinger, LLC. for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee. 39 p.

5. Kerns, Jessica; Erickson, Wallace P; Arnett, Edward B. 2005. Bat and Bird Fatality at Wind Energy Facilities in Pennsylvania and West Virginia. In: *Relationships Between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines*, E.B. Arnett (technical editor). Bat Conservation International. Austin, Texas. pp. 24-95.

6. Kunz, Thomas H.; Arnett, Edward B.; Cooper, Briam M.; Erickson, Wallace P; Larkin, Ronald P.; Mabee, Todd; Morrison, Michael L.; Strickland, M. Dale; Szewczak, Joseph M. 2007. Assessing Impacts of Wind-energy Development on Nocturnally Active Birds and Bats: A Guidance Document. Journal of Wildlife Management 71(8): 2449-2486.

7. MacKenzie, Darryl I.; Nichols, James D.; Royle, J. Andrew.; Pollock, Kenneth H.; Bailey, Larissa L.; Hines, James E. 2006. Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence. Elsevier, Inc., San Diego, California.

81 – Monitoring Plan

The monitoring plan describes all pre- and post-construction monitoring conducted as part of a permit for construction and operation of a wind energy facility. The monitoring plan may need to address more than one monitoring objective and more than one monitoring design for different target species or species' group, especially when data is to be collected for both direct and indirect effects.

The authorized officer shall identify species or species groups that require monitoring, based on the potential for impacts to these species derived from existing information and from surveys conducted under the site testing and feasibility permit (FSH 2709.11, chapter 70). For each species or group identified for monitoring, the authorized officer shall approve a monitoring design developed and/or reviewed by representatives from the Forest Service, U.S. Fish and Wildlife Service, State wildlife agency, and wind facility applicant, in consultation with an individual who has expertise in sampling design. Each monitoring design must contain the following components:

1. Monitoring objectives;

2. Monitoring measure(s), including the trigger point or range of values for each measure that may result in a modification to the operation permit;

3. Sampling design;

4. Data collection method(s);

5. Anticipated methods of analysis; and

6. The reporting timetable.

The sampling design section should include the seasons when monitoring is performed, the length of time between monitoring intervals, and the anticipated length of the entire monitoring program.

82 – Monitoring Objectives

The objective of monitoring is to determine, to the extent possible, whether environmental changes due to the construction and operation of a wind energy facility affect wildlife presence, abundance, activity levels, or mortality rates. The objectives of each specific monitoring design should be clearly identified in the monitoring plan, and as appropriate, should address both direct and indirect effects. Two types of objectives that are appropriate for monitoring at wind energy facilities are:

1. Monitoring changes in wildlife presence, abundance, or activity levels before and after the establishment of a wind energy facility; and factors related to the wind energy facility that may influence changes in wildlife presence, abundance, or activity levels, such as the quality and amount of habitat, fragmentation of habitat, road density, traffic volume, and noise levels.

2. Monitoring mortality rates and factors that may influence mortality rates such as season of year, temperature, precipitation, wind speed, and blade cut-in speed.

Other monitoring objectives may be considered (see section 82.3).

Endangered and threatened species and other federally protected species, such as bald and golden eagles and migratory birds, should be included in monitoring plans as appropriate, based on risks determined from the best available science and from surveys conducted under the permit for site testing and feasibility. Bats should also be included due to their known sensitivity to wind energy developments, along with other species that are of management concern.

82.1 – Monitoring Wildlife Presence, Abundance, or Activity Levels

If monitoring indicates that the presence, abundance, or activity levels of any species of management concern is approaching or has reached an undesired management threshold identified in the objective of the species' monitoring design, the information should be used to develop mitigation measures and modify terms and conditions in the permit holder's annual operating plan to minimize impacts to the extent practical and feasible. In order to develop suitable mitigation or modifications, monitoring should also measure factors that potentially are changed by a wind energy facility that affect wildlife presence, abundance, or activity levels. Examples include quality or quantity of habitat, fragmentation of habitat, road density, traffic volume, and noise levels. Monitoring along these lines may include bird and bat species, but may also include other species that are of management concern that utilize habitat beneath turbines or habitat in the vicinity of the project area.

A Before-After-Control-Impact (BACI) study design is recommended for evaluating whether the construction and operation of a wind energy facility has affected wildlife presence, abundance, or activity levels (Anderson et al. 1999). The BACI design calls for measurements at the wind energy facility (impact) and at an ecologically similar site (control), with measurements collected during the pre-construction phase (Before) and during operation (After). Control sites should be

matched to proposed sites based on proximity to the proposed facility, as well as similarity to the proposed site in terms of topography and habitat. Data from surveys conducted under the site testing and feasibility permit can be incorporated into the BACI design if they were collected using the same field methods as the post-construction surveys. The measures used in the BACI design do not need to include all surveys conducted for the siting evaluation, but only those selected for evaluating specific changes over time.

Monitoring changes in wildlife presence, abundance, or activity level may apply to a single species or a group of similar species. For commonly detected species (> 1 per sampling unit), an appropriate measure is the relative abundance of individuals. For species that are infrequently observed (< 1 per sampling unit), an appropriate measure is frequency of occurrence (presence). Regardless of the measure that is selected, the monitoring design must incorporate a method that adjusts for detection rate.

See section 85, (ex. 01) for a summary of methodologies that have been used in the past to monitor wildlife at proposed turbine facilities. Monitoring designs should incorporate new methods and technologies as these become available. This exhibit does not include methods for measuring the associated factors such as the quality and amount of habitat, fragmentation of habitat, road density, traffic volume, and noise levels.

Pre-construction monitoring must be for a minimum of 2 years to partially capture inter-annual variability in animal presence, abundance, or activity levels due to environmental fluctuations. The authorized officer shall determine whether pre- or post-construction monitoring should be extended beyond 2 years, based on site-specific issues and the level of risk to species of management concern. Pre-construction monitoring should occur across multiple seasons in order to evaluate inter-seasonal variability in habitat use and to sample during migration periods of the target species.

The sample size within each season should be sufficient to detect differences in presence, abundance, or activity level between seasons. The sample size should also be sufficient to meet the monitoring objective (has the wind energy facility resulted in changes in presence, abundance, or activity level) with a reasonable level of confidence.

Post-construction monitoring must begin once all of the turbines are constructed and operational. Monitoring should encompass a period of time sufficient for meeting the monitoring objectives for the target species. Post-construction monitoring must occur for a minimum of 2 years and shall continue for a minimum of 1 additional year if significant risks to any species of management concern have been identified, or if a permit has been modified in response to outcomes from the first 2 years of monitoring. If the authorized officer determines that additional monitoring is needed, this can take place at multi-year intervals (for example, every 3 or 5 years) rather than occur annually. Long-term monitoring of the proposed project is key to understanding the relationships between wildlife impacts and the proposed project design, siting of towers, and operation of the facility.

82.2 – Monitoring Mortality

The objective of post-construction mortality monitoring is to estimate the approximate annual number of collision fatalities of birds and bats on a per-turbine or per-megawatt basis, and to estimate the influence of physical and biological factors such as season, weather, topography, wind speed, and turbine cut-in speed on mortality rates. Correlating daily mortality counts with these factors may lead to the development of useful mitigation measures, as well as changes in the terms and conditions of the holder's permit.

In estimating total mortality, monitoring must adjust for carcasses removed due to scavenging or missed by individuals performing monitoring.

1. Carcasses removed due to scavenging. Scavenging limits the proportion of carcasses detectable during monitoring. The site-specific scavenging rate for the wind energy facility is estimated by placing a known number of carcasses under and around a sample of turbines prior to the onset of monitoring and estimate the rate of carcass removal over different time intervals (Kerns et al. 2004; Kerns et al. 2005).

2. Carcasses missed by observers. An individual's ability to detect carcasses is affected by visual acuity, the topography of a site, and the height of vegetation. Therefore, searcher efficiency trials are needed to yield a correction factor for missed carcasses (Kerns et al. 2004; Kerns et al. 2005). As an alternative, statistical modeling of detection rates may be used, based on multiple visits to each sample site (for example, MacKenzie et al. 2006). Search dogs provide higher searching efficiency than human searchers (Arnett 2006).

The frequency (how often searches should occur) and intensity (amount of area searched based on number of turbines) of mortality searches varies depending on the site-specific scavenging and decomposition rates of carcasses. If those rates are high, mortality searches may need to be conducted daily, at least during periods of high mortality (such as during bird/bat migratory periods). If scavenging rates are low, then searches may be conducted more infrequently, based on the best available science.

Use results from mortality studies at nearby existing facilities to determine an appropriate sample size. If such data are not available, then base the sample size on the size of the project. If the project contains 20 or fewer turbines, mortality searches should be conducted at all turbines unless otherwise directed by the authorized officer, using a specified time interval within which all turbines will be surveyed (for example, daily, every 10 days, monthly). For facilities with greater than 20 turbines, a sufficient number of turbines will be determined by the authorized officer. It may be necessary to stratify across different vegetation types to account for differences in mortality rates. If so, a sufficient number of turbines should be sampled in each stratum.

The distance from turbines that carcasses may be found after turbine collision is dependent on the wind speed and the topography of the ground beneath each tower. As a general rule though,

mortality searches should extend some distance beyond the blade sweep, and preliminary field tests may be needed to determine the optimal search distance for local conditions.

All avian and bat carcasses located within survey areas should be recorded and a cause of death determined, if possible, based on field examination. Only individuals trained in proper monitoring techniques should conduct the searches. The monitoring plan must provide details on documenting and mapping the location of carcasses; procedures for collecting all or a proportion of carcasses; the name of the repository or academic collection where carcasses are sent; and proper handling of tissue for potential future analyses of DNA.

The authorized officer shall inform the permit holder and specify in the contract that, over the life of the facility operation, the Forest Service and the U.S. Fish and Wildlife Service shall be notified within 24 hours when a carcass of an endangered or threatened species or bald or golden eagle is found. Carcasses of other migratory bird species shall be reported to the authorized officer and the U.S. Fish and Wildlife Service by the next business day, and other species should be reported in progress reports to the authorized officer at intervals specified in the monitoring plan. The contract must also specify that the permit holder promptly notifies the authorized officer when an anomalous or unusually high mortality event takes place involving any species or combination of species. An annual report should be prepared by the holder which summarizes each year's survey effort. The annual report should be used to set the terms and conditions of the next year's operating plan, including plans for mitigation of turbine impacts.

Post-construction mortality monitoring (see sec. 82.1) must occur for a minimum of 2 years, and the authorized officer shall determine if further monitoring is needed, based on the level of risk to species of management concern and the results of the first 2 years of monitoring, especially if the holder's permit has been modified to reduce mortality rates. Mortality monitoring should occur during multiple seasons to determine inter-seasonal variation in mortality rates.

83 – Monitoring Tools and Evolving Technology

Monitoring tools and technologies used at wind energy facilities are rapidly developing. Therefore, the authorized officer should ensure that a literature search is performed to identify and evaluate the tools most appropriate for local wildlife monitoring prior to the initiation of such activities. This ensures that the authorized officer has current information on any emerging monitoring tools. A subset of monitoring tools is briefly summarized in section 85, exhibit 01 that may be useful in conducting monitoring activities. To the extent possible, only peer-reviewed tools should be used.

84 – Adaptive Management

Adaptive management is a system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that best ensure that those outcomes are met or re-evaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain. As data from monitoring emerges, management strategies are changed or adapted in response to the newly available information and changing

circumstances. The purpose of monitoring wildlife at wind energy facilities is to detect both desired and undesired effects as soon as possible and to minimize undesired effects through changes in operation to the extent possible.

Pre-construction monitoring should be designed to provide site-specific information on wildlife responses that may be used in an adaptive management context to ensure that the siting of wind turbines (location and configuration) is done in a manner that reduces potential impacts to wildlife and that mitigation is accomplished before turbines are constructed, to the extent possible.

Post-construction monitoring should be designed to provide site-specific information on wildlife responses that may be used in an adaptive management context to alter the operation of the existing facility to the extent feasible in order to reduce unacceptable impacts. Additionally, post-construction monitoring results should be used for the design and operation of future wind energy facilities so that appropriate mitigation may be included in planning, construction, and operating the future wind energy facilities.

85 – Exhibits

85 – Exhibit 01

Review of Commonly Used Survey Techniques for Application at Wind Energy Facilities

This exhibit describes some of the techniques that have typically been utilized when performing wildlife surveys at wind energy facilities. This review points out the utility, as well as some of the limitations, of each technique. Spatial and temporal variation in wildlife activity should be accounted for if using any of the techniques below, and peer-reviewed guidelines and recommendations for their use (for example, Anderson et al. 1999) should be followed. Regardless of the method employed, sampling should occur over multiple days and nights and across multiple seasons.

Line Transects

This method involves the observation of wildlife along multiple linear transects of equal length that are located in a representative random or stratified random manner. Where baseline data are needed on the presence/absence or density of wildlife, transects may be laid out in a linear or circular fashion. During mortality counts, individuals may monitor transects with the turbine as the point of origin. Collected data might include nest counts, burrow counts, data from live trapping, and so forth. Density estimates may be calculated as long as the distance from the transect line to the subject is measured.

Point Counts

During point counts, observers stop at predetermined points and, from that point, record all wildlife observed for a set time interval over a prescribed area. For smaller birds that are actually occupying the site during breeding or migration, time periods of $\leq$ 10 min and survey areas 50 – 100 meters are typical. For larger birds, particularly flying raptors, longer time periods (30-60 minutes) and larger survey areas (often "unlimited radius counts") are used. For birds occupying the sites during breeding or stopover, point counts may be used to calculate density as long as the distance from the point to the subject is measured. For raptors and other migratory birds flying by, point counts yield an estimate of species composition and use at the site.

Radar

Radar may be a useful tool to determine bird and bat flybys at proposed wind energy sites. It may be particularly useful at night when darkness prevents on-the-ground-counts. However, current radar technologies are limited in that they cannot discriminate species. Furthermore, they cannot differentiate individuals. As a result, radar provides an estimate of overall aerial wildlife use but should not be used determine the number of individuals in an area nor the species composition.

85 – Exhibit 01--Continued

Acoustic Bat Detectors

Bat detectors may allow for automated counts of bat flyovers if bats are echolocating. Because bat detectors cannot discriminate among individuals, they should not be used to estimate the number of individuals in an area. Some species of bats are identifiable from their echolocation calls. Therefore, with proper training and established acoustic sampling protocols, these methodologies can provide both complementary and unique information not readily available through other means such as mist-netting. When using bat detectors, they should be placed at turbine-blade height so that they can effectively detect bats flying at turbine height. Multiple devices should be employed at a number of turbines. So that surveying can occur over long time-periods, detectors should be used that allow for automated detection over multiple nights.

Capture-Recapture

Wildlife abundance at a site may be estimated using capture-recapture studies. In the simplest of capture-recapture methods, animals are live-trapped and marked at one point in time and released back to the population. At a second point in time occurring soon thereafter, live trapping occurs again at the same location. The numbers of marked and unmarked animals are recorded. Abundance may then be calculated using a variety of different capture-recapture estimators. This method assumes there is no immigration or emigration during the sampling period. Similarly, recapture rates for migratory wildlife will be extremely low. As such, this technique is not suitable for use with migratory wildlife. However, it can be useful when surveying resident species (including wildlife living beneath the turbines). This technique is also referred to as mark-recapture.

Mist Netting

Mist netting may be useful in helping to develop a list of species (birds or bats) that may occur at a site, though this sample may not be representative of the species composition at turbine-blade height. In addition, mist-netting may yield indices of reproductive success through the analyses of ratios between adult and juvenile animals. Mist-netting may also yield indices of physical condition through the use of fat scores or measures of mass scaled by skeletal measurements. However, mist netting cannot estimate the number of animals present at the site unless it is performed using a capture-recapture design. Unfortunately, recapture rates are typically low for mist-nets. Thus, even with capture-recapture, the utility for density estimates is limited. Without a substantial amount of time and effort, netting of rare or migrant species is difficult. Mist netting of bats is usually most successful near areas of standing water (for example, ponds). For bats then, mist netting may not be suitable at all sites.