# FOREST SERVICE HANDBOOK
# NATIONAL HEADQUARTERS (WO)
# WASHINGTON, DC

## FSH 2609.13 - WILDLIFE AND FISHERIES PROGRAM MANAGEMENT HANDBOOK

## CHAPTER 80 – WILDLIFE MONITORING AT WIND ENERGY FACILITIES

**Amendment No.:** The Directive Manager completes this field.

**Effective Date:** The Directive Manager completes this field.

**Duration:** This amendment is effective until superseded or removed.

**Approved:** NAME OF APPROVING OFFICIAL
Title of Approving Official

**Date Approved:** mm/dd/yyyy

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| **New Document** | | xx Pages |
| **Superseded Document(s) by Issuance Number and Effective Date** | | xx Pages |

**Digest:**

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

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

80.4 – Establishes code and caption "Responsibilities."

## Digest--Continued:

80.5 – Establishes code and caption "Definitions."

80.6 – Establishes code and caption "References."

81 – Establishes code and caption "Monitoring Plans" and sets forth direction setting forth the elements of monitoring.

82 – Establishes code and caption "Monitoring Wildlife Presence or Abundance" and sets forth direction.

82.1 – Establishes code and caption "Monitoring Mortality" and sets forth direction defining monitoring requirements.

82.2 – Establishes code and caption "Other Monitoring" and sets forth direction about 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 on wildlife monitoring at sites that have been identified for potential wind energy development. Direction regarding the authorization, administration, and management of wind energy sites can be found in Forest Service Manual 2726.21 and in Forest Service Handbook 2709.11, Chapter 70.

## 80.2 – 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, or activity levels. The objectives of each specific monitoring plan should be clearly identified at the beginning of the plan, and as appropriate, address both direct and indirect effects. Two objectives that are appropriate for monitoring at wind energy facilities are:

1. Monitoring changes in wildlife presence before and after the establishment of a wind energy facility; and

2. Monitoring mortality rates and associated factors post-construction.

Other 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. Bats should also be included due to their known sensitivity to wind energy developments, along with other species that are of management concern or of high public interest.

## 80.4 - Responsibilities

The authorized official shall:

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

2. Ensure that all elements of the monitoring plan are implemented.

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

4. Ensure that the appropriate legal instruments are in place, in accordance with cost recovery regulations 36 CFR Part 251, that allow for:

   a. The proponent to cover expenses for pre-construction wildlife monitoring, and

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

5. 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.

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

7. Ensure that the selected third party for monitoring:

   a. Implements the monitoring plan;

   b. Fully performs all of the objectives and specific analytical tasks associated with successful completion of the monitoring and analyses;

   c. Consults and adheres to peer-reviewed monitoring guidelines and recommendations (such as Anderson et al. 1999); and

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

## 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.

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.

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.

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.

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 PLANS

After identifying species or group or species that will be monitored, the authorized official should develop monitoring plans that describe how the monitoring objectives will be met for each species or group. The monitoring plan should state the plan objectives, the target species, the selected monitoring measure(s), the sampling design, data collection methods, the anticipated methods of analysis, and expected reports. The sampling design section should include the seasons when monitoring will be performed, the length of time between monitoring intervals, and the anticipated length of the entire monitoring program. To the extent possible, monitoring plans should be designed or reviewed by an interagency committee of wildlife experts.
A monitoring plan may need to address more than one monitoring objective and more than one monitoring design for a target species or species' group, especially when data is to be collected for both direct and indirect effects.

## 82 – MONITORING WILDLIFE PRESENCE AND ABUNDANCE

If monitoring indicates that the presence or abundance of any species of management concern has changed significantly due to the construction or operation of a wind energy facility, then the information should be used to develop mitigation measures and modify stipulations in the holders operating plan to reduce adverse effects to wildlife. Evaluating the ecology of the targeted species and identifying potential risks and sensitivities can aid in the selection of specific environmental factors to target during monitoring. Examples of factors that could change are quality and amount of habitat, fragmentation of habitat, road density, traffic volume, noise levels, and human disturbance.

To meet the monitoring objectives set out in this chapter, a Before-After-Control-Impact (BACI) study design is an effective approach to determine whether environmental changes due to the construction and operation of a wind energy facility have affected wildlife presence or abundance (Anderson et al. 1999). The BACI design is applicable when the monitoring objective is to look for treatment effects, which in the present context, is the construction and operation of a wind energy facility. The 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 post-construction (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. 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 or abundance could 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. The design may also use some measure of reproductive rate, when appropriate. Regardless of the measure that is selected, the monitoring design should incorporate a statistical method that adjusts for the imperfect detectability of individuals.

See section 85, exhibit 01 for a summary of the methodologies that have been used in the past to monitor wildlife at proposed turbine facilities.

The authorized official shall determine the length of term for pre-construction and post-construction monitoring. To the maximum extent possible, pre-construction monitoring should be for a recommended minimum of 2 years. Pre-construction monitoring should occur across multiple seasons in order to evaluate inter-annual and inter-seasonal variability in habitat use and to specifically include important 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 should begin once all of the turbines are constructed and operational. Monitoring should encompass a period of time sufficient for meeting the monitoring objective for the target species. Post-construction monitoring should occur for a recommended minimum of 3 year(s). If monitoring continues beyond the first 3 years, then the subsequent monitoring plan can establish a multi-year interval between monitoring years (for example, every 3 years, every 5 years) rather than annual monitoring. 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.

## 82.1 - Monitoring Mortality

The purpose of post-construction mortality monitoring is to determine, to the extent possible, the factors associated with changes in mortality rates, in order to minimize adverse effects to wildlife. Correlating daily mortality counts with indices of wildlife activity and meteorological data could lead to the development of useful mitigating measures, as well as changes in the terms and conditions of the holders permit.

In estimating total mortality, monitoring should 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. Because scavenging rates are site specific, developing on-site estimates for scavenging should be encouraged (Kerns et al. 2004; Kerns et al. 2005).

2. Carcasses missed by observers. An individual's ability to detect carcasses may be dependent on the topography of a site and the height of vegetation. To correct for any missed carcasses that may result, experiments can be performed to estimate the proportion of carcasses that an individual will be able to find relative to the total number of carcasses present at the site (Kerns et al. 2004; Kerns et al. 2005). As an alternative, statistical modeling of detection rates based on multiple visits to each sample site (e.g. MacKenzie et al. 2006) may be performed.

The frequency (how often searches should occur) and intensity (amount of area searched based on number of turbines) of mortality searches will vary 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 removal rates are low, then searches may be conducted every other day or every three days.

In the event that sampling every turbine regularly is cost prohibitive, a subset of turbines may be sampled. However, the sample of turbines that are surveyed should be randomly drawn (with replacement) from the total number of samples so that differences in mortality rates at different turbines can be evaluated.

The distance from turbines that carcasses may be found after turbine collision will be dependent on the wind speed and the topography of the ground beneath each tower. As a general rule though, individuals should conduct mortality searches in a 50 meter radius around each turbine.

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 should provide details on how to document and map findings, and salvage carcasses, as appropriate.

The authorized official should inform the permit holder and specify in the contract for wildlife monitoring that the Forest Service and the U.S. Fish and Wildlife Service shall be promptly notified when a carcass of an endangered or threatened species or bald or golden eagle is found. Other migratory bird species and other species should be reported in progress reports to the authorized official at intervals specified in the monitoring plan. 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.

The authorized official shall determine the length of term for post-construction mortality monitoring. To the maximum extent possible, post-construction mortality monitoring should last not less than three years and should occur during multiple seasons. This will allow for a determination of inter-annual and inter-seasonal variation in wildlife use and mortality.

## 82.2 - Other Monitoring

The authorized official may also determine that it is necessary to monitor whether turbine development at the proposed site impacts wildlife in ways that do not include mortality (for example, causes emigration from the site, changes local population dynamics, causes behavioral alterations, and so forth). Monitoring along these lines may include bird and bat species but may also include other species that are of management concern or of substantial public interest that utilize habitat beneath turbines or habitat in the vicinity of the project area.

## 83 – MONITORING TOOLS

Monitoring tools and technologies used at wind energy facilities are rapidly developing. Because of this, the authorized official 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 will ensure that the authorized official 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 (FSH 2709.11, ch. 70) incorporates emerging science and monitoring into the decisionmaking process. As data from monitoring emerges, management strategies should change or adapt in response to the newly available information and changing circumstances. The purpose of monitoring wildlife at wind energy facilities is to ensure that these facilities do not have long-term, unacceptable impacts to wildlife.

Pre-construction monitoring should be designed to provide site-specific information on wildlife responses that could be used in an adaptive management context to ensure that the siting of wind turbines (location and configuration) in the project area is done in a manner that reduces potential impacts to wildlife.

Post-construction monitoring should be designed to provide site-specific information on wildlife responses that could be used in an adaptive management context to alter the structure or operation of the facility in a manner that reduces impacts. The authorized official should adjust the terms and conditions of the holder's permit in accordance with the agreed upon operating plan, as appropriate based on the outcome of monitoring.

## 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. Note that 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 can 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 ≤ 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 can 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 can be a useful tool to determine bird and bat flybys at proposed wind energy sites. It can 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 can 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 can 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 can 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 can 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 can yield indices of reproductive success through the analyses of ratios between adult and juvenile animals. Mist-netting can 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 will be 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.

### Spotlighting

Spotlighting is similar to point counts except that in spotlighting, a bright light is oriented skyward at night and the number and species of birds/bats visible in the spotlight is counted. This gives an estimate of the species composition and use at the site. However, with spotlighting, species identification is usually difficult and the narrow beam that spotlights project will only allow for a survey of a very small portion of the night-sky. For nocturnal migrants, radar is often more useful because of its ability to detect animals over a greater area.