# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

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Memorandum

To: Regional Directors, Regions 1-7

From: Deputy Director

Subject: Service Interim Guidance on Avoiding and Minimizing Wildlife Impacts from Wind Turbines

Wind-generated electrical energy is renewable, produces no emissions, and is considered to be generally environmentally friendly technology. Development of wind energy is strongly endorsed by the Secretary of the Interior, as expressed in the Secretary's Renewable Energy on Public Lands Initiative (May 2002). However, wind energy facilities can adversely impact wildlife, especially birds and bats, and their habitats. As more facilities with larger turbines are built, the cumulative effects of this rapidly growing industry may initiate or contribute to the decline of some wildlife populations. The potential harm to these populations from an additional source of mortality makes careful evaluation of proposed facilities essential. Due to local differences in wildlife concentration and movement patterns, habitats, area topography, facility design, and weather, each proposed development site is unique and requires detailed, individual evaluation.

Service personnel may become involved in the review of potential wind energy developments on public lands through National Environmental Policy Act review (sections 1501.6, *opportunity as a cooperating agency*, and section 1503.4, *duty to comment on federally-licensed activities for agencies with jurisdiction by law*, i.e., the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act); or because of special expertise. The National Wildlife Refuge System Improvement Act requires that any activity on Refuge lands be determined to be compatible with the Refuge system mission and Refuge purpose(s). In addition, the Service is required by the Endangered Species Act to assist other Federal agencies in ensuring that any action they authorize, implement, or fund will not jeopardize the continued existence of any federally endangered or threatened species. Service biologists have also received requests from industry for consultation on wildlife impacts of proposed wind energy developments on private lands.

The following guidance was prepared by the Service's Wind Turbine Siting Working Group. It is intended to assist Service staff in providing technical assistance to the wind energy industry to avoid or minimize impacts to wildlife and their habitats through: (1) proper evaluation of potential wind energy development sites; (2) proper location and design of turbines and

associated structures within sites selected for development; and (3) pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife. This guidance is intended for terrestrial applications only; guidelines for wind energy developments in marine environments and the Great Lakes will be provided at a future date. The interim guidelines are based on current science and will be updated as new information becomes available. They will be evaluated over a two-year period, and then modified as necessary based on their performance in the field and on the latest scientific and technical discoveries developed in coordination with industry, states, academic researchers, and other Federal agencies. A Notice of Availability and request for comments will be published in the Federal Register simultaneously with the release of this guidance to Service personnel. We encourage industry use of this guidance and solicit their feedback on its efficacy.

These guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, and to take enforcement action against any individual, company, industry or agency or to relieve any individual, company, industry, or agency of its obligations to comply with any applicable Federal, State, or local laws, statutes, or regulations.

Implementation of Service recommendations provided in accordance with these guidelines by the wind energy industry is voluntary. Field offices have discretion in the use of these guidelines on a case-by-case basis, and may also have additional recommendations to add which are specific to their geographic area.

The Migratory Bird Treaty Act (16 U.S.C. 703-712) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the Act has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as wind turbines even if all reasonable measures to avoid it are implemented. The Service's Office of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the Act to absolve individuals, companies, or agencies from liability if they follow these recommended guidelines, the Office of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals, companies, or agencies who have made good faith efforts to avoid the take of migratory birds.

Please ensure that all field personnel involved in review of wind energy development proposals receive copies of this memorandum. Questions regarding this issue should be directed to Dr. Benjamin N. Tuggle, Chief, Division of Federal Program Activities, at (703) 358-2161, or Brian Millsap, Chief, Division of Migratory Bird Management, at (703) 358-1714.

Attachment

# INTERIM GUIDELINES TO AVOID AND MINIMIZE WILDLIFE IMPACTS FROM WIND TURBINES

## Introduction

Wind-generated electrical energy is renewable, produces no emissions, and is generally considered to be an environmentally friendly technology. Development of wind energy is strongly endorsed by the Secretary of the Interior, as expressed in the Secretary's Renewable Energy on Public Lands Initiative (May 2002). However, wind energy facilities can adversely impact wildlife, especially birds (e.g., Orloff and Flannery 1992, Leddy et al. 1999, Woodward et al. 2001, Braun et al. 2002, Hunt 2002) and bats (Keeley et al. 2001, Johnson et al. 2002, Johnson et al. 2003). As more facilities with larger turbines are built, the cumulative effects of this rapidly growing industry may initiate or contribute to the decline of some wildlife populations (Manes et al. 2002, Johnson et al. 2002, Manville 2003). The potential harm to these populations from an additional source of mortality or adverse habitat impacts makes careful evaluation of proposed facilities essential. Due to local differences in wildlife concentration and movement patterns, habitats, area topography, facility design, and weather, each proposed development site is unique and requires detailed, individual evaluation.

The following guidance was prepared by the U.S. Fish and Wildlife Service (Service). Like the Service's voluntary guidance addressing the siting, construction, operation, and decommissioning of communication towers (http://migratorybirds.fws.gov/issues/towers/comtow.html) and the voluntary guidance developed in cooperation with the electric utility industry to minimize bird strikes and electrocutions (APLIC 1994, APLIC 1996), this guidance is intended to assist the wind energy industry in avoiding or minimizing impacts to wildlife and their habitats. This is accomplished through: (1) proper evaluation of potential Wind Resource Areas (WRAs), (2) proper location and design of turbines and associated structures within WRAs selected for development, and (3) pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife. These guidelines are based on current science and will be updated as new information becomes available. They are voluntary, and interim in nature. They will be evaluated over a two-year period, and then modified as necessary based on their performance in the field, on comments from the public, and on the latest scientific and technical discoveries developed in coordination with industry, states, academic researchers, and other Federal agencies. After this period, the Service plans to develop a complete operations manual for evaluation, site selection, design, construction, operation, and monitoring of wind energy facilities in both terrestrial and aquatic environments.

Data on wildlife use and mortality collected at one wind energy facility are not necessarily applicable to others; each site poses its own set of possibilities for negative effects on wildlife. In addition, the wind industry is rapidly expanding into habitats and regions that have not been well studied. The Service therefore suggests a precautionary approach to site selection and development, and will employ this approach in making recommendations and assessing impacts of wind energy developments. We encourage the wind energy industry to follow these guidelines and, in cooperation with the Service, to conduct scientific research to provide additional information on the impacts of wind energy development on wildlife. We further encourage the industry to look for opportunities to promote bird and other wildlife conservation when planning wind energy facilities (e.g., voluntary habitat acquisition or conservation easements).

The Service is guided by the Fish and Wildlife Service Mitigation Policy (Federal Register 46 (15), January 1981) in evaluating modifications to or loss of habitat caused by development. This policy follows the sequence of steps recommended in the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) in seeking to avoid, minimize, or compensate for negative impacts. Mitigation can involve (1) avoiding the impact of an activity by taking no action; (2) minimizing impacts by limiting the degree of activity; (3) rectifying an impact by repairing, rehabilitating, or restoring an affected environment; (4) reducing or eliminating an impact by conducting activities that preserve and maintain the resources; or (5) compensating for an impact by replacing or providing substitute resources or environments. Any mitigation recommended by the Service

for wind energy development would be voluntary on the part of the developer unless made a condition of a Federal license or permit. Mitigation does not apply to "take" of species under the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, or Endangered Species Act. The goal of the Service under these laws is the elimination of loss of migratory birds and endangered and threatened species due to wind energy development. The Service will actively expand partnerships with regional, national, and international organizations, States, tribes, industry, and environmental groups to meet this goal.

Projects with Federal involvement may require additional analysis under the National Environmental Policy Act (http://www.fws.gov/r9esnepa), Endangered Species Act (http://endangered.fws.gov), or National Wildlife Refuge System Administration Act (http://www.fws.gov/policyMakers/mandates/index.html#adminact). This includes projects on federally-owned lands (e.g., National Wildlife Refuges, National Forests), lands where a Federal permit is required for development (e.g., BLM-administered lands), or lands where Federal funds were used for purchase or improvement (some State Wildlife Management Areas).

These guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, and to take enforcement action against any individual, company, or agency, or to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, or local laws, statutes, or regulations.

The guidelines contain a site evaluation process with checklists for pre-development evaluations of potential terrestrial wind energy development sites (Appendix 1). Use of this process allows comparison of one site with another with respect to the impacts that would occur to wildlife if the area were developed. The evaluation area for a potential development site should include the "footprint" encompassing all of the turbines and associated structures planned for that proposed facility, and the adjacent wildlife habitats which may be affected by the proximity of the structures, but excluding transmission lines extending outside the footprint. All potential development sites within a geographic area should be evaluated before a site is selected for development.

Pre-development evaluations should be conducted by a team that includes Federal and/or State agency wildlife professionals with no vested interest (e.g., monetary or personal business gain) in the sites selected. Teams may also include academic and industry wildlife professionals as available. Any site evaluations conducted by teams that do not include Federal and/or State agency wildlife professionals will not be considered valid evaluations by the Service.

The pre-development evaluation may also identify additional studies needed prior to and after development. Post-construction monitoring to identify any wildlife impacts is recommended at all developed sites. Pre- and post-development studies and monitoring may be conducted by any qualified wildlife biologist without regard to his/her affiliation or interest in the site.

Additional information relevant to these guidelines is appended as follows:

Appendix 2 – Definitions Related to Wind Energy Development and Evaluation
Appendix 3 – Wildlife Laws Relevant to Wind Power Development Projects
Appendix 4 - Research Needs on the Impacts of Wind Power Development on Wildlife
Appendix 5 – Procedures for Endangered Species Evaluations and Consultations
Appendix 6 – Guidelines for Considering Wind Turbine Siting on Easement Lands Administered as Part of the National Wildlife Refuge System in Region 6 (CO, KS, MT, NE, ND, SD, UT, WY)
Appendix 7 – Known and Suspected Impacts of Wind Turbines on Wildlife
Appendix 8 – Literature Cited

**Site Evaluation**

The site evaluation protocol presented in Appendix 1 was developed by a team of Federal, State, university, and wind energy industry biologists to rank potential terrestrial wind energy development sites by their potential impacts on wildlife. There are two steps to follow:

1. Identify and evaluate reference sites, preferably within the general geographic area of the proposed facility. Reference sites are high-quality wildlife areas where wind development would result in the maximum negative impact on wildlife (i.e., sites selected to have the highest possible rank using the protocol). Reference sites are used to determine the comparative risks of developing other potential sites.

2. Evaluate potential development sites to determine risk to wildlife and rank sites against each other using the highest-ranking reference site as a standard. Although high-ranking sites are generally less desirable for wind energy development, a high rank does not necessarily preclude development of a site, nor does a low rank automatically eliminate the need to conduct pre-development assessments of wildlife resources or post-development assessments of impacts.

**Studies to Assess and Monitor Wildlife Impacts**

While ranking potential development sites, the site evaluation team referenced above may identify pre-development studies that are needed to better assess potential negative impacts to wildlife. Ranking may also suggest the extent and duration of study required. Developers are encouraged to conduct any studies suggested by the team in coordination with Service and other agency wildlife biologists.

Post-development mortality studies should be a part of any site development plan in order to determine if or to what extent mortality occurs. As with pre-development studies, ranking may suggest the extent and duration of study needed. Studies should be designed in coordination with Federal and other agency biologists.

**Site Development Recommendations**

The following recommendations apply to locating turbines and associated structures within WRAs selected for development of wind energy facilities:

1. Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act.

2. Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low (e.g., birds present rarely enter the rotor-swept area). Examples of high concentration areas for birds are wetlands, State or Federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.

3. Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.

4. Configure turbine locations to avoid areas or features of the landscape known to attract raptors (hawks, falcons, eagles, owls). For example, Golden Eagles, hawks, and falcons use cliff/rim edges extensively; setbacks from these edges may reduce mortality. Other examples include not locating turbines in a dip or pass in a ridge, or in or near prairie dog colonies.

5. Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species (e.g., Sage Grouse).

6. Avoid fragmenting large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.

7. Avoid placing turbines in habitat known to be occupied by prairie grouse or other species that exhibit extreme avoidance of vertical features and/or structural habitat fragmentation. In known prairie grouse habitat, avoid placing turbines within 5 miles of known leks (communal pair formation grounds).

8. Minimize roads, fences, and other infrastructure. All infrastructure should be capable of withstanding periodic burning of vegetation, as natural fires or controlled burns are necessary for maintaining most prairie habitats.

9. Develop a habitat restoration plan for the proposed site that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. For example, avoid attracting high densities of prey animals (rodents, rabbits, etc.) used by raptors.

10. Reduce availability of carrion by practicing responsible animal husbandry (removing carcasses, fencing out cattle, etc.) to avoid attracting Golden Eagles and other raptors.

**Turbine Design and Operation Recommendations**

1. Use tubular supports with pointed tops rather than lattice supports to minimize bird perching and nesting opportunities. Avoid placing external ladders and platforms on tubular towers to minimize perching and nesting. Avoid use of guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices (Avian Power Line Interaction Committee 1994).

2. If taller turbines (top of the rotor-swept area is >199 feet above ground level) require lights for aviation safety, the minimum amount of pilot warning and obstruction avoidance lighting specified by the Federal Aviation Administration (FAA) should be used (FAA 2000). Unless otherwise requested by the FAA, only white strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. Solid red or pulsating red incandescent lights should not be used, as they appear to attract night-migrating birds at a much higher rate than white strobe lights.

3. Where the height of the rotor-swept area produces a high risk for wildlife, adjust tower height where feasible to reduce the risk of strikes.

4. Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution of birds. Use recommendations of the Avian Power Line Interaction Committee (1994, 1996) for any required above-ground lines, transformers, or conductors.

5. High seasonal concentrations of birds may cause problems in some areas. If, however, power generation is critical in these areas, an average of three years monitoring data (e.g., acoustic, radar, infrared, or observational) should be collected and used to determine peak use dates for specific sites. Where feasible, turbines should be shut down during periods when birds are highly concentrated at those sites.

6. When upgrading or retrofitting turbines, follow the above guidelines as closely as possible. If studies indicate high mortality at specific older turbines, retrofitting or relocating is highly recommended.

## Appendix 1

## PROTOCOL TO RANK POTENTIAL TERRESTRIAL WIND ENERGY DEVELOPMENT SITES BY IMPACTS ON WILDLIFE

This protocol was developed by a team of Federal, State, university, and industry biologists to rank potential wind development sites in Montana by their potential for impacts on wildlife (USFWS 2002). It has been modified to apply nationwide. The protocol allows the user to evaluate potential development sites and rank them against a reference site. Objectives are to: (1) assist developers in deciding whether to proceed with development; (2) provide a procedure to determine pre-construction study needs to verify use of potential sites by wildlife; and (3) provide recommendations for monitoring potential sites post-construction to identify, quantify, or verify actual impacts (or lack thereof).

Although this protocol focuses on impacts to wildlife, potential impacts to fish, other aquatic life, and plants should be considered as well. Surveys for rare, threatened, or endangered plants known or suspected to occur in the geographic area should be conducted at all proposed terrestrial development sites having suitable habitat.

This protocol is intended to provide a conceptual framework for initial steps in investigating a site. It is not intended to be all-inclusive relative to objectives, methods, and analysis nor to serve as the definitive reference or directive for any step in wind power related investigations. The Physical Attributes, Species Occurrence and Status, and Ecological Attractiveness groupings in this protocol should serve as a model framework; the terrain features, species, and conditions used in these groupings will be dictated by local conditions and should be developed by wildlife biologists familiar with the region in which this protocol is being used.

### Potential Impact Index (PII)

The Potential Impact Index represents a "first cut" analysis of the suitability of a site proposed for development. It does so by estimating use of the site by selected wildlife species as an indicator of potential impact. Emphasis of the PII is on initial site evaluation and is intended to provide more objectivity than simple reconnaissance surveys.

There are two steps to follow in ranking sites by their potential impact on wildlife:

1. Identify and evaluate reference sites within the general geographic area of Wind Resource Areas (WRA's) being considered for development of a facility. Reference sites are areas where wind development would result in the maximum negative impact on wildlife, resulting in a high PII score. Reference sites are used to determine the comparative risks of developing other potential sites.

2. Evaluate potential development sites to determine risk to wildlife, and rank sites against each other using the highest-ranking reference site as a standard. While high-ranking sites are generally less desirable for wind development, a high rank does not necessarily preclude development of a site, not does a low rank automatically eliminate the need to conduct pre-development assessments of wildlife use and impact potential.

The following assumptions are implicit in the PII process:

1. All WRA sites, regardless of turbine design, configuration, placement, or operation present some hazard and risk to wildlife from both an individual and population perspective.

2. Certain sites present less hazard and risk to wildlife than others.

3. No adequate and defensible information exists regarding the appropriateness of the proposed WRA site being evaluated relative to impacts to wildlife.

4. Evaluations will be conducted by qualified biologists without competitive interest in site selection, including those from State and Federal agencies who are familiar with local and regional wildlife.

The PII is designed primarily to evaluate potential impacts on aerial wildlife from collision with turbines and infrastructure. The PII is derived from the results of three checklists (forms are attached). These checklists should be developed and applied as follows:

A. The PHYSICAL ATTRIBUTE checklist considers topographic, meteorological, and site characteristics that may influence bird and bat occurrence and movements.

B. The SPECIES OCCURRENCE AND STATUS checklist includes: Birds of Conservation Concern at the Bird Conservation Region level (http://migratorybirds.fws.gov/reports/reports.html); all federally-listed Endangered, Threatened, and Candidate Species (http://endangered.fws.gov); bird species of high recreational or other value (e.g., waterfowl, prairie grouse); State Endangered, Threatened, and Species of Management Concern; and any additional species of concern listed by State Natural Heritage Programs.

C. The ECOLOGICAL ATTRACTIVENESS checklist evaluates the presence and influence of ecological magnets and other conditions that would draw birds or bats to the site or vicinity.

Each checklist has boxes to be checked for a particular attribute or species found at an evaluation site. The number of boxes in each checklist will vary from region to region due to variations in the number of physical attributes and species of concern in that region. Keep in mind that all boxes in a checklist are very unlikely to be checked at a single evaluation site, because all species and ecological physical conditions potentially occurring in the region would not exist at one site.

Each checklist should be assigned a divisor, which is developed by dividing the number of boxes in a checklist by the total number of boxes in all three checklists. This expands the spread of index values and more dramatically displays the magnitude of differences among sites. For example, if the PHYSICAL ATTRIBUTE checklist has 36 boxes and the total number of boxes in all three checklists is 144, divide 36 by 144 = 0.25, the divisor.

You can change the number of boxes in any of the checklists to fit your geographic area, habitat type, or other selected region (e.g., a state or portion of a state). Remember to recalculate the divisor if you change the number of boxes.

Boxes in a checklist are checked if the condition or species is known or strongly suspected to occur. Criteria for checklist conditions marked with an asterisk (*) are explained on the following page. Conditions that are self-explanatory are not included. Conditions are not weighted. Boxes are checked in the SPECIES OCCURRENCE AND STATUS checklist if presence of the species is unconfirmed but strongly suspected (i.e., WRA is within the range and habitat of the species). This permits more liberal assignment of potential impact, reduces the probability of missing impacts on specific species due to lack of empirical data, and focuses future study and monitoring effort. Totals for each checklist are simple column sums. The PII is calculated from the checklist totals. A completed example from Montana is provided at the end of this Appendix.

**Determining Checklist Scores**

Checklist scores are determined as follows:

1. Place a check in each box for which an attribute, species, or condition is present or strongly suspected.

2. After completing the three checklists for each site, add the total number of checks in a checklist for an ending sum (each box checked equals one).

**Determining PII Score**

The Potential Impact Index score is determined as follows:

1. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

2. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

3. Add the adjusted checklist sums (Σ/p column) to produce the PII score.

Include any questions, statements, comments, or concerns regarding any checklist cell or category on the SITE SPECIFIC COMMENTS sheet. These comments are critical to determining pre-construction study needs. They will also help identify and refine questions and objectives to be addressed by follow-up study and monitoring. The nature of suspected Significant Ecological Events should be noted on the SITE SPECIFIC COMMENTS sheet.

**Ranking PII Scores**

PII of each site evaluated is assigned a ranking based on its proportional relationship to the reference site that has the maximum PII score, as shown in Figure 2 in the Montana example. Ranking categories (High, Low, etc.) in the example are arbitrarily set at intervals of 20 percent of maximum.

Rankings are intended as a guide to developers. They are designed to serve as indicators of relative risk to wildlife and thus provide an estimator of the level of impact that may be expected should a site be developed. A high rank does not preclude development, nor does a low rank automatically eliminate the need to conduct pre-development assessments of impacts on wildlife. More intensive pre-construction studies may be needed for both scenarios if development of the site is pursued. Rankings may also suggest the extent of additional study needed.

In the case of federally listed threatened, endangered, or candidate species of wildlife, fish, or plants, consultation with the Fish and Wildlife Service under the Endangered Species Act is required, and may preclude development of a site regardless of its PII score. See Appendix 5 for procedures for obtaining lists of these species that may be present, and for consulting with the Fish and Wildlife Service if species or their habitats are found.

**Determining Pre-construction Study Needs**

The goals of pre-construction studies are to estimate impacts of proposed wind power development on wildlife by addressing areas of concern identified during the PII process. Objectives, intensity, duration, and methods of pre-construction studies are likely to be site specific, but may be independent of ranking. Regardless of ranking, studies should be designed to address (1) verification of use of WRAs by all species recorded in the "SPECIES OCCURRENCE AND STATUS" checklist, (2) verification of natural conditions (e.g., under "Significant Ecological Events", the magnitude, timing, and location of suspected bird/bat migration), or (3) questions noted in the SITE SPECIFIC COMMENTS sheet for that site. The SITE SPECIFIC COMMENTS sheet may also indicate conditions that need not be investigated. As a result, a site with a low rank may require radar surveillance (e.g., important songbird migration site) while a site with a high rank may require only a single season visual survey (e.g., site potentially contains autumn Whooping Crane habitat). The process should involve a feedback mechanism within an adaptive management strategy (Figure 1). Timely review of study results will determine if data are

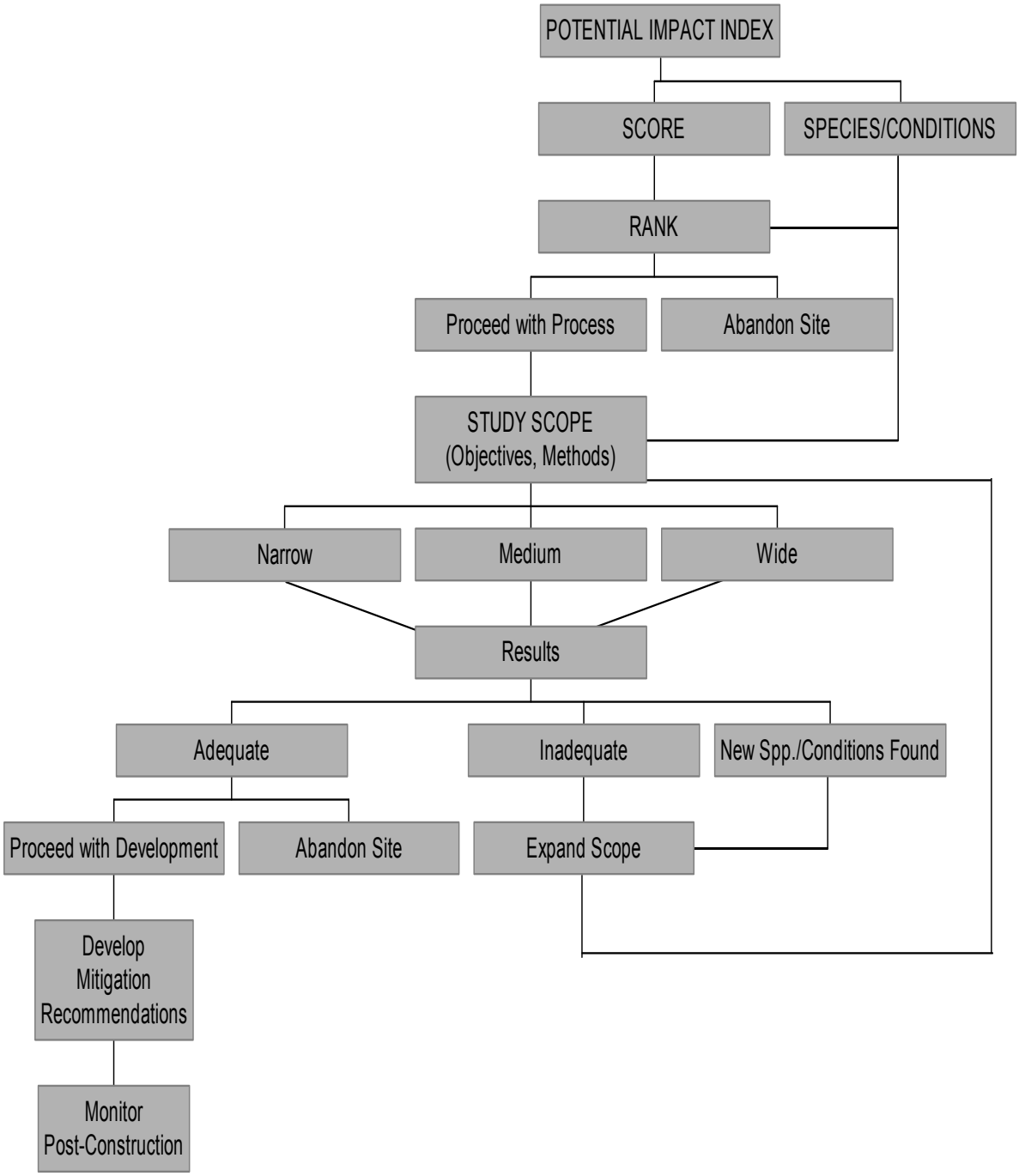


Figure 1. A suggested decision tree for assessing potential development sites. Begin by developing a PII score.

adequate, if conclusions are defensible (Anderson et al. 1999), and if additional investigational effort is required (e.g., if Black-footed Ferrets are found on Mountain Plover searches). Projects with Federal involvement may require additional analysis under the National Environmental Policy Act (http://www.fws.gov/r9esnepa), Endangered Species Act (http://endangered.fws.gov), or National Wildlife Refuge System Administration Act (http://www.fws.gov/policyMakers/mandates/index.html#adminact). Also, the mere existence of a pre-construction study, whether in progress or completed, does not imply Federal sanction for development of a site.

**Post-construction Studies**

The Service recommends that all sites be monitored for impacts on wildlife after construction is completed. Some sites may be so obviously benign that little more than simple reconnaissance study may be needed and any impact will be revealed during post-construction monitoring. Otherwise, pre-construction studies should be designed to explicitly consider post-construction monitoring that permits statistically valid evaluation of actual impacts. Accordingly, studies should be conducted as much as possible within a Before-After-Control-Impact (BACI) study design (Green 1979). Such design requires investigation of at least two sites (Impact [proposed site] and Control) simultaneously, both pre-construction (Before) and post-construction (After). Because true "Control" sites are seldom available, other sites may be substituted, including reference sites used in developing the PII ranking. In the case of radar surveillance studies, sites within the proposed WRA boundaries may be acceptable (e.g., Harmata et al. 1998). Structuring pre-construction studies within a hypotheses-testing framework will help identify appropriate metrics, focus effort, and permit comparisons with post-construction conditions or other WRAs.

Where feasible, post-construction studies should also be utilized to test measures that may eliminate or reduce impacts on wildlife. See Appendix 4, Research Needs on the Impacts of Wind Power Development on Wildlife.

**Metrics and Methods**

Metrics and methods are specific tools used to assess wildlife populations and their status (e.g., point counts, line transects, nest success studies, radar surveys, mortality rates, and risk). They can provide important information about birds, bats, and other wildlife at proposed development sites. Metrics and methods may be selected to collect seasonal, group, guild, or habitat specific information, based on data and comments in the SPECIES OCCURRENCE AND STATUS checklist and SITE SPECIFIC COMMENTS sheet. For example, a proposed WRA may be in a narrow north-south oriented valley of relatively monotypic habitat. These conditions suggest a heavy seasonal avian migration corridor but little avian breeding habitat. Accordingly, study emphasis should be on defining use and mortality of migratory birds during autumn or spring or both, with little effort directed at defining use and mortality of breeding birds. Conversely, a potential WRA on a flat plain in diverse habitat would indicate the exact opposite in study emphasis.

While metrics represent specific measurements, concepts, and relationships, methods refer to observational or manipulative study techniques that may be used to verify the location of birds and other wildlife, estimate their numbers, and document their use and behavior (Anderson et al. 1999). Table 1 depicts some commonly used metrics and methods for wildlife studies.

Table 1. Examples of metrics and methods associated with evaluating use and mortality of wildlife at proposed Wind Resource Areas in Montana.

| Data Need | Metric | Methods |
|---|---|---|
| Use Profile | Individuals/Count | Point Counts (birds)<br>Winter Raptor Surveys<br>Lek Counts (grouse)<br>Migration Counts<br>Ungulate Surveys<br>Spotlight Surveys |

| | | |
|---|---|---|
| | Species/Count | Species/guild/group List<br>Point Counts (birds)<br>Raptor Nesting Surveys<br>Raptor Migration Counts<br>Winter Raptor Surveys<br>Acoustic Surveillance (bats)<br>Pellet Counts<br>Bait Stations<br>Track Boards |
| | Use per unit of time (e.g., hour, season) | Radar<br>Migration Counts<br>Raptors/watch<br>Area Searches |
| | Individuals/capture effort | Various techniques for capture |
| | Productivity | Nests/area<br>Raptor Nesting Surveys<br>Nest Success<br>Ungulate Surveys |
| | Events/height category (Altitude Profile) | Radar |
| | Events/distance category (Spatial Profile) | Radar |
| Mortality | Dead/injured individuals/unit | Transects<br>Spot Searches<br>Carcass Removal Study<br>Observer Detection Efficiency Study |

Studies should also strive to generate information to mitigate impacts by properly locating, configuring, or operating turbines (Johnson et al. 2000). Every effort should be made to choose metrics and methods that allow comparisons of pre-construction studies with post-construction studies, other WRAs, and other regions.

**Interpreting Metrics**

It may be difficult to establish empirically exactly what constitutes high use (i.e., potentially high impact). When looking at the distribution and movements, and local, regional, or range-wide population estimates for particular species, the relative proportions of species, groups, or guilds of wildlife using proposed WRAs may indicate degrees of risk. If baseline population data are unknown, consult with a qualified biologist who can recommend a specific metric.

It is likely that little or no evidence of mortality will be found during pre-construction study. If, however, post-construction mortality is found, and statistical evaluation is not possible, that mortality should be assessed in regard to the species status (e.g., ESA-listed species or Birds of Conservation Concern) or the effect of the loss of individuals of that species on a local, regional, or continental population.

**Determining Post-construction Monitoring Needs**

Post-construction monitoring is important to the Service, industry, and public because of the limited information available on impacts of wind turbines and WRAs on wildlife. Therefore, post-construction monitoring should be designed to detect major impacts. The intended time frame for post-construction monitoring is not expected to exceed three years, however. Major impacts may be considered as statistically significant decreases in use by species of concern, or limited to statistically significant increases in mortality rates of any wildlife. Monitoring effort may be intensive or cursory, depending on results of pre-construction use and mortality studies. Simple, infrequent mortality surveys on impact and

control plots may be all that is needed at WRAs where recorded pre-construction use by wildlife is low. Documented high use of a proposed WRA may require monitoring methods identical to those employed in pre-construction studies. Anderson et al. (1999) provide specific, detailed direction in post-construction study design and monitoring. Manville (2002) developed a monitoring protocol for use by the U.S. Forest Service at three National Forests in Arizona to monitor the impact of cellular telecommunications towers on migratory birds that could be modified for use at land-based wind turbines.

**POTENTIAL IMPACT INDEX CHECKLIST FORMS AND INSTRUCTIONS**

PHYSICAL ATTRIBUTE CHECKLIST

| Physical Attribute | | | | Site | | | |
|---|---|---|---|---|---|---|---|
| Topography | Mountain Aspect, if mountainous* | Side | W | | | | |
| | | | E | | | | |
| | | | N | | | | |
| | | | S | | | | |
| | | Top | | | | | |
| | | Foothill | W | | | | |
| | | | E | | | | |
| | | | N | | | | |
| | | | S | | | | |
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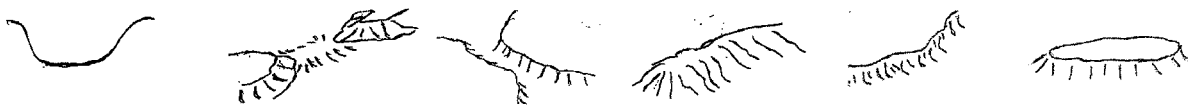
| | | | | | | | |
| Wind* Direction | S | | | | | | |
| | N | | | | | | |
| | E | | | | | | |
| | W | | | | | | |
| | Updrafts* | | | | | | |
| Migratory* Corridor Potential | Latitudinal (N ↔ S) | | | | | | |
| | Longitudinal (E ↔ W) | | | | | | |
| | Wide Approaches (>30 km)* | | | | | | |
| | Funnel Effect | Horizontal | | | | | |
| | | Vertical | | | | | |
| Site Size (acres) & Configuration* | <640 | | | | | | |
| | >640 <1000 | | | | | | |
| | >1000 <1500 | | | | | | |
| | Turbine Rows not Parallel to | | | | | | |
| Infrastructure To Build | Transmission | | | | | | |
| | Roads | | | | | | |
| | Buildings* | | | | | | |
| | Maintenance | | | | | | |
| | Daily Activity | | | | | | |
| | Substation | | | | | | |
| Increased Activity* | | | | | | | |
| Totals | | | | | | | |

∗ Criteria on following page

PHYSICAL ATTRIBUTE CRITERIA - categories, max Σ = , (p = ).

Topography - Terrain characteristic within the ecological influence of the proposed wind development site, generally, but not restricted to ± 5 mi. Some examples are:

Valley Pass Gap Ridgetop Bluff Butte



Mountain Aspect - Aspect of topography for site of proposed development. Multiple categories may be checked.

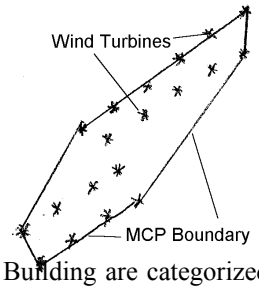
Wind Direction - Compass direction *from* which prevailing winds approach. Multiple categories may be checked.

Updrafts - Do updrafts/upslope winds prevail?

Migratory Corridor Potential - Subjective estimate of area to be a potential avian/bat migratory corridor based strictly on topographical characteristics. Multiple categories may be checked.

- Wide (>20 mi) - Terrain characteristics of approaches to site from each migratory direction, i.e., a large plain, river corridor, long valley. The larger the area that migrant birds/bats are drawn from, the more may be at risk
- Funnel Effect - Is the site in or near an area where migrant birds/bats may be funneled (concentrated) into a smaller area, either altitudinally, laterally, or both?

Site Size & Configuration – Size is estimated as if a minimum convex polygon (MCP) were drawn around peripheral turbines.




Successive boxes are checked to convey relationship of larger size = increased impact to birds/bats, *e.g.*, a 700 acre site will have 2 categories checked while a 1,200 acre site will have all 3 categories checked.

Configuration of turbine rows is usually perpendicular to prevailing wind direction. Rows aligned perpendicular or oblique to route of migration intuitively presents more risk to birds than rows aligned parallel to movement.

Buildings – Building are categorized by relative size and visitation frequency, *i.e.,* structures that are visited daily are usually larger and present more impact than those that are not. If a "Daily Activity" building is required, all Building categories are checked. If a maintenance structure is required, Substation is also checked.

Increased Activity - Will any type of human activity increase? Sites in urban-suburban or otherwise developed areas (oil, gas, mines) will have less impact on wildlife than those in remote or undeveloped areas.

Avian Species of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

| | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds (n = ) | | | | | | | | | | | | |
| Occurrence | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | |

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS checklist. Consult Birds of Conservation Concern (http://migratorybirds.fws.gov/reports/reports.html) and Threatened/Endangered Species list (http://endangered.fws.gov), and list other species of high value or management concern such as migratory waterfowl and prairie grouse. Appropriate avian field guides and species accounts should be consulted for confirmation of species distribution and habitat associations. State Natural Heritage Programs may also provide species accounts that include additional information useful in completing checklists.

In addition to species lists (rows), season of occurrence is also indicated (columns). "B" indicates breeding or summer occurrence and "M/W" indicates presence during migration or as wintering species. If occurrence within or in the vicinity of a proposed site is confirmed or suspected, an "X" is entered.

Bat Species Of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

| | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bats (n = ) | | | | | | | | | | | | |
| Occurrence | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| Subtotals | | | | | | | | | | | | |
| Total | | | | | | | | | | | | |

Bat Species Of Concern Checklist (  species, max Σ =  ).

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS checklist. Appropriate bat field guides and references (Barbour and Davis 1969) should be consulted for confirmation of species distribution and habitat associations. State Natural Heritage Programs may also provide species accounts that include additional information useful in completing checklists.

In addition to species lists (rows), season of occurrence is also indicated (columns). "B" indicates breeding or summer occurrence and "M/W" indicates presence during migration or as wintering species. If occurrence within or in the vicinity of a proposed site is confirmed or suspected, an "X" is entered.

SPECIES OCCURRENCE & STATUS CHECKLIST

| Species | | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Occurrence | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| Threatened & Endangered (includes wildlife, fish, and plants) | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| Candidate* | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Special Concern* | Birds (max Σ=) | | | | | | | | | | | | |
| | Bats (max Σ=) | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | Subtotals | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | |

∗ Criteria on following page

SPECIES OCCURRENCE & STATUS Checklist (  categories, max Σ =  , (p =  ).

Checklist totals for each column in "Avian Species of Concern List" and "Bat Species of Concern List" are inserted in this checklist.

Threatened & Endangered Species - Species on the Federal List of Endangered and Threatened Species (http://endangered.fws.gov).

Candidate Species - Species being investigated for inclusion in the Federal List of Endangered and Threatened Species (http://endangered.fws.gov).

Species of Special Concern - Species listed in Birds of Conservation Concern; by Natural Heritage Programs that are known or suspected to be rare, endemic, disjunct, threatened or endangered; and species of high value such as migratory or other game birds.

Golden Eagles may be included in this checklist because of special protective status afforded under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). Other species (e.g., Sage Grouse) may be included because of recent concern over population declines range wide. Bats (other than bat Species of Special Concern) should be included due to generally unknown impacts of wind farms on individuals and populations.

ECOLOGICAL ATTRACTIVENESS CHECKLIST

| Ecological Attractor | | | Site | | | |
|---|---|---|---|---|---|---|
| Migration Route* | Local | | | | | |
| | Continental* | N | | | | |
| | | S | | | | |
| | | E | | | | |
| | | W | | | | |
| Ecological Magnets* | Lotic System | | | | | |
| | Lentic System | | | | | |
| | Wetlands | | | | | |
| | Native Grassland | | | | | |
| | Forest | | | | | |
| | Food Concentrated | | | | | |
| | Energetic Foraging | | | | | |
| | Vegetation/ Habitat | Unique | | | | |
| | | Diverse | | | | |
| Significant Ecological Event* | | | | | | |
| Site of Special Conservation Status* | | | | | | |
| Total | | | | | | |

∗ Criteria on following page

ECOLOGICAL ATTRACTIVENESS CRITERIA - categories, max Σ = , (p = ).

Migration Route - Indicates predominate direction of movement of seasonal migrations. Multiple categories may be checked.

Local - Some avian populations move only altitudinally & direction may be East-West (Sage Grouse, owls, Bald Eagles).

Continental - Some migratory corridors experience mass movements in only one season/direction annually (e.g., Bridger Mountains autumn eagle migration).

Ecological Magnets - Special, unique, unusual, or super ordinary habitats or conditions within the vicinity of the site that may attract wildlife. Lotic systems include small perennial or seasonal creeks to major rivers. Lentic systems include stock ponds to lakes to marine environments. Multiple categories may be checked.

Vegetation/Habitat - Unique or exceptionally diverse vegetation or habitat in the vicinity may indicate exceptional diversity and abundance of avian species or bats.

Significant Ecological Event - Special, unique, unusual, or super ordinary events that occur or are suspected to occur in the vicinity of the site, e.g., up to one third of the Continental population of Trumpeter Swans visit Ennis Lake, < 2.5 miles from a proposed Wind Resource Area; the Continental migration of shorebirds passes over (many stop) at Benton Lake National Wildlife Refuge) and up to 2,000 Golden Eagles pass over the Bridger Mountains in autumn. If unknown but suspected a "?" is entered. Specifics regarding the cell are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up investigation and assist in definition of study objectives.

Site of Special Conservation Status - Any existing or proposed covenants, conservation easements, or other land development limitations intended to conserve, protect, or enhance wildlife or habitat. This criterion is weighted (2 entered if true) because of previous financial or other investment in ecological values. Specifics regarding the easement are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up attention.

**POTENTIAL IMPACT INDEX**

| | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Checklist (p)[1] | Σ | Σ/p | Σ | Σ/p | Σ | Σ/p | Σ | Σ/p |
| Physical ( ) | | | | | | | | |
| Species Occurrence & Status ( ) | | | | | | | | |
| Ecological ( ) | | | | | | | | |
| Totals | | | | | | | | |

[1]Proportion of total checklist categories.

**Determining PII Score**

A. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

B. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

C. Add the Σ/p boxes for the three checklists to obtain a total score.

SITE SPECIFIC COMMENTS

| Checklist | Site | | | |
|---|---|---|---|---|
| Physical | | | | |
| | | | | |
| | | | | |
| Species Occurrence | | | | |
| | | | | |
| | | | | |
| Ecological | | | | |
| | | | | |
| | | | | |

**EXAMPLE SITE ASSESSMENT AND**
**CALCULATION OF POTENTIAL IMPACT INDEX (PII)**
**FROM MONTANA**

**POTENTIAL IMPACT INDEX CHECKLISTS**

**Calculating Divisors**

A. Each checklist should be assigned a divisor, which is developed by dividing the number of boxes in a checklist by the total number of boxes in all three checklists. In this example, the total number of boxes in all three checklists is 143.

B. Physical Attribute checklist: 36 boxes ÷ 143 = 0.25; Species Occurrence and Status checklist: 91 boxes ÷ 143 = 0.63; Ecological Attractiveness checklist: 16 boxes ÷ 143 = 0.11.

**Determining Checklist Scores**

A. Place a check in each box for which an attribute, species, or condition is present or strongly suspected.

B. After completing the three checklists for each site, add the total number of checks in a checklist for an ending sum (each box checked equals 1).

PHYSICAL ATTRIBUTE CHECKLIST

| Physical Attribute | | | | Site: Snowy Mtn.Range | | | |
|---|---|---|---|---|---|---|---|
| Topography | Mountain Aspect | Side | W | X | | | |
| | | | E | | | | |
| | | | N | | | | |
| | | | S | | | | |
| | | Top | | | | | |
| | | Foothill | W | X | | | |
| | | | E | | | | |
| | | | N | | | | |
| | | | S | | | | |
| | Valley | | | X | | | |
| | Pass | | | | | | |
| | Gap | | | | | | |
| | Ridge | | | X | | | |
| | Bluff | | | | | | |
| | Butte | | | | | | |
| Wind Direction | S | | | | | | |
| | N | | | X | | | |
| | E | | | | | | |
| | W | | | | | | |
| | Updrafts | | | X | | | |
| Migratory Corridor Potential | Latitudinal (N ↔ S) | | | | | | |
| | Longitudinal (E ↔ W) | | | X | | | |
| | Wide Approaches (>30 km) | | | | | | |
| | Funnel Effect | Horizontal | | X | | | |
| | | Vertical | | | | | |
| Site Size (acres) & Configuration | <640 | | | X | | | |
| | >640 <1000 | | | X | | | |
| | >1000 <1500 | | | X | | | |
| | Turbine Rows not Parallel to | | | | | | |
| Infrastructure To Build | Transmission | | | X | | | |
| | Roads | | | X | | | |
| | Buildings | | | X | | | |
| | Maintenance | | | X | | | |
| | Daily Activity | | | X | | | |
| | Substation | | | X | | | |
| Increased Activity | | | | X | | | |
| Totals | | | | 18 | | | |

Avian Species of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

| | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds (n = 12) | Snowy Mtn. R. | | | | | | | | | | | |
| Occurrence | B | M/W | ∑ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| Nelson's Sharptailed Sparrow | X | X | 2 | | | | | | | | | |
| LeConte's Sparrow | X | X | 2 | | | | | | | | | |
| Baird's Sparrow | X | X | 2 | | | | | | | | | |
| Dickcissel | X | | 1 | | | | | | | | | |
| Cassion's Kingbird | X | | 1 | | | | | | | | | |
| Blackbacked Woodpecker | X | | 1 | | | | | | | | | |
| Yellow-billed Cuckoo | X | | 1 | | | | | | | | | |
| Peregrine Falcon | X | | 1 | | | | | | | | | |
| Northern Goshawk | | X | 1 | | | | | | | | | |
| Ferruginous Hawk | | X | 1 | | | | | | | | | |
| Clark's Grebe | X | | 1 | | | | | | | | | |
| Common Loon | X | | 1 | | | | | | | | | |
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| | | | | | | | | | | | | |
| Subtotals | 10 | 5 | 15 | | | | | | | | | |
| Total | | | 15 | | | | | | | | | |

Bat Species Of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

| Bats (n = 2) | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Snowy Mtn. Range | | | | | | | | | | | |
| Occurrence | B | M/W | ∑ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| Fringed Myotis | X | | 1 | | | | | | | | | |
| Spotted Bat | X | | 1 | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Subtotals | 2 | | 2 | | | | | | | | | |
| Total | | | 2 | | | | | | | | | |

SPECIES OCCURRENCE & STATUS CHECKLIST

| | Species | Site: Snow Mtn. R. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Occurrence | B | M/W | ∑ | B | M/W | Σ | B | M/W | Σ | B | M/W | Σ |
| Threatened & Endangered | Bald Eagle | | X | 1 | | | | | | | | | |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| Candidate | Columbian Sharp-tailed Grouse | X | X | 2 | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Special Concern | Birds (max ∑=) | | | 15 | | | | | | | | | |
| | Bats (max ∑=) | | | 2 | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | Subtotals | | | 20 | | | | | | | | | |
| | Total | | | 20 | | | | | | | | | |

ECOLOGICAL ATTRACTIVENESS CHECKLIST

| Ecological Attractor | | | Site: Snowy Mtn. Range | | | |
|---|---|---|---|---|---|---|
| Migration Route | Local | | | | | |
| | Continental | N | X | | | |
| | | S | X | | | |
| | | E | | | | |
| | | W | | | | |
| Ecological Magnets | Lotic System | | | | | |
| | Lentic System | | | | | |
| | Wetlands | | X | | | |
| | Native Grassland | | X | | | |
| | Forest | | X | | | |
| | Food Concentrated | | | | | |
| | Energetic Foraging | | X | | | |
| | Vegetation/ Habitat | Unique | | | | |
| | | Diverse | X | | | |
| Significant Ecological Event | | | | | | |
| Site of Special Conservation Status | | | | | | |
| Total | | | 7 | | | |

POTENTIAL IMPACT INDEX

| | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Checklist (p)[1] | Σ | Σ/p | Σ | Σ/p | Σ | Σ/p | Σ | Σ/p |
| Physical (0.25) 15÷.25=60 | 15 | 60 | | | | | | |
| Species Occurrence & Status (0.63) 20÷.63=32 | 20 | 32 | | | | | | |
| Ecological (0.11) 7÷.11=64 | 7 | 64 | | | | | | |
| Totals | 42 | **156** | | | | | | |

[1]Proportion of total checklist categories.

**Score is 156, compared to the highest reference site score of 244 (Figure 2).**

**Determining PII Score**

A. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

B. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

C. Add the Σ/p boxes for the three checklists to obtain a total score.

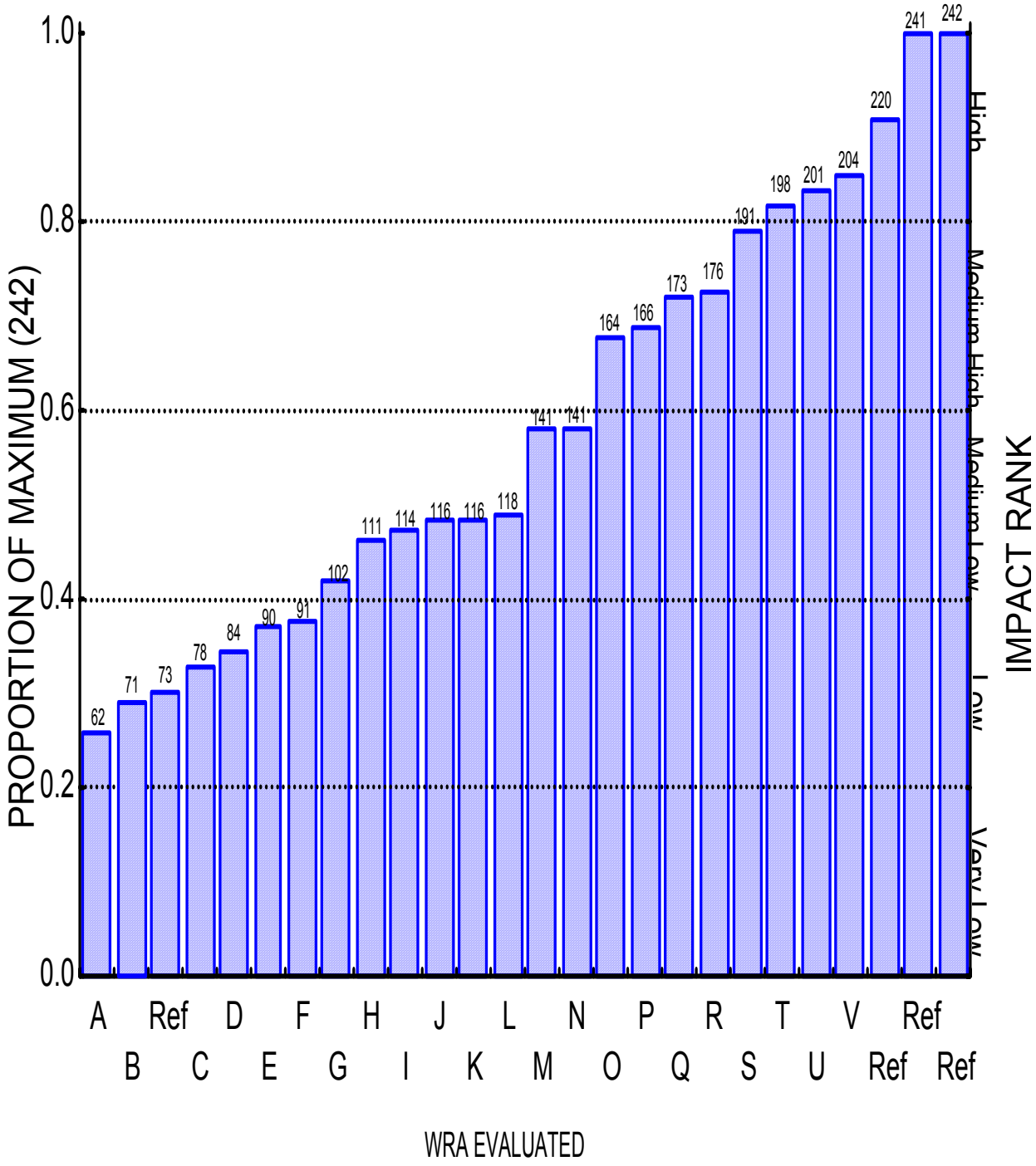


Figure 2. Impact ranks of proposed Wind Resource Areas in Montana. The number above each bar is the PII score. Rank is a function of the proportional relationship of proposed development sites to the maximum score of 4 Reference Sites evaluated.

## Appendix 2

## DEFINITIONS RELATED TO WIND ENERGY DEVELOPMENT AND EVALUATION

**AGL**: height above ground level in feet.

**Breco Bird Scaring Buoy**: a device developed to disperse seabirds at oil spills, which emits some 30 different sounds (including alert calls) up to 130 dB, generally effective in scaring birds at distances up to 200 yards, but may deter birds to 0.5 mile radius. The floating device can be used daytime or night, in fog, wind or storms.

**Deterrent Devices**: specific equipment, devices, or techniques which are intended to be seen or heard to alert and deter birds from contacting turbine towers, rotors, guy wires, or related equipment. These include diverters installed on turbine or meteorological tower guy wires, dark (e.g., black) paint on single turbine blades or portions of a blade, or noise-making devices that alert (e.g., infrasound) or frighten (e.g., Breco Buoys) birds.

**Fish and Wildlife**: any member of the animal kingdom, including any bird (including any migratory, non-migratory, or endangered bird for which protection is afforded), mammal, fish, amphibian, reptile, mollusk, crustacean, arthropod, or other invertebrate. Unless otherwise indicated, the Fish and Wildlife Service is particularly concerned about the impacts of wind turbines on birds and bats.

**Flyway**: a concentrated, predictable flight path of migratory bird species (e.g., particularly water birds such as ducks, geese, large waders, and shorebirds, but also raptors, and sometimes songbirds) from their breeding ground to wintering area. Except along coast lines, the flyway concept may not generally apply to songbirds because they tend to migrate in broad fronts rather than down specific flyways. The term "corridors" has sometimes been used. These frontal movements of songbirds can change within and between seasons and years – as can, for example, movements of waterfowl – making specific designations more difficult. The concept applies both biologically and administratively. For administrative purposes, for example, there are four waterfowl flyways (Atlantic, Pacific, Central, and Pacific and three shorebird flyways (East, Central, and Pacific). "Daily flyways" may also exist between roosting, breeding, and feeding areas.

**Lek**: A traditional site used year after year by males of certain species of birds (in North America, Greater and Lesser Prairie-chickens, Sage and Sharp-tailed grouse, and Buff-breasted Sandpiper), within which the males display communally to compete for female mates. Dominant males secure the majority of all the matings. Pair bonds are not formed; females leave to nest and raise the young, and males do not take part in parental care.

**Passerines**: a scientific term for the order of songbirds, many of which winter in tropical areas.

**Precautionary Approach**: a conservative, scientific approach to conserving and managing habitats and species. Absent definitive data, the approach suggests taking the best steps available to initiate appropriate conservation actions. Those actions should then be refined through the use of principles of adaptive management and sound science. The absence of complete or definitive scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species, or non-target species and their environments. Specifically, developers should apply a precautionary approach widely to conservation and management of birds, bats, other fauna, flora, and affected habitats. This will protect the resources and preserve Wind Resource Areas by taking account of the best scientific evidence available.

**Reference Site**: an area of high wildlife value which is used to evaluate the suitability of other areas for wind energy development. Reference sites are selected by biologists familiar with the wildlife in the geographic area and habitat types where wind energy development is contemplated, and evaluated using the Ranking Protocol in Appendix 1. The reference site having the highest score, i.e., the area where wind energy development would have the greatest negative impact on wildlife, is used as the standard against which potential wind energy development sites are ranked.

**Riparian Area**: The vegetation, habitats, or ecosystems that are associated with streams, rivers, or lakes, or are dependent upon the existence of perennial, intermittent, or ephemeral surface or subsurface water drainage. Relative to other habitats, riparian habitats have a disproportionately high wildlife value in the drier western states due to the

presence of surface water and/or lush vegetation that is typically surrounded by harsher, arid or semi-arid environments.

**Rookery**: the breeding place of a colony of gregarious birds (e.g., herons) or mammals (e.g., bats).

**Rotor-swept Area**: generally the vertical airspace within which the turbine blades (usually 3) rotate on a pivot point or drive train rotor. The Area will vary in location depending on the direction of the prevailing wind. While "slower" turbines may operate at speeds less than 30 revolutions per minute (RPMs), turbine speeds at the blade tips can still exceed 220 miles per hour in stiff winds. Recent studies indicate that birds appear unable to recognize blade presence at rotor tips during high blade speed, referred to as the "smear effect."

**Staging Area**: a traditional site where migratory birds of one or more species congregate in spring and fall for varying periods of time to forage and build up fat reserves prior to launching migratory flights. The term may be used on both the breeding and wintering grounds, as well as at intermediate stopover sites used at any point along the migration route.

**Turbine Position within a Row/String**: the specific position of a turbine within a string or row of turbines. It may be designated as an end-row, mid-row, or lone row turbine (one not located within a row).

**Wind Resource Area**: the geographic area or footprint within which wind turbines are located and operated, such as the Altamont Pass, California, WRA, or where location and operation of turbines are anticipated. The term may be used to describe an existing facility, or a general area in which development of a facility is proposed. Existing facilities are known variously as "wind farms," "wind parks," or "energy parks." WRAs are selected based primarily on the reliability and availability of sufficient wind. These areas are designated by the *United States Wind Resource Map*, published by the National Renewable Energy Laboratory, Department of Energy (http://rredc.nrel.gov). The *Map* delineates wind power classifications from "marginal" to "superb" based on a Weibull wind speed index.

## Appendix 3

## WILDLIFE LAWS RELEVANT TO WIND POWER DEVELOPMENT PROJECTS

**The Migratory Bird Treaty Act** (16 U.S.C. 703-712; MBTA), which is administered by the Fish and Wildlife Service (FWS), is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute wherein proof of intent is not an element of a taking violation. Wording is clear in that most actions that result in a "taking" or possession (permanent or temporary) of a protected species can be a violation. Specifically, the MBTA states:

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

A 1972 amendment to the MBTA resulted in inclusion of Bald Eagles and other birds of prey in the definition of a migratory bird. The MBTA provides criminal penalties for persons who, by any means or in any manner, pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird (including Bald Eagles) as well as possessing Bald Eagles, their parts, nests, or eggs without a permit. A violation of the MBTA by an individual can result in a fine of up to $15,000, and/or imprisonment for up to 6 months, for a misdemeanor, and up to $250,000 and/or imprisonment for up to 2 years for a felony. Fines are doubled for organizations. Penalties increase greatly for offenses involving commercialization and/or the sale of migratory birds and/or their parts. Under authority of the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; BGEPA), Bald and Golden Eagles are afforded additional legal protection. Penalties for violations of the BGEPA are up to $250,000 and/or 2 years imprisonment for a felony, with fines doubled for an organization.

While these Acts have no provision for allowing unauthorized take, the FWS realizes that some birds may be killed even if all reasonable measures to avoid the take are implemented. The FWS Office of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals, companies, and industries who seek to eliminate their impacts on migratory birds. Unless the activity is authorized, it is not possible to absolve individuals, companies, or agencies from liability even if they implement avian mortality avoidance or similar conservation measures. However, the Office of Law Enforcement focuses on those individuals, companies, or agencies that take migratory birds with disregard for their actions and the law, especially when conservation measures have been developed but are not properly implemented.

**The Endangered Species Act** (16 U.S.C. 1531-1544; ESA) was passed by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The purposes of the Act are to protect these endangered and threatened species and to provide a means to conserve their ecosystems. To this end, Federal agencies are directed to utilize their authorities to conserve listed species, as well as "Candidate" species which may be listed in the near future, and make sure that their actions do not jeopardize the continued existence of these species. The law is administered by the Interior Department's FWS and the Commerce Department's National Marine Fisheries Service (NMFS). The FWS has primary responsibility for terrestrial and freshwater organisms, while the NMFS has responsibility for marine species such as whales and salmon. These two agencies work with other agencies to plan or modify Federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the States, with Federal financial assistance and a system of incentives available to encourage State participation. The FWS also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take means ". . . to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The Secretary

of the Interior, through regulations, defined the term "harm" as "an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." However, permits for "incidental take" can be obtained from the FWS for take which would occur as a result of an otherwise legal activity, such as construction of wind turbines, and which would not jeopardize the species.

Section 10 of the ESA allows for the development of "Habitat Conservation Plans" for endangered species on private lands. This provision is designed to assist private landowners in incorporating conservation measures for listed species with their land and/or water development plans. Private landowners who develop and implement an approved habitat conservation plan can receive an incidental take permit that allows their development to go forward.

**The National Environmental Policy Act** of 1969 (42 U.S.C. 4371 et seq.; NEPA) requires that Federal agencies prepare an environmental impact statement (EIS) for Federal actions significantly affecting the quality of the human environment. "Federal Actions" are those actions in which a Federal agency is conducting the activity, providing funding for the activity, or licensing or permitting the activity. An EIS must describe the proposed action, present detailed analyses of the impacts of the proposed action and alternatives to that action, and include public involvement in the decision making process on how to proceed to accomplish the purpose of the action. The purpose of NEPA is to allow better environmental decisions to be made. The Council on Environmental Quality, established by NEPA, has promulgated regulations in 40 CFR 1500-1508 that include provisions for 1) preparing EISs and Environmental Assessments, 2) considering categorical exclusions from NEPA documentation requirements for certain agency actions, and 3) developing cooperating agency agreements between Federal agencies.

Other Federal agencies may be required by NEPA to review and comment on proposed activities as a cooperating agency with the action agency under Section 1501.6, or because of a duty to comment on federally-licensed activities for which the agency has jurisdiction by law (Section 1503.4). For the FWS, this would be the MBTA and BGEPA. Other agencies may also be called on for review and comment because of special expertise.

**The National Wildlife Refuge System Administration Act** (16 U.S.C. 668dd), as amended, serves as the "organic act" for the National Wildlife Refuge System. It consolidates the various categories of lands administered by the Secretary of the Interior (Secretary) through the FWS into a single National Wildlife Refuge System. The Act establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. The Act states first and foremost that the mission of the National Wildlife Refuge System will be focused singularly on wildlife conservation.

The Act identifies six priority wildlife-dependent recreation uses; clarifies the Secretary's authority to accept donations of money for land acquisition; and places restrictions on the transfer, exchange, or other disposal of lands within the Refuge System. Most importantly, the Act reinforces and expands the "compatibility standard" of the Refuge Recreation Act, authorizing the Secretary, under such regulations as he may prescribe, to "permit the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he determines that such uses are compatible with the major purposes for which such areas were established." This section applies to any proposed development of wind energy on Refuge System lands; such development must be compatible with the major purpose for which that Refuge was established.

**The National Historic Preservation Act** of 1966 (16 U.S.C. 470-470b, 470c-470n) approved October 15, 1966 and repeatedly amended, provides for preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the States. It established a National Register of Historic Places and a program of matching grants under the existing National Trust for Historic Preservation (16 U.S.C. 468-468d). The Act also requires Federal agencies to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register. Thus, the Act functions similarly to NEPA, requiring a determination of the presence of any such items or sites, and an evaluation of the effects of proposed developments (such as wind energy facilities) on them, if the facility would be built, funded, licensed or permitted by a Federal agency. This includes State lands purchased or improved with Federal Aid in Wildlife Restoration funds.

## Appendix 4

## RESEARCH NEEDS ON THE IMPACTS OF WIND POWER DEVELOPMENT ON WILDLIFE

Representatives of the Fish and Wildlife Service's Wind Turbine Siting Working Group have suggested the following research needs:

- Effects of inclement weather in attracting birds and bats to lighted turbines, e.g., drawing birds and bats to within rotor-swept area of turbines, particularly for passerines during spring and fall migrations.

- Localized effects of turbines on wildlife: habitat fragmentation and loss; effects of noise on both aquatic and terrestrial wildlife; habituation.

- Effects of wind turbine string configuration on mortality, e.g., end of row turbine effect, turbines in dips or passes or draws, setbacks from rim/cliff edges.

- Effectiveness of deterrents: alternating colors on blades (particularly, effect of black/white and UV gel coats on the smear effect); lights (e.g., color, duration, and intensity of pilot warning lights; lasers); infrasound (Breco Buoys, other noisemakers such as predator and distress calls if not irritating to humans, other wildlife, or domestic animals); visual markers on guy wires.

- Utility of acoustic, infrared, and radar technologies to detect bird species presence, abundance, location height, and movement.

- Accuracy of mortality counts: estimate of the number of carcasses (especially of passerines) lost because they have been fragmented and lost to collision momentum and the wind; size and shape of dead bird search areas; possibility of recording collisions acoustically or with radar or infrared monitoring.

- Annual variability (temporal and spatial) in migratory pathways; what is the utility of Geographic Information System to assess migratory pathways and stopovers, particularly for passerines and bats.

- Effectiveness of seasonal wind turbine shutdowns at preventing mortalities, including the feasibility of using "self-erecting" turbines that are easily erected and dismantled without cranes, and taking them down during critical periods such as migrations.

- Impacts of larger turbines versus smaller models.

- Changes in predator-prey relationships due to placing potential perching sites in prairie habitats.

## Appendix 5

## PROCEDURES FOR ENDANGERED SPECIES EVALUATIONS AND CONSULTATIONS

The Endangered Species Act (ESA) directs all Federal agencies to participate in endangered species conservation. Specifically, section 7(a)(1) of the ESA charges Federal agencies to aid in the conservation of listed species. Section 7 (a)(2) requires Federal agencies to consult with the Fish and Wildlife Service (FWS) to ensure that actions that they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify designated critical habitats. The FWS has developed a handbook describing the consultation process in detail. It is available on the FWS web site at http://endangered.fws.gov/consultations. Consultation may be informal or formal, depending upon the presence of listed species and the potential for the proposed project to affect them.

Before initiating an action, the Federal action agency (the agency authorizing a specific action) or its non-Federal permit applicant, must ask the FWS to provide a list of threatened, endangered, proposed, and candidate species and designated critical habitats that may be present in the project area. This initiates the informal consultation process. If the FWS answers that no species or critical habitats are present, then the Federal action agency or permit applicant has no further ESA obligation under section 7(a)(2), and consultation is concluded. If listed species or critical habitats are present, then the action agency or applicant must determine whether the project may affect those species (known as a *may affect* determination), and informal consultation continues. If the action agency or applicant determines, and the FWS agrees, that the project does not adversely affect any listed species, then the consultation is concluded and the decision is put in writing.

If the action agency or applicant determines that a project *may adversely affect* a listed species or designated critical habitat, the action agency/applicant prepares a *Biological Assessment* and requests formal consultation. There is a designated period of time in which to consult (90 days), and beyond that, another set period of time for the FWS to prepare a *biological opinion* (45 days). An analysis of whether or not the proposed action would be likely to jeopardize the species or adversely modify its critical habitat is determined in the biological opinion. If a *jeopardy* or *adverse modification* determination is made, the biological opinion must identify any reasonable and prudent alternatives that could allow the project to move forward.

The biological opinion will contain an "incidental take statement." "Take" is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting or attempting to engage in any such conduct. "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to a listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, an otherwise lawful activity. If the FWS issues a *jeopardy* opinion, the incidental take statement will simply state that no take is authorized. If the FWS issues a nonjeopardy opinion, the FWS will anticipate the take that may result from the proposed project and describe that take in the incidental take statement. The statement will contain clear terms and conditions designed to reduce the impact of the anticipated take to the species; these terms are non-discretionary on the action agency or applicant.

When non-Federal activities will result in take of threatened or endangered species, an *incidental take permit* is required under section 10 of the ESA. A habitat conservation plan or "HCP" must accompany an application for an incidental take permit. The habitat conservation plan associated with the permit is to ensure that there are adequate conservation measures to avoid jeopardy to the species.

Examples:

1. **No Effect** – The appropriate conclusion when the action agency or applicant determines that its proposed action will not affect a listed species or designated critical habitat.

   Example: A permit applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 3 plants, 1 fish, and 1 butterfly. The proposed project would be constructed at an upland site on clay soils. The 3 plants are found only on sandy soils. The butterfly's habitat is one of the plants on sandy soil. The nearest sandy soils are 10 miles from the proposed project. The fish is in a stream 5 miles from the proposed project. Conclusion: No effects from the project, either

direct or indirect. Justification: No construction is proposed in listed species habitat or in an area that may affect listed species. In addition, the project proponent has charted a route for heavy equipment moving onto the construction site that avoids listed species habitat.

2. **May Affect, but Not Likely to Adversely Affect** – The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (a) be able to meaningfully measure, detect, or evaluate insignificant effects, or (b) expect discountable effects to occur.

   Example: The applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 2 birds and 1 fish. The proposed project would be constructed at an upland site, 200 yards from the stream (fish habitat) and adjoining riparian vegetation (bird habitat). The migratory birds use the riparian vegetation to nest between April 15 and August 15. The uplands are highly erodible soils. The project proponent agrees not to construct during the nesting season. He flags the riparian vegetation to indicate an avoidance zone and installs silt fencing between the riparian vegetation and the construction site. He states that he will plant the disturbed soils surrounding the project with native vegetation after construction. He also agrees to monitor the vegetation planted for 3 years to assure that it establishes sufficiently to prevent any additional erosion in the project area caused by construction. Conclusion: Although the project proponent is working in very close proximity to listed species habitat, the action is not likely to adversely affect listed species. Justification: The proponent has incorporated sufficient avoidance and other mitigation measures into the project that any effects to listed species would be discountable. The project proponent prepares a Biological Assessment that includes a complete description of the project, all proposed avoidance and other mitigation measures, and the resulting effects of the project on the listed species. The Biological Assessment is sent to the FWS to request concurrence that the project is not likely to adversely affect listed species.

3. **May Affect, and Likely to Adversely Affect** – The appropriate finding in a Biological Assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made. This determination requires the initiation of formal section 7 consultation.

   Example: The applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 10 birds. The proposed project would be constructed at an upland site within a significant migratory bird corridor that is utilized by the 10 listed birds. Construction will permanently alter the character of the corridor and will likely cause take of listed birds every year during the migration periods. Conclusion: Formal consultation will be required. The project proponent prepares a Biological Assessment to submit to the action agency to accompany their request to initiate formal consultation. Justification: The project is likely to cause take of listed birds every year during their migration periods.

**Appendix 6**

## GUIDELINES FOR CONSIDERING WIND TURBINE SITING ON EASEMENT LANDS ADMINISTERED AS PART OF THE NATIONAL WILDLIFE REFUGE SYSTEM IN REGION 6

Grassland easements are acquired to protect native and planted grasslands essential for grassland dependent migratory birds and other wildlife. Healthy grasslands provide both nesting and migration habitat necessary to maintain these important populations. Wind energy could severely impact this important program if not developed carefully with as little impact to migratory birds and their habitat as possible.

The following guidelines are to be used when making compatibility determinations for the siting of wind turbines and associated facilities on lands encumbered by U.S. Fish and Wildlife Service (Service) grassland easements and USDA conservation easements administered by the Service in Region 6, particularly in North Dakota, South Dakota, and Montana. These guidelines are intended to provide guidance for considering compatibility determinations during the period while the Service and the wind power industry monitor potential impacts to migratory birds as a result of turbine construction, maintenance, and operation. The following guidelines will be incorporated into rights-of-way permits issued for the construction of turbines, access roads, and other associated activities necessary to make the turbines operational. The intention of these guidelines is to minimize impacts to migratory birds and protect the habitat covered by the easement. The guidelines pertain only to permits issued for the alteration or destruction of grassland habitat as a result of turbine and other associated construction on lands encumbered by Service easements.

Refuge Managers and Wetland District Managers shall use these guidelines for site-by-site consideration of compatibility determinations for individual right-of-way requests for wind turbines on easement lands. These guidelines may be incorporated as needed as right-of-way or permit stipulations.

These guidelines may be revised and modified as a result of the findings of research and monitoring conducted in the future. Wind turbine rights-of-way applications will be reviewed according to these guidelines in conjunction with the Service's compatibility policy and in accordance with 50 CFR 29.21 and the Service Realty Manual. Future right-of-way applications will be reviewed using the guidelines in effect at the time of application. The Service will not make changes to previously issued rights-of-way or easement permits issued under these guidelines.

1) The Service may permit up to one turbine per 160 acres on an individual easement tract. No more than one turbine may be allowed on an individual easement tract of less than 160 acres. Current biological information (Attachment 2) indicates that this density of turbines would not have any significant impact to grassland habitat and its value to migratory birds or other wildlife. This is the upper limit for the density of turbines on easements. However, consideration may be given to clump or consolidate towers within an easement tract(s) to minimize the disturbance to the remaining habitat, i.e., two turbines may be clumped on a tract of 320 acres. Information available at this time indicates that turbine densities at this level will not materially interfere with or detract from the purposes of the easement (Attachment 2). Wind power industry turbine spacing recommendations are 2,000 feet between wind turbines and 2,000 feet from an occupied building. This constraint may limit the ability to clump turbines.

2) Turbines shall not be constructed in wetlands, including lakes, ponds, marshes, sloughs, swales, swamps, or potholes. Similarly, turbine locations should avoid obvious "duck passes" between large (20 acres or greater), semi-permanent (type 4, or cattail/bulrush) wetlands or sloughs. In addition, known migratory bird corridors or flight paths and environmentally sensitive areas such as colonial bird nesting areas or upland game bird leks, should be avoided.

3) Siting recommendations made by the Service for turbines and access roads and turbine lighting recommendations shall be consistent with all general siting and mitigating measures for tower and transmission line construction (Director's September 14, 2000 memorandum, attachment 3, APLIC 1996, and APLIC 1994).

4) Priority should be given to siting turbines on tame, planted, or seeded grasslands in preference to unbroken native prairie when such options are available on a given easement tract.

5) Spoil material from the excavated turbine pad shall not be deposited in wetlands and must be stored or deposited off easement lands using established roads to transport the material off site.

6) Turbines shall be sited as close to existing roads or the edge of the grassland tract as practical. Disturbance of grassland to construct and maintain a wind turbine shall be done in such a manner as to minimize the destruction or alteration of the habitat. Use of existing roads as a means of accessing a turbine within protected habitats is strongly encouraged. Conservation measures shall be used to avoid the impacts of erosion and sedimentation in order to protect grasslands and wetlands during the construction of the access road. Buried transmission lines, electric lines, and other cables shall be co-located on the access road when practical. Turbine construction should be encouraged to occur outside the breeding season for migratory birds when practical.

7) Regardless of a Service permit the developer is responsible for adhering to all local, state, and federal regulations in siting turbine location and construction. In the event that location and construction criteria conflict between the various levels of government, the criteria providing the maximum protection to the habitat shall be the criteria used during turbine location and construction.

8) In the event that a turbine is no longer utilized for power generation and has been abandoned for that purpose, the turbine owner shall remove the turbine at his/her own expense from the easement tract. The turbine site and associated facilities shall be reclaimed by the turbine owner by planting these areas to a grass mixture consistent with the surrounding grassland or such mixture as is mutually agreed upon by the Service and the turbine owner.

9) The turbine owner must update bird strike avoidance equipment on turbines and implement techniques that reduce the disturbance to nesting birds at turbine sites as future research and evaluation by the Service and the industry indicate.

These guidelines provide flexibility for the Service Refuge Manager in evaluating compatibility determinations and to negotiate with the energy company and the easement landowner to allow wind turbine development consistent with the purposes of the conservation easements. Where development is found to be compatible with easement purposes the guidelines will be used to negotiate siting, lighting, and other restrictions to grant rights-of-way and easement permits for wind turbines.

References:

Avian Power Line Interaction Committee (APLIC). 1994. Mitigating bird collisions with power lines: The state of the art in 1994.

Avian Power Line Interaction Committee (APLIC). 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996.

Attachment 2

**Potential Effect of Wind Turbine Presence on Numbers of Breeding Grassland Birds and Nesting Ducks on Grassland Easement Properties in North and South Dakota.**

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Recently, companies that develop wind-powered electricity generation have begun operations in areas of South Dakota and North Dakota where the U.S. Fish and Wildlife Service has purchased or intends to purchase conservation easements on grasslands. Questions have been raised within the FWS as to whether the placement of wind towers on easement tracts would violate terms of the easement contract, and whether the Service would consider purchasing easements on lands after towers are in place. Before allowing turbines on easement lands, the Service must address the issue of whether placement of wind turbines on grassland easements is compatible with the

goals and purpose of refuge lands as defined by the Refuge Improvement Act, which states that, "A Compatible use means . . . any other use of a National Wildlife Refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes(s) of the National Wildlife Refuge." If birds avoid the area surrounding wind turbines because of noise, disruption of habitat, or disturbance, the biological value of an easement may be compromised. At this time, we do not know if wind turbines are compatible with the purpose of grassland easements, because we do not know if turbines reduce the attractiveness of a site to birds or if turbines affect avian reproductive success. The issue is complicated partly because, if, the FWS restricts certain alternative uses on easements, this may reduce the willingness of landowners to offer to sell easements to the FWS in the future. For example, some landowners believe the potential income derived from wind generators will exceed the income from selling grass easements to the FWS or other conservation organizations. In this respect, the future success of the easement program could be compromised if these restrictions are unnecessary.

Little is known about bird avoidance of grasslands near wind turbines, as previous avian research at wind towers has focused primarily on bird strikes. In one study that did consider avoidance, density of grassland birds was reduced in the immediate vicinity of wind turbines at Buffalo Ridge, Minnesota, (Leddy et al. 1999), although at larger scales no differences were detected (Johnson et al. 2000). However, in the Buffalo Ridge study, wind turbines were placed primarily in Conservation Reserve Program fields with few wetlands and much higher densities of breeding birds than are typically found in native prairie where grassland easements are targeted in the Dakotas, and therefore results from Leddy et al. (1999) may not be applicable here. In the absence of specific data on the effect of wind turbines on birds in North and South Dakota, we used two approaches to assess the potential impact; 1) existing data (Igl and Johnson 1997, D. H. Johnson, unpublished data) was used to estimate the potential impact of wind turbine placement on grassland bird use in quarter-section (160 acre) parcels, and 2) a Mallard productivity model (Cowardin et al. 1988) was used to predict changes in nesting and recruitment rate of ducks on grassland areas with wind turbines in place.

**Grassland birds.** For the first assessment, abundance of grassland birds, standardized to 160 acres of grassland habitat, was estimated from data gathered on 128 quarter sections in North Dakota during summers of 1992 and 1993 (Igl and Johnson 1997, D. H. Johnson, unpublished data). We estimated the potential impact of wind turbines at two scales representing a five-acre and two-acre loss of habitat for each wind tower, with one wind tower per quarter section. We estimated the two-acre potential area of impact as approximately 4 times the area of road and tower pad (Appendix 1); the five-acre area of impact was estimated using the 80-m reported zone of reduced bird density surrounding towers at Buffalo Ridge (Leddy et al. 1999, Appendix 1). For purposes of our analysis, we assumed that no grassland birds would be present in the area immediately surrounding the tower, which is a worst-case scenario, because (Leddy et al. 1999) showed that birds are present immediately adjacent to turbines, but at reduced densities. Thus, our methods guaranteed we would predict a reduction in birds using easements, however, our intent was to put this change into perspective relative to bird use on the entire easement. Given the high variance associated with the grassland bird data we used, it would be impossible to detect a statistically significant decrease in grassland bird numbers, because the lower 95% confidence limit for population estimates was less than zero for each species (D. H. Johnson, unpublished data). Therefore, we estimated the impact of tower presence by calculating the density of each grassland bird species per 160-acre tract, and then calculating the mean reduction in the number of pairs if 2 acre and 5 acre areas of habitat were considered as unused (Table 1).

Expected reductions were estimated at approximately 1% and 3% of the number of individuals present for each species. As expected, greatest reductions in number of pairs occurred with common species such as the chestnut-collared longspur and horned lark; where, at the 5 acres level, a reduction of less than 1 pair per 160-acre tract would be expected. For all species combined, we estimated the expected maximum reduction would be about 2 pairs per 160 acre area, or about 3 percent of the total population. As mentioned previously, based on variation observed in the existing data set, these levels of change would not be statistically significant. Additionally, because we would expect some bird use of the area near the tower, the actual change would likely be less than the numbers presented in table 1.

Table 1. Mean number of breeding pairs of grassland birds found per 160 acres of grassland and expected reduction in pairs with loss of 5 acres and 2 acres of habitat. Data based on surveys of 128 160-acre parcels in North Dakota during summers of 1992 and 1993 (Igl and Johnson 1997, D. H. Johnson, unpublished data).

| | Mean Number (pairs) | | Mean Reduction (pairs) | |
|---|---|---|---|---|
| Species | 1992 | 1993 | 5 acre | 2 acre |
| Baird's Sparrow | 1.424 | 2.464 | 0.06075 | 0.0243 |
| Bobolink | 0.336 | 0.784 | 0.0175 | 0.007 |

| | | | | |
|---|---|---|---|---|
| Brewer's Sparrow | 0 | 0 | 0 | 0 |
| Brown-headed Cowbird | 2.88 | 3.632 | 0.10175 | 0.0407 |
| Chestnut-collared Longspur | 15.584 | 19.696 | 0.55125 | 0.2205 |
| Clay-colored Sparrow | 2.08 | 1.92 | 0.0625 | 0.025 |
| Common Yellowthroat | 0.144 | 0.112 | 0.004 | 0.0016 |
| Dickcissel | 0.304 | 0.32 | 0.00975 | 0.0039 |
| Ferruginous Hawk | 0.032 | 0.24 | 0.00425 | 0.0017 |
| Field Sparrow | 0.24 | 0 | 0.00375 | 0.0015 |
| Grasshopper Sparrow | 6.368 | 8.928 | 0.239 | 0.0956 |
| Gray Catbird | 0 | 0 | 0 | 0 |
| Gray Partridge | 0.16 | 0.128 | 0.0045 | 0.0018 |
| Horned Lark | 6.88 | 12.544 | 0.3035 | 0.1214 |
| Killdeer | 0.544 | 0.848 | 0.02175 | 0.0087 |
| Lark Bunting | 8.416 | 4.16 | 0.1965 | 0.0786 |
| Lark Sparrow | 0.448 | 0.128 | 0.009 | 0.0036 |
| Le Conte's Sparrow | 0 | 0.192 | 0.003 | 0.0012 |
| Northern Harrier | 0.304 | 0.512 | 0.01275 | 0.0051 |
| Red-winged Blackbird | 1.616 | 1.248 | 0.04475 | 0.0179 |
| Ring-necked Pheasant | 0.16 | 0.368 | 0.00825 | 0.0033 |
| Savannah Sparrow | 1.184 | 2.144 | 0.052 | 0.0208 |
| Sedge Wren | 0.16 | 0 | 0.0025 | 0.001 |
| Sharp-tailed Grouse | 0.432 | 0.464 | 0.014 | 0.0056 |
| Sharp-tailed Sparrow | 0.032 | 0 | 0.0005 | 0.0002 |
| Short-eared Owl | 0.032 | 0.032 | 0.001 | 0.0004 |
| Sprague's Pipit | 0.256 | 0.576 | 0.013 | 0.0052 |
| Swainson's Hawk | 0.032 | 0.16 | 0.003 | 0.0012 |
| Upland Sandpiper | 1.52 | 1.552 | 0.048 | 0.0192 |
| Vesper Sparrow | 1.312 | 0.976 | 0.03575 | 0.0143 |
| Western Meadowlark | 7.088 | 11.184 | 0.2855 | 0.1142 |
| **SUM** | **59.97** | **75.31** | **2.11** | **0.85** |

**Ducks.** To assess the impact of wind turbines on ducks, we used the Mallard Productivity Model (Cowardin et al. 1988). The Mallard Model is particularly useful for this exercise because it allowed us to predict any "net" change in nest site selection and recruitment that might occur as a result of simulating the reduction of grasslands available to nesting hens due to the placement of wind turbines. For example, if grassland availability is reduced as a result of disturbance, displaced hens may select other habitat types (e.g., cropland, hayland etc.) in the area for nesting, or they may elect to nest elsewhere in the grasslands protected by easement. If other habitats are selected, this could result in reduced recruitment because, most other habitats are characterized by lower nest success compared to grass habitats. However, if these hens select nest sites in the remaining grasslands outside the influence of the wind turbines, nest success will not change materially and recruitment rate will be the same with-or-without turbines. For this exercise, we selected six study areas from Four Square Mile plots used for breeding population and production surveys (Cowardin et al. 1995) in the Kulm Wetland Management District in North Dakota. Plots were selected that had ≥160 acres of grassland in one unit, and were accessible to ≥60 breeding duck pairs (≥12 mallard pairs) based on the "thunderstorm map" (HAPET 2000) for North Dakota. These criteria are consistent with those used by FWS Realty Office, Bismarck, ND for focusing grassland easements, and the Kulm WMD is representative of areas where the grassland easement program is being targeted. For the purpose of our assessment, all grasslands on study plots selected were treated as protected by easement. This was done to obtain sample acreage similar to easement acreage being purchased. We ran the model on plots with-and-without wind turbines in place and compared the response by mallard hens. The area of influence for turbines was set at 5 acres and was converted to barren habitat which simulated eliminating all nesting activity in that area. To reduce variability, and thus increase the precision of our estimates we conducted eight model runs (1000 hens each) and then scaled the average results to the estimated mallard population on each study plot.

Neither nests initiated or recruitment rates differed significantly between treatment and control model runs (Table 2). The variation shown in nests initiated and recruitment rate between treatment and control runs is due to variation inherent in the biological system being examined. The model predicts that hens displaced by the presence of wind turbines will select nesting sites in the remaining available grass habitat and that recruitment rates will not be influenced.

**Summary.** Using data collected in North Dakota and South Dakota for grassland birds and ducks, we were able to estimate the magnitude of change that would likely be observed if similar data were collected on grassland easement properties. For some species of grassland birds that have restricted distributions the changes predicted could be underestimated on some sites, but it is unlikely these would be of a different order of magnitude. For ducks, the changes predicted account for differences in geographic distribution. Based on our assessment, the expected impact of wind turbines on grassland nesting species would be negligible with the density of one turbine per 160 acre area.

Table 2. Mallard nests initiated and recruitment rate estimates on six study plots with-and-without wind turbines, based on Mallard Model predictions. ( ) standard errors.

| | | | Without Wind Turbines | | | With Wind Turbines | | | |
|---|---|---|---|---|---|---|---|---|---|
| Study plot | Pop. Estimate | Grass Acres | Init. Nests | Recr. Rate | SE | No. Turbines | Init.Nests | Recr. Rate | SE |
| 153 | 55 | 761 | 21 | 0.67 | (.0115) | 2 | 21 | 0.64 | (.0090) |
| 178 | 60 | 205 | 14 | 0.53 | (.0094) | 1 | 13 | 0.52 | (.0064) |
| 329 | 45 | 1496 | 59 | 0.57 | (.0055) | 3 | 59 | 0.59 | (.0124) |
| 330 | 35 | 1810 | 51 | 0.55 | (.0163) | 8 | 52 | 0.55 | (.0118) |
| 331 | 26 | 1310 | 18 | 0.62 | (.0104) | 2 | 18 | 0.59 | (.0120) |
| 332 | 70 | 1312 | 58 | 0.58 | (.0166 | 2 | 60 | 0.58 | (.0072) |

LITERATURE CITED

Cowardin, L. M., D. H. Johnson, T. L. Shaffer, and D. L. Sparling. 1988. Applications of a simulation model to decisions in mallard management. U. S. Fish and Wildlife Service Technical Report 17.

Cowardin, L. M., T. L. Shaffer, and P.M. Arnold. 1995. Evaluation of Duck habitat and estimation of duck population sizes with a remote-sensing-based system. Biological Science Report 2.

Igl, L. D., and D. H. Johnson. 1997. Changes in breeding bird populations in North Dakota: 1967 to 1992-1993. Auk 114:74-92.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. A. Shepherd. 2000. Avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: results of a 4-year study. Western Ecosystems Technology, Inc. Cheyenne, Wyoming. 262pp.

Leddy, K. L., K. F. Higgins, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bulletin 111:100-104.

APPENDIX 1. Calculations of potential area of impact for wind towers on grassland easements in North Dakota and South Dakota.

**Two-acre impact**:

| | | |
|---|---|---|
| 40 foot by 40 foot pad for tower | | 1,600 $ft^2$ |
| 16.5 foot by 1320 foot access road | | 21,780 $ft^2$ |
| | total | 23,380 |

Physical disruption of site is approximately 0.54 acre; we multiplied this by four to estimate a zone of potential impact.

**Five-acre impact**:
80-m zone of reduced density surrounding tower

| | |
|---|---|
| 80 m * 80 m * 3.14 | 2.0 ha |
| ˜ 2.5 acres per ha | 5.0 acres |

Attachment 3

Memorandum

To: Regional Directors, Regions 1-7

From: Director

Subject: Service Guidance on the Siting, Construction, Operation and Decommissioning of Communications Towers

Construction of communications towers (including radio, television, cellular, and microwave) in the United States has been growing at an exponential rate, increasing at an estimated 6 percent to 8 percent annually. According to the Federal Communication Commission=s *2000 Antenna Structure Registry*, the number of lighted towers greater than 199 feet above ground level currently number over 45,000 and the total number of towers over 74,000. By 2003, all television stations must be digital, adding potentially 1,000 new towers exceeding 1,000 feet AGL.

The construction of new towers creates a potentially significant impact on migratory birds, especially some 350 species of night-migrating birds. Communications towers are estimated to kill 4-5 million birds per year, which violates the spirit and the intent of the Migratory Bird Treaty Act and the Code of Federal Regulations at Part 50 designed to implement the MBTA. Some of the species affected are also protected under the Endangered Species Act and Bald and Golden Eagle Act.

Service personnel may become involved in the review of proposed tower sitings and/or in the evaluation of tower impacts on migratory birds through National Environmental Policy Act review; specifically, sections 1501.6, opportunity to be a cooperating agency, and 1503.4, duty to comment on federally-licensed activities for agencies with jurisdiction by law, in this case the MBTA, or because of special expertise. Also, the National Wildlife Refuge System Improvement Act requires that any activity on Refuge lands be determined as compatible with the Refuge system mission and the Refuge purpose(s). In addition, the Service is required by the ESA to assist other Federal agencies in ensuring that any action they authorize, implement, or fund will not jeopardize the continued existence of any federally endangered or threatened species.

A Communication Tower Working Group composed of government agencies, industry, academic researchers and NGO=s has been formed to develop and implement a research protocol to determine the best ways to construct and operate towers to prevent bird strikes. Until the research study is completed, or until research efforts uncover significant new mitigation measures, all Service personnel involved in the review of proposed tower sitings and/or the evaluation of the impacts of towers on migratory birds should use the attached interim guidelines when making recommendations to all companies, license applicants, or licensees proposing new tower sitings. These guidelines were developed by Service personnel from research conducted in several eastern, midwestern, and southern States, and have been refined through Regional review. They are based on the best information available at this time, and are the most prudent and effective measures for avoiding bird strikes at towers. We believe that they will provide significant protection for migratory birds pending completion of the Working Group=s recommendations. As new information becomes available, the guidelines will be updated accordingly.

Implementation of these guidelines by the communications industry is voluntary, and our recommendations must be balanced with Federal Aviation Administration requirements and local community concerns where necessary. Field

offices have discretion in the use of these guidelines on a case by case basis, and may also have additional recommendations to add which are specific to their geographic area.

Also attached is a Tower Site Evaluation Form which may prove useful in evaluating proposed towers and in streamlining the evaluation process. Copies may be provided to consultants or tower companies who regularly submit requests for consultation, as well as to those who submit individual requests that do not contain sufficient information to allow adequate evaluation. This form is for discretionary use, and may be modified as necessary.

The Migratory Bird Treaty Act (16 U.S.C. 703-712) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the Act has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as communications towers even if all reasonable measures to avoid it are implemented. The Service=s Division of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the Act to absolve individuals or companies from liability if they follow these recommended guidelines, the Division of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals or companies who have made good faith efforts to avoid the take of migratory birds.

Please ensure that all field personnel involved in review of FCC licensed communications tower proposals receive copies of this memorandum. Questions regarding this issue should be directed to Dr. Benjamin N. Tuggle, Chief, Division of Habitat Conservation, at (703)358-2161, or

Jon Andrew, Chief, Division of Migratory Bird Management, at (703)358-1714. These guidelines will be incorporated in a Director=s Order and placed in the Fish and Wildlife Service Manual at a future date.

Attachment

cc: 3012-MIB-FWS/Directorate Reading File
3012-MIB-FWS/CCU Files
3245-MIB-FWS/AFHC Reading Files
840-ARLSQ-FWS/AF Files
400-ARLSQ-FWS/DHC Files
400-ARLSQ-FWS/DHC/BFA Files
400-ARLSQ-FWS/DHC/BFA Staff
520-ARLSQ-FWS/LE Files
634-ARLSQ-FWS/MBMO Files (Jon Andrew)

FWS/DHC/BFA/RWillis:bg:08/09/00:(703)358-2183
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**Service Interim Guidelines For Recommendations On**
**Communications Tower Siting, Construction, Operation, and Decommissioning**

1. Any company/applicant/licensee proposing to construct a new communications tower should be strongly encouraged to collocate the communications equipment on an existing communication tower or other structure (e.g., billboard, water tower, or building mount). Depending on tower load factors, from 6 to 10 providers may collocate on an existing tower.

2. If collocation is not feasible and a new tower or towers are to be constructed, communications service providers should be strongly encouraged to construct towers no more than 199 feet above ground level, using construction techniques which do not require guy wires (e.g., use a lattice structure, monopole, etc.). Such towers should be unlighted if Federal Aviation Administration regulations permit.

3. If constructing multiple towers, providers should consider the cumulative impacts of all of those towers to migratory birds and threatened and endangered species as well as the impacts of each individual tower.

4. If at all possible, new towers should be sited within existing "antenna farms" (clusters of towers). Towers should not be sited in or near wetlands, other known bird concentration areas (e.g., State or Federal refuges, staging areas, rookeries), in known migratory or daily movement flyways, or in habitat of threatened or endangered species. Towers should not be sited in areas with a high incidence of fog, mist, and low ceilings.

5. If taller (>199 feet AGL) towers requiring lights for aviation safety must be constructed, the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white (preferable) or red strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. Current research indicates that solid or pulsating (beacon) red lights attract night-migrating birds at a much higher rate than white strobe lights. Red strobe lights have not yet been studied.

6. Tower designs using guy wires for support which are proposed to be located in known raptor or waterbird concentration areas or daily movement routes, or in major diurnal migratory bird movement routes or stopover sites, should have daytime visual markers on the wires to prevent collisions by these diurnally moving species. (For guidance on markers, see *Avian Power Line Interaction Committee (APLIC). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D.C., 78 pp*, and *Avian Power Line Interaction Committee (APLIC). 1996. Suggested Practices for Raptor Protection on Power Lines. Edison Electric Institute/Raptor Research Foundation, Washington, D.C., 128 pp.* Copies can be obtained via the Internet at http://www.eei.org/resources/pubcat/enviro/, or by calling 1-800/334-5453).

7. Towers and appendant facilities should be sited, designed and constructed so as to avoid or minimize habitat loss within and adjacent to the tower "footprint"@ However, a larger tower footprint is preferable to the use of guy wires in construction. Road access and fencing should be minimized to reduce or prevent habitat fragmentation and disturbance, and to reduce above ground obstacles to birds in flight.

8. If significant numbers of breeding, feeding, or roosting birds are known to habitually use the proposed tower construction area, relocation to an alternate site should be recommended. If this is not an option, seasonal restrictions on construction may be advisable in order to avoid disturbance during periods of high bird activity.

9. In order to reduce the number of towers needed in the future, providers should be encouraged to design new towers structurally and electrically to accommodate the applicant/licensee's antennas and comparable antennas for at least two additional users (minimum of three users for each tower structure), unless this design would require the addition of lights or guy wires to an otherwise unlighted and/or unguyed tower.

10. Security lighting for on-ground facilities and equipment should be down-shielded to keep light within the boundaries of the site.

11. If a tower is constructed or proposed for construction, Service personnel or researchers from the Communication Tower Working Group should be allowed access to the site to evaluate bird use, conduct dead-bird searches, to place net catchments below the towers but above the ground, and to place radar, Global Positioning

System, infrared, thermal imagery, and acoustical monitoring equipment as necessary to assess and verify bird movements and to gain information on the impacts of various tower sizes, configurations, and lighting systems.

12. Towers no longer in use or determined to be obsolete should be removed within 12 months of cessation of use.

In order to obtain information on the extent to which these guidelines are being implemented, and to identify any recurring problems with their implementation which may necessitate modifications, letters provided in response to requests for evaluation of proposed towers should contain the following request:

> "In order to obtain information on the usefulness of these guidelines in preventing bird strikes, and to identify any recurring problems with their implementation which may necessitate modifications, please advise us of the final location and specifications of the proposed tower, and which of the measures recommended for the protection of migratory birds were implemented. If any of the recommended measures can not be implemented, please explain why they were not feasible."

## Appendix 7

## KNOWN AND SUSPECTED IMPACTS OF WIND TURBINES ON WILDLIFE

While wind-generated electrical energy is renewable, emission-free, and generally environmentally clean (American Wind Energy Association [AWEA] unpubl. data, <http://www.awea.org>), it does have one significant downside -- rotor blades kill birds, especially raptors (Hunt 2002) and bats. Birds can strike the towers; electrocutions can occur if designs are poor; and wind farms may impact bird movements, breeding, and habitat use.

Wind turbine technology is not new to the United States. In the 1800s, Cape Cod supported over 1,000 working wind turbines (Ferdinand 2002). In the late 1930s, Vermont boasted the world's then-largest turbine, which was likely disabled by high winds due to design flaws. But wind turbine 'farms' and their impacts to birds are a recent phenomenon compared to power lines and communication towers, where mortality has been documented for decades or longer (Boeker and Nickerson 1975, Olendorff et al. 1981, APLIC 1994, APLIC 1996, Harness 1997, Ainley et al. 2001, Manville 2001). The problem in the U.S. surfaced in the late 1980s and early 1990s at the Altamont Pass Wind Resource Area, a facility then containing some 6,500 turbines on 73 $mi^2$ of gently rolling hills just east of San Francisco Bay, California (Davis 1995). Orloff and Flannery (1992) estimated that several hundred raptors were killed each year due to turbine collisions, guy wire strikes, and electrocutions. The most common fatalities were those of Red-tailed Hawks (*Buteo jamaicensis*), American Kestrels (*Falco sparvarius*) and Golden Eagles (*Aquila chrysaetos*), with fewer mortalities of Turkey Vultures (*Cathartes aura*), Common Ravens (*Corvus corax*), and Barn Owls (*Tyto alba*). The impacts of this wind farm were of most concern to the population of Golden Eagles, which was showing a "disturbing source of mortality" to a disproportionately large segment of the population (Southern Niagara Escarpment [WI] Wind Resource Area unpubl. report). More recent studies indicate that a model previously used to assess Golden Eagle mortality was defective, and that nonbreeding Golden Eagles representing a "floater" population were likely suffering less mortality based on a new model (Hunt 2002). Research continues at this time to further assess the impacts of Altamont turbines on raptors. The Altamont turbines are still estimated to kill 40-60 subadult and adult Golden Eagles each year, as well as several hundred Red-tailed Hawks and American Kestrels – a continuing concern for the FWS. Of the variety of wind turbines at the site, the smaller, faster moving, Kenetech-built, lattice-supported turbines caused most of the mortality. As part of a re-powering effort, these turbines are now being replaced with slower moving, tubular-supported turbines. While Europeans have used tubular towers almost exclusively, the U.S. has almost solely used lattice support, at least until recently (Berg 1996).

Colson (1995) indicated that some 16,000 wind turbines operated in California, making the State the largest concentration of wind energy development in the world. Since 1995, that statistic has changed. While California still boasts the greatest number of turbines in the U.S., many smaller turbines are being replaced by fewer but larger models. Worldwide, an estimated 50,000 turbines are generating power (AWEA unpubl. data; Ferdinand 2002), of which over 15,000 are currently in 29 states in the U.S. Turbine numbers are often difficult to track since statistics are generally presented in megawatts (MW) of electricity produced rather than number of turbines present. The latter statistic is of greater concern to ornithologists. In 1998, for example, Germany was the greatest producer with 2,874 MW of electricity produced by turbines, followed by the U.S. (1,884), and Denmark (1,450); (AWEA unpubl. data). While some project that the number of wind turbines in the U.S. may increase by another 16,000 in the next 10 years, current trends indicate an even greater potential growth. Although the U.S. presently produces less than 1% of its electrical energy from turbines – compared, for example, to Norway's 15% – 2001 was a banner year for U.S. turbine technology, doubling the previous record for installed wind production. Companies installed 1,898 turbines in 26 states, which will produce nearly 1,700 MW, at a cost of $1.7 billion for the new equipment (J. Cadogan, U.S. Department of Energy, 2002, pers. comm.). Over the past decade, wind power has been the fastest growing energy industry in the world. By 2020, the AWEA (unpubl. data) predicts that wind will provide 6% of this nation's electricity, serving as many as 25 million households. Enron Wind Corporation constructed some 1,500 of the 1,898 turbines installed in the U.S. in 2001. Although Enron is now bankrupt, General Electric purchased the company and is now producing wind turbines.

In March 2002, President Bush signed the Job Creation and Worker Assistance Act, extending the production tax credit to the wind industry for another two years. There are presently attempts in Congress to amend the reauthorization of this legislation for five or more years. However, even with a bright future for growth, and with low speed tubular-constructed wind turbine technology now being stressed, larger and slower moving turbines still kill raptors, passerines, waterbirds, other avian species, and bats. Low wind speed turbine technology requires much larger rotors, blade tips often extending more than 420 ft. above ground, and blade tips can reach speeds in excess of 200 mph under windy conditions (J. Cadogan, U.S. Department of Energy, 2002, pers. comm.). When birds

approach spinning turbine blades, "motion smear" – the inability of the bird's retina to process high speed motion stimulation – occurs primarily at the tips of the blades, making the blades deceptively transparent at high velocities. This increases the likelihood that a bird will fly through this arc, be struck by a blade, and be killed (Hodos et al. 2001).

What cumulative impact these larger turbines will have on birds and bats has yet to be determined. Johnson et al. 2002b raised some concerns about the impacts of newer, larger turbines on birds. Their data indicated that higher levels of mortality might be associated with the newer and larger turbines, and they indicated that wind power-related avian mortality would likely contribute to the cumulative impacts on birds. Since little research has been conducted on the impacts of large land-sited and offshore turbines on birds and bats, this newer technology is ripe for research.

Howell and Noone (1992) estimated U.S. avian mortality at 0.0 to 0.117 birds/turbine/yr., while in Europe, Winkelman (1992) estimated mortality at 0.1 to 37 birds/turbine/yr. Erickson et al. (2001) reassessed U.S. turbine impact, based on more than 15,000 turbines (some 11,500 in California), and estimated mortality in the range of 10,000 to 40,000 (mean = 33,000), with an average of 2.19 avian fatalities/turbine/yr. and 0.033 raptor fatalities/turbine/yr. This may be a considerable underestimate. As with other structural impacts, only a systematic turbine review will provide a more reliable estimate of mortality. While some have argued that turbine impacts are small (Berg 1996), especially when compared to those from communication towers and power lines, turbines can pose some unique problems, especially for birds of prey. Mortalities must be reduced, especially as turbine numbers increase. In addition to protections under the MBTA, Bald and Golden Eagles are afforded protections under the ESA for the former and the BGEPA for both raptors. As strict liability statutes, MBTA and BGEPA also provide no provisions for unauthorized "take." Wind farms can affect local populations of Golden Eagles and other raptors whose breeding and recruitment rates are naturally slow and whose populations tend to have smaller numbers of breeding adults (Davis 1995). Large raptors are also revered by Native Americans as well as by many others within the public. They are symbolic megafauna, and provide greater emotional appeal to many than do smaller avian species. Raptors also have a lower tolerance for additive mortality (Anderson et al. 1997). As with all other human-caused mortality, we have a responsibility to reverse mortality trends.

Until very recently, U.S. wind turbines have mostly been land-based. Perhaps following the European lead of siting wind turbines in estuarine and marine wetlands (van der Winden et al. 1999, van der Winden et al. 2000), and perhaps due to an assessment of a large number of potential offshore turbine locations in the U.S. (based on Weibull analyses of "good, excellent, outstanding, and superb" wind speed potentials [National Renewable Energy Laboratory 1987]), a new trend is evolving in North America. Several proposals for huge offshore sites are being submitted for locations on both Atlantic and Pacific coasts. These, at the very least, should require considerable research and monitoring to assess possible impacts to resident and migrating passerines, waterfowl, shorebirds, and seabirds. One site at Nantucket Shoals, offshore of Nantucket Island near Cape Cod, Massachusetts, is proposed by the Cape Wind Association to contain 170 turbines, many over 420 feet high, within a 25 $mi^2$ area (AWEA unpubl. data, Ferdinand 2002). What impacts this wind farm would have on wintering sea ducks and migrating terns, especially the Federally endangered Roseate Tern (*Sterna dougallii dougallii*), and on Northern Gannets (*Morus bassanus*), is unknown. The Long Island Power Authority is proposing a site offshore of Long Island, New York's south shore, covering as much as 314 $mi^2$. Other sites are being proposed for Portland, Maine, and Lake Erie. The largest proposed wind farm in North America is being planned for a 50 $mi^2$ area between Queen Charlotte Island, BC, and Alaska. It is being designed to contain 350 turbines, many exceeding 400 feet in height. The potential for significant offshore turbine impacts on waterbirds is great, virtually no research has been conducted in the United States to quell these concerns, and finding carcasses at sea is very challenging.

Europe presently has 10 offshore wind projects in operation, producing over 250 MW of electricity (British Wind Energy unpub. data, www.offshorewindfarms.co.uk). Many other projects are currently under review. To avoid citizen concerns regarding the "not in my backyard" complex, most European turbines are sited offshore or in estuaries, away from immediate human development (Larsen and Madsen 2000). While Europe is well ahead of the United States regarding turbine research, their study results are still generally inconclusive (T. Bowan, FWS, 2003 pers. comm.). Collision mortality, while generally unknown, is believed to be small because birds appear to avoid offshore wind farms. There are exceptions, including for Whooper Swans (*Cygnus Cygnus*; Larsen and Clausen 2002) that are susceptible to turbine strikes in the early mornings and evenings, especially in inclement weather. The collection of carcasses at offshore sites is more challenging than for land-based turbines since nets generally must be used to collect carcasses, tides and weather affect collection, and fog is a frequent problem. While habitat loss is not believed to be a serious concern, its impacts continue to be assessed. Disturbance may be problematic since some species such as Common Eiders avoid wind farms and may not return to a coastal area for several years (Guillemette and Larsen 2002). Disturbance may lead to displacement, and turbines may serve as barriers to

seaduck movements. Only a few studies have been conducted in Denmark, the Netherlands, and Sweden, so further research is needed. Studies deal mostly with wintering species (Noer et al. 2000, Percival 2001, Langstron and Pullan 2002, Christensen et al. 2002, and Bruns et al. 2002).

In an attempt to begin addressing the bird mortality issue – and ancillary to this, the issue of ESA-listed bat strikes – the National Wind Coordinating Committee was created in 1994 as part of President Clinton's Global Climate Change Action Plan (Colson 1995). Shortly following the creation of the Committee, the Avian Subcommittee (now called the Wildlife Work Group) was formed, co-founded by the Service. In 1999, the Avian Subcommittee published a *Metrics and Methods* document to study turbine impacts on birds (Anderson et al. 1999). The document provides an excellent resource for conducting research on proposed and existing turbines and wind farms.

**Appendix 8**

**LITERATURE CITED**


Ainley, D.G., R. Podolsky, L. DeForest, G. Spencer, and N Nur. 2001. The status and population trends of the Newell's Shearwater or Kauz'i: insights into modeling. Studies in Avian Biology No. 22: 108-123

Aldrich, J.W., R.C. Banks, T.J. Cade, W.A. Calder, F.G. Cooch, S.T. Emlen, G.A. Greenwell, T.R. Howell, J.P. Hubbard, D.W. Johnston, R.F. Johnston, and L.R. Mewaldt. 1975. Report of the American Ornithologists Union and *ad hoc* Committee on Scientific and Educational Use of Birds. Auk 92 (3, Supple.): 1A-27A.

Anderson, R.L., H. Davis, W. Kendall, L.S. Mayer, M.L. Morrison, K. Sinclair, D. Strickland, and S. Ugoretz. 1997. Standard metrics and methods for conducting avian/wind energy interaction studies. Pp 265-272 *in* G. Miller (editor). Windpower '97 Proceedings, June 15-18, 1997, Austin, TX, American Wind Energy Association.

Anderson, R., M. Morrison, K. Sinclair, D. Strickland, H. Davis, and W. Kendall. 1999. Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Avian Subcommittee, National Wind Coordinating Committee, Washington, DC. 87 pp.

Avian Power Line Interaction Committee. 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute, Washington, DC. 78 pp.

Avian Power Line Interaction Committee. 1996 (reprinted 2000). Suggested practices for raptor protection on powerlines: the state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, DC. 125 pp.

Barbour, R.W., and W.H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington , KY. 286 pp.

Berg, P. 1996. The effects of avian impacts on the wind energy industry. Undergraduate Engineering Review, Department of Mechanical Engineering, University of Texas, Austin. 9 pp.

Boekev, E.L., and P.R. Nickerson. 1975. Raptor electrocutions. Wildlife Society Bulletin 3: 79-81.

Braun, C. E., O. O. Oedekoven, C. L. Aldridge. 2002 In Press. Oil and Gas development in western North America: effects on sage brush steppe avifauna with particular emphasis on sage grouse. In Press.

Bruns, E., A. Andersson, and S-E. Thor. 2002. Environmental issues of offshore wind farms. Summary of IEA R&D Wind, Topical Expert Meeting No. 40. September 2002, Husum, Germany. 6 pp.

Christensen, T.K., I. Clausager, and I.K. Petersen. 2002. Status report of seabird surveys at Horns Rev, 2000-2001. National Environmental Research Institute, Ministry of Environment and Energy, Dept. Coastal Zone Ecology, Denmark. 22 pp.

Cochran, W.W., and R.R. Graber. 1958. Attraction of nocturnal migrants by lights on a television tower. Wilson Bulletin 70:378-380.

Cohen, D.A. 1896. California department. Osprey 1:14-15.

Colson and Associates. 1995. Investigation of bird electrocutions at the Kenetech Windpower, Altamont Pass windplant. Preliminary report. March 1995.

Colson, E.W. 1995. Avian interactions with wind energy facilities: a summary. Pp 77-86 *in* V. Jamison (editor). Wind Power 1995, March 26-30, 1995, Washington, DC, American Wind Energy Association.

Davis, H. (editor). 1995. A pilot Golden Eagle population study in the Altamont Pass Wind Resource Area, California. National Renewable Energy Laboratory, Golden, CO, Contract No. DE-AC36-83CH10093, NREL/TP-441-7821. 219 pp.

Drewien, R.C. 1973. Ecology of Rocky Mountain Greater Sandhill Cranes. Ph.D. dissertation. University of Idaho. 152 pp.

Erickson, W.P., G.D. Johnson, M.D. Strickland, K.J. Sernka, and R.E. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. Western EcoSystems Technology, Inc., Cheyenne, WY. National Wind Coordinating Committee Resource Document, August: 62 pp.

Federal Aviation Administration. 2000. Obstruction marking and lighting. Advisory Circular AC 70/7460-1K, Air Traffic Airspace Management, March 2000. 31 pp.

Ferdinand, P. 2002. Windmills on the water create storm on Cape Cod. Washington Post, August 20, A3.

Field and Stream. 1874. The St. Augustine Press. 3(10):150.

Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York, NY. 257 pp.

Guillemette, M., and J.K. Larsen. 2002. Postdevelopment experiments to detect anthropogenic disturbances: the case of sea ducks and wind parks. Ecological Applications 12(3):868-877.

Harmata, A.R., J.R. Zelenak, and K.M. Podruzny. 1998. Avian use of Norris Hill Wind Resource Area, Montana. US Dept. of Energy, National Renewable Energy Lab., Wind Tech. Ctr., Golden CO. 72 pp plus appendices.

Harness, R.E. 1997. Raptor electrocutions caused by rural electric distribution powerlines. M.S. thesis, Colorado State University. 110 pp.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 1999. Bats of the United States. Arkansas Game & Fish Commission. Bat Conservation International, Austin, TX. 64 pp.

Hodos, W., A. Potocki, T. Storm, and M. Gaffney. 2001. Reduction of motion smear to reduce avian collisions with wind turbines. Proceedings of the National Avian-Wind Power Planning Meeting IV: 88-105.

Howell, J.D., and J. Noone. 1992. Examination of avian use and mortality at a U.S. windpower, wind energy development site, Montezuma Hills, Solano Country, CA.

Huckabee, J.W. 1993. Proceedings: avian interactions with utility structures, international workshop, September 13-16, 1992, Miami, FL. Electric Power Research Institute, Project 3041, EPRI TR-103268.

Hunt, W.G. 2002. Golden eagles in a perilous landscape: predicting the effects of mitigation for wind turbine blade-strike mortality. Public Interest Energy Research, CA Energy Comm. Consultant Report P500-02-043F. 52 pp.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd and D.A. Shepherd. 2000. Final report. Avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-year study. Prepared for Northern States Power Co. Western EcoSystems Technology, Inc. Cheyenne, WY. 262 pp.

Johnson, G.D., W.P. Erickson, D.A. Shepherd, M. Perlik, M.D. Strickland, and C. Nations. 2002a. Bat interactions with wind turbines at the Buffalo Ridge, Minnesota, wind resource area: 2001 field season. Electric Power Research Inst., Palo Alto, CA.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002b. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30(3): 879-887.

Johnson, G.D., W.P. Erickson, and M.D. Strickland. 2003. What is known and not known about bat collision mortality at windplants? *In* R.L. Carlton (ed.), Proc. Workshop on Avian Interactions at Wind Turbines, 16-17 October, 2002, Jackson Hole, WY. Electric Power Research Inst., Palo Alto, CA.

Keeley, B., S. Ugoretz, and D. Strickland. 2001. Bat ecology and wind turbine considerations. Proc. National Avian-Wind Power Planning Meeting, 4:135-146. National Wind Coordinating Committee, Washington, DC.

Langston, R.H.W., and J.D. Pullan. 2002. Windfarms and birds: an analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues. Convention on the Conservation of European Wildlife and Natural Habitats, Standing Comm., December 2-5, 2002, T-PVS/ Inf (2002) 30 revised. 37 pp.

LaRoe, E.T., G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac. 1995. Our living resources: a report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems. U.S. Department of Interior, National Biological Service, Washington, DC. 530 pp.

Larsen, J.K, and J. Madsen. 2000. Effects of wind turbines and other physical elements on field utilization by Pink-footed Geese (*Anser brachyrhynchus*): a landscape perspective. Landscape Ecology 15:755-764.

Larsen, J.K., and P. Clausen. 2002. Potential wind park impacts on Whooper Swans in winter: the risk of collision. Waterbirds 25 (Spec. Pub. 1):327-330.

Leddy, K.L., K.E. Higgins, and D.E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bull. 111(1): 100-104.

Lehman, R.N., A.R. Ansell, M.G. Garrett, A.D. Miller, and R.R. Olendorff. 1999. Suggested practices for raptor protection on power lines: the American story. Pp 125-144 I*n* M. Ferrer and G.F.E. Janss (editors). Birds and power lines – collision, electrocution and breeding. Quercus Publishing Co.

Lewis, J.C. 1993. The U.S. Fish and Wildlife Service and bird-power line interactions. Pp. 2-1- 2.6 I*n* J.W. Huckabee (editor). Proceedings: avian interactions with utility structures, international workshop, September 13-16, 1992, Miami, FL. Electric Power Research Institute, Project 3041, EPRI TR-103268.

Lewis, J.C. 1997. Alerting the birds. Endangered Species Bulletin XXII:2.

Lockman, D.C. 1988. Trumpeter Swan mortality in Wyoming 1982-1987. Pp. 12-13. Proceedings and papers of the eleventh Trumpeter Swan Society conference.

Manes, R., S. Harmon, B. Obermeyer, and R. Applegate. 2002. Wind energy and wildlife: an attempt at pragmatism. Spec. Report of Wildlife Management Inst., October. 11 pp.

Manville, A.M. 2001. Avian mortality at communication towers: steps to alleviate a growing problem. Pp. 75-86 *In* B.B. Levitt (editor), Cell towers – wireless convenience? Or environmental hazard? Proceedings of the "Cell Towers Forum," state of the science/state of the law, Dec. 2, 2000, Litchfield, CT. New Century Publishing 2000, Markham, Ontario.

Manville, A.M. 2002. Protocol for monitoring the impact of cellular telecommunication towers on migratory birds within the Coconino, Prescott, and Kaibab National Forests, Arizona. Special research protocol, Division of Migratory Bird Management, USFWS, Arlington, VA 10 pp. for the U.S. Forest Service.

Manville, A.M. 2003. Bird strikes and electrocutions at power lines, communication towers, and wind turbines: state of the art and state of the science – next steps toward mitigation. *In* T. Rich (ed.). Proceedings of 3rd International Partners In Flight Conference: a Workshop on Bird Conservation Implementation and Integration, Asilomar, CA, March 20-24, 2002. 23 pp. In press.

National Renewable Energy Laboratory. 1987. Wind energy resource atlas of the United States. National Renewable Energy Laboratory, U.S. Department of Energy. 1 p.

Noer, H., T.K. Christensen, I. Clausager, and I. Krag. 2000. Effects on birds of an offshore wind park at Horns Rev: Environmental impact assessment. Ministry of Environment and Energy, National Environmental Research Inst., Dept. of Coastal Zone Ecology, Denmark. Elsamprojekt A/S 2000.

Olendorff, R.R., A.D. Miller, and R.N. Lehman. 1981. Suggested practices for raptor protection on powerlines: the state of the art in 1981. Raptor research report No. 4. Raptor Research Foundation, University of Minnesota, St. Paul. 111 pp.

Orloff, S., and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas. Report to the Planning Departments of Alameda, Contra Costa and Solano Counties and the California Energy Commission, Grant No. 990-89-003 to BioSystems Analysis, Inc., Tiburton, CA.

Percival, S.M. 2001. Assessment of the effects of offshore wind farms on birds. ETSU W/13/00565/REP, DTI/Pub URN 01/1434. 66 pp.

Tordoff, H.B., and R.M. Mengel. 1956. Studies of birds killed in nocturnal migration. University Kansas Museum Natural History Publication 10:1-44.

U.S. Fish and Wildlife Service. 2002. Evaluating potential impacts of wind resource areas on wildlife in Montana: A strategy for identification of study and monitoring needs. Ecological Services Division, Helena, MT. 21 pp.

U.S. Fish and Wildlife Service. 2003. Birds of conservation concern 2002. Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Arlington, VA. 99 pp.

van der Winden, J., A.L. Spaans, and S. Dirksen. 1999. Nocturnal collision risks of local wintering birds with wind turbines in wetlands. Bremer Beitrane fur Naturkunde und Naturschutz Band 4:33-38.

van der Winden, J., H. Schekkerman, I. Tulp, and S. Dirksen. 2000. The effects of offshore windfarms on birds. Pp 126-135 I*n* T. Merck and H. von Nordheim (editors). Technische Eingriffe in marine Lebensraume, BfN-Skripten 29, Bundesamt fur Naturschutz.

Winkelman, J.E. 1992. The impact of the SEP wind park near Oosterbierum (Fr.), the Netherlands, on birds, 2: nocturnal collision risks (Dutch, English summary). RIN- report 92/3, DLO-Institute for Forestry and Nature Research, Arnhem.

Woodward, A. J., S. D. Fuhlendorf, D. M. Leslie Jr., and J. Shackford. 2001. American Midland Naturalist, 145: 261-274.