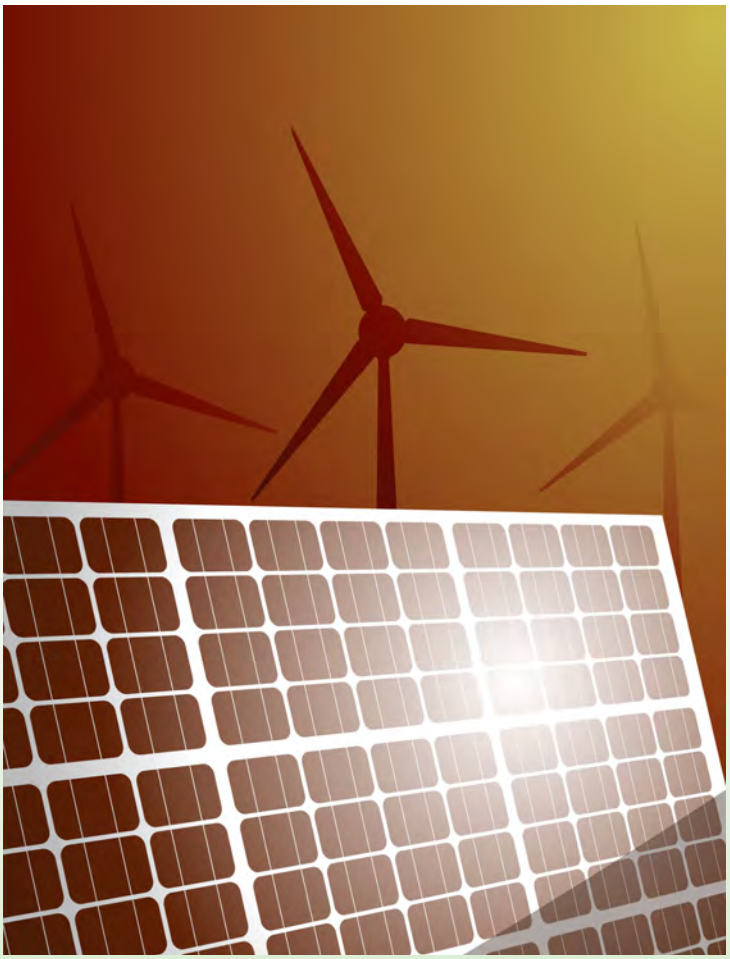
Best Management Practices

for siting, developing, operating, and monitoring renewable energy in the Intermountain West

A Conservationist's Guide



March 2012

Best Management Practices

for siting, developing, operating

and monitoring renewable energy

in the Intermountain West:

A Conservationist's Guide

March 2012

Edited by:
Allison Jones, Wild Utah Project, with assistance from Western Resource Advocates

Reviewers:
Expert peer review provided by — Sara Baldwin: Utah Clean Energy, Greg Erdman: OCAS, Inc., Sophie Hayes: Utah Clean Energy, Cris Hein: Bat Conservation International, Matt Holloran: Wyoming Wildlife Consultants, LLC, Arthur Morris: HEAL Utah, Jamo O'Reilly: Wasatch Wind, Sophie Osbourne: Wyoming Outdoor Council, Steve Slater: Hawkwatch International, and anonymous agency reviewers as well as anonymous reviewers from wind and solar development companies.

Layout:
Amy O'Connor

Cover Art:
Image Envision LLC

Prepared by:

Wild Utah Project

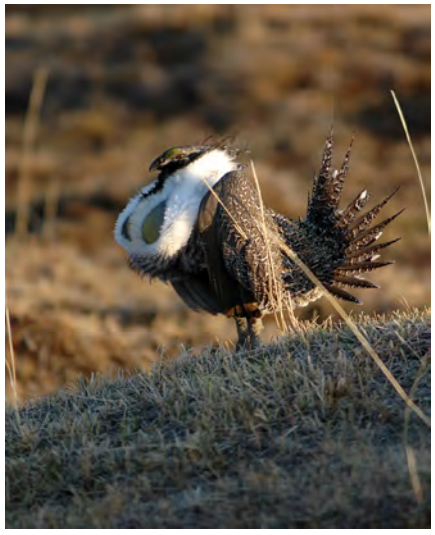
www.wildutahproject.org

824 S 400 W, SUITE B117
Salt Lake City, UT 84101

801-328-3550

To download a free copy, go to www.wildutahproject.org/resources

Table of Contents



Sage-grouse. Photo © Utah Division of Wildlife Resources.

Abstract

Best Management Practices (BMPs) provide science-based criteria and standards that land managers and conservation planners follow in making and implementing decisions about human uses and projects that affect our natural resources. BMPs are usually developed based on legal obligations, pragmatic experience, and institutional practices, and should be supported by the best available scientific knowledge.

Up until now, conservation advocates have lacked a comprehensive set of science-based Best Management Practices they could systematically bring to land managers, renewable energy developers and the public process that are designed to minimize the adverse impacts of wind and solar energy development projects on wildlife and wildlife habitat. This document draws from over one hundred other scientific studies, renewable energy development guidance documents and other published BMPs in order to bring the best conservation science to the process of wisely choosing wind and solar energy sites, as well as the permitting, construction and operation of renewable facilities destined for wild places.

These BMPs are organized according to the needs of sage grouse, raptors, other birds, bats, general wildlife (not covered by the first 5 categories), and soil/vegetation/site hydrology. Within each of these categories the BMPs are broken down into siting BMPs, pre-construction BMPs, construction BMPs, and monitoring BMPs. These BMPs also give guidance about how to address renewable energy development within the context of public land-use planning. The role of adaptive management in renewable energy planning, monitoring, research and mitigation is also featured, as well as areas that need further research. This document should offer sound guidance for all stages of wind and solar energy development in the West, from siting, permitting, construction, operation, monitoring, and mitigation.

Glen Canyon National Recreation Area. Photo © Warren Gretz, DOE/National Renewable Energy Laboratory.

Introduction

Red-tailed hawk. Photo © Utah Division of Wildlife Resources.

Development of renewable energy provides important benefits, including enhancing our energy security and independence, increasing the diversity of our energy resources, and helping us shift away from an over-reliance on fossil fuels that contribute to numerous negative environmental and wildlife impacts. The Department of the Interior has recently "fast-tracked" more than 30 " wind and solar generation and transmission projects on public lands, and reached its goal of 9,000 megawatts of new renewable energy by the end of 2011. So far eight of eleven western states have adopted Renewable Portfolio Standards requiring utilities to generate 15-33% of energy from renewable sources. It is likely that the U.S. will have over 30,000 MW of new wind power online in the U.S by 2020.

Our early experiences with permitting and constructing wind and solar energy facilities has demonstrated that meaningful renewable energy development at the pace and scale needed to transition away from fossil fuels needs to be done "smart-from-the-start." That means establishing a proactive approach to siting and conservation strategies that protect wildlife and wildlands while allowing renewable energy deployment to ramp up. This document explores a set of Best Management Practices (BMPs) for renewable energy siting and development in the west that strives to achieve these goals.

These Best Management Practices for renewable energy siting and development draw on scientific, peer-reviewed research. While primarily written for conservationists who are working to positively affect renewable energy development in the West (and primarily on public lands) this manual can also help to better inform wind and solar energy developers, stakeholders and decision-makers about the link between renewable energy development and consequences to wildlife and the functions of their habitat. The goal of these BMPs is to enable developers, wildlife agencies, conservationists and other stakeholders to work with a consistent knowledge base and set of appropriate technical questions and well-established guidelines to assess a given project location and to develop wind and solar energy in a way that is smart from the start for wildlife and their habitats. This guidance document is an improvement over the hundreds

Photo © DOE/National Renewable Energy Laboratory.

of other available guidances on the topic, as this one is meant to deliver a "one stop shopping" approach for all aspects of affecting renewable energy development in the west.

A long-legged myotis. © J. Scott Altenbach.

These BMPs were designed to guide conservationists to positively affect renewable energy siting and development outside of the built environment. There is tremendous potential for distributed small-scale generation, such as rooftop solar, coupled with energy efficiency measures, to meet Western energy needs. However, the broad consensus from renewable energy and climate change analysts is that utility scale renewable development will be necessary to produce the short-term carbon reductions needed immediately to mitigate climate change. There are now literally hundreds of proposed wind and solar projects – outside of the built environment – on the books for the coming decades, and we must work to ensure that these developments are done right with regard to wildlife species and their habitats. Decreasing energy demand in our cities through efficiency and other demand-side measures that reduce the need for large-scale renewable energy facilities to be built outside of our cities is essential but this topic is outside the scope of this document.

Similarly, this document does not address geothermal development. Instead, we refer readers working on geothermal plant siting and environmental issues to a number of other useful publications, including the Bureau of Land Management's and U.S Forest Service's Programmatic Environmental Impact Statement for geothermal leasing in the Western U.S (BLM and USFS 2008a and b), the Wilderness Society's publication on geothermal development on public lands (TWS 2010), the Geothermal Energy Association's A Guide to Geothermal Energy and the Environment (GEA 2007), and the U.S. Department of Energy's Geothermal Power Plants – Minimizing Land Use and Impact (USDOE 2008).

Mitigation for any documented environmental impacts of renewable energy development, especially for bird and bat fatalities at wind farms,

Boulder, CO, wind tower closeup. Photo © Dennis Schroeder, DOE/ National Renewable Energy Laboratory.

is a critical element of renewable energy planning, development, and adaptive management of those facilities. Detailed mitigation strategies for environmental and wildlife impacts at solar and wind facilities is beyond the scope of this document.[1]

These guidelines and BMPs are not designed to address decommissioning, or transmission beyond the point of connection to the transmission system. The national grid and proposed smart grid systems are beyond the scope of this document. For wildlife and habitat related issues regarding transmission impacts and transmission planning, we refer readers to Smart Lines: Transmission for the Renewable Energy Economy (Resource Media and WRA 2008), the Western Electric Coordinating Council's Environmental Data Task Force's Preliminary Environmental Recommendations for the Transmission Planning Process (WECC 2011), and the Avian Power Line Interaction Committee's Suggested Practices for Avian Protection on Power Lines (APLIC 2006).[2]

Ferruginous Hawk. Photo © Scott Root, Utah Division of Wildlife Resources.

Use of this BMP and guidance document by the conservation community and others should help reduce potentially adverse impacts to most species of concern and their habitats present at renewable energy project sites. These BMPs and associated guidelines will evolve over time as additional experience, monitoring and research regarding minimizing wildlife and habitat impacts from wind and solar energy projects becomes available. As such, we plan to continue to work with industry, developers, the conservation community and other stakeholders and states to evaluate, revise and update these BMPs and guidelines on a periodic basis.

---

[1] However, developers that are planning to use promised mitigation to clear NEPA hurdles should pay very close attention to a recent memo from the Council on Environmental Quality (CEQ 2011) which clarifies the appropriateness of "mitigated Findings Of No Significant Impact (FONSI)" and the importance of carefully monitoring environmental mitigation commitments (and conservationists watch-dogging renewable developers should similarly take note of this memo).

[2] NOTE to readers: Unfortunately, none of these documents adequately addresses the very serious concerns of habitat fragmentation and wildlife displacement. Indirect effects are often the driving forces in biological/ecological systems, and few guidance or NEPA documents provide either a thorough analysis or mitigation that addresses quantified impacts. Funding towards applied research in this area is critically needed.

Laws and Regulations for Renewable Energy Regulation

Numerous laws, federal regulations, state ordinances, and Executive Orders either directly or indirectly provide management, regulatory and policy guidance for siting, zoning for, and permitting solar and wind energy development on both private and public lands. Much more detailed guidance on these topics has been published by the National Wind Coordinating Collaborative (2002), American Wind Energy Association (2008) and Stoel Rives, LLP (2010). While these guidelines for understanding zoning, siting, regulatory, and permitting process are primarily focused on wind energy and wind energy developers and utilities, they are still useful for conservationists trying to affect these processes for both solar and wind development.

Executive and Interior Secretarial Orders relating to energy development

On May 18, 2001, President George W. Bush issued Executive Order (E.O.) 13212, "Actions to Expedite Energy-Related Projects," which established a policy that federal agencies should take appropriate actions, to the extent consistent with applicable law, to expedite projects to increase the production, transmission, or conservation of energy.

In 2009, the Secretary of the Department of the Interior Ken Salazar issued Secretarial Order Number 3285, which acknowledged the need to identify suitable areas for both wind and solar development on Interior Lands and also prioritized environmentally responsible renewable energy development. This was a great stride toward creating a policy framework capable of tackling the challenge inherited by the Obama administration, when it inherited an Interior bureaucracy focused on oil and gas development, and faced with hundreds of wind and solar permits languishing in a queue dating back to 2002. This Secretarial Order was clarified in 2010 by Secretarial Order 3285A1 which ordered the Department of the Interior to identify and prioritize locations best suited for solar development.

Inter-agency MOUs

Also in May of 2001, the President's National Energy Policy Development Group (NEPDG) recommended to President Bush, as part of National Energy Policy, that the Departments of the Interior, Energy, Agriculture, and Defense work together to increase renewable energy produc-

tion (NEPDG 2001). In July 2001, the Departments created an interagency task force to address the issues associated with increasing renewable energy production on federal lands (USDOE and USDOI 2002). The task force developed a Memorandum of Understanding (MOU) among the U.S. Department of Energy, U.S. Department of the Interior, U.S. Department of Agriculture, U.S. Environmental Protection Agency, Council on Environmental Quality and the members of the Western Governors' Association to establish a framework for cooperation between western states and the federal government to address energy problems facing the West and to facilitate renewable energy production. Ten years later, it is clear that this framework of cooperation among western states has been established and has resulted in many new wind and solar projects in the west.

In 2009, the Secretary of the Department of the Interior Ken Salazar issued Secretarial Order Number 3285, which acknowledged the need to identify suitable areas for both wind and solar development on Interior Lands and also prioritized environmentally responsible renewable energy development.

Moreover, a number of Memorandums of Understanding have been signed between the US Fish and Wildlife Service and virtually all of the federal land management agencies that might have wind and solar development cropping up on their holdings. These MOU's with the Department of Defense, Department of Energy, Department of Agriculture, Forest Service, Federal Energy Regulatory Commission, National Park Service, and Bureau of Land Management outline how these agencies will abide by the 2001 Executive Order to Protect Migratory Birds, and outline how the agencies will protect migratory birds while allowing various land uses on those holdings. This includes renewable energy development. All of the Memorandums of Understanding can be viewed at http://www.fws.gov/migratorybirds/PartnershipsAndInitiatives.html. Of particular relevance is the migratory bird conservation MOU in 2010 between the BLM and the USFWS (BLM 2010d), which calls on the BLM to evaluate any effects at the project level on BLM lands on migratory birds, and identify where take may have a measurable negative effect on migratory bird populations, focusing first on species of concern, priority habitats, and key risk factors. In such situations, according to the MOU, BLM will implement approaches lessening such take. In addition, the MOU specifically requires the BLM to integrate migratory bird conservation measures, as applicable, into future operating standards and guidelines for renewable (wind, solar, and geothermal) energy development NEPA mitigation.

Energy Legislation

On August 8, 2005, the President signed into law the Energy Policy Act of 2005 (P.L. 109-58). Section 211 of the Act states, "It is the sense of the Congress that the Secretary of the Interior should, before the end of the 10-year period beginning on the date of enactment of this Act, seek to have approved non-hydropower renewable energy projects located on the public lands with a generation capacity of at least 10,000 megawatts of electricity."

Renewable Energy on Tribal Lands

Many tribal traditional lands and tribal rights extend outside federal lands onto state regulated lands, and tribal interests can be impacted by private land developments. Therefore, it is critical to coordinate with Tribes to solicit their input on applicable solar and wind projects.

Tribal lands are not federal public lands or part of the public domain, but are rather retained by Tribes or set aside for tribal use pursuant to treaties, statutes, court orders, executive orders, judicial decisions, or agreements. Thus, Tribal lands are not subject to the controls or restrictions set forth in federal public land laws, and Tribes manage Indian lands in accordance with tribal goals and objectives, within the framework of applicable laws. Many tribal traditional lands and tribal rights extend outside federal lands onto state regulated lands, and tribal interests can be impacted by private land developments. Therefore, it is critical to coordinate with Tribes to solicit their input on applicable solar and wind projects.

Bureau of Land Management

We chose to focus chiefly on the Bureau of Land Management (BLM) for this guidance document because the majority of applications for solar and wind facilities, as well as already permitted solar and wind facilities, on public lands have been on BLM lands. The American Wind Energy Association's (AWEA) Wind Energy Siting handbook (2008) addresses wind energy development on lands administered by other federal agencies, such as Bureau of Reclamation, Bureau of Indian Affairs, U.S. Forest Service, and U.S. Department of Defense. While AWEA's handbook primarily addresses siting, zoning, permitting, and regulatory issues surrounding development of wind projects, there is also applicability to solar energy development in terms of these issues and processes on a variety of federal lands.

BLM Wind PEIS and permitting. In 2005 the Bureau of Land Management (BLM) issued a Record Of Decision (ROD) on the implementation of a wind energy development program and how this would affect 52 land use plans in nine states (basically by amendment of the Resource Management Plans governing BLM lands in those states). The decision (BLM 2005a) established policies and Best Management Practices for the administration of wind energy development activities and established minimum requirements for mitigation measures. The policies and BMPs were evaluated in the Final Wind Energy Programmatic Environmental Impact Statement, or PEIS (BLM 2005b). The amendments to the 52 land-use plans were to include (1) adoption of the BLM's Wind Energy Development Program policies and best management practices, and (2) identification of specific areas where wind energy development will not be allowed.

The ROD for the Wind PEIS explains how site-specific concerns, and the development of additional mitigation measures, will be addressed in project-level reviews, including NEPA analyses, as required. It also requires that at this site-specific level, natural resource issues and concerns must be addressed by project-specific plans, programs, and stipulations during each phase of wind energy development, and that mitigation measures protecting these resources will be required to be incorporated into project Plans Of Development. This will include incorporation of specific programmatic BMPs as well as the incorporation of additional mitigation measures contained in other, existing and relevant BLM guidance, or developed to address site-specific or species-specific concerns.

Photo © DOE/National Renewable Energy Laboratory.

The ROD also outlines how the BLM will initiate consultation early in the process of wind development on BLM lands with the following, as appropriate and required by law: Indian Tribal governments, U.S Department of Defense, the U.S. Fish and Wildlife Service, and the State Historic Preservation Office. It goes on to say that the level of environmental analysis to be required under NEPA for individual wind power projects will be determined at the Field Office level, will incorporate public involvement, and will include analyses of project site configuration and micrositing considerations, monitoring program requirements, and appropriate mitigation measures. The BLM also requires financial bonds for all wind energy development projects on BLM-adminis-

tered public lands to ensure compliance with the terms and conditions of the rights-of-way authorization and the requirements of applicable regulatory requirements, including reclamation costs.

With the decision to implement the Wind Energy Development Program, the BLM Interim Wind Energy Policy (BLM 2002) was replaced by a new policy in 2006 (Wind Energy Development Policy IM 2006-16) that incorporates the programmatic policies and BMPs evaluated in the PEIS. That framework was carried forward and supplemented by BLM's revised Wind Energy Development Policy IM 2008-043, issued in 2008. One major revision in the 2008 IM compared to the 2006 IM allows wind energy development on a case-by-case basis in Areas of Critical Environmental Concern (ACEC) to the extent that it would be consistent with the management prescriptions of those individual ACECs.

BLM is in charge of permits for all wind facilities under their jurisdiction. Photo © Iberdrola Renewables.

On BLM lands, wind project development usually proceeds in two phases:

(1) a site testing and monitoring phase and
(2), if the wind resource is viable, a project construction and operation phase.

BLM permits all wind facilities, whether for testing and monitoring or for project construction and operation, through use of Right of Way (ROW) grants authorized by the Federal Land Policy and Management Act ("FLPMA"), 43 U.S.C. §§ 1701-1784. BLM offers three types of BLM wind energy ROWs: a Site Specific Grant for Testing and Monitoring ("Site-Specific Grant"), a Project Area Grant for Testing and Monitoring ("Project Area Grant"), and a Development Grant for project construction and operation.

BLM Solar PEIS and permitting. In 2007, the BLM developed and issued a Solar Energy Development Policy (BLM Instruction Memorandum 2007-097) to establish procedures for processing Right of Way applications. This policy was updated in 2010 by two more detailed policies (BLM Instruction Memorandums 2010-141 and 2011-003). In accordance with these policies,

the BLM currently evaluates solar energy ROW applications on a project-specific basis. In 2010 the BLM issued a Draft Programmatic Environmental Impact Statement (PEIS) (BLM 2010a) in order to develop a new Solar Energy Program. The PEIS determines which lands are open for applications for development and supports utility scale solar energy development on BLM-administered lands that would be applicable to all pending and future solar energy development applications upon execution of the Record of Decision (ROD) and implementation of this decision through amendment of relevant BLM land use plans in six western states.

The Solar PEIS evaluated the potential effects of establishing the solar energy program elements and strategies across the six-state study area (California, Nevada, Utah, Arizona, Colorado and New Mexico). As part of the PEIS, the BLM has identified 24 Solar Energy Zones within the six-state study area. These Solar Energy Zones were identified based on criteria developed by BLM's Washington office, analyses performed by Argonne National Laboratories, and input from BLM state and field office personnel, BLM has proposed 24 locations (Solar Energy Zones) where utility-scale solar development should be prioritized. These areas have high resource potential and were judged by BLM to have a low level of environmental conflict.

The PEIS also explains that the BLM's proposed solar energy program would require that site-specific and species-specific issues be addressed during individual project reviews.

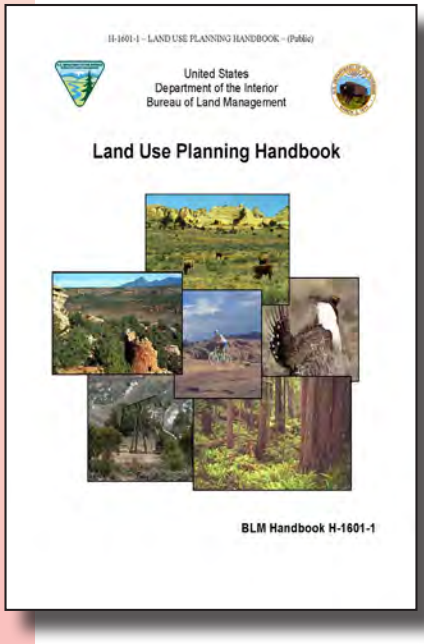
Joint comments submitted by a coalition of environmental groups in response to the BLM proposed zones may be found at http://wilderness.org/content/comments-draft-solar-programmatic-eis. In addition to presenting general design features to best develop solar resources, the Solar PEIS identified specific design features for projects developed within individual Solar Energy Zones. However, the PEIS also explains that the BLM's proposed solar energy program would require that site-specific and species-specific issues be addressed during individual project reviews. These evaluations would tier to the programmatic analyses in the Solar PEIS and the decisions implemented in the resultant ROD. The PEIS is still in development, and will be refined in the Final PEIS expected to be published in 2012.

Placing solar installations in the 24 Solar Energy Zones identified by BLM will minimize environmental impacts. Photo © Iberdrola Renewables.

Utility-scale renewable energy projects are distinct from many other types of land and realty actions due to their size and potential for significant resource conflicts.

BLM regulations pertaining to both solar and wind energy. In the case of either wind or solar development on BLM lands, BLM Manual 6840 "Special Status Species Management" (BLM 2001) would require that appropriate survey, avoidance, and mitigation measures be identified and implemented prior to any construction activities in order to avoid impacting any sensitive species or the habitats on which they rely. Also, in areas that experience ground disturbing activity, it is important to remember that the BLM Standards and Guidelines for Healthy Rangelands (BLM 1995), still apply to those lands. This is particularly important to consider when, for example, wind turbines are erected in an active grazing allotment.

Also, in February 2011 the BLM issued three Instruction Memoranda (IM 2011-59, IM 2011-60 and IM 2011-61) to reiterate and clarify existing BLM National Environmental Policy Act (NEPA) policy to assist offices that are analyzing externally-generated, utility-scale renewable energy right-of-way applications. It includes examples and guidance applicable to renewable energy right-of-way applications that supplement information in the BLM's NEPA Handbook (H-1790-1). Utility-scale renewable energy projects are distinct from many other types of land and realty actions due to their size and potential for significant resource conflicts, as well as the priority that has been placed on them by the Department of the Interior.



Amending BLM land use plans in light of Solar and Wind Programmatic Environmental Impact Statements

Land use plans are important in siting renewable energy facilities. Such a planning process provides a means to comprehensively address the diverse topics described in this best management practice guide. In most settings, compliance with approved land use plans is a legal requirement for a large project on public lands.

The American Planning Association defines a land use plan as "an adopted statement of policy, in the form of text, maps, and graphics, used to guide public and private actions that affect the future. A plan provides decision makers with the information they need to make informed decisions affecting the long-range social, economic, and physical growth of a community" (APA 2006). Given goals or end results that are desired, planners determine the best means for achieving them.

Since more of the future renewable energy proposed for the West will occur on BLM lands than on any other government agency's land, here we focus on the application of land use planning by BLM. BLM's land use planning process is guided by BLM Handbook 1601-1 (BLM 2005c). Required by an act of Congress (FLPMA, 43 U.S. C. 1711-1712), BLM land use plans are called Resource Management Plans (RMPs). BLM's handbook directs land use plans to establish goals and objectives for resource management (desired outcomes) and measures to achieve these goal and objectives (management actions and allowable uses). Such RMPs are to make decisions that guide future land management actions and site specific implementation (BLM 2005).

Three types of land use plan decisions are described in BLM's planning handbook – **desired outcomes, allowable uses, and management actions.** These can be defined as follows:

- **Desired outcomes** are "expressed in terms of specific goals and objectives." Goals are "broad statements of desired outcomes (e.g. maintain ecosystem health and productivity, . . .)." (BLM 2005) Objectives are quantifiable and measured for objective achievement within an established time frame.

- **Allowable use** identifies the type of use and where it is allowed or prohibited. The resulting plan then defines which areas allow, prohibit, or put limitations on actions or uses.

- **Management actions** include active restoration or administrative designations for areas such as Areas of Critical Environmental Concern or Research Natural Areas. For example, where undesired habitat conditions may not correct themselves on their own, management actions may be necessary to restore habitat to land use plan objectives. Any action that BLM takes must by law conform to an approved land use plan. Conformance means that the action is consistent with the terms, conditions, and decision of the plan (43 CFR 1601.0-5(b). For example, a decision to permit a drilling operation in an area where the approved RMP prohibits surface activity would not conform to the plan.

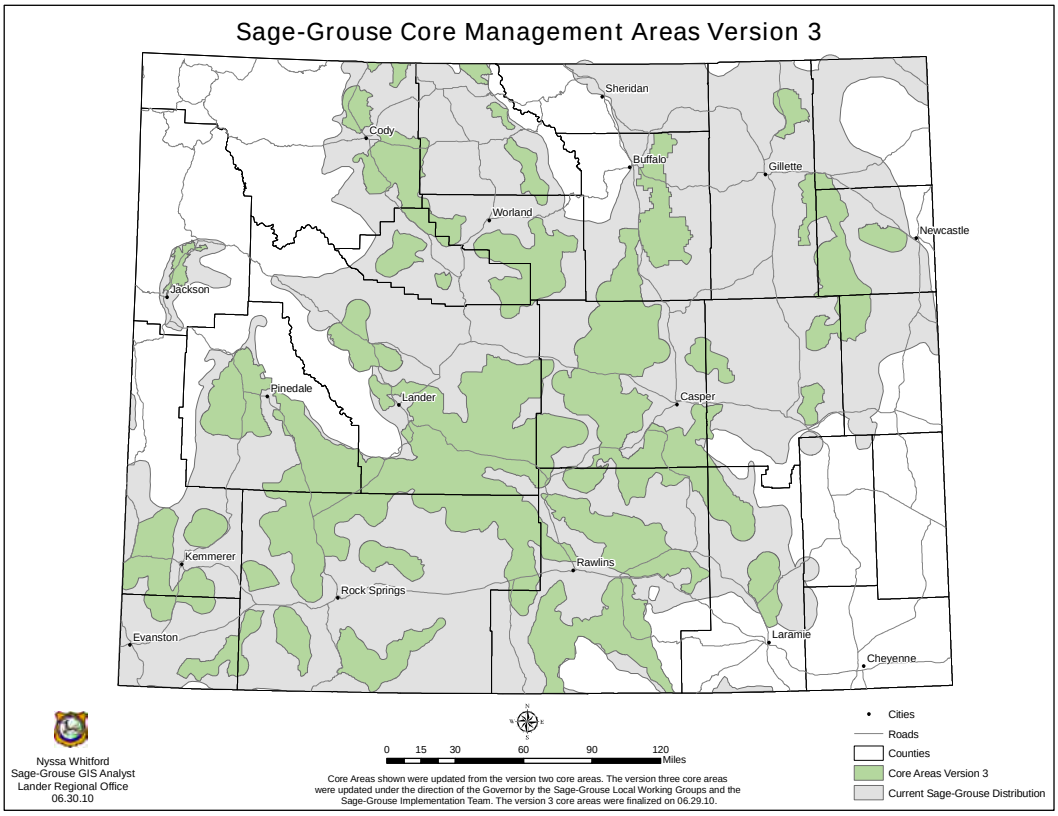
Any action that BLM takes must by law conform to an approved land use plan. Conformance means that the action is consistent with the terms, conditions, and decision of the plan.

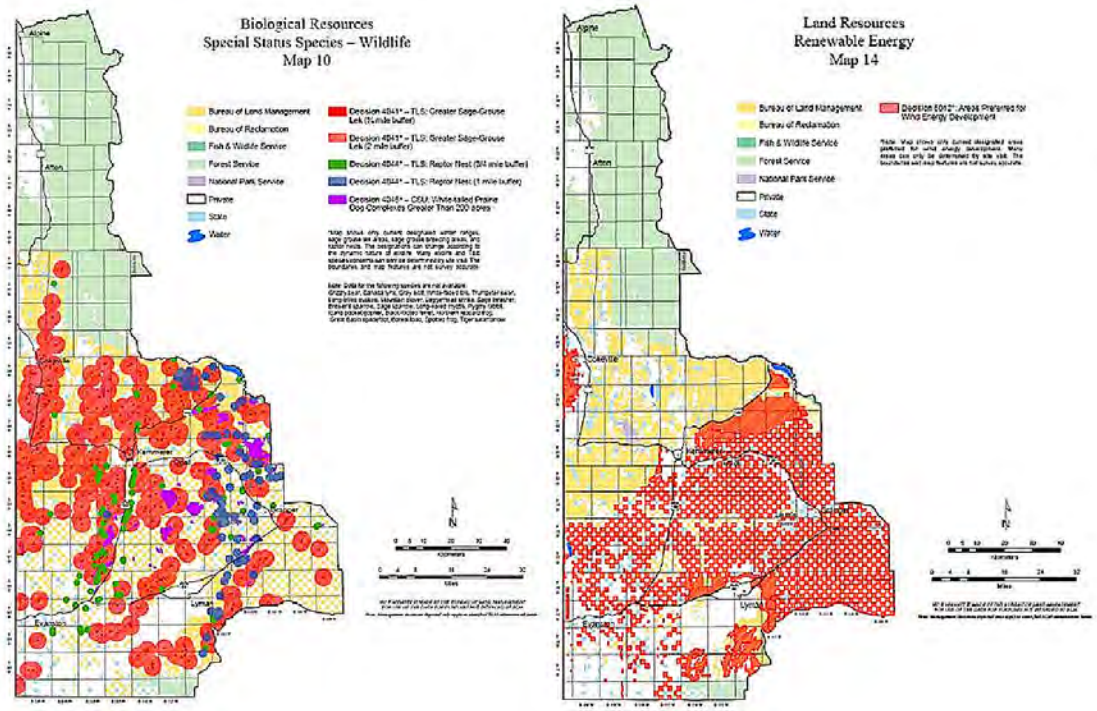
Sage-grouse Issue Not Addressed in BLM Plan

In practice, BLM has defined planning more narrowly than its handbook describes. Many of BLM's RMPs focus primarily on one of the three types of decisions: allowed uses. For example, BLM's RMP for the Kemmerer area in southwest Wyoming has excellent potential for renewable energy facilities, especially wind power. The Kemmerer RMP outlines land use decisions of the allowed use type; therefore, to describe "allowed uses" for wind energy production, this plan presents preferred wind power development sites and exclusion areas. In considering renewable energy, most BLM land use plans provide "avoidance areas" and "exclusion areas" for wind energy. These avoidance areas are areas with important or sensitive resource values and thus will be excluded or avoided (BLM 2005).

In 2008, the state of Wyoming updated its greater sage-grouse management plan that identified sage-grouse core areas based on lek location and potential nesting habitat use areas (See core area map at right, top). These core areas are designated so as to limit surface disturbing activities, including the installation of renewable energy facilities[3] (Freudenthal 2010). BLM's Wyoming state director found it appropriate for BLM to "base our management strategy on these core areas" (Simpson 2008). But in the Kemmerer RMP issued in 2010, BLM did not designate these core areas as development avoidance or prohibition areas. Instead this plan allows, and in fact encourages in some sage-grouse core areas surface disturbing development. The Kemmerer RMP's preferred areas for renewable energy (see Kemmerer map at right, bottom) overlap about half of the sage-grouse leks identified in the planning process. Over 154,000 acres are excluded from wind power which is 5% of all lands BLM manages in this area. BLM promised to address sage-grouse issues on a case by case basis but not in the land use plan.

3 The Governor's Executive Order that updated the sage-grouse management plan in 2010 states that development is permitted as long as the developer can demonstrate that its activities will not cause declines in sage-grouse populations. Once adequate studies have determined what the impact of wind turbines is on grouse, wind energy development may be able to proceed (depending on the results of the research).


Sage-Grouse Core Management Areas Version 3
Sheridan
Cody
Buffalo
Gillette
Worland
Newcastle
Jackson
Pinedale
Lander
Casper
Kemmerer
Rawlins
Rock Springs
Evanston
Laramie
Cheyenne
Nyssa Whitford
Sage-Grouse GIS Analyst
Lander Regional Office
06.30.10
0 15 30 60 90 120
Miles
Core Areas shown were updated from the version two core areas. The version three core areas were updated under the direction of the Governor by the Sage-Grouse Local Working Groups and the Sage-Grouse Implementation Team. The version 3 core areas were finalized on 06.29.10.
Cities
Roads
Counties
Core Areas Version 3
Current Sage-Grouse Distribution


Biological Resources
Special Status Species – Wildlife
Map 10
Land Resources
Renewable Energy
Map 14

Summary, use of BMPs on BLM Lands

Within the BLM, the use of BMPs is at the discretion of the decision-maker to a greater degree than with other agencies, such as the Department of Defense. A "performance-based approach" may be one avenue to pursue on BLM lands. This might involve, for example, a commitment to offset adverse effects, and, for species with declining populations, to provide additional enhancement. Otherwise, what we may be faced with in the near future, with many renewable energy projects coming down the pike, are cumulative impacts from scores of renewable projects that contribute to declining populations for multiple species. This "performance approach" should be coupled with a commitment to partner with the other players on the same piece of ground to achieve this goal, not just with other wind or solar operators, but with recreationists, traditional energy development, grazing permittees, conservationists, etc.

A multitude of laws have sections that are applicable to the siting, development, permitting, and operation of wind and solar energy, and therefore also provide a foundation for the Best Management Practices described in this document.

Other Applicable Federal Laws

For all solar and wind projects on federally managed lands, issuance of land use permits and right-of-way authorizations by the relevant federal agency does not relieve the applicant of obtaining any and all other permits and authorizations that may be required for the proposed project, and abiding by various federal laws and acts, many of which also apply on private lands. A multitude of laws have sections that are applicable to the siting, development, permitting, and operation of wind and solar energy, and therefore also provide a foundation for the Best Management Practices described in this document. Below is a list of the most important of these laws, with a brief description of how each may apply.

- ***The National Environmental Policy Act (NEPA)*** (42 U.S.C. §§ 4321-4370f)…

Will be triggered by the developer's need for a federal permit (such as a take permit under the Bald & Golden Eagle Protection Act) or approval, siting of the project on federal lands, accessing a federally owned transmission line, or being eligible for federal grants for the project. Depending on the type of actions and the potential for impacts, the federal agency involved at the development site may have to prepare an

Environmental Assessment or Environmental Impact Statement for the project before it can act. The NEPA process requires public involvement in identifying issues to be considered and in commenting on the agency's analysis. Also, under NEPA various alternatives for the project must be assessed before carrying out an action that may significantly affect the integrity of the land and its uses. And, potential cumulative impacts must be assessed.[4] The reviewing agency may use the results of the NEPA review (a Record of Decision or a Finding of No Significant Impact or a Categorical Exclusion) to clarify requirements for mitigation and monitoring to address the project's environmental impacts.[5]

- ***The Endangered Species Act (ESA)*** (16 U.S.C. § 1536(a)(2)...

Requires that agencies insure that permitting solar and wind development "is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of critical habitat of such species. The U.S Fish and Wildlife Service (USFWS) has primary responsibility for terrestrial and freshwater organisms protected under the Act. To insure that there is no harm to federally listed species, the developer will need to consult with the USFWS under section 7 of the Act. To be in compliance with the ESA, the developer or relevant agency might have to write a Biological Assessment if there are any predicted impacts of the project to a federally listed species, and the USFWS, which typically administers the ESA, would then write a Biological Opinion is response to the Biological Assessment. Unlike NEPA, the ESA has the authority to actually stop a project based on a potential taking of endangered species or habitat (while NEPA only requires analysis of impacts).

The Utah prairie dog is listed as an endagered species. Permitting for wind or solar develoment must not jeopardize its continued existence. Photo © Utah Division of Wildlife Resources.

- ***Federal Noxious Weed Act*** -- Public Law 93-629 (7 U.S.C. 2801 et seq.; 88 Stat. 2148)...

Enacted in 1975, established a Federal program to control the spread of noxious weeds. Under this law, renewable energy developers must demonstrate that their project is not likely to lead to significant spread of noxious weeds, and lay out a plan to reduce or control the spread of noxious weeds if an outbreak occurs post construction.

4 Cumulative impact analysis should include determining which species of concern or their habitats within the landscape are most at risk of significant adverse impacts from renewable development in conjunction with other reasonably foreseeable significant adverse impacts. The magnitude and extent of the impact on a resource depends on whether the cumulative impacts exceed the capacity for resource sustainability and productivity. (USFWS 2010a).

5 Also see Council on Environmental Quality 2011, which outlines the appropriate use of planned mitigation and monitoring for NEPA analysis.

Bald Eagle. The Bald and Golden Eagle Protection Act allows legal "take" permits for renewable energy companies, but it also gives guidance regarding the creation of Eagle Conservation Plans that minimize loss of eagles. Photo by Brent Stettler, Utah Division of Wildlife Resources.

- ***The Federal Land Policy and Management Act (FLPMA)*** as amended (43 U.S.C. 1701 et seq.)...

Recognizes the value of public lands and provides a framework in which they can be managed in perpetuity for the benefit of present and future generations. FLPMA defined BLM's mission as one of multiple use. Under FLPMA, the BLM is authorized to grant Right of Ways on BLM land for solar and wind installations.

- ***The Migratory Bird Treaty Act***, as amended (16 USC 703-712)...

Implements a variety of treaties and conventions among the United States, Canada, Mexico, Japan, and Russia. This treaty makes the take, killing, or possession of migratory birds, their eggs, or nests unlawful, except as authorized under a valid permit. Most of the bird species reported from the 11 western states are classified as migratory under this act. The USFWS maintains a list of migratory birds protected by the MBTA.

In addition, under E.O. 13186, each federal agency that is taking an action that has or is likely to have negative impacts on migratory bird populations must work with the USFWS to develop an agreement to conserve those birds. The protocols developed by this consultation are intended to guide future agency regulatory actions and policy decisions. Notably, E.O. 13186 is also in furtherance of NEPA, the ESA, and the Bald and Golden Eagle Protection Act.

- ***The Bald and Golden Eagle Protection Act*** (16 U.S.C. 668-668c. 50 Code of Federal Regulations [CFR] 22)...

Provides for the protection of both bald and golden eagles by prohibiting take unless allowed by permit. In September 2009 the U.S.

Western tanager, a migratory species that may be affected by renewable energy development. Photo by Scott Root, Utah Division of Wildlife Resources

Fish and Wildlife Service published a final rule (Eagle Permit Rule) under the Bald and Golden Eagle Protection Act authorizing limited issuance of permits to take bald and Golden Eagles ''for the protection of . . . other interests in any particular locality'' where the take is compatible with the preservation of the bald eagle and the golden eagle, is associated with and not the purpose of an otherwise lawful activity, and cannot practicably be avoided (USFWS 2009a).[6]

The Eagle Permit rules fall under 50CFR 22. Section 22.26 deals with take of eagles, while Section 22.27 deals with nests. The Draft Eagle Conservation Plan Guidance (USFWS 2011a) explains the Service's approach to issuing programmatic eagle take permits specifically related to wind energy development under this authority, and provides guidance to permit applicants, Service biologists, and biologists with other jurisdictional agencies on the development of draft Eagle Conservation Plans to support permit issuance.

Currently, the draft Eagle Conservation Plan guidance suggests that USFWS will be applying a "no-net-loss" standard to permit issuance.

Currently, the draft ECP guidance suggests that USFWS will be applying a "no-net-loss" standard to permit issuance. There may be significant adverse cumulative effects from loss or fragmentation of habitat, and displacement of eagles, which may not individually lead to take under the Eagle Act. In order to meet federal responsibilities under E.O. 13186, these effects should be addressed through the NEPA process of either the federal agency permitting the action or through the USFWS NEPA on the Eagle Act permit.

6 The programmatic permits under the BGEPA were originally envisioned to be broad, industry wide take permits. However, the greatest demand in practice has been from individual companies, and as a result, the USFWS is seeing a demand for many smaller-scale permits covering individual installations that may take few eagles individually, but cumulatively could take many (USFWS 2011a). In the Final Rule establishing permits for take of eagles and eagle nests under 50 CFR 22.26 and 50 CFR 22.27, the Service defined "compatible with the preservation of the bald eagle and the golden eagle," the standard by which the Service must determine whether take can be permitted, to mean "consistent with the goal of stable or increasing breeding populations." But note that the BGEPA does not specifically protect the habitat supporting bald eagles and golden eagles or their prey. Incremental, cumulative losses and fragmentation of eagle habitat can lead to declining breeding populations without individually violating the Eagle Act. Declining breeding populations would not be compatible with the preservation of the bald eagle and golden eagle, would further limit the availability of permits for take of golden eagles, and increase mitigation levels required to offset the take that occurs (Personal Communication, Diana Whittington, USFWS). Thus, the Service recommends that developers evaluate effects to habitat and prey that would result in negative effects to breeding populations of eagles, and carefully address cumulative impacts that may involve other projects nearby.

- ***The Clean Water Act*** (33 USC 1251-1387)…

Governs impacts to water resources. The Clean Water Act has a broad goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. Among other things, the Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States and managing polluted runoff. In particular, wind and solar energy projects may be subject to Water Quality Certification under Section 401 of the CWA and permit requirements under Sections 402 and 404 of the CWA.

- ***The National Historic Preservation Act*** (of 1966, as amended through 1992. Public Law 102-575)…

Established a program for the preservation of historic properties throughout the nation. Renewable energy development cannot be built within sites that are on the National Register of Historic Sites. In addition, the Act allows for native American take of golden eagles, so it is important that all activities (such as renewable energy development) do not suppress local golden eagle populations, so there are strong, healthy populations that can sustain some level of permitted native American take if desired.

Photo © Tom Stoffel, DOE/National Renewable Energy Laboratory.

State Permitting, Siting and Regulation of Renewable Energy

Extensive discussions have been taking place around the country on the issue of siting wind and solar energy facilities. Federal, state and local governments have long governed siting and permitting of energy facilities in the United States. As renewable energy has become more prominent, numerous states have developed (or are in the process of developing) siting guidelines, model ordinances, statutes, and checklists that address specific issues that are frequently raised in siting and permitting solar and wind energy facilities. While many of the guidelines being developed will be optional, and many renewable energy projects will be up and running prior to these guidelines being approved, it is a start towards achieving guidance where previously none had existed.

Jurisdiction over siting energy facilities varies from state to state. In some states, siting authority rests with a local branch of government. In these cases, county commissions, planning and zoning boards, or other local government departments are responsible for approving wind farms and other energy facilities. Other states retain primary siting authority at the state level. Often other state regulatory agencies are involved in permitting processes. For example, when wildlife or other environmental issues arise, a state environmental protection agency may become involved.

Most state guidelines dealing with specific siting issues make reference to pre- and post-construction surveying and monitoring to ensure that no threatened or endangered species, nor their habitats, are affected by development of wind or solar energy. In most cases, state guidelines call for applicable authorities to consult with agencies charged with implementing the Endangered Species Act and other habitat protection requirements. Not all state approaches call for consideration of non-wildlife environmental issues, such as visual, noise, and construction-related effects. Others set clear limits on allowable levels of state influence in these areas. In most cases, granting of stormwater management permits for construction activities will be issued by a state's environmental quality department. Still other permits such as conditional use permits, building permits, and encroachment permits are handled at the county level, usually with a county planning and zoning department, but we will not go into detail on that level of planning in this guidance document.

In summary, the regulatory process for siting and permitting wind or solar energy projects varies widely from state to state. Both the American Wind Energy Association's Wind Energy Siting Handbook (2008), and the National Wind Coordinating Collaborative State Siting and Permitting of

Energy Facilities Fact Sheet (2006) discuss the typical state-level and local regulatory frameworks that a wind developer is likely to encounter, and go into more detail on these state-level processes than we can go into here. "The Law of Wind" (Stoel Rives 2010) similarly gives good guidance on siting and permitting wind facilities on the state and local level. And "Lex helius: The law of solar energy" (Stoel Rives 2009) does the same for solar facility permitting. A particularly helpful guidance document for wind and solar projects on BLM lands was released by the BLM in November 2010 (BLM 2010c). This document, "Best Management Practices and guidance manual: Desert renewable energy projects," is an excellent source for developers going through the federal regulatory process for siting on public lands, for both the pre-application and post-application periods.

Typical Steps in Wind and Solar Permitting Process

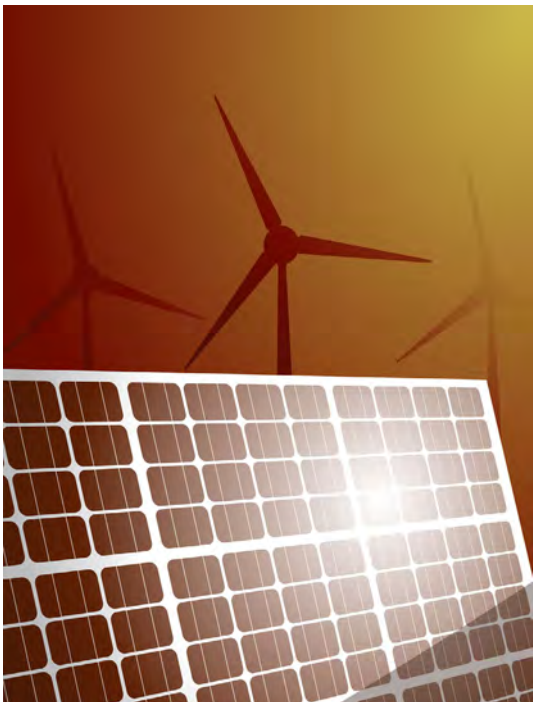


Image Envision LLC

Pre-application.

During the pre-application phase, project developers often meet with nearby landowners, community leaders, Tribes, environmental groups, and other potentially affected interests. This acquaints the developer with any initial concerns and allows the developer to respond to questions regarding the project. In some jurisdictions, the project developer is required to hold public meetings or submit a public notice regarding the project during this phase. At this stage, on public lands, pre-NEPA preliminary environmental screening analysis is recommended (especially by the BLM), since this pre-NEPA analysis is often reviewed by potential investors as they evaluate the feasibility and risks associated with a proposed project and how much capital may be required. This is also when the developer should be coordinating with the U.S. Fish & Wildlife Service. Wildlife issues can translate into additional NEPA for USFWS take permits, (such as BGEPA permits), and, on private lands, for any Habitat Conservation Plan that is developed to obtain an Incidental Take Permit under ESA. If the US Fish & Wildlife Service is aware early on of another agency's or entity's pre-NEPA analysis, they have a greater ability to partner on it and adopt it as theirs.

Application review.

For most agencies, the application review for projects on public lands begins when the project developer files a permit application. Any NEPA-related environmental assessment and review would occur during this stage. The public has an opportunity to participate in this stage, through public scoping and comment periods associated with the preparation and publication of any NEPA documents such as Environmental Assessments and Environmental Impact Statements.

Decision-making.

Based on the application review phase above, the relevant federal agency not only determines whether or not to allow a proposed wind or solar facility to be constructed and operated (on public land), or to permit take of listed species or eagles via its activity, but also whether environmental mitigation and other construction, operation, or decommissioning requirements are needed. This phase frequently includes one or more public hearings. For Bald and Golden Eagle Protection Act permits, the U.S. Fish & Wildlife Service evaluates whether and which supplemental permit conditions apply, as well as the monitoring requirements. Also, if there is mitigation for any agency's NEPA analysis, monitoring is required (CEQ2011).

Administrative Appeals and Judicial Review.

Appeals of all or a portion of a final decision on public land renewable energy development are considered during the administrative and judicial review phase. The public can be an appellant but first must make sure they have standing. This requires that the organization or individual would have participated in every opportunity to register interest in the project, such as submitting comments during every opportunity. The first avenue of appeal is directed to the decision-maker. Only after all administrative appeals have been exhausted are challenges to the decision reviewed by the courts. Appeals to the courts most frequently are directed at determining whether the permitting process was executed fairly and in accordance with the review requirements.

Permit Compliance.

The permit compliance phase extends throughout a solar or wind project's lifetime, and may include inspection or monitoring to ensure that the project is constructed, operated, and decommissioned in compliance with the terms and conditions of its various permits and all applicable laws.

The BMPs below are expected to be adapted to the needs of specific site conditions after careful environmental screening and analysis.

Best Management Practices for Wildlife and Habitat for Solar and Wind Development on Western Lands

Because the Solar Energy Zones have been selected for their low conflicts with other resources and uses, opposition to projects that leads to extended conflicts may be reduced. By reducing the time required to approve projects and the conflicts with stakeholders, project approvals may cost less if they are built in the already identified Solar Energy Zones.

After we review the siting BMPs, below, these Best Management Practices are broken up into six sections according to the species or resource affected: (e.g. raptors, vegetation/hydrology, etc.). Each section provides recommendations for those species and resources and, afterwards, reviews research on solar and wind energy production and its impacts to lowlands and desert systems in the West using the best available science. The BMPs below are separated into "Siting BMPs", "Planning and preconstruction BMPs", "Construction/Operation BMPs", and "Monitoring BMPs." This breakdown reflects the different decision-making processes that land managers often encounter. There is an additional, seventh, section on how to address renewable energy development within the land-use planning context. These BMP's do not cover decommissioning of a site.

We wish to be very clear that the Best Management Practices featured below are not meant to be "one size fits all"; project specific analysis is very important at the site level for every proposed project. The BMPs below are expected to be adapted to the needs of specific site conditions after careful environmental screening and analysis.

1.0 Siting - General

Not all lands are suitable for renewable energy development, and difficult choices will be required to minimize the environmental impacts of significantly expanded renewable energy. The following screening suggestions are an amalgamation of screening recommendations of dozens of different

Lands that have been previously degraded or disturbed should be prioritized for wind and solar development. Photo © Dennis Schroeder, DOE/National Renewable Energy Laboratory.

sources.[7] There was considerable overlap with the screening recommendations of all of these sources. We note that screening recommendations from the BLM for both wind (BLM 2005b) and solar (BLM 2010a) were also incorporated into this list. **Based on this comprehensive collection of all other renewable screening guidance we could locate, categories of land that should be prioritized for wind and solar development include:**

- (for solar) Lands identified by the BLM in the 2010 Solar Programmatic Environmental Impact Statement (PEIS) as Solar Energy Zones (BLM 2010a).[8] By guiding projects to zones that have already been analyzed in the PEIS, BLM will be able to rely on some of the environmental analysis already conducted, making project-specific environmental evaluation and development of any needed mitigation measures faster.

Further, because the zones have been selected for their low conflicts with other resources and uses, opposition to projects that leads to extended conflicts may be reduced. By reducing the time required to approve projects and the conflicts with stakeholders, project approvals may cost less if they are built in the already identified Solar Energy Zones. In addition, because projects are likely to be located closer to existing roads and transmission lines, there will be fewer costs associated with constructing new supporting infrastructure. Also, because these projects are in areas that have fewer conflicts with natural and cultural resources, there should be fewer costs associated with design adjustments and mitigation measures to address potential damage to other values (TWS 2010).

7 Sources include BLM 1992, BLM 2005b, Clean Energy States Alliance 2006, National Wind Coordinating Collaborative 2007, Audubon 2008, Molvar 2008, Oregon Natural Desert Association 2009, BLM 2010a, California Desert & Renewable Energy Working Group 2010, The Wilderness Society (TWS) 2010, TWS et al. 2010, US Fish and Wildlife Service 2010a, Wyoming Game and Fish 2010, Wyoming Outdoor Council 2010, American Bird Conservancy 2011, USFWS 2011b, and BLM Instruction Memoranda IM 2011-59, IM 2011-60 and IM 2011-61.

8 Note that during the public comment period on the Draft PEIS that many members of the public recommended that some of the proposed Solar Energy Zones be refined, and that a few be removed from consideration.

- Western Renewable Energy Zones identified by the Western Governors Association's Western Renewable Energy Zone initiative.

Placing renewable energy infrastructure adjacent to urbanized areas, such as this site in Golden, CO, helps provide jobs for local residents. Photo © DOE/National Renewable Energy Laboratory.

- Lands that have been previously degraded or disturbed, such as fallow or abandoned agricultural fields, landfills, reclaimed mine sites or any tract of land that has resulted in "type-conversion" from native vegetation through plowing, bulldozing or other mechanical impact.
- Private lands of comparatively low resource value, or public lands of comparatively low resource value located adjacent to degraded and impacted private lands, which would allow for the expansion of renewable energy development onto private lands.[9]
- Brownfields and contaminated or previously-contaminated sites, including abandoned mines.[10]
- Areas of land previously disturbed by energy develpment, such as oil, gas and coalbed methane fields.
- Privately owned feedlots and lands currently in intensive agricultural production[11]
- Locations adjacent to urbanized areas. This can also provide jobs for local residents often in underserved communities, while also minimizing workforce commute and associated greenhouse gas emissions.
- Locations that minimize the need to build new roads.
- Locations that could be served by existing substations.
- Locations proximate to load centers.
- Locations with adequate access to transmission lines.

Categories of land to be prioritized for avoidance include:

- Units of the National Landscape Conservation System, including National Parks, National Monuments, National Wildlife Refuges, Wild and

9 Private lands development offers tax benefits to local government. Also, in a Netherlands study, van den Berg (2008) found that respondents with direct economic benefits (such as private land owners siting wind farms on their properties) were more accepting of wind turbines from visual and noise perspectives. This suggests that siting turbines on private lands may entail greater acceptance as landowners realize direct benefits while the public does not perceive direct compensation for the development of utility-scale wind projects on public lands.

10 This can also revitalize idle or underutilized industrialized sites, which is what the EPA "RE-Powering America" projects are attempting to do.

11 The National Wind Coordinating Collaborative (2002) considers agriculture as "a wind-compatible resource." Because wind developments typically take less that 2% of the land out of agricultural production and yield additional sources of revenue, they may be especially attractive to private agricultural landowners (Molvar 2008). In addition, crop fields support a monoculture of non-native vegetation and tend to provide ecologically impoverished fauna and low biodiversity. In general, bird fatalities at sites located in agricultural croplands have been at the lower end of the spectrum (Erickson et al. 2003, Molvar 2008).

Scenic Rivers, National Conservation Areas, and designated Wilderness areas.

- Special federal land management designations, such as Areas of Critical Environmental Concern (ACECs), Desert Wildlife Management Areas (DWMAs); Research Natural Areas (RNAs), Outstanding Natural Areas (ONAs), and other areas that have been identified by a federal agency for the protection of important wildlife resources, ecological features, and significant historical, paleontological, and archeological resources.
- Wilderness Study Areas and other wilderness quality lands, including USFS Inventoried Roadless Areas, areas where there is an applicable land use plan decision to protect lands with wilderness characteristics, and other inventoried roadless areas.
- Lands that support federally threatened/endangered and candidate species, including federally designated and proposed critical habitat, and other lands that provide important habitat for federal T/E/Candidate species, such as greater sage-grouse core breeding areas (called "Sage-Grouse Core Areas").
- Globally "Important Bird Areas" identified by the Audubon Society.
- Key Raptor Areas identified by the Bureau of Land Management.
- Wild and Scenic rivers, wetlands, riparian areas and ecologically significant intermittent washes.
- All areas where the applicable land use plan designates no surface occupancy, or Right of Way Exclusion or Avoidance Areas, or is otherwise precluded for development by law or regulation.

The Utah Division of Wildlife Resources has identified 36 wetlands speices of conservation concern, including the Columbia spotted frog. By avoiding "Wildlife Action Plan Focus Areas" in Utah, renewable energy development can help avert additional damage to these species. Photo courtesy of Utah Division of Wildlife Resources.

- Landscape level biological linkages, including lands in wildlife corridors, such as Big Game Migratory Corridors identified in land use plans.
- Big Game Winter Ranges identified in applicable land use plans.
- Historic Property/National Register lands, and cultural sites eligible for National Register or areas with a high density of cultural resources requiring inventory and consultation.
- Lands purchased or acquired by exchange for conservation purposes including lands conveyed to the BLM.
- State wildlife management areas and state parks.
- Important wildlife habitat as identified in State Wildlife Action Plans. Good examples are the "Wildlife Action Plan Focus Areas" outlined in Utah's State Wildlife Action Plan (UDWR 2005).
- Lands identified as portfolio sites in Nature Conservancy Ecoregional Plans or as "core areas" in regional Conservation Area Designs or Wildlands Network Designs.

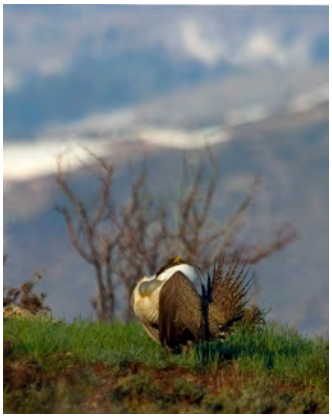
2.0 BMPs for Siting, Constructing, Operating and Monitoring Wind and Solar Development on Western Lands

These Best Management Practices for renewable energy siting and development draw on scientific, peer-reviewed research, with the goal to enable developers, wildlife agencies, conservationists and other stakeholders to work with a consistent knowledge base and set of appropriate technical questions and well-established guidelines to assess a given project location and to develop wind and solar energy in a way that is smart-from-the-start for wildlife and their habitats. These BMPs are a generalized set of recommendations, and specific project best practices might differ based on unique sites/conditions/projects. All Best Management Practices outlined below apply to both wind and solar developments, unless specifically stated that it applies to one or the other. There are a number of BMPs that are relevant to raptors, sage grouse and all birds, which are only listed in the "All birds" BMP section, rather than to repeat these BMPs in the sage grouse and/or raptor section.

Smart-from-the-Start

These BMPs for renewable energy siting and development draw on scientific, peer-reviewed research, with the goal to enable developers, wildlife agencies, conservationists and other stakeholders to work with a consistent knowledge base and set of appropriate technical questions and well-established guidelines to assess a given project location and to develop wind and solar energy in a way that is smart-from-the-start for wildlife and their habitats.

2.1 Best Management Practices for Sage-Grouse



Sage-grouse. Photo by Dan Christensen, Utah Division of Wildlife Resources.

The Siting, Planning/Preconstruction, Construction/Operation, and Monitoring BMPs for sage-grouse, below, is an amalgamation of BMP's gathered from numerous different sources.[12] The bullets below are based on scientific studies, analysis and conclusions that are summarized in the justification section that follows the BMP bullets.

2.1.1 Siting BMPs for Sage-Grouse for Wind Installations

- Wind turbines should not be located within designated Sage-Grouse Core Areas.[13]
- Wind turbines and met towers should not be sited within 5 km of an active sage-grouse lek.
- Wind turbines should not be sited within sage-grouse nesting and brood-rearing habitat, and should be sited away from other high-use sage-grouse areas identified in preconstruction surveys (see below).

2.1.2Planning and Preconstruction BMPs for Sage-Grouse

- Consult with the state fish and game agency to determine locations of sage-grouse leks, nesting and brood-rearing habitat, and wintering areas based on past surveys.
- Use scientifically sound, peer reviewed research protocols to determine how sage-grouse use a proposed project area. If possible, try to determine whether the site has a resident or migratory population.
- Populations of sage-grouse at the site should be assessed by lek counts (a count of the maximum number of males attending a lek) during the breeding season (e.g., Connelly et al. 2000). Methods for lek counts require repeated visits to known sites and a systematic search of all suitable habitat for leks, followed by repeated visits to active leks to estimate the

12 Sources include Manville 2004, Molvar 2008, ONDA 2009, Wyoming Outdoor Council 2009, U.S Fish & Wildlife Service 2010a, USFWS 2011b.

13 If turbines must be placed in sage-grouse core areas, Wyoming Governor Freudenthal's 2010 Executive Order states that placement of wind turbines in core areas must occur at levels that are known not to cause sage-grouse declines.

number of grouse using them (USFWS 2010a). If resources are not sufficient to conduct a lek count, lek surveys (classification of known leks as active or inactive) may be adequate.

- If resources allow, monitor radio-tagged sage-grouse on the proposed development site for at least two years preconstruction.

Sage-grouse displaying to females on a lek, a time when sage-grouse are particularly sensitive to disturbance. Photo by Ron Stewart, Utah Division of Wildlife Resources.

- Suitable nesting and brood rearing habitat at the site should be mapped to the best of the developer's ability, in conjunction with the state wildlife agency.[14]
- Conduct a basic risk assessment. This should include the formulation of likely risk to sage-grouse from developing a site, a determination of risk exposure, an assessment of possible effects if the project goes forward, and a characterization of risk based on the overall review. Adjust siting and facility design based on the results of these assessments to reduce potential impacts to sage-grouse.

2.1.3 Construction and Operation BMPs for Sage-grouse

- If possible, all transmission lines (including high-voltage DC lines) sited within 5 km of a grouse lek should be buried.
- As practicable, do not conduct surface-use activities within crucial sage-grouse wintering and areas from December 1 through March 15. Also restrict ground disturbance activities in known sage grouse lekking and nesting areas from March 15 to June 1.
- Use sage-grouse diverters on any fences in the project area.

2.1.4 Monitoring BMPs for Sage-grouse

- Post construction populations of sage-grouse at the site should be assessed by lek counts during the breeding season (e.g., Connelly et al. 2000).
- Monitor radio-tagged sage-grouse on the project site for at least five years post-construction (ten years is preferable).[15]
- If many fences have been built at the project site, conduct fence-line fatality surveys.

14 This may require radio-tagged birds in both core and non-core habitats for an accurate representation of different habitat types in the project areas, and the incorporation of vegetation covariates into a Resource Selection Function (RSF) model.

15 This length of time is supported by the literature describing post construction monitoring findings of radio tagged sage-grouse in gas fields.

2.1.5 Justification for Sage-Grouse BMPs

The area within five km of a sage-grouse lek is crucial to both the breeding activities and nesting success of local sage-grouse populations in unfragmented habitat[16] (Manville 2004, USFWS 2010a). Hulet et al. (1986) found that 10 of 13 hens nested within two miles of the lek site during the first year of their southern Idaho study, and 100% of hens nested within two miles of the lek site during the second year of this study. In addition, research has shown that a four-mile buffer around leks encompasses 74-80% of sage-grouse nests (Moynahan 2004, Holloran and Anderson 2005). Because lek sites are used traditionally year after year and many researchers suspect that they represent selection for optimal breeding and nesting habitat, it is important to protect the area surrounding lek sites from impacts if possible.

Sage-grouse have an innate aversion to vertical structures because predators such as raptors can perch and hunt from these structures.

Sage-grouse have an innate aversion to vertical structures because predators such as raptors can perch and hunt from these structures (Utah Department of Natural Resources 2010). Thus, sage-grouse may be negatively impacted by wind energy development, not so much from the standpoint of direct mortality from collisions but from displacement from favored habitats due to behavioral avoidance of tall structures like met towers and turbines.

For example at the Cotterel Mountain wind project site in Idaho, there were nine known sage-grouse leks on Cotterel Mountain prior to the placement of eight meteorological (met) towers erected to measure wind veloc-

Photo © Iberdrola Renewables.

16 This distance may be greater in fragmented habitat (personal communication, Matt Holloran, Wyoming Wildlife Consultants, LLC).

ity for a commercial wind power feasibility study (Reynolds 2004). Overall sage-grouse population estimates were 59 to 72 individuals in 2004 and 2005 (Reynolds and Hinckley 2005). In spring 2006, after the met towers were erected, the population of sage-grouse on Cotterel Mountain declined to an estimated 16 individuals and seven of nine leks were unoccupied, while sage-grouse populations elsewhere in the county exhibited steady population trends in 2004 and 2005 and only a very slight dip in 2006 (Collins and Reynolds 2006). It is instructive that the Cotterel Mountain sage-grouse population crashed following installation of met towers across the crest of Cotterel Mountain. With relevance for solar installations as well, transmission towers[17] for power lines also serve as perches for hunting raptors so may cause abandonment of sage-grouse habitats through behavioral avoidance. An unpublished study found that sage-grouse habitat use increased with distance (up to 600 meters) from powerlines (Braun, unpublished data, reported in Strickland 2004).

> "We anticipate that potential impacts from direct habitat losses, habitat fragmentation through roads and powerlines, noise, and increased human presence…will generally be similar to those …for non-renewable energy development" (USFWS 2010b).

Much of what is known about the tolerance of sage-grouse to industrial development derives from studies on oil, gas, and coalbed methane development. To the extent that both wind power and solar power development also involve habitat fragmentation and loss from new construction and development, road construction and subsequent vehicle traffic, human activity and noise associated with maintenance, some of the impacts recorded in the context of oil and gas development may apply to varying degrees to wind and solar power developments (Molvar 2008).

For example in a study near Pinedale, Wyoming, sage-grouse from disturbed leks where gas development occurred within 3 miles of the lek site showed lower nesting rates (and hence lower reproduction), traveled farther to nest, and selected greater shrub cover than grouse from undisturbed leks (Lyon 2000). Walker et al. (2007) found that coalbed methane development within two miles of a sage-grouse lek had negative effects on lek attendance. Holloran (2005) found that active drilling within 3 miles of a lek reduced breeding populations, while wells already constructed and drilled within 2 miles of the lek reduced breeding populations. Both Hol-

17 While this document is not meant to cover transmission, this information supports the argument that tall structures can be problematic for sage grouse.

loran (2005) and Walker et al. (2007) documented the extirpation of breeding populations at active leks as a result of oil and gas development in the Upper Green River Valley and Powder River Basin, respectively. Lyon and Anderson (2003) found that in habitats fragmented by natural gas development, only 26 percent of hens captured on disturbed leks nested within 2 miles of the lek of capture, whereas 91 percent of hens from undisturbed areas nested within the same area. Based on this research on the impacts of oil and gas development, USFWS (2010a) stated, "Based primarily on data documenting reduced fecundity (a combination of nesting, clutch size, nest success, juvenile survival, and other factors) in sage-grouse populations near roads, transmissions lines, and areas of oil and gas development/production (Holloran 2005, Connelly et al. 2000), development within three to five miles (or more) of active sage-grouse leks may have significant adverse impacts on the affected grouse population." Currently, most of what we know about the impacts of oil and gas development on sage-grouse, which could have implications for renewable energy development, is summarized by Naugle et al. (2011).

The US Fish and Wildlife Service generally agrees with the prediction of wind power impacts on sage-grouse, similar to those made in the reviews and studies above, stating in its recent 12-month finding of whether to list the sage-grouse under the ESA, "wind power typically require[s] many of the same features for construction and operation as do nonrenewable energy resources. Therefore, we anticipate that potential impacts from direct habitat losses, habitat fragmentation through roads and powerlines, noise, and increased human presence…will generally be similar to those … for nonrenewable energy development" (USFWS 2010b).

Sage-grouse displaying on a lek. Photo © Utah Division of Wildlife Resources.

2.2 Best Management Practices for Raptors

The Siting, Planning/Preconstruction, Construction/Operation, and monitoring BMPs for raptors, below, is an amalgamation of BMPs gathered from numerous different sources.[18] Many of the BMPs in the section following this one, "Best Management Practices for All Other Birds," include many BMPs that are also relevant to raptors. BMPs that overlap both categories are thus included in the Birds BMP section, not this one, to avoid redundancy. The bullets below are based on scientific studies, analysis and conclusions that are summarized in the Justification Section that follows the BMP bullets.

There must be a demonstrated no-net-loss for eagles due to the project to be eligible for take permitting.

2.2 1 Siting BMPs for Raptors for Wind Installations

- Avoid all development in Key Raptor Areas identified by the Bureau of Land Management, as well as "important eagle use areas," as defined in the 2009 USFWS regulations (50 Code of Federal Regulations Parts 13 and 22) (CFR Vol. 74, No. 175).
- Avoid placement of turbines in known raptor nesting concentration areas, including within high-use raptor areas identified in preconstruction surveys (see below).
- Configure turbines so as to avoid landscape features known to attract raptors, such as cliff and rim edges, canyons, and passes (or "dips" or "notches") in ridgelines. Turbines should be set back at least 100 m. from cliff and rim edges, or at least two times the total height of the turbine.
- Rows of turbines should be oriented parallel to known migratory raptor movements/corridors (if known a priori) rather than perpendicular to them.
- Avoid placement of turbines in sites that potentially have high concentrations of prey such as prairie dogs and ground squirrels.

18 Sources include BLM 1992, U.S Fish & Wildlife Service 2002, the Kansas Renewable Energy Working Group 2003, Smallwood and Neher 2004, Smallwood and Thelander 2004, 2005; Lamphier-Gregory et al. 2005, Smallwood and Spiegel 2005, The Clean Energy States Alliance 2006, California Energy Commission 2007, Molvar 2008, Oregon Natural Desert Association 2009, Smallwood 2009a, 2009b, the 2010 National Golden Eagle Colloquium, Pagel et al. 2010, USFWS 2010a, Wyoming Outdoor Council 2010, USFWS 2011a, USFWS 2011b, personal communication with Steve Slater, HawkWatch Intl, and personal communication with staff of the USFWS.

2.2.2 Planning and Preconstruction BMPs for Raptors

- Consult with state fish and game agency and collect and synthesize any and all pre-existing information on raptor nests, reproductive activity and chronologies, natal dispersal, pertinent data from VHF and satellite telemetry, winter roosts, migration corridors, and foraging habitats contained within 10 miles of areas slated for development. In addition, consult with other wildlife and conservation organizations that may be particularly knowledgeable of the area and potential raptor issues (e.g., HawkWatch International may have location data for nesting raptors).

- For at least one full year pre-construction, assess all four seasons of use by raptors within the project area (either typical home ranges of species, telemetry defined use areas, or a standard buffer size).

- Preconstruction raptor surveys should follow science based, peer-reviewed protocols and comply with BLM, USFWS,[19] and state wildlife agency guidelines. For wind projects, the USFWS (2010a) guidelines recommend that raptor surveys should be done using point counts. The point count method and systematic observation are recommended to be used together for bald and golden eagle surveys (USFWS 2011a, personal communication, Jeep Pagel and Diana Whittington, USFWS). It is important that the survey radius for a given survey be less than 800 m.[20] Preconstruction raptor surveys should also collect vertical (such as flight height) as well as horizontal data to identify levels of activity within what will be the turbine rotor-swept zone. Observation of and delineation of habitat use of adult non-breeders (floating population) should be undertaken. Background mortality surveys of raptors at the project site should also be undertaken.

American Kestrel . Photo by Utah Division of Wildlife Resources.

- Presence of a raptor migration corridor or stopover site in the project area is best documented and

19 We refer readers to the USFWS (2010a) Wind Turbine Guidelines Advisory Committee Policy Recommendations and Guidelines, and USFWS 2011 a and 2011b, for further guidance on designing and implementing pre and post wind facility construction inventories, surveys and monitoring plans for raptors, and Pagel et al. 2010 for designing and implementing pre and post wind facility construction inventories (including presence/absence), surveys and monitoring plans for golden eagles, as well as information on contributing survey data to a USFWS regional office or to the Division of Migratory Bird Management for collation into a national database. Pagel et al. (2010) also include protocols on how to complete golden eagle inventories with minimal disturbance to golden eagles, which is very important since human-caused nesting failure and nest-site abandonment constitutes take under the Bald & Golden Eagle Protection Act.

20 Smallwood (2009) states that "one of the largest problems [with prior raptor surveys at wind development sites] is the extremely large survey areas being used to count birds. A common survey radius has been 800 meters, … but detection rates of even large birds decline rapidly with increasing survey radius [see Smallwood et al. 2009b]. A survey radius of 800 meters is scientifically indefensible unless analytical adjustments are made to the data before comparing them to utilization rates made from plots with different survey radii (Smallwood and Neher, Unpublished Data)."

delineated by using a standard hawk migration counting protocol.[21] Surveys will need to identify the locations of migration routes and movements during migration in relation to proposed turbines and rotor-swept area.

- Raptor nest searches during the breeding season within the project site and within at least three miles of the project site are also recommended. Per the Draft Eagle Conservation Plan Guidance (USFWS 2011a), in order to determine whether there are nesting golden and bald eagles near the project site, and to adequately describe the nesting territory and whether its occupied and if so how productive it is, direct observation (including aerial surveys), telemetry or a combination of both for at least three years is recommended by the USFWS (2011a and references within). To detect and document bald and golden eagle communal roosts and other nesting sites, direct, systematic observation in early morning and evening is recommended (Pagel et al. 2010 USFWS 2011a). See Pagel et al. (2010) for specific guidance on when and how a golden eagle nesting territory or inventoried habitat can be designated as unoccupied by golden eagles.

Golden Eagle. Photo by Brent Stettler. Utah Division of Wildlife Resources.

- Nests of raptors located during surveys should have non-disturbance buffer zones delineated around them. Avoid siting turbines within the home range of local eagles. The USFWS is currently recommending at least a four mile buffer of no development around a golden eagle territory.

- Per the Draft Eagle Conservation Plan Guidance (USFWS 2011a), the developer should identify the location and type of "important eagle use areas" (those that contain nesting, roosting and foraging habitat) within a 10-mile radius surrounding a wind project footprint. The 10-mile radius is derived from the definition of project area nesting population in the regulations of the Bald and Golden Eagle Protection Act. The Service goes on to say in the Draft Guidance that size and shape of important eagle use areas can vary seasonally, so documentation of spatial use by resident eagles should encompass all seasons

21 See guidelines published by the Hawk Migration Association of North America: http://www.hmana.org/ .

(USFWS 2011a, and references therein). This evaluation includes an assessment of the relative importance of various areas to resident breeding and non-breeding eagles, and to migrant and wintering eagles (see Pagel et al. 2010).

- It is critical that all raptor inventories, surveys and nest searches be conducted by competent and experienced observers. Pagel et al. (2010) outline the observer qualifications recommended by the USFWS for golden eagle inventories and surveys.

- Per the Draft Eagle Conservation Plan Guidance (USFWS 2011a), the USFWS recommends that preconstruction survey data for proposed wind facilities be used in standardized models linked to the Service's adaptive management process to generate predictions of eagle risk (based on height estimates) in the form of a predicted number of fatalities per year. These models can be used to comparatively evaluate alternative siting, construction, and operational scenarios,[22] a useful feature in quantifying the predicted effects of "Advanced Conservation Practices" that are recommended as "pre-emptive" mitigation strategies for golden eagles. It is critical that these models use the best possible information available about eagle flight paths and specific behaviors leading to collisions (Smallwood 2009a).

Models can predict the number of eagle fatalities to be expected in for any given proposed wind development. Photo © DOE/ National Renewable Energy Laboratory.

- Wind developers with operating or soon-to-be operating facilities at the time the USFWS Draft Eagle Conservation Plan Guidance were first released (January 2011) that are interested in obtaining a programmatic eagle take permit should coordinate with the Service (USFWS 2011a) as soon as possible. An applicant may need to provide up-to-date biological information about eagles that breed, feed, shelter, and/or migrate in the vicinity of the activity and may potentially be affected by the proposed activity (Pagel et al 2010). There must be a demonstrated no-net-loss for eagles due to the project to be eligible for take permitting. When develop-

22 Also note that et al. (2007) describe a landscape analysis "tool kit" they developed that was designed to screen wind resource areas for potential bird and raptor impacts caused by wind farm development, which may also be helpful for modeling a-priori impacts of turbines providing that suitable behavior data has been collected, and that suitable digital data inputs are available.

ing a new alternative energy project, project proponents should meet with the Service at their earliest opportunity (pre-project planning).

- Wind developers should consider development of a detailed eagle conservation plan which would be used as an integral part of the permit process (USFWS 2011a). The plan should document how the applicant will comply with the regulatory requirements for programmatic take permits and the associated NEPA process by avoiding and minimizing the risk of taking eagles up-front, and formally evaluating possible alternatives in (ideally) siting, configuration, and operation of wind projects, as well as discuss advanced conservation practices, and if all alternatives are used to prevent take but take is still likely, development of compensatory mitigation to offset predicted take necessary to achieve no-net loss.

2.2.3 Construction and Operation BMPs for Raptors for Wind Power

- Cluster turbines as much as possible.
- Avoid placing external ladders and platforms on wind towers that can be used by birds as perches or nest sites.
- Design the turbine/towers to position the blades at a height domain that is less likely to kill raptors at a particular location, based on pre-construction surveys.
- There must be spatial and temporal protections for raptors during construction based on the species known to be present. Consult USFWS 2010a, and regional offices of both USFWS and state wildlife agency, to devise best set of temporal and spatial protections during construction for the specific project site.
- Conduct proper vegetation management around turbines to avoid attracting greater than normal amounts of rodent prey resources for raptors. Reduce the vertical and lateral edge in slope cuts and nearby roads to lessen attraction to burrowing animals. Retrofit tower platforms to prevent under-burrowing by small mammals, including spreading gravel around the pad out to 5 feet. Exclude cattle grazing from wind turbine zones as resulting stature of taller vegetation may discourage raptor foraging near wind turbines.
- Cease wind turbine operations during seasons, weather events or times of day (such as times of peak activity) that are more likely to kill rap-

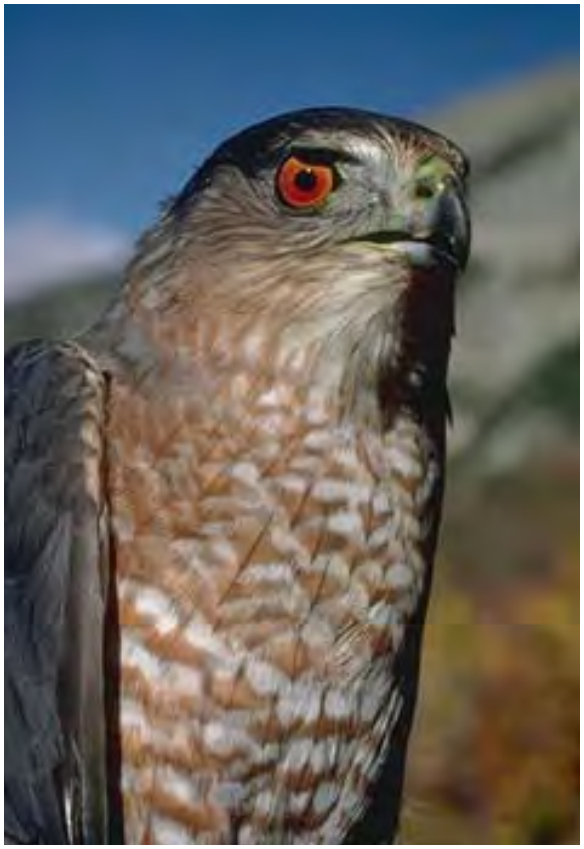
Red-tailed Hawk. Wind power developement design can reduce the number of raptors killed by turbines. Photo © Utah Division of Wildlife Resources,

tors, based on pre-construction surveys, especially those times corresponding with generation of relatively less power.

- Remove broken/defunct turbines that cannot be fixed or are unnecessary, allowing towers to remain at ends of rows to experimentally determine whether these may be beneficial as flight diverters.

2.2.4 Monitoring BMPs for Raptors

For at least three years[23] post construction, conduct carcass searches within 65 m. of turbines to determine whether the project siting efforts were successful or if raptors are being killed. Post-construction monitoring carcass surveys should always include appropriate scavenger removal and searcher efficiency trials. Some turbines should be searched most days, and if there are a small number of turbines (i.e. 10 or less), all turbines should be monitored.[24] Fatality rates should be reported on either a "per megawatt-hour" (MW/h) or per-GW/h basis. Necropsies of bird carcasses should be done to more accurately determine cause of death and time since death.



Cooper's Hawk. Photo © Jim Parrish, Utah Division of Wildlife Resources

- Post-construction raptor surveys[19] should be done using the same methods that were used for pre-construction surveys. These surveys should also collect vertical as well as horizontal data to identify levels of activity within the rotor-swept zone.

- Using the same methods as used pre construction, survey for active raptor nests within three miles of the project area. Be sure to make adjustments in pre and post survey methods when survey sites vary in topography (Smallwood 2009a).[25]

23 Per the Draft Eagle Conservation Plan Guidance (USFWS 2011a), the USFWS will require wind-facility operators to monitor eagles for at least three years post construction, to include a minimum of three years of operation, then assess monitoring data to consider whether additional "Advanced Conservation Practices" for eagles are appropriate and warranted.

24 Smallwood (2009) states that whether the sample of turbines is selected systematically or randomly should depend on the pool of turbines available in order to ensure that gradient effects are accounted for. Psuedoreplication can easily result from taking a random sample of 10 turbines from a pool of 20, so he suggests that the only sure way to prevent psuedoreplication in a case like this would be to systematically sample from the pool.

25 Smallwood (2009) states that raptor use "rates are… incomparable when survey sites vary in topography. The observer will view different proportions of the available airspace within the search radius depending on the complexity of the

A Scientific Advisory Team should be established to review monitoring results and make suggestions regarding the need to adjust site operations or mitigation and monitoring requirements.

- Compare post construction survey data with pre construction survey data, using BACI (Before After Control Impact) monitoring design. Manage adaptively through changes in site operation (i.e retrofitting certain hazardous turbines with markings, paint or devices to help avert collisions; operation of certain turbines that are particularly hazardous or relocation of those turbines to less hazardous areas, or experimental winter shut-down of turbines) if monitoring indicates that total raptor population (adult breeders and floaters) numbers might be in decline compared to pre-construction levels. A Scientific Advisory Team should be established to review monitoring results and make suggestions regarding the need to adjust site operations or mitigation and monitoring requirements.

- Where take of bald or golden eagles is unavoidable at a wind facility, and when eagle populations at the project site are not healthy enough to sustain additional mortality over existing levels, the developer will likely be required by the USFWS to reduce the effect of permitted mortality to a "no-net-loss" standard, best accomplished through compensatory mitigation. No-net-loss means that additional mortality caused by the wind facility is offset by compensatory mitigation that reduces another, ongoing form of mortality by an equal or greater amount (USFWS 2011a).

2.2.5 Justification for Raptor BMPs

There are indications that raptors are sensitive to wind turbines, partly because they tend to fly at heights within the rotor swept area (e.g. Kingsley and Whittam 2003). Golden Eagles are vulnerable to collisions with wind turbines (Hunt 2002, Chamberlain et al. 2006, Hunt and Hunt 2006), and in some areas such collisions are a major source of mortality, (Hunt et al. 1999, Hunt 2002), especially among floaters (or non-breeders) (Hunt and Hunt 2006, 2010 National Golden Eagle Colloquim) This is a matter of great concern since Golden Eagle populations are believed to be declining throughout their range in the contiguous United States (Pagel et al. 2010, and references within).[26] At Tehachapi Pass in California, Anderson et al.

terrain and where the observer is stationed on the terrain. Without accounting for variation in visible airspace fatality rates will not relate to utilization rates spatially (see Smallwood et al. 2009b). Smallwood and Neher (unpublished data) developed a methodology to subtract the hidden airspace from the survey radius-defined airspace to arrive at the viewable airspace. This step needs to be taken along with adjusting the utilization rate for variation in maximum distance of birds from the observer to generate comparable utilization rates."

26 At the 2010 North American Golden Eagle Science Meeting, attendees listed renewable energy in the top six concerns regarded for golden eagles.

(2004) found that red-tailed hawks, American kestrels, and great horned owls showed the greatest risk of collision of all bird species, and Osborn et al. (2008) concluded that raptors, along with waterfowl, were found to have the highest risk of turbine collision in Minnesota. Moreover, it does not appear that raptors make behavioral adjustments to wind power facilities that reduce fatality rates over time. Indeed, Smallwood and Thelander (2005) found that per-capita risk of raptor fatalities for individual birds actually increased over 15 years of study at Altamont Pass in California, even as raptor densities decreased.

The Altamont Pass wind site in California has been intensively studied (e.g. Hunt et al. 1999, Thelander and Rugge 2000, Hoover 2002, Hunt 2002,Smallwood and Thelander 2004, 2005, 2008; Hoover and Morrisson 2005, Hunt and Hunt 2006, Smallwood et al. 2009a, 2009b) and the most recent conclusions on the impacts of this wind farm on the local golden eagle population is that Altamont is essentially a resource sink, with the breeding population being kept stable by the influx of sub-adults and "floaters" into the population (Hunt and Hunt 2006). Altamont is often cited as an example of how wind turbines cause direct mortality to a variety of birds, especially raptors. Altamont has largely served as an example of how projects should not be sited and built, due to its location (right in the middle of avian migratory pathways, and in the middle of one of the highest known nesting concentrations of Golden Eagles), and the types of wind turbines in operation (fast-moving blades; short, latticed towers, etc).

Great Horned Owl. Photo © Scott Root, Utah Division of Wildlife Resources.

Siting turbines in canyons and passes increases the risk of fatalities for migrating raptors. In Montana, Harmata et al. (2000) found that more migrating raptors passed over valleys and swales than over high points; while migrating birds tended to avoid passing over high points during headwinds, low passes received greatest use by migrating raptors overall. In general, raptors are known to concentrate along ridge tops, upwind sides of slopes, and canyons to take advantage of wind currents that are favor-

able for hunting and traveling, as well as for migratory flights (Barrios and Rodriguez 2004, Hoover and Morrison 2005, Manville 2009). Smallwood and Thelander (2005) found that golden eagles at the Altamont Pass facility were killed disproportionately by turbines sited in canyons. At Altamont Pass, Hoover (2002) noted that golden eagles preferred to use narrow corridors that transect large hills. Also at Altamont Pass, Hoover and Morrisson (2005) reported that raptor kiting behavior was most frequently observed on steep windward slopes, and kiting raptors selected for the tallest peaked slopes; slopes where this behavior occurred had a disproportionate amount of red-tailed hawk mortality. In the context of the Foote Creek Rim project in Wyoming, Johnson et al. (2000) also reported higher than expected raptor use of rim edge habitats. And the same was noted for raptor use at the Columbia Wind Farm #1 in Washington state (Erickson and Johnson 1999). In addition, it has been noted that bald and golden eagles tend to migrate along north-south oriented cliff lines, ridges, and escarpments, where they are buoyed by uplift from deflected winds (Kerlinger 1989, Mojica et al. 2008).

In addition to direct mortality, wind turbines have been shown to change how raptors use an area (USFWS 2011b). For example, on Kodiak Island, Alaska, eagles discontinued flying over a portion of a ridge once turbine towers had been constructed along that portion of the ridge (Sharp et al. 2010). And, in a pre- and post-construction comparison study of Golden Eagle use for a wind facility in Scotland, a pair of resident Golden Eagles altered their ranging behavior to avoid the entire wind facility area post-construction, except when intercepting intruding birds (Walker et al. 2005).

There is more to doing wind energy smart-from-the-start for raptors than just siting the wind turbines properly. It is also important to ensure that ground disturbance between turbines is minimized.

There is more to doing wind energy smart-from-the-start for raptors than just siting the wind turbines properly. It is also important to ensure that ground disturbance between turbines is minimized. A disturbed ground surface can be more suitable for burrowing animals, many of which are attractive prey for raptors and other predators (NWCC 2002, Smallwood 2009b). It is thus possible that disturbed soils under turbines can lure more raptors towards the turbines than would happen otherwise. In general, preconstruction, construction, or maintenance of a facility can cause disturbance and result in loss of productivity at nearby nests or disturbance to nearby concentrations of eagles (USFWS 2011a). If this disturbance is permanent, it can result in the permanent or long-term loss of a nesting territory (NWCC 2002). Additionally, disturbances near areas that are important for roosting or foraging might stress eagles to a degree that leads to reproductive failure or mortality elsewhere (Hunt and Hunt 2006, USFWS 2011a).

2.3 Best Management Practices for All Other Birds

The Siting, Planning/Preconstruction, Construction/Operation, and Monitoring BMPs for all birds, below, is an amalgamation of BMPs gathered from numerous different sources.[27] The bullets below are based on scientific studies, analysis and conclusions that are summarized in the Justification Section that follows the BMP bullets.

Wind installations affect many bird species. Photo © Iberdrola Renewables.

2.3 1 Siting BMPs for Birds

- Avoid known avian concentration areas such as wetlands, riparian areas, roosts, nesting colonies, staging areas, and known daily movement flyways (e.g., between feeding and resting or breeding areas), as well as away from high-use areas identified in preconstruction surveys (see below).
- Avoid siting renewable energy projects in wintering areas and migratory corridors used by birds.
- Avoid siting turbines in areas prone to fog, mist, low visibility, or low cloud ceilings.

2.3.2. Planning and Preconstruction BMPs for Birds.

- Gather information from the Natural Heritage Program database or comparable State wildlife database with past location information on sensitive bird species. Consultations should occur with the state fish and game agency to determine sensitive bird species nesting locations, foraging areas, migration corridors, and concentration areas.
- Field surveys should follow science-based, peer-reviewed

Kkilldeer on nest with two eggs. Photo © J. Kirk Gardner, Utah Division of Wildlife Resources,

27 Sources include National Wind Coordinating Collaborative 2002, the Kansas Renewable Energy Working Group 2003, Smallwood and Neher 2004, Smallwood and Thelander 2004, 2005; BLM 2005a, BLM 2005b, Smallwood and Spiegel 2005, Canadian Wildlife Service 2006, the Clean Energy States Alliance (2006), California Energy Commission and California Dept of Fish and Game 2007, BLM 2008, ONDA 2009, Arizona Game and Fish Department 2010, U.S Fish & Wildlife Service 2007 and 2010a, WOC 2010, American Bird Conservancy 2011, USFWS 2011b.

protocols and comply with BLM, USFWS,[28] and state Game and Fish guidelines. Surveys should occur, if possible, in conjunction with the state fish and game agency. Sampling should either be distributed randomly or systematically throughout the area of interest.

Preconstruction studies can quantify avian use of the project site by habitat, determine the presence of species of concern, and provide a baseline for assessing displacement effects and habitat loss. Photo © Iberdrola Renewables.

- For wind developments, daytime and nighttime avian surveys[29] during the spring and fall migration season to determine use of the proposed project area, and daytime avian surveys during the breeding season should be conducted for at least two years prior to construction.
- For wind developments, the USFWS (2010a) recommends that avian surveys include surveys that allow calculations of indices of abundance in the area, such as weekly point-counts (e.g. Reynolds et al. 1980) or transect surveys[30] (similar to Schaffer and Johnson, 2008). These methods are most useful for preconstruction studies to quantify avian use of the project site by habitat, determine the presence of species of concern, and to provide a baseline for assessing displacement effects and habitat loss (USFWS 2010a). Standardized protocols for estimating avian abundance and temporal and spatial use of the project area are well-established (e.g., Dettmers et al. 1999).
- Nests of special status bird species located during surveys should have non-disturbance buffer zones delineated around them.
- Conduct a basic risk assessment. This should include the formulation of likely risk to birds from developing a site, a determination of risk exposure, an assessment of possible effects if the project goes forward, and a characterization of risk based on the overall review.

28 We refer readers to the USFWS (2010a) Wind Turbine Guidelines Advisory Committee Policy Recommendations and Guidelines for further guidance on designing and implementing pre and post wind facility construction monitoring plans and surveys for birds.

29 An index of migration activity can often be obtained by diurnal counts of a nocturnal migrating species during their daily stop-over (CESA 2006).

30 The Clean Energy States Alliance (2006) posits that in grasslands and shrub-steppe where passerines are the primary target, belt transects may be most appropriate for estimating species occurrence and relative abundance.

- For wind facilities, place and configure meteorological towers to minimize impacts on birds. Sonic detection and ranging should be used instead of meteorological towers if possible. If met towers are used, un-guyed met towers are preferable. Un-guyed towers should be tubular, not latticed (latticed towers attract perching and nesting birds). If un-guyed met towers cannot be used (such as on temporary met towers), guy-wires should be fitted with recommended bird-deterrent devices, such bird flight diverters, or other high visibility marking devices.

2.3.3 Construction and Operation BMPs for Birds

- Avoid construction activities during breeding and nesting seasons, and within (buffered) areas of active nests identified during preconstruction surveys.

- Design lighting to prevent skyward projection of lighting that may disorient night migrating birds. Sodium vapor lights, widely used for street-lights and security lighting, should never be used at energy facilities because they have been shown to attract night-flying birds. There should be no permanently installed high intensity lighting at the facility. Site lighting should be "off" unless needed for specific tasks.

- Bury electrical collector lines in a manner that minimizes additional surface disturbance (e.g., along roads or other paths of surface disturbance). Overhead lines can be considered in cases where burying lines would result in disturbance of significant habitat, but must be balanced with the concern for creation of additional bird perching opportunities.[31]

- Ensure that all above-ground low and medium voltage lines, transformers, or conductors comply with Avian Power Line Interaction Committee (APLIC) standards (APLIC 2006), including the use of bird deterrents.

- For wind facilities, for turbines that require lights for aviation safety, use a minimal number of simultaneously flashing white or red lights, unless otherwise requested by the FAA. Lights with short flash durations

White Faced Ibis and eggs. Photos © Utah Division of Wildlife Resources.

31 The USFWS (2010a) states that "Overhead lines may be acceptable if sited away from high bird crossing locations…such as between roosting and feeding areas or between lakes, rivers, prairie grouse and sage-grouse leks, and nesting habitats. Overhead lines may be used when the lines parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.

that emit no light during the "off phase" should be used—those that have the minimum number of flashes per minute and the briefest flash duration allowable.

- For wind facilities, make sure that wind turbine arrays are built with the tops of blades positioned lower than nearby ridgetops. Birds usually maintain altitude after crossing ridgetops (Mabee et al. 2006), suggesting that ensuring that arrays are lower than ridgetops could result in lower rates of mortality for migratory birds.
- For wind facilities, use tubular, non-latticed turbines (with nor perchable surfaces or appendages) to reduce the ability of birds to perch on turbines.

More research is needed to determine the relationship between bird mortality and such factors as topography, wind turbine speed and blade configuration. Photo © Jenny Hager Photography, DOE/ National Renewable Energy Laboratory.

- For wind facilities, Design the turbine/towers to position the blades at a height domain that is less likely to kill birds at a particular location, based on pre-construction surveys.
- For wind facilities, consider turbine blade "feathering" or idling to avoid or minimize bird take. This strategy uses a radar detection system, which is designed to detect a certain number of approaching "targets" and send a signal to all operating turbines within a facility to feather their blades. Once the radar determines that the risk has passed, a signal is sent to the turbines to change their blade pitch and begin operating once again. This measure needs further refinement, testing and validation.
- For wind facilities, design the turbine to lock blades in place while the turbine is not generating power.
- For wind facilities, synchronize the operations of the wind turbines to be on and off at the same times.
- For wind facilities, ease wind turbine operations during seasons, weather events or times of day (such as times of peak activity) that are more likely to kill birds, based on pre-construction surveys, especially those times corresponding with generation of relatively less power.
- For wind facilities, remove broken/defunct turbines that cannot be fixed or are unnecessary, allowing towers to remain at ends of rows if deemed beneficial as flight diverters.

2.3.4 Monitoring BMPs for Birds for Wind Facilities

- Conduct fatality surveys[32] to determine fatality rates of birds, including carcass searches and associated scavenger removal trials (to determine how many dead birds are removed from the site by scavengers) and searcher efficiency trials (to determine the proportion of dead birds actually found by searchers). These trials are important for adjusting fatality estimates. Some turbines should be searched most days, and if there are a small number of turbines (i.e. 10 or less), all turbines should be monitored. Fatality estimates should be reported on a "per megawatt-hour" or per-GW/h basis.[33]

- Avian presence/absence and/or breeding/nesting surveys[28], using the same methods as used pre-construction, should be conducted during the spring and fall migration periods and during the breeding season for at least two years post-construction.

- Compare post-construction survey data on bird abundance with pre-construction survey data. Manage adaptively through changes in site operation (i.e., operation of certain turbines that are particularly hazardous, or shut downs if research suggests that doing so would reduce fatalities) if monitoring indicates that bird fatalities are too high. If possible, a technical advisory committee should be established to review monitoring results and make suggestions regarding the need to adjust site operations or mitigation and monitoring requirements.

- Consider conducting additional research on the site associated with the post construction monitoring data, such as GIS analysis of fatality data to identify topographic associations with mortality, testing for patterns between fatalities and wind turbine attributes such as rotor speed and blade configuration; and testing for patterns between fatalities and the percentage of time each turbine is operated.

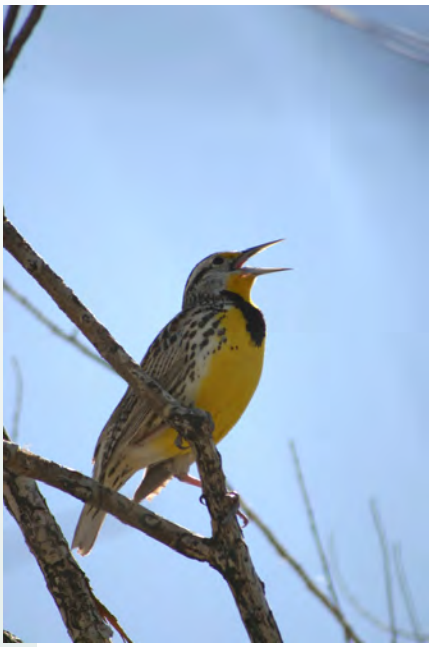
2.3.5 Justification for Bird BMPs

Both solar and wind installations have the potential to impact a variety of avian species through a number of means. These include direct mortality from collisions; loss of habitat from construction activities; habitat alteration as a result of soil erosion and/or introduction of non-native vegetation; destruction of the nests of ground-nesting birds; increased predation by providing additional perches for raptors; and indirect effects as a result

Both solar and wind installations have the potential to impact a variety of avian species through a number of means.

32 Other good sources for designing scientifically rigorous post construction avian fatality surveys and monitoring studies are "Studying wind energy/bird interactions: a guidance document" (NWCC 1999), and the USFWS (2011b) "Draft land-based wind energy guidelines."

33 Reporting mortality rates on a per MWh basis will facilitate meaningful comparisons across a broader landscape, and will help standardize fatality monitoring results between facilities and time periods.



Western meadowlark. Photo © Scott Root, Utah Division of Wildlife Resources.

of increased human presence, noise, or motion of operating wind turbines (NWCC 2010).

Some of these habitat alteration effects and other indirect effects can lead to avoidance or abandonment of certain habitats, reduced nesting/breeding density, loss of refugia, habitat unsuitability, and behavioral effects (Stewart et al. 2004, 2007). There are some cases where the impacts of habitat disturbance at a wind farm may actually be more egregious than the impacts of the turbine blades, such as the case of the Stateline Wind Resource Area, where impacts on grassland nesting passerines may have been largely due to the direct reduction of habitat from turbine pads and roads and the temporary disturbance of habitat between turbines and road shoulders, rather than due to collisions with turbines (Erickson et al. 2003b).

Principal sources of noise during construction activities for solar and wind facilities include truck traffic, operation of heavy machinery, and occasionally blasting (i.e. to level or place foundations). The most adverse impacts associated with construction noise could occur if critical avian life-cycle activities are disrupted (e.g., mating and nesting, NWCC 2002). If birds are disturbed sufficiently during the nesting season to cause displacement, then nest or brood abandonment might occur, and the eggs and young of displaced birds would be more susceptible to cold or predators (BLM 2005b). Much of the research on wildlife-related noise effects has focused on birds, and has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996).

Much of the research on wildlife-related noise effects has focused on birds, and has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning.

Wind turbine arrays have the potential to be major sources of bird mortality. Erickson et al. (2001) reported that in a California study, 78% of mortalities were songbirds protected by the Migratory Bird Treaty Act, while only 3.3% of bird mortalities were unprotected, such as non-native species like pigeons or starlings. At Wyoming's Foote Creek Rim wind facility, 92% of bird mortality between 1998 and 2002 was comprised of passerines, as opposed to raptors or waterfowl (Young et al. 2003).

Fatality rates for birds due to direct impact with turbines vary. Birds have relatively poor hearing. To make a comparison, human ears can detect wind turbines at roughly twice the distance as birds can (Dooling 2002). Both resident and migratory birds are involved in collisions, although resident birds

may have a higher probability of colliding with turbines than migrants, given that residents tend to fly lower and spend more time in an area than migrants (Janss 2000). Birds typically migrate at altitudes of 500 to 2,500 feet, well above the top of turbine blades in most locations (NWCC 2002, NWCC 2010). Therefore, collisions with wind turbines during actual migratory flights should be, and appear in actuality to be, rare. However, studies have shown that songbirds are vulnerable to colliding with wind turbines during poor weather conditions that force them to lower altitudes (Erickson et al. 2001; Johnson et al. 2002; Manville 2009). And, Osborneet al. (1998) noted that 75% of the bird mortality at the Buffalo Ridge Wind Resource Area occurs during migration periods.

Burrowing owls are reported to approach wind turbines in the late evening hours. Photo © Phil Douglass, Utah Division of Wildlife Resources.

The USFWS (2010a) points out that collision risk to individual birds at a particular wind energy facility may be the result of complex interactions among species distribution, relative abundance, behavior, weather conditions (e.g., wind, temperature) and site characteristics. Put simply, the relative abundance of a bird species does not predict the relative frequency of fatalities per species (Thelander and Rugge 2000). For example, collision risk for an individual may be low regardless of abundance if its behavior does not place it within the rotor-swept zone. If individuals frequently occupy the rotor-swept zone but effectively avoid collisions, they are also at low risk of collision with a turbine (e.g. ravens). Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher risk of collisions with turbines regardless of abundance.

For a given species, increased abundance increases the likelihood that individuals will be killed by turbine strikes, although the risk to individuals will remain about the same. It turns out apparently that bats are not alone at being attracted to turbines. Burrowing owls are reported as approaching turbines in the late evening hours (Smallwood et al. 2009b), and other birds routinely forage around them or perch on them while they are inactive or broken (Smallwood et al. 2009a, b). The risk to a population increases as the proportion of individuals in the population at risk to collision increases (USFWS 2010a). However, to date, the only known concern regarding population effects of wind energy on birds has arisen in the Altamont Pass wind development project, where poor siting of turbines resulted in greater than normal fatality of birds (NWCC 2002, NWCC 2010). That said, as wind turbines become more prevalent on the landscape, the number of birds killed is likely to increase. More important, the cumulative impact of all of these factors plus the indirect effects from loss and fragmentation of

Tubular wind turbine towers are used almost exclusively today and result in less bird mortality than the latticed designs. Photo © DOE/National Renewable Energy Laboratory.

habitat, currently and in the foreseeable future, should not be underestimated (many bird populations are in serious decline).

Latticed rather than tubular turbine designs have been shown to be detrimental to birds, because latticed support towers offer many more perching sites for raptors and other birds than do monopole towers, and hence may encourage high raptor occupancy in the immediate vicinity, or rotor swept area, of wind turbines (Orloff and Flannery 1992; NAS 2007). At Altamont pass, lattice turbine types were associated with a higher mortality rate than all other turbine types combined (Orloff and Flannery 1992). Similar findings at multiple sites have led many researchers to call for tubular rather than latticed designs for turbines at wind farms. It seems that this call has generally been heeded and tubular towers are used almost exclusively today.

Reduced visibility because of fog, clouds, rain, and darkness may be a contributing factor in collisions of birds with wind turbines. For example as many as 51 of the 55 collision fatalities (93%) in a study at the Buffalo Ridge Wind Resource Area (WRA) may have occurred in association with inclement weather such as thunderstorms, fog, and gusty winds (Johnson et al. 2002). Sometimes birds experience reduced ability to detect moving blades because of motion smear.

Interestingly, birds are also susceptible to collisions with mirrored heliostats at solar generation facilities. At the 10-MW Solar One pilot power tower facility located in the Mojave Desert, 70 bird fatalities involving 26 species were documented during a 40-week study. 81% of the birds died from colliding with mirrored heliostats, while the rest died from burns received by flying through standby points. The rate of mortality was estimated to be 1.9 to 2.2 birds per week. It was estimated that this represented 0.6 to 0.7% of the local population present at any given time. While this loss was considered minimal, it was concluded that larger facilities could produce nonlinear increases in the rate of avian mortality and, when coupled with the removal of large tracts of land from biological production, could be of concern with regard to the ecological effects of a solar energy project (McCrary et al. 1986).

In terms of meteorological towers, studies have shown guy-wired towers can cause five times more bird mortality than towers without guy wires (Young et al. 2003), and in fact guyed towers may be more dangerous to

birds than wind turbines (BLM 2005b, Erickson et al. 2005). The Nine Canyon wind project in Washington used an unguyed meteorological tower, which resulted in no recorded bird or bat fatalities (Erickson et al. 2003a).

> Larger facilities could produce nonlinear increases in the rate of avian mortality and, when coupled with the removal of large tracts of land from biological production.

Lighting requirements at facilities are determined by the Federal Aviation Administration and there is often little leeway on these requirements. That said, steady-burning night lights, especially bright lights (both white and red), have been well documented to attract and kill a variety of night-migrating bird species especially during inclement weather events (BLM 2005b, Gehring et al. 2009, Gehring et al. 2010 in press). Often individual turbine lights span an entire wind farm. While recent studies have concluded that there is no difference in avian mortality rates between a wind farm with flashing lights vs. no lights, the International Dark Sky Association still feels that there could be an issue with nocturnal environment disruption. The presence of lighting on some turbines might attract birds to the area and increase the potential for collision mortality at both the lit and unlit turbines (Johnson et al. 2002). Quickly flashing white strobes appear to be less attractive to birds (Ugoretz 2001).

A note on conducting Risk Assessments for birds (including raptors) for wind projects: The USFWS, in their Draft Land-Based Wind Energy Guidelines (USFWS 2011b), recommends conducting basic risk assessments (or, preconstruction fatality estimates) before commencing with construction at a wind site, and gives some guidance on how to carry these assessments out. This includes the use of collision models for preconstruction risk assessments. Models have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the United States (Madders and Whitfield 2006). Models should be based on the best available empirical data. For example, estimating potential bird fatalities at a proposed site may be accomplished by comparing exposure estimates at the proposed site with exposure estimates and fatalities at existing projects with similar characteristics (e.g., similar technology, landscape, and weather conditions). As with other prediction tools, model predictions should be evaluated and compared with post-construction fatality data to validate the models (USFWS 2011b).

Solar installation. Photo © DOE/ National Renewable Energy Laboratory.

Two spotted bats in flight, moving in opposite directions. To their detriment, bats are sometimes attracted to wind turbines. Photo © Merlin D. Tuttle, Bat Conservation International, www.batcon.org.

2.4 Best Management Practices for Bats

The Siting, Planning/Preconstruction, Construction/Operation, and Monitoring BMPs for bats, below, is an amalgamation of BMP's gathered from numerous different sources.[34] The bullets below are based on scientific studies, analysis and conclusions that are summarized in the Justification Section that follows the BMP bullets.

2.4.1 Siting BMPs for Bats for Wind Projects

- Avoid siting turbines near bat hibernacula, breeding colonies and maternity roosts.
- Avoid siting turbines within wintering areas, migration corridors and flight paths among and between colonies and feeding areas.
- Site turbines away from wetlands, riparian areas, streams, ponds, canyon edges and woodlands to reduce potential bat/turbine interactions.
- Site turbines away from high-use bat areas identified in preconstruction surveys (see below).

34 Sources include Kuenzi and Morrison 1998, O'Farrell et al. 1999, Smallwood and Neher 2004, BLM 2005a, BLM 2005b, Smallwood and Neher 2005, Smallwood and Spiegal 2005, CESA 2006, BLM 2008, Molvar 2008, ONDA 2009, Arizona Game and Fish Department 2010, NWCC 2010, U.S Fish & Wildlife Service 2010a, WOC 2010, USFWS 2011b.

2.4.2 Planning and Preconstruction BMPs for Bats for wind projects

- Consult with the state fish and game agency to determine the locations of crucial chiropteran habitats and migration corridors.
- Conduct bat surveys during the spring and fall migration season to determine use of the proposed project area, and conduct nighttime bat surveys during the breeding season. Surveys may include roost searches and exit counts of any cave or mine in close proximity to the proposed project area.
- Surveys should follow science-based, peer-reviewed protocols,[35] and can include acoustic, radar, and/or thermal imaging surveys to determine relative abundances and occupied habitats for bats in and near the project area prior to site selection, and foraging habitats and migration pathways used by these species.
- If acoustic surveys are done, the USFWS (2010a) recommends placing acoustic detectors on existing met towers, approximately every two kilometers across the site where turbines are expected to be sited. Acoustic detectors should be placed at high positions on each met tower to record bat activity at or near the rotor swept zone. In addition, sampling stations may be established at low positions (~2 meters) to increase coverage of the proposed project area. Acoustic surveys should adequately cover periods of migrations and periods of known high activity for other (i.e., non-migratory) species.
- Monitoring for a full year is recommended in areas where there is year round bat activity.
- Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so these weather data can be used in the analysis of bat activity levels.
- Pre-construction survey efforts may be recommended to determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the

It is important to site wind installations away from wetlands, riparian areas, streams, ponds, canyon edges, and woodlands to reduce potential bat/turbine interactions. Photo © Iberdrola Renewables.

35 We refer readers to the USFWS (2010a) Wind Turbine Guidelines Advisory Committee Policy Recommendations and Guidelines for further guidance on designing and implementing pre and post wind facility construction monitoring plans and surveys for bats.

project vicinity, and to confirm whether known or likely bat roosts are occupied by bats.

- Conduct a basic risk assessment. This should include the formulation of likely risk to bats from developing a site, a determination of risk exposure, an assessment of possible effects if the project goes forward, and a characterization of risk based on the overall review.

2.4.3 Construction and Operation BMPs for Bats for Wind facilities

- Lighting for operation and maintenance facilities and substations should be hooded downward and directed to minimize horizontal and skyward illumination. Minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.
- If turbines are sited across migratory routes, consider curtailing, or raising the minimum cut-in speed of, turbines during migration.
- Focus most construction activities in either summer or winter, if possible.
- Because some studies have demonstrated that bat fatalities occur primarily on nights with low wind speed and typically increase immediately before and after the passage of storm fronts, consider curtailing turbines during these weather conditions.
- Design the turbine/towers to position the blades at a height domain that is less likely to kill bats at a particular location, based on pre-construction surveys.
- Design the turbine to lock blades in place while the turbine is not generating power.
- Synchronize the operations of the wind turbines to be on and off at the same times.
- Cease wind turbine operations during seasons, weather events or times of day that are more likely to kill bats (such as times of peak activity), based on pre-construction surveys, especially those times corresponding with generation of relatively less power.

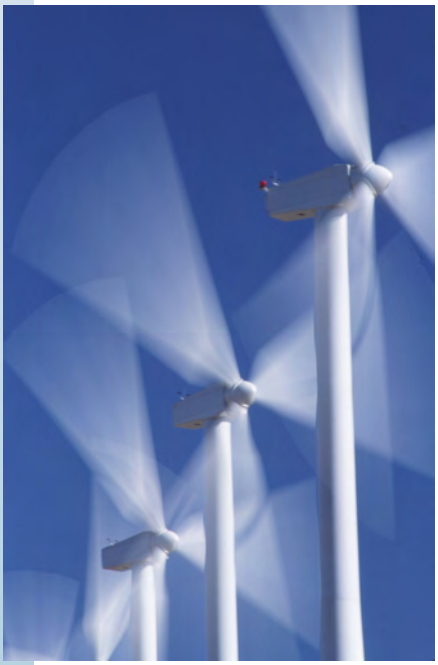


Photo © Iberdrola Renewables.

2.4.4 Monitoring BMPs for Bats for Wind Facilities

- A Technical Advisory Committee (TAC) should be established to review study designs and monitoring results, and should make suggestions regarding the need to adjust monitoring requirements, site operations, or mitigation.
- Conduct daily to weekly fatality surveys to determine fatality

rates of bats.[36] Fatality studies also should conduct carcass removal and searcher efficiency trials using accepted methods (Anderson 1999, Morrison et al. 2001, Kunz et al. 2007a, Arnett et al. 2007, NRC 2007, Huso 2010). For large facilities, a subset of turbines should be searched, but for facilities with 10 or fewer turbines, all should be monitored. Fatality estimates should be reported bats/turbine, bats/MW, and bats/megawatt-hour basis."[37]

- Post-construction bat fatality surveys should be conducted from spring through fall for two years.

- Compare post-construction survey data with pre-construction survey data. Data should be related to weather variables to determine patterns of activity and fatality.

- Manage adaptively through changes in site operation (i.e., if high fatality rates occur, consider curtailing turbines on low wind nights). Shut down turbines during seasons, time periods, or wind speeds found to be killing surprisingly large numbers of bats, or that present reasonable tradeoffs between power generation and bat fatalities

2.4.5 Justification for Bat BMPs

Overall, the impacts of wind development on bats are well documented (Arnett et al. 2008, Johnson (2005), Kunz et al. 2007a, b, National Wind Coordinating Collaborative 2010).

Bats not only collide with turbine blades, but also are vulnerable to barotrauma, or decompression associated with air pressure gradients caused by spinning turbines (Arnett et al. 2008, Baerwald et al. 2008). At most projects, bat fatalities are higher than bird fatalities, but the exposure risk of bats at these facilities is not fully understood (National Research Council 2007). In their literature review on patterns of bat facilities at wind energy facilities in North America, Arnett et al. 2008 noted that none of the studies they reviewed reported bat fatalities associated with meteorological towers. These findings support the contention that bats collide with moving objects (i.e., spinning

Bats not only collide with turbine blades, but also are vulnerable to barotrauma, or decompression associated with air pressure gradients caused by spinning turbines.

36 Alternatively, Arnett (2005) recommends daily carcass searches rotating through a subset of the turbines, so that there are some carcass data coming in each day. Also, the Clean Energy States Alliance (2006) posits that initial post-construction bat mortality surveys can be done at a modest level of intensity (e.g., weekly or biweekly at a sample of turbines during the migration period) to determine a general level of bat mortality. However, if the monitoring indicates larger than expected bat fatalities, additional monitoring will be needed. USFWS 2011b gives more comprehensive guidance for bat fatality studies for wind facilities.

37 Reporting mortality rates on a per MWh basis will facilitate meaningful comparisons across a broader landscape, and will help standardize fatality monitoring results between facilities and time periods.

turbine blades) and that they do not strike stationary blades or towers (Arnett 2005). Across North America, taller towers with greater rotor-swept area induce greater bat mortality rates than smaller, shorter wind turbines (Arnett et al. 2008). As the trend within the industry is toward taller wind turbines with larger propellers, bat fatality rates presumably will increase over time.

A portrait of a long-legged myotis. Photo Photo © Merlin D. Tuttle, Bat Conservation International, ww.batcon.org.

Almost 75% of all bats killed by wind turbines nationwide are made up of three species[38] of tree-roosting, migratory Lasiurids: the foliage-roosting eastern red bat (Lasiurus borealis), hoary bat (Lasiurus cinereus), and tree cavity-dwelling silver-haired bat (Lasionycteris noctivagans) (NAS 2007, Kunz et al. 2007b, Arnett et al. 2008). All three of these species have spring and fall migration periods (NatureServe 2011). In general, migrating bats are most vulnerable to wind development and resident, breeding, or foraging bats have a lower risk of mortality (Erickson et al. 2003, Johnson et al. 2003, Johnson and Strickland 2004, Johnson et al. 2004). The National Wind Coordinating Collaborative (2010) stated that, "all studies of bat impacts have demonstrated that fatalities peak in late summer and early fall, coinciding with the migration of many species (Johnson 2005; Kunz et al. 2007a;Arnett et al. 2008).

Kunz et al. (2007a) reported that bat fatalities at wind power facilities ranged from 0.8 to 53.3 bats per megawatt per year, with the highest mortality rates in forested ridgelines of the Eastern United States. In their literature review on patterns of bat facilities at wind energy facilities in North America, Arnett et al. 2008 noted that estimates of bat fatalities were highest at wind energy facilities in the eastern United States (which are often located on forested ridges), and lowest in the Rocky Mountain and Pacific Northwest regions. High levels were first reported from the Mountaineer wind power facility in the forested mountains of West Virginia (Arnett 2005). Fiedler (2004) reported that bat fatalities in 2004 at a wind power facility in mixed hardwood forest in eastern Tennessee were an order of magnitude greater than at 8 other facilities in the region, and blamed siting on a prominent ridgeline surrounded by forests with rocky outcrops for the higher bat mortality at this site and the Mountaineer wind farm. Johnson et al. (2004) found that turbines located near woodlands also experienced higher levels of bat activity at the Buffalo Ridge facility

> Bats may be more vulnerable to mortality at wind power facilities than birds because bats seem to be attracted to operating turbines.

38 Arnett et al. (2008) and Miller (2008) report that the Brazilian Free-tailed Bat comprised a large proportion (41–86%) of the bats killed at developments within this species' range.

in southwestern Minnesota. Arnett et al. (2005) found that forested ridges pose especially high fatality risks to bats at wind facilities.

Bats may be more vulnerable to mortality at wind power facilities than birds[39] because bats seem to be attracted to operating turbines. Kunz et al. (2007b) suggested a number of hypotheses as to why bats may be attracted to wind turbines and provided thermal images of bats attempting to land or actually landing on stationary blades. It is possible that migrating tree-roosting species perceive turbines as potential roost trees (Arnett 2005, Kunz et al. 2007b, Horn et al. 2008). Others (Cryan and Brown 2007) have suggested bats are attracted to the tallest features on the landscape for use as mating sites. Arnett (2005) hypothesized that hoary bats may confuse turbine movements for flying insects and be drawn toward operating turbine blades. The attraction of bats to wind turbines during feeding was validated experimentally by Horn et al. (2008), who videoed foraging bats approaching and pursuing moving turbine blades and then being trapped by their vortices of air. Other researchers also have noted that many turbines are located on ridge top sites where there are often elevated numbers of insect prey (Horn et al. 2008).

A long-legged myotis takes a drink of water. © J. Scott Altenbach.

Bat fatalities occur primarily on warm nights with low wind speed and typically increase immediately before and after the passage of storm fronts. Therefore, weather patterns may be a useful predictor of bat activity and fatalities, and mitigation efforts focusing on these high risk periods may reduce bat fatalities substantially (Arnett et al. 2008). Studies have shown that by curtailing wind turbines or raising the cut-in speed (i.e., the speed at which turbines begin spinning and generating electricity), bat fatalities may be reduced by 44–93% (Arnett et al. 2010, Baerwald et al. 2009). Future research efforts should focus on "fine-tuning" this mitigation strategy to minimize power loss (i.e., amount of time turbines are curtailed), while maximizing reductions in bat fatality.

39 Bats are also more susceptible to population-level effects of turbine mortality compared to birds since they have lower reproductive rates and are relatively long-lived, making bat populations less able to recover from the cumulative effects of individual mortalities.

2.5 Best Managemenet Practices for Wildlife — General

The Siting, Planning/Preconstruction, Construction/Operation, and Monitoring BMPs for (general) wildlife, below, is an amalgamation of BMP's gathered from numerous different sources.[40] The bullets below are based on scientific studies, analysis and conclusions that are summarized in the Justification Section that follows the BMP bullets. While the previous sections described BMPs specific just to sage grouse, raptors, all other birds, and bats, this section summarizes BMPS that pertain to all wildlife, including ungulates and special status species.

2.5.1 Siting BMPs for Wildlife

- Avoid development in critical big game winter and parturition ranges.

Elk on critical winter range. Photo © Phil Douglass, Utah Division of Wildlife Resources.

- Avoid development in core areas, linkages and portfolio sites identified in Nature Conservancy Ecoregional Plans or other conservation areas designs or reserve designs.
- Avoid siting in important, sensitive, or unique habitats in the vicinity of the project (i.e., away from riparian habitats, streams, wetlands, drainages, or other critical wildlife habitats). See below on surveys that may be needed to identify these important wildlife areas.
- For wind facilities, place turbines in such a way to minimize fragmentation of large contiguous tracts of wildlife habitat, and to avoid wildlife migratory pathways and known travel corridors.

2.5.2 Planning and Preconstruction BMPs for Wildlife

Planning and preconstruction BMPs should include pre-construction evaluations conducted at potential solar and wind energy sites, which can

40 Sources include BLM 2005a, BLM 2005b, Clean Energy States Alliance 2006, California Energy Commission 2007, BLM 2008, Molvar 2008, ONDA 2009, Wyoming Outdoor Council 2009, Arizona Game & Fish Dept. 2010, BLM 2010a, U.S Fish & Wildlife Service 2010a, Wyoming Game and Fish 2010, U.S. Fish and Wildlife Service, 2011b.

help indicate whether a renewable power development is likely to cause wildlife impacts at levels of concern, help identify sites to avoid, and help to design a less impactful project. For all wildlife, including sage-grouse, raptors, and bats, developers should closely follow the recommendations outlined in the U.S. Fish and Wildlife Service's Draft Land-Based Wind Energy Guidelines (USFWS 2011b). The preconstruction surveys should use scientifically sound, peer reviewed research protocols to determine how wildlife temporally and spatially utilize a proposed project area during breeding and non-breeding seasons. The estimation of displacement risk requires an understanding of animal behavior and population demography in response to a project and its infrastructure, and a pre-construction estimate of relative abundance or estimated absolute abundance of species whose behavior would cause them to avoid areas in proximity to turbines, roads and other components of the project. Adjust siting and facility design based on the results of these studies to reduce potential impacts to the animals. The following are recommended preconstruction and operation BMPs:

Preconstruction surveys should use scientifically sound, peer reviewed research protocols to determine how wildlife temporally and spatially utilize a proposed project area during breeding and non-breeding seasons.

- Consult with the state fish and game agency to determine locations of species of concern or other special-status species identified by the agency in past surveys. In addition, consult with other wildlife and conservation organizations that may be particularly knowledgeable of the area and potential wildlife issues.
- Conduct surveys for federally listed and state-protected species, as well as for other species of concern such as other special-status species identified by the state fish and game agency. Submit survey protocols with ample time to the USFWS and appropriate lead state fish and game agency agencies for review, comment, and approval. Most listed species have required protocols for detection and descriptions of these protocols can be obtained from the U.S. Fish and Wildlife Service. Also know that some surveys may impact other listed or sensitive species, and that alternatives to those field efforts should be considered (i.e. bighorn sheep and Golden Eagle aerial surveys)
- Conduct surveys to determine the spatial and temporal use of the project area by key and important species of wildlife.
- Relate wildlife use to site characteristics (e.g., covariates such as vegetation and topography). The statistical relationship between wildlife use and these covariates can be used to predict occurrence in un-surveyed areas during the survey period and for surveyed areas in the future.

- Consult with the state fish and game agency to determine the locations of crucial ungulate habitats and migration corridors.

Pronghorn antelope. Photo © Utah Division of Wildlife Resources.

- Preconstruction studies should be sufficiently rigorous and detailed to create maps of special status species habitats (e.g. wetlands or riparian habitat, and large, contiguous tracts of undisturbed wildlife habitat) as well as other local species movement corridors (e.g., deer, elk, pronghorn, eagles, other raptors, bats, waterfowl, etc.) that are used daily, seasonally, or year-round.

- Consider whether there are areas of intact habitat in the area of influence where development would result in habitat degradation, loss or fragmentation. This should include an analysis and assessment of the current habitat quality and spatial configuration of the area of influence with respect to the potential species sensitive to habitat fragmentation. This will include reviewing the most recent aerial and remote sensing imagery of the area of influence to determine distinct habitat patches, boundaries, and the extent of existing habitat fragmenting features and lack of habitat integrity (e.g., highways, transmission lines, and other infrastructure).

- Conduct a basic and detailed risk assessment and/or, where necessary, an alternatives assessment (O'Brien 2000). Assumptions and data limitations should be clearly described. This should include the formulation of likely risk to wildlife from developing a site, assumptions, data gaps, a determination of risk exposure, an assessment of possible effects if the project goes forward, and a characterization of risk based on the overall review.

2.5.3 Construction and Operation BMPs for Wildlife

- Minimize project disturbance area (footprint) as much as possible.

- If lights on auxiliary buildings are deemed necessary, they should be motion-activated and downcast (avoid side-casting light) to reduce light pollution and to prevent disturbing or attracting wildlife.

- Minimize roads and other infrastructure. Use existing roads whenever possible. If new access roads and ways are needed, avoid paved or gravel roads if possible and instead rely on dirt tracks and jeep trails constructed by cross country travel. Use road surfacing, road sealant, soil

bonding, and stabilizing agents if needed on non-paved surfaces that are non-toxic to wildlife.

- Avoid constructing energy infrastructure during critical wildlife seasons such as breeding, nesting, and parturition seasons.[41] Wind power facility construction activities should not occur within 2 miles of crucial migration corridors during migratory periods.

- Minimize construction and operation related noise levels to minimize impacts to wildlife. All equipment should have sound-control devices no less effective than those provided on the original equipment. All construction equipment used should be adequately muffled and maintained.

- Avoid the use of fencing. A 6-ft chain-link fence with 2 strands of barbed wire on the top, or a woven wire/high tensile electric/barbed wire combination exclusion fence can be used around central operations and maintenance buildings. If other fencing away from central operations must be used, use a smooth bottom wire at least 18 inches off the ground to facilitate pronghorn movements. Use a smooth top wire or top rail to facilitate elk and deer movements, and to reduce avian fatalities. Spacing between the two top wires should be 12 inches to avoid entangling deer. Fences should be no higher than 40-42 inches. Minimize the length of temporary fencing.

- Instruct project and maintenance personnel to drive at appropriate speeds (i.e. less than 30 mph), be alert for wildlife, and to avoid harassing and/or disturbing wildlife.

- For wind energy, close portions of the wind energy facility inside crucial winter ranges or migration corridors to vehicle use (and minimize human presence) during their period of use by wildlife.

- For solar energy, use of evaporation ponds should be avoided where the water would be considered toxic to birds and other wildlife. If evaporation ponds are absolutely necessary, they should be fenced and netted to prevent use by wildlife. The lower 18 in. (46 cm) of the fencing should be a solid barrier that would exclude entrance by amphibians and other small animals.

Wind power facility construction activities should not occur within 2 miles of crucial migration corridors during migratory periods.

2.5.4 Monitoring BMPs for Wildlife

- Conduct post construction surveys for same wildlife species of concern that preconstruction surveys were conducted for, using the same survey methods.

41 The Wyoming Game and Fish (2010) states that if siting within big game winter ranges cannot be avoided, suspend construction activities from November 15 – April 30, and if siting within big game parturition areas cannot be avoided, suspend construction activities from May 1 – June 15.

- Relate post-construction wildlife use to site characteristics. This requires that site characteristics thought to influence wildlife use (i.e., covariates such as vegetation and topography) are measured in relation to wildlife use. Compare post-construction habitat use data to preconstruction habitat use.

- Compare pre construction survey data with post construction survey data. When appropriate survey and analysis methods are used, pre and post construction data can be compared using a Before After Control Impact (BACI) framework.

- Manage adaptively through changes in site operation (i.e. operation of turbines) if monitoring indicates that wildlife population numbers are dropping below levels detected in pre-construction wildlife surveys. If possible, a technical advisory committee should be established to review monitoring results and make suggestions regarding the need to adjust site operations or mitigation and monitoring requirements.

On solar power installations, the site may be cleared of all vegetation to allow access to the installed equipment and to prevent fires. Photo © Joe Verrengia, DOE/National Renewable Energy Laboratory.

2.5.5 JUSTIFICATION FOR WILDLIFE BMPS

Solar installations and wildlife. On solar power installations, the site may be cleared of all vegetation to allow access to the installed equipment and to prevent fires. Herbicides may be sprayed or vegetation mowed to maintain cleared zones under and around the solar fields. These facilities can include graded access roads, construction of new or expansion of existing substations, new transmission lines, and a surrounding security fence that prevents movement of wildlife through the site (Arizona Game and Fish Department 2010, Randall et al. 2010). Current proposed solar projects range in size from 50 to over 8,500 acres. Typically, the smaller facilities will have fewer of the possible impacts described above.

Clearing and grading activities can result in the direct injury or death of wildlife that are not mobile enough to avoid construction operations (e.g., reptiles, small mammals, and young), that utilize burrows (e.g., ground squirrels and burrowing owls), or that are defending nest sites (such as ground-nesting birds). Although more mobile species of wildlife, such as deer and adult birds, may avoid the initial clearing activity by moving into habitats in adjacent areas (Hagan et al. 1996), adjacent habitats are often at carrying capacity for the species that live there and often cannot support additional biota from the construction areas (BLM 2010a). The subse-

quent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations (BLM 2005b).

Lighting issues associated with solar power plants can also be problematic for wildlife. Nighttime lighting for security or other reasons may negatively impact a variety of local species, many of which have developed nocturnal behavior to escape the daytime heat of the desert (Longcore and Rich 2004).

Some solar facilities, which use water for cooling or cleaning solar array mirrors, will have evaporation ponds on the site. Open water sources in the desert provide water (that would not otherwise be there) to ravens and other predators that may feed on special status species (e.g., desert tortoise). In addition, these water sources may attract wildlife to them but may also have elevated levels of harmful contaminants (e.g., TDS and selenium) that can harm many species of wildlife (BLM 2010a).

Wind installations and wildlife. On big game winter ranges, where wind farms are most likely to be sited (as opposed to higher elevation summer ranges), elk and other big game are highly susceptible to disturbance. Disturbance during this time of year can be particularly costly, since the metabolic costs of locomotion are up to five times as great when snows are deep (Parker et al.1984). To the degree that wind power facilities involve human presence in crucial ranges during the most sensitive time periods, these developments may tend to displace elk from their preferred habitats into marginal ranges, where habitat conditions may be poor or where they

Bull elk. Photo © Utah Division of Wildlife Resources.

Photo © Jenny Hager Photography, DOE/National Renewable Energy Laboratory.

Mule Deer. Photo © Brent Stettler, Utah Division of Wildlife Resources.

may be forced to compete with resident animals already at or near their carrying capacity.

Several studies have shown that elk abandon calving and winter ranges in response to oilfield development (e.g. Johnson and Lockman 1979, Johnson and Wollrab 1987, Van Dyke and Klein 1996), with potential implications for utility-scale wind power development. For mule deer, Sawyer et al. (2005) found that in the Pinedale area, wellfield development caused abandonment of mule deer crucial winter ranges for years at a time, and ultimately resulted in a 46% decline in mule deer populations, while herds in undeveloped areas showed a much smaller decline over the same period; the affected population has yet to recover to predisturbance levels (Molvar 2008). Other researchers have posited that overcrowding of species such as mule deer in sub-optimal winter ranges after they have been pushed out of optimal ranges could cause density-dependent effects, such as increased fawn mortality (Sawyer et al. 2006).

Wind farms may disrupt wildlife movements, particularly during migrations. For example, herd animals such as elk, deer and pronghorn can be affected if rows of turbines are placed along migration paths between winter and summer ranges or in calving areas (NWCC 2002). One lesson learned from oil and gas development in the Piney Front elk study in Wyoming demonstrated that oil and gas development could pose a barrier to elk migration, denying herds access to crucial winter ranges (Molvar 2008). Other researchers have posited that loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindzey 2001; Thomson et al. 2005). That said, the National Wind Coordinating Collaborative (2002) points out that because wind farms affect a relatively small proportion of the land they occupy, these sorts of effects on wildlife should be minor in most cases.

Impacts to wildlife common to solar and wind installations. Both solar and wind installations have the potential to impact a variety of wildlife species through a number of means. These include direct loss of habitat from construction activities; habitat alteration as a result of soil erosion and/or introduction of non-native vegetation; construction of obstacles to migration; and indirect habitat loss as a result of increased human presence and noise. In particular, increased traffic, noise, night lighting, and other human activities can temporarily discourage wildlife from using areas around energy facilities while these projects are being constructed (NWCC 2002).

Both large scale wind and solar installations can fragment wildlife habitat (BLM 2005b, BLM 2010a). Habitat fragmentation is defined as the separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments is reduced (e.g. Dobson et al. 1999, Willyard et al. 2004, Dixon et al. 2007). Site clearing, access roads, transmission lines and turbine tower arrays remove habitat and displace some species of wildlife, and may fragment continuous habitat areas into smaller, isolated tracts (USFWS 2010a). Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding and foraging. Consequences of isolating local populations of some species include decreased reproductive success, reduced genetic diversity, and increased susceptibility to chance events (e.g. disease and natural disasters), which may lead to extirpation or local extinctions (Noss 1983, Harris 1984, Dobson et al. 1999).

Wind farms may disrupt wildlife movements, particularly during migrations. For example, herd animals such as elk, deer and pronghorn can be affected if rows of turbines are placed along migration paths between winter and summer ranges or in calving areas.

In addition to displacement, development of wind and especially solar energy infrastructure may result in additional loss of habitat for some species due to "edge effects" resulting from the break-up of continuous stands of similar vegetation resulting in an interface (edge) between two or more types of vegetation (USFWS 2010a). The extent of edge effects will vary by species and may result in adverse impacts from such effects as a greater susceptibility to colonization by invasive species, increased risk of predation, and competing species favoring landscapes with a mosaic of vegetation (Harper et al. 2005).

Pronghorn antelope doe. Photo © Utah Division of Wildlife Resources.

Related to habitat fragmentation is what is referred to as the "barrier effect" (USFWS 2011b). This occurs when animals avoid a wind or solar facility, and this can result in decreased movement or an increase in energy use to circumvent the facility (Goodale and Divoll 2009). Avoidance of the area may also occur as the result of noise or habitat loss due to construc-

tion of roads and other structures associated with facility development (Fox et al. 2006). The level of barrier effect depends on the species, solar panel or turbine layout or configuration, size of facility, season, and the species' ability to compensate for losses in energy due to avoidance (Fox et al. 2006). Though population-scale effects currently have not been documented, scientists are concerned that "barriers" between breeding and feeding areas may have significant effects (Fox et al. 2006; Goodale and Divoll 2009; Drewitt and Langston 2006).

Noise associated with developments can also cause physiological effects, such as damage to hearing from acoustic over-exposure.

Construction activities to build both solar arrays and wind turbines can be noisy. Construction noise can affect "communication distance" (the distance animals need to be from each other to hear each other's vocalizations), and an animal's ability to detect calls or danger or biologically relevant sounds, or ability to effectively forage (Dooling and Popper 2007, USFWS 2011b). Data suggest noise increases of 3 dB to 10 dB correspond to 30 percent to 90 percent reductions in alerting distances for wildlife, respectively (Barber et al. 2010). Some birds are able to shift their vocalizations to reduce the masking effects of noise (USFWS 2011b). However, when shifts don't occur or are insignificant, masking may prove detrimental to the health and survival of wildlife (Barber et al. 2010). Noise associated with developments can also cause physiological effects, such as damage to hearing from acoustic over-exposure (USFWS 2011b).

Sometimes renewable energy installations require the use of fencing. Fencing may disrupt wildlife movements, entangle wildlife, and increase bird fatalities (WOC 2009, ADGF 2010).

In addition, both wind and solar installations have the potential, during construction activities, to see increases in exotic plant species such as cheatgrass, which is known to do well with ground disturbance (BLM 2010a). The establishment of invasive vegetation could reduce habitat quality for wildlife and locally affect wildlife occurrence and abundance (BLM 2005b).

Lastly, many new solar and wind facilities in previously undisturbed, open areas will require a new network of roads to access them. A number of studies have shown that wildlife such as elk avoid roads (e.g. Grover and Thompson 1986, Rowland et al. 2000, in part because increased motorized access results in decreased elk habitat and security (Lyon 1983, Hayes et

al. 2002, Rowland et al. 2005). Songbirds are also sensitive to road impacts; Ingelfinger and Anderson (2004) reported that population densities of sagebrush obligates, particularly Brewer's sparrow and sage sparrow, were reduced by 40% to 60% within a 330-ft (100-m) buffer around dirt roads at their sagebrush study sites. And with new roads can come many new problems for wildlife that can occur when there is increased access to lands that previously had limited access. These impacts can include wildlife harassment and poaching, (PBS&J 2002), and unauthorized OHV use off of these roads (BLM 2005b) (and exotic plant seeds that can hitch a ride on the knobby tires (BLM 2010a). Even if all vehicles stay on the roads, roads are often considered to facilitate the dispersal of invasive plant species by altering existing habitat conditions, stressing or removing native plant species, and allowing easier movement by wildlife, livestock or human vectors that can unknowingly carry seeds (Trombulak and Frissell 2000).

Marsh wren. Photo © Phil Douglass, Utah Division of Wildlife Resources.

2.6 Best Management Practices For Site Hydrology (Including Soils and Vegetation

The Siting, Planning/Preconstruction, Construction/Operation, and Monitoring BMPs below is an amalgamation of BMPs gathered from numerous different sources. [42] The bullets below are based on scientific studies, analysis and conclusions that are summarized in the Justification Section that follows the BMP bullets.

Photo © Howie Garber, www.wanderlustimages.com.

2.6.1 Siting BMPs for Soils, Vegetation and Hydrology

- If location is on BLM lands, note that BLM will prohibit the disturbance of any population of federally listed plant species. If possible, avoid siting on any area with known plant communities of concern.
- All structures related to the solar or wind energy facility should be sited in locations that minimize impacts to surface water bodies, ephemeral washes, playas, and natural drainage areas (including groundwater recharge areas). Siting within 100-year floodplains should be avoided.
- For CSP solar installations, ensure that there are adequate and readily available local water supplies needed for cooling. In particular, wet-cooling technology is not recommended because of the large amounts of water that is required (unless recycled or gray water is available for use).
- For wind facilities, locate turbines in an area that does not disrupt sand transport processes nor removes some or all of a sand source relative to nearby sand dune systems harboring listed or otherwise sensitive plant species. Projects should not armor sand sources for nearby dune systems.

42 Sources include BLM 2005a, BLM 2005b, California Energy Commission 2007, NWCC 2007, BLM 2008, Molvar 2008, The Nature Conservancy 2008, ONDA 2009, Arizona Game and Fish Department 2010, BLM 2010a U.S Fish & Wildlife Service 2010a, WOC 2010, USFWS 2011b.

2.6.2 Planning and preconstruction BMPs for Soils, Vegetation and Hydrology

- Natural Heritage Program databases should be consulted to identify rare plants of state (S1, S2), and global (G1, G2, G3) rankings known to or suspected to occur on the site.
- Surveys should be done for threatened and endangered plants suspected to be at the site.
- Provide a complete site grading plan, and drainage, erosion, and sediment control plan with applications to applicable lead agencies.
- For solar facilities, conduct soil surveys to identify soil types and the typical silt content of soils in many locations, to estimate soil erosion hazard.
- For solar facilities, project developers should conduct a preliminary hydrologic study of the project area in order to identify surface watersheds and groundwater basins potentially directly affected and connected to the location of the project site. The study should include the relationship of the project site hydrologic basin to the other basins in the region; identification of all surface water bodies (including ephemeral washes/ drainages, playas and floodplains); identification of all applicable groundwater aquifers; the connectivity of surface water and groundwater, and the regional climate (seasonal and long term).
- For solar facilities, project developers should plan to implement water conservation measures related to solar energy technology water needs in order to reduce project water requirements. Developers should minimize the consumptive use of fresh water for power plant cooling by, for example, using dry cooling, using recycled or impaired water, or selecting solar energy technologies that do not require cooling water.
- The capability of local surface water or groundwater supplies to provide adequate water for the operation of proposed solar facilities should be considered early in the project siting and design.

2.6.3 Construction and Operation BMPs for Soils, Vegetation and Hydrology

- Minimize project disturbance area as much as possible, including minimizing lay-down areas and borrow areas.
- Build wind and solar facilities and access routes away from steep slopes (greater than 20 degrees).
- Do not build facilities on unstable slopes, alluvial fans or areas with high erosion potential. Identify local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, slope angles, and geologic structure).

- Ensure that all temporary use areas during construction are restored. Reclaim areas disturbed during construction by spreading excess excavated soil to match surrounding topography, and reclaim as soon as possible with native seedings/vegetation and locally sourced topsoil.

- If new access roads and ways are needed, avoid gravel roads if possible and instead rely on dirt tracks and jeep trails constructed by cross country travel.

- If a paved road is absolutely necessary use standard BLM road construction BMPs (such as outlined in BLM Manual 9113 [43]) for all road construction.

- Make sure that any access roads that are built avoid stream crossings, wetlands and drainages. Where access roads must cross a dry wash, the road gradient should be 0% to avoid diverting surface waters from the channel.

- Minimize natural vegetation removal and consider cutting or mowing vegetation rather than total removal whenever possible.

- Take actions to prevent spread of weeds. Thoroughly wash all surfaces and undercarriages of vehicles and equipment before moving to the project site to remove any noxious or non-native plant seeds. Use certified weed-free straw or hay bales for sediment barrier installations, and certified weed-free mulch if mulching is needed on the site.

    - If a weed problem persists on the site during construction, limit herbicide use to non-persistent, immobile herbicides. All herbicides should be applied in accordance with guidance provided in the Final PEIS on vegetation treatments using herbicides (BLM 2007).

    - Avoid using fresh ground or surface water for solar power plant cooling. Instead, employ air-cooled technology or recycled/impaired water. If groundwater must be used, a comprehensive analysis of the groundwater basin must be conducted and any potential impacts thoroughly evaluated.

Killpecker Dunes. Photo © Scott T. Smith, www.ScottSSmithPhoto.com.

- Develop and follow a dust abatement plan for the site. This should include the use of dust abatement techniques on unpaved, unvegetated surfaces to minimize airborne dust; 25 mph speed limits on, and to and from, the site; covered construction materials and stockpiled soils; and dust abatement techniques that are used before and during surface clearing, excavation, or blasting activities.

- For solar facilities, minimize the amount of area of impervious surfaces, and consider the use of permeable pavement for areas that must be paved.

43 http:/www.blm.gov/pgdata/etc/medialib/blm/mt/blm_programs/energy/oil_and_gas/operations/gold_book.Par.10040.File.dat5/9113.pdf

2.6.4. Monitoring BMPs for Soils, Vegetation and Hydrology

- Develop and abide by a storm water management plan to ensure compliance with state and federal regulations and prevent off-site migration of contaminated storm water or increased soil erosion.
- Monitor for the spread of invasive plant species post construction, and take action to prevent further spread of invasive weeds away from the site.[44]
- Regularly monitor rights-of-way (ROWs), access roads, and other project areas for indications of erosion.
- For revegetation and reclamation sites, keep livestock out of reclaimed areas until vegetation cover resembles the Potential Natural Community described in the NRCS Range Site Type description or Ecological Site Description.
- For CSP solar facilities using groundwater and surface water for cooling operations, develop and implement a Water Resources Monitoring and Mitigation Plan, which includes monitoring the effects of groundwater and surface water withdrawal for project uses. The use of water should not contribute to the significant long-term decline of groundwater levels or surface water flows and volumes.

> In order to ensure that a reduction in wind velocity does not result in the stabilization of actively migrating dunes and the loss of open dune habitats, wind power projects should not be sited in or immediately upwind of areas of actively migrating dunes.

2.6.5 Justification for Soil, Vegetation, and Hydrology BMPs

In terms of siting issues, development in areas of actively migrating sand dunes has the potential to slow or alter wind patterns, resulting in the conversion of open dune habitats to dunes stabilized by vegetation. Keith et al. (2004) reported that large amounts of wind power can extract kinetic energy and alter turbulent transport in the atmospheric boundary layer, with the result of slower wind speeds and greater turbulence near the surface. Roy et al. (2004) modeled the effects of wind farms in the Great Plains region and found that wind farms can significantly slow down the wind at the turbine hub-height level, and that turbulence generated by

44 The BLM (2010a) recommends that integrated pest management, including biological controls, should be used to prevent the spread of invasive species, per the "Vegetation Treatments Using Herbicides on BLM Lands in 17 Western States", and the National Invasive Species Management Plan, 2009.

rotors creates eddies downwind of turbine arrays. In order to ensure that a reduction in wind velocity does not result in the stabilization of actively migrating dunes and the loss of open dune habitats, wind power projects should not be sited in or immediately upwind of areas of actively migrating dunes.

When either solar or wind developments create large areas of disturbance, soil and groundwater and surface water resources can be impacted.

A number of construction-associated activities may adversely impact vegetation at a renewable energy development site. These activities include the clearing and grading of vegetated areas, and the introduction of invasive vegetation into disturbed areas of the immediate project site, and possibly into surrounding areas (BLM 2005b, BLM 2010a). Additional impacts on vegetation communities could occur from soil compaction (which can have even worse impacts in very arid environments such as salt desert, BLM 2008), loss of topsoil, and removal of or reductions in the seed bank during site clearing activities. Fugitive dust during construction activities can also potentially impact the plant community by coating the leaves of plants and potentially reducing photosynthesis rates (Thompson et al. 1984, Hirano et al. 1995) and increasing water loss (Eveling and Bataille 1984). These sorts of impacts that result from basic land clearing exercises are more common for solar facilities than for wind farms; typical rates are about nine acres of land cleared per megawatt of solar power generated (BLM 2010a).

A solar parabolic trough installation or solar power tower site requires flat land, and grading is the industry norm. The site is typically cleared of all vegetation to allow access to the installed equipment and to prevent fires. Herbicides may be sprayed or vegetation mowed to maintain cleared zones under and around the solar fields. Because some native plant species in our western deserts and arid landscapes may take decades or even centuries to recolonize after disturbance, development of this type has long-term consequences that cannot be undone, even if all of the installed equipment is removed and restoration attempts are made (Randall et al. 2010). The disturbance to fragile soil biological crusts can destabilize soils (Belnap and Herrick 2006), leading to increased particulate air pollution as soils are displaced by strong desert winds. In total, the surface disturbance at a solar facility is similar in intensity to commercial facilities, with an additional downside: the great expanse of exposed, disturbed soils found onsite and on associated roads is susceptible to invasion by non-native invasive plants which are known to thrive in areas of surface disturbance, and can serve as a reservoir of invasive species, furthering their dispersal into nearby natural lands which could result in long-term impacts to the native plant community (BLM 2010a, Randall et al. 2010).

When either solar or wind developments create large areas of disturbance, soil and groundwater and surface water resources can be impacted. In particular, the large, cleared, impervious surface areas created can

block or reroute surface flows (Arizona Game and Fish Department 2010). This in turn can lead to and exacerbate soil erosion, weathering of newly exposed soils leading to leaching and oxidation which release chemicals into groundwater, discharges of waste or sanitary water, presence of dissolved salts from untreated groundwater used to control dust, and herbicide or pesticide applications (AGFD 2010, BLM 2010a). Soil erosion at a site can be particularly problematic as it can remove soil, decrease its productivity and damage biological resources. Further, if uncontrolled runoff from construction sites causes short-term increases in turbidity in nearby watercourses, this can exacerbate flooding and also lead to increases in sedimentation and siltation which degrades water quality (AGFD 2010).

Most solar facilities need relatively small amounts of water for periodic cleaning of their mirrors, but some solar-thermal facilities also require large amounts of water for cooling. Depending on how much water is needed at a given solar generation site, there can be a locally large impact on water resources (Randall et al. 2010), with possible concomitant effects on local springs and seeps (Patten et al. 2008). While photovoltaic installations often require little or no water to generate electricity, water is required to wash panels. Solar power companies have indicated that between two and 10 acre-feet of water per 100 megawatt (MW) per year might be needed for this purpose (TNC 2008). Parabolic trough and solar technologies heat a transfer fluid that is in turn used to heat water to create stream and turn the turbines to generate electricity. Water is also required for the steam circuit and washing mirrors. In addition, if a plant uses wet-cooling of the exhaust steam from its turbines, industry standards indicate that up to 600 acre-feet of water per 100 MW per year may be required. [45] Often, the proposed sources of water for many currently proposed solar facilities are unclear. The BLM's recent Draft Programmatic Environmental Impact Statement for solar development stated that in most areas where solar projects are proposed, groundwater would likely be withdrawn from local aquifers to meet the project's water needs (BLM 2010a). Other options include water purchased through a water district and pumped to the site (Randall et al. 2010), though this is not usually an economically viable activity out in remote locations in our western deserts where most solar facilities are planned.

Photo © Arizona Public Service, DOE/National Renewable Energy Laboratory.

45 For more information on how to reduce water consumption with CSP technologies, please refer to the U.S. Department of Energy report entitled, "Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation" http://www.nrel.gov/csp/publications.html.

2.7. Special BMP Section on Addressing Land Use Planning And Renewables

The following Best Management Practices ensure that the basic, guiding principles of planning are followed in a land use plan's consideration for renewable energy. These should be followed by the land management agency that is amending a land use plan to incorporate renewable energy development. These BMPs should thus be solid guidance for those commenting on a land use plan that is being amended in an area that will incorporate new renewable energy:

These BMPs should be solid guidance for those commenting on a land use plan that is being amended in an area that will incorporate new renewable energy.

- Describe planning issues in a way such that a remedy can clearly be seen to address the issue.
- Design the land use plan around goals and measurable objectives that capture important ecological factors.
- Design monitoring to measure ecological factors.
- Based on habitat and wildlife population conditions, establish ecological objectives for the renewable energy site and surrounding watershed that lead to restoration where needed for maintenance of healthy habitat.
- For areas within the project site that need restoration or wildlife recovery, develop in the land use plan (or amendment) the actions needed to achieve wildlife and/or habitat recovery.
- Threats or stressors that either have led to degraded conditions in the planning area or threaten habitat in the future should be identified and the means to address those stressors developed.
- The plan should present the required sequence of actions that is needed for the siting and construction of renewable energy facilities that lead to achieving ecological objectives for the planning area. Construction and operation approval for renewable energy needs to be contingent on reaching and maintaining these goals.

Spotted towhee, one of many migratory species of birds that can be affected by renewable energy development. Photo © Utah Division of Wildlife Resources.

- The land use plan should describe the resources available to implement the plan and assess whether they are adequate in order to achieve ecological objectives.

- Monitoring should begin well in advance of construction. Background information on ecological goals is required in order to have a starting place to assess the impacts of the renewable energy site. Ecological reference areas should be established for comparison and long term monitoring.

- The land use plan should present how adaptive management will be used to incorporate renewable energy in the planning area. Adaptive management based on ecological goals uses monitoring data to determine whether renewable energy facility construction and operation are meeting goals, and this triggers responses in management to ensure goals are met (see below).

2.8 Importance of Adaptive Management and BMPs

One important component of responsible and environmentally sustainable planning for and operation of renewable energy sites is adaptive management. While we do not specifically link the guidelines and suggested BMPs in this document to specific recommendations for adaptive management, it should nevertheless be a part of all renewable energy monitoring. For the purposes of these BMPs, adaptive management can be thought of as a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs (Nyberg 1998). The U.S. Fish and Wildlife Service defines adaptive management as the "incremental environmental impact or effect of the proposed action, together with impacts of past, present, and reasonably foreseeable future actions" (50 CFR 22.3).

One important component of responsible and environmentally sustainable planning for and operation of renewable energy sites is adaptive management.

With ecological adaptive management, ecological goals are expressed in terms of measurable objectives that can be evaluated through monitoring. Evaluation of monitoring data assesses indicators of wildlife viability and habitat function as well as human use. Monitoring is then linked to analysis that determines whether the occurring human use (in this case, renewable energy production) is consistent or not with the ecological goals for the site. This analysis has thresholds that, when reached, call for management changes that will lead to meeting ecological objectives. Post construction monitoring efforts at wind and solar facilities should always be designed and carried out with an eye to adaptive management at the facility.

The BLM's Wind Programmatic Environmental Impact Statement Record of Decision provides the following instruction on the use of adaptive management:

Wind facilities can be shut down temporarily at night during peak migration periods to reduce collisions for bats and birds. Photo © Iberdrola Renewables.

"The BLM's Wind Energy Development Program will incorporate adaptive management strategies to ensure that potential adverse impacts of wind energy development are avoided (if possible), minimized, or mitigated to acceptable levels. The programmatic policies and BMPs will be updated and revised as new data regarding the impacts of wind power projects become available. At the project-level, operators will be required to develop monitoring programs to evaluate the environmental conditions at the site through all phases of development, to establish metrics against which monitoring observations can be measured, to identify potential mitigation measures, and to establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and project-specific stipulations. The BLM has the right to reassess mitigation measures if monitoring shows they are not succeeding/achieved or if new science supports the use of different or additional mitigation measures."

All wind facilities should incorporate this type of adaptive management into their site operation plans. If post-construction surveys indicate unacceptable levels of avian or bat fatalities for example, actions to mitigate these impacts should be taken. For example, wind facilities can be shut down temporarily at night during peak migration periods to reduce collisions. Alternatively, individual turbines that appear to be particularly dangerous to birds and bats can be shut down temporarily. To avoid bat fatalities, wind turbines also may be programmed to begin operating at higher minimum wind speeds during bat migration periods. Adaptive management can also help an agency take corrective action is mitigation commitments originally made in NEPA and decision documents fail to achieve projected outcomes (CEQ 2011).

It is also important that adaptive management take into account cumulative impacts to wildlife at renewable energy production sites. Numerous relatively minor disruptions to wildlife from multiple developments or activities, even if spatially or temporally distributed, may lead to disturbance

that would not have resulted from fewer or more carefully sited activities. For example, the accumulation of multiple land development projects or activities may cumulatively reduce the availability of alternative sites suitable for breeding, feeding, or sheltering, resulting in a greater than additive risk of take to wildlife (Pagel et al 2010).

Bald eagle populations could be impacted by many smaller-scale permits for numerous renewable energy companies. Photo © Scott Root, Utah Division of Wildlife Resources.

To use eagle take as an example, development that is concentrated in particular areas can lead to effects on the larger management population because 1) disproportionate take in local populations where breeding pairs are 'high' producers may reduce the overall productivity of the larger population; and 2) when portions of the management population become isolated from each other the productivity of the overall management population may decrease (Pagel et al 2010). A real-life example of the problem regarding lack of consideration of cumulative effects is that the programmatic eagle take permits under the Bald & Golden Eagle Protection Act given to wind developers by the USFWS were originally envisioned to be broad, industry wide take permits. However, the greatest demand in practice has been from individual companies, and as a result, the USFWS is seeing a demand for many smaller-scale permits covering individual installations that may take few eagles individually, but cumulatively could take many (personal communication with Diana Whittington, USFWS).

To ensure that renewable energy development impacts are not concentrated in particular localities to the detriment of locally important wildlife populations, cumulative effects need to be considered, before land development, both at the population management level — for example for a given U.S. Fish and Wildlife Service Management Region — and at local area population levels (Pagel et al 2010). The USFWS recommends that cumulative effect analysis for golden eagles go out at least 140 air miles from the project footprint (National Golden Eagle Colloquium 2010).

To ensure that renewable energy development impacts are not concentrated in particular localities to the detriment of locally important wildlife populations, cumulative effects need to be considered.

3.0 Research Needs

We have found very few studies that investigate the impacts of wind energy development on big game. There is some anecdotal information that pronghorn and even elk may continue to use the Foote Creek Rim wind power site in Wyoming, but this area has not been subjected to rigorous scientific study (Molvar 2008). As such, we would recommend that the first wind projects to be constructed within big game crucial ranges or migration corridors should be accompanied by rigorous scientific studies to determine the level of tolerance of big game for wind power facilities. These studies should describe the area of avoidance if displacement occurs; determine population level effects, if any; and determine how long it takes for animals to resume using the wind power facility site. Such studies should use Before-After-Control formats for maximum scientific rigor. If these comprehensive replicated studies indicate that displacement of big game by wind power development from sensitive ranges or migration corridors in a variety of habitats is negligible, then other wind power projects should be free to proceed in that type of range or migration corridor.

Mule deer. Photo © Phil Douglass, Utah Division of Wildlife Resources.

In terms of avian research, further research is needed to determine whether wind turbines adversely affect local sage-grouse populations. Also, it is unclear whether clustered wind turbines increases or decreases raptor mortalities (Anderson et al. 2004, Smallwood and Thelander 2005). More study is needed to determine whether advantages can be gained by altering the density of turbine arrays. Also on the avian and wind energy research front, there is a need for rigorous BACI ("Before-After-Control-Impact") type research for birds at wind facilities that is spear-headed well before the wind turbines are built. Most of what we know about bird fatality comes from Altamont and other post-construction surveys. We need to understand better how pre-construction surveys and risk assessments compare with post construction fatality studies. For example, is there avoidance or attraction that occurs post-construction that requires adjustments to our pre-survey risk assessments?

Sage-grouse. Photo © Phil Douglass, Utah Division of Wildlife Resources.

Kunz et al, 2007b, Horn et al. (2008) and Cryan (2008) hypothesize that bats are attracted to turbines, which, if true, would further complicate estimation of exposure. Reasons for apparent attraction may include sounds produced by turbines, a concentration of insects near turbines, bats attempting to find roost locations (NWCC 2010), or attraction

to a prominent landscape feature. Further research is required to determine if bats are attracted to turbines and if so, whether this increased individual risk translates into higher population-level impacts for bats.

Two spotted bats in flight, moving in opposite directions. Photo © Merlin D. Tuttle, Bat Conservation International, www.batcon.org.

Also on the bat research front, there is a need to better relate bat fatalities among wind facilities to landscape characteristics (e.g., geology, topography, habitat types, proximity of facilities to features such as mountain ranges or riparian systems). Relating fatalities to features within the vicinity of a turbine (e.g., proximity to water or forest edge) will help with designing future facilities and locating turbines to avoid higher risk areas within a site. (Kunz et al. 2007b; Kuvlesky et al. 2007; NAS 2007; Arnett et al. 2008). In their literature review on patterns of bat facilities at wind energy facilities in North America, Arnett et al. (2008) also noted that more research is needed to elucidate fatality patterns associated with weather conditions (e.g., wind speed, barometric pressure) and technical parameters (e.g., turbine size and height, linear array of turbines vs. scattered individual turbine locations) of different facilities. Thus, Arnett at al. propose that manipulative experiments be implemented at wind facilities across different regions to test various curtailment treatments with regard to the effect on reducing bat fatalities and enumerating economic costs of those treatments. For example, development of ultrasonic devices designed to infuse the entire rotor-swept area of a turbine with high frequency sound intended to alert and frighten bats from within the operating area are currently being tested. Preliminary results are promising (USFWS 2011b). By that same token, laser bird-alerting lights used as airport bird deterrents may provide promising alerting "tools" for turbine deterrent devices. Further testing of this approach, for both birds and bats, is recommended (USFWS 2011b).

What is really needed on the research front, and which has relevance to all wildlife, is pro-active vs. reactive research—for example: research on how to minimize on-site impacts through siting alternatives; research on effective off-site mitigation and how to establish that these mitigation measures actually off-set impacts as established through monitoring (probably one of few "adaptive options" on the table for a permanent energy development); research on how to minimize direct mortality impacts through siting and possibly techniques for minimizing interaction of birds with turbines.

4.0 Conclusion

This peer-reviewed document has presented a set of BMPs, which, if followed, should help reduce potentially adverse impacts to species of concern and their habitats at renewable energy project sites. However, we stress that, like all other science-informed management directions, the use and implementation of these BMPs must be adaptive and respond to new science-based information as it emerges.

These BMPs and this guidance document will evolve over time as additional experience, monitoring and research becomes available on how best to minimize wildlife and habitat impacts from wind and solar energy projects.

These BMPs and this guidance document will evolve over time as additional experience, monitoring and research becomes available on how best to minimize wildlife and habitat impacts from wind and solar energy projects. Therefore, we plan to continue work with industry, developers, the conservation community and other stakeholders and states to evaluate, revise and update these BMPs and this guidance document on a periodic basis.

Akowledgements

We wish to thank the following individuals for helpful comments on this report: Jim Catlin: Wild Utah Project; Alex Daue and Jon Belak: The Wilderness Society; Sophie Osborn: Wyoming Outdoor Council; Kirk Robinson: Western Wildlife Conservancy; and Sophie Hayes, Sara Baldwin, and Sarah Wright: Utah Clean Energy.

In addition,we thank Western Resource Advocates for their special role in producing this document.

Without the generous contribution of photos from the Utah Division of Wildlife Resources, Iberdrola Renewables, and the Department of Energy's National Renewable Energy Laboratory — none of whom have any affiliation with Wild Utah Project — this document would be far less visually compelling. Thanks also to Howie Garber of Wanderlust Images and Scott T. Smith for their images. We thank them all!

Finally, we are especially grateful to the Charles Redd Center for Western Studies for partnering with us by funding the publication of this document — in both hard copy and CDs.

Photo © Alstom 2010, National Renewable Energy Laboratory.

Literature Cited

American Planning Association (APA). 2006. Planning and urban design standards. John Wiley & Sons, New Jersey.

American Planning Association. 2009. American Institute of Certified Planners code of ethics and professional conduct. http://www.planning.org/ethics/ethicscode.htm

American Bird Conservancy. 2011. American Bird Conservancy's Policy Statement on Wind Energy. http://www.abcbirds.org/abcprograms/policy/collisions/wind_policy.html

American Wind Energy Association (AWEA). 2008. Wind Energy Siting Handbook. Document Prepared for AWEA by Tetra Tech EC, Inc. and Nixon Peabody LLP. Copyright 2008 by American Wind Energy Association, Washington, D.C. http://www.awea.org/sitinghandbook/

Anderson, R., M. Morrison, K. Sinclair, and D. Strickland. 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. National Wind Coordinating Committee/RESOLVE. Washington, D.C., USA.

Anderson, R., N. Neumann , W.P. Erickson, M.D. Strickland, M. Bourassa, K.J. Bay, and K.J. Sernka. 2004. Avian Monitoring and Risk Assessment at the Tehachapi Pass Wind Resource Area, Period of Performance: October 2, 1996 - May 27, 1998. NREL Report NREL/SR-500-36416, 90 pp. Available online at http://www.nrel.gov/wind/pdfs/36416.pdf

Arizona Game and Fish Department (AGFD). 2010. Guidelines for solar development in Arizona. www.azgfd.gov/hgis/documents/FinalSolarGuidelines03122010.pdf

Arnett, E.B., editor. 2005a. Relationships between bats and wiarch protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Austin, TX: Bat Conservation International. Available online at www.batcon.org/wind/BWEC-2004finalreport.pdf

Arnett, E. B., editor. 2005b. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas, USA. http://www.batcon.org/windliterature. Accessed 1 Sep 2007.

Arnett, E.B., D.B. Inkley, D.H. Johnson, R.P. Larkin, S. Manes, A.M. Manville, R. Mason, M. Morrison, M.D. Strickland, and R. Thresher. 2007. Impacts of Wind Energy Facilities on Wildlife and Wildlife Habitat. Issue 2007-2. The Wildlife Society, Bethesda, Maryland, USA.

Arnett, E.B., W.K. Brown, W.P. Erickson, J.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.P. Koford, C.P. Nicholson, T.J. O'Connell, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. Journal of Wildlife Management 72: 61- 78.

Arnett, E. B., M. M. P. Huso, M. R. Schirmacher, and J. P. Hayes. 2010. Altering turbine speed reduces bat mortality at wind-energy facilities. Frontiers in Ecology and the Environment 2010; doi:10.1890/100103

Audubon. 2008. Audubon's Position on Wind Power. http://policy.audubon.org/wind-power-overview-0

Avian Powerline Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA. http://www.aplic.org/SuggestedPractices2006(LR-2watermark).pdf

Baerwald, E. F., J. Edworthy, M. Holder, and R. M. R. Barclay. 2009. A large-scale mitigation experiment to reduce bat mortalities at wind energy facilities. Journal of Wildlife Management. 73: 1077-1081.

Barrios, L. and A. Rodríguez. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. Journal of Applied Ecology. 41: 72-81.

Belnap, J.and J. Herrick. 2006. Recovery Time of Soil and Vegetation from Historical Geophysical Exploration in Southeastern Utah. Report prepared for the U.S. Department of Energy and Bureau of Land Management.

Bureau of Land Management (BLM). 1992. Raptor Habitat Management on Public Lands: A strategy for the future. BLM/SC/PT-92+6635. Written by Olendorff, R. and M. Kochert, Raptor Research and Technical Assistance Center, Boise, ID.

Bureau of Land Management (BLM). 1995. Fundamentals of Rangeland Health and Standards and Guidelines for Grazing Administration. 43 CFR, Part 4100.

Bureau of Land Management (BLM). 2001. Manual 6840 ▫▫Special Status Species Management. Release No. 6-121, U.S. Department of the Interior.

Bureau of Land Management (BLM). 2002. "Instruction Memorandum No. 2003-020, Interim Wind Energy Development Policy," issued by the Director of the BLM, Washington, D.C., Oct. 16.

Bureau of Land Management (BLM). 2005a. Record of decision: implementation of a wind energy development program and associated land use plan amendments.

Bureau of Land Management (BLM). 2005b. Wind Energy Development Programmatic EIS. U.S. Department of the Interior, Washington, D.C.

Bureau of Land Management (BLM). 2005c. H-1601-1 Public Land Use Planning Handbook. BLM Manual release 1-1693 11th March 2005.

Bureau of Land Management (BLM). 2007. Final Programmatic Environmental Impact Statement, Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States. FES 07-21, U.S. Department of the Interior, Washington, D.C., June 29. Available at http://www.blm.gov/15 wo/st/en/prog/more/veg_eis.html

Bureau of Land Management (BLM). 2008. Environmental Assessment (EA) for Milford Wind Corridor Project, Millard and Beaver Counties, Utah. EA UT-040-07-20. UTU-82972 and UTU 82973. October 15, 2008. BLM Cedar City and Fillmore Field Offices, UT.

Bureau of Land Management (BLM). 2010a. Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States. http://solareis.anl.gov/documents/index.cfm

Bureau of Land Management (BLM). 2010b. Record of decision and approved Kemmerer Resource Management Plan. May 2010 Kemmerer, Wyoming.

Bureau of Land Management (BLM). 2010c. Best Management Practices and guidance manual: Desert renewable energy projects. Renewable energy action team report. November 2010.

Bureau of Land Management (BLM). 2010d. Memorandum of Understanding between the U.S. Department of the Interior Bureau of Land Management and the U. S. Fish and Wildlife Service to Promote the Conservation of Migratory Birds. Signed 4.12.2010

Bureau of Land Management (BLM) and U.S Forest Service (USFS). 2008a. Final Programmatic Environmental Impact Statement for Geothermal Leasing in the Western United States, Volume I: Programmatic Analysis, October 2008.

Bureau of Land Management (BLM) and U.S Forest Service (USFS). 2008b. Record of Decision and Resource Management Plan Amendments for Geothermal Leasing in the Western United States. December 2008.

California Desert and Renewable Energy Working Group. 2010. Recommendations to Secretary of the Interior Ken Salazar on Ways to Improve Planning and Permitting for the Next Generation of Solar Energy Projects on BLM Land in the California Desert California Desert & Renewable Energy Working Group special report, December 22, 2010.

California Energy Commission (CEC) 2007. Best Management Practices and Guidance Manual: Desert Renewable Energy Projects. Report # CEC-700-2009-016-SD.

California Energy Commission and California Department of Fish and Game. 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. Commission Final Report. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division. CEC-700-2007-008-CMF.

Canadian Wildlife Service. 2006. Wind Turbines and Birds: A Guidance Document for Environmental Assessment. Environment Canada, Canadian Wildlife Service.

Gatineau, Quebec. http://www.fws.gov/midwest/wind/guidance/CanadianEAguidelines.pdf

Clean Energy States Alliance (CESA). 2006. Model state guidance document governing avian and bat impacts from wind facilities. October, 2006.

Collins, C.P. and T.D. Reynolds. 2006. Greater sage-grouse lek surveys and lek counts on Cotterel Mountain, 2006 Results. Ribgy, ID: TREC, Inc.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage-grouse population and their habitats. Wildlife Society Bulletin 28(4):967-85.

Council on Environmental Quality. 2011. Memorandum for appropriate use of mitigation and monitoring and clarifying the appropriate use of mitigated Findings of No Significant Impact. http://ceq.hss.doe.gov/current_developments/docs/Mitigation_and_Monitoring_Guidance_14Jan2011.pdf

Cryan, P.M. 2008. Mating Behavior as a Possible Cause of Bat Fatalities at Wind Turbines. Journal of Wildlife Management 72(3): 845-49.

Dettmers, R., D.A. Buehler, J.G. Bartlett, and N.A. Klaus. 1999. Influence of Point Count Length and Repeated Visits on Habitat Model Performance. Journal of Wildlife Management 63(3): 815-23.

Dixon, J.D., et al. 2007. Genetic Consequences of Habitat Fragmentation and Loss: The Case 41 of the Florida Black Bear (Ursus americanus floridanus). Conservation Genetics 8(2):455–464.

Dobson, A., Ralls, K., Foster, M., Soule, M.E., Simberloff, D., Doak, D., Estes, J., Mills, S., Mattson, D., Dirzo, R., Arita, H., Ryan, S., Norse, E., Noss, R., and D. Johns. 1999. Regional and Continental Restoration. In: (Soulé, M.E. and J. Terborgh, editors) Continental Conservation: Scientific Foundations of Regional Reserve Networks. Island Press, Washington, DC.

Dooling, R. 2002. Avian Hearing and the Avoidance of Wind Turbines. NREL Report NREL/TP-500-30844, 83 pp. Available online at http://www.nrel.gov/wind/pdfs/30844.pdf

Drewitt, A.L. and R.H.W. Langston. 2006. Assessing the Impacts of Wind Farms on Birds. Ibis 148: 29-42.

Erickson, W. P., G. D. Johnson, et al. 1999. Baseline Avian Use and Behavior at the CARES Wind Plant Site, Klickitat County, Washington. Prepared for the National Renewable Energy Laboratory: 1-75.

Erickson, W.P., G. D. Johnson, M. D. Strickland, D. P. Young, Jr., 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. National Wind Coordinating Committee, 62 pp. Available online at http://www.west-inc.com/reports/avian_collisions.pdf

Erickson, W.P., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002. Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments, prepared by Western EcoSystems Technology, Inc., Cheyenne, Wyo., for Bonneville Power Administration, Portland, Ore., Dec.

Erickson, W.P., B. Gritski, and K. Kronner. 2003a. Nine Canyon Wind Power Project Avian and Bat Monitoring Report, September 2002 – August 2003. Technical report submitted to Energy Northwest and the Nine Canyon Technical Advisory Committee. Available online at http://www.westinc.com/reports/nine_canyon_monitoring_final.pdf

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2003b. Stateline Wind Project Wildlife Monitoring Final Report, Results for the Period July 2001–December 2003. Prepared by Western EcoSystems Technology, Inc., Cheyenne, Wyo., and Walla Walla, Wash., for FPL Energy, Oregon Office of Energy, and Stateline Technical Advisory Committee. May 2003.

Erickson, W.P. Johnson, G.D. and D.P. Young. 2005. A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. 2005.

Eveling, D.W. and A. Bataille, 1984. The Effect of Deposits of Small Particles on the Resistance of Leaves and Petals to Water Loss. Environmental Pollution. Series A 36:229–238.

Fiedler, J.K. 2004. Assessment of bat mortality and activity at Buffalo Mountain Windfarm, eastern Tennessee. MS Thesis, Univ. of Tennessee Knoxville, 165 pp. Available online at http://www.wind-watch.org/documents/wpcontent/uploads/fiedler2004-bat_mortality_bmw.pdf

Foppen, R. and R. Reijnen. 1994. The Effects of Car Traffic on Breeding Bird Populations in Woodland. II. Breeding Dispersal of Male Willow Warblers (Phylloscopus trochilus) in Relation to the Proximity of a Highway. Journal of Applied Ecology 32:95-101.

Forester, J. 1989. Planning in the face of power. University of California Press, Berkeley.

Fox, A.D., M. Desholm, J. Kahlert, T.K. Christensen and K. Petersen. 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds Ibis 148 (Suppl. 1): 129–144.

Fruedenthal, Dave. 2010. State of Wyoming executive order 2010-4, greater sage-grouse core area protection. Cheyenne, Wyoming.

Gehring, J., P. Kerlinger, and A.M. Manville, II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19(2): 505-514.

Geothermal Energy Association. 2007. A Guide to Geothermal Energy and the Environment. April, 2007. http://www.geo-energy.org/publications/reports/Environmental%20Guide.pdf

Goodale W. and T. Divoll. 2009. Birds, Bats and Coastal Wind Farm Development in Maine: A Literature Review. Report BRI 2009-18. BioDiversity Research Institute, Gorham, Maine.

Grover, K.E., and M.J. Thompson, 1986. Factors influencing spring feeding site selection by elk (Cervus elaphus) in the Elkhorn Mountains, Montana. J. Wildl. Manage. 50(3):466-470.
Hagan, J.M., et al. 1996. The Early Development of Forest Fragmentation—Effects on Birds. Conservation Biology 10(1):188-202.

Harmata, A.R., K.M. Podruzny, J.R. Zelenak, and M.L. Morrisson. 2000. Passage rates and timing of bird migration in Montana. Am. Midl. Nat. 143: 30-40.

Harper, K.A., et al. 2005. Edge Influence on Forest Structure and Composition in Fragmented Landscapes. Conservation Biology 19(3):768-782.

Harris, L.D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago.

Hayes, S.G., D.J. Leptich, and P. Zager. 2002. Proximate factors affecting male elk hunting mortality in northern Idaho. Journal of Wildlife Management 66(2): 491-499.

Hirano, T. et al. 1995. Physical Effects of Dust on Leaf Physiology of Cucumber and Kidney Bean Plants. Environmental Pollution 89(3):255-261.

Holloran, M.J. 2005. Greater sage-grouse (Centrocercus urophasianus) population response to natural gas field development in western Wyoming. PhD Dissertation, University of Wyoming, Laramie.

Hoover, S. 2002. The Response of Red-tailed Hawks and Golden Eagles to Topographical Features, Weather and Abundance of a Dominant Prey Species at the Altamont Pass Wind Resource Area, California. Prepared for the National Renewable Energy Laboratory: 1-64.

Hoover, S.L., and M.L. Morrisson. 2005. Behavior of red-tailed hawks in a wind turbine development. J. Wildl. Manage. 69: 150-159.

Horn, J.W., E.B. Arnett, and T.H. Kunz. 2008. Behavioral Responses of Bats to Operating Wind Turbines. J. Wildl. Manage. 72:123-132.

Horváth, G., M. Blahó, A. Egri, G. Kriska, I. Seres, and B. Robertson. 2010. Reducing the maladaptive attractiveness of solar panels to polarotactic insects. Conservation Biology. DOI: 10.1111/j.1523-1739.2010.01518.x

Hunt, W. G., R. E. Jackman, T. L. Brown, and L. Culp. 1999. A population study of golden eagles in the Altamont Pass Wind Resource Area: population trend analysis 1994-1997. Report to National Renewable Energy Laboratory, Subcontracts XAT-5-15174-01, XAT- 6-16459-01. Predatory Bird Research Group, University of California, Santa Cruz, California, USA.

Hunt, G. 2002. Golden eagles in a perilous landscape: predicting the effects of mitigation for wind turbine bladestrike mortality. California Energy Commission Report P500-02-043F. Sacramento, California, USA.

Hunt, G. and T. Hunt. 2006. The Trend of golden eagle territory occupancy in the vicinity of the Altamont pass wind resource

area: 2005 survey. Prepared for the California Energy Commission. June 2006. CEC-500-2006-056.

Huso, M. M. P., 2010. An estimator of wildlife fatality from observed carcasses. Environmentrics. DOI: 10.1002/env.1052.

Janss, G. 2000. Bird Behavior in and near a Wind Farm at Tarifa, Spain: Management Considerations. In: Proceedings of NWCC National Avian-Wind Power Planning Meeting III,San Diego, Calif., May 1998. Available at http://www.nationalwind.org/pubs/avian98/default.htm

Johnson, B.K., and D. Lockman. 1979. Response of elk during calving to oil/gas drilling activity in Snider Basin, Wyoming. WDGF report, 14 pp.

Johnson, B.K, and L. Wollrab. 1987. Response of elk to development of a natural gas field in western Wyoming 1979-1987. WDGF Report, 28 pp.

Johnson, G.D. 2005. A review of bat mortality at wind-energy developments in the United States. Bat Research News. 46: 45-49.

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

Johnson, G.D., and M.D. Strickland. 2004. An Assessment of Potential Collision Mortality of Migrating Indiana Bats (Myotis sodalis) and Virginia Big-eared Bats (Corynorhinus townsendii virginianus) Traveling between Caves, supplement to Biological Assessment for the Federally Endangered Indiana Bat (Myotis sodalis) and Virginia Big-eared Bat (Corynorhinus townsendii virginianus). Prepared by Western Ecosystems Technology, Inc., Cheyenne, Wyo., for NedPower Mount Storm LLC, Chantilly, Va., April 14.

Johnson, G.D., M.K. Perlik, W.P. Erickson, and M.D. Strickland. 2004. Bat activity, composition, and collision mortality at a large wind plant in Minnesota. Wildl. Soc. Bull. 32: 1278-1288.
Johnson, G.D., E.P. Wallace, M.D. Strickland., M.F. Shepherd, D.A. Shepherd and S.A. Sarappo. 2002. Collision Mortality of Local and Migrant Birds at a Large-scale Wind-power Development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30(3):879–987.

Johnson, G.D., E.P. Wallace, M.D. Strickland., M.F. Shepherd, D.A. Shepherd and S.A. Sarappo. 2003. Mortality of Bats at a Large-scale Wind Power Development at Buffalo Ridge, Minnesota. American Midland Naturalist 150:332–342.

Johnson, G. D., D. P. Young, Jr., W. P. Erickson, C. E. Derby, M. D. Strickland, and R. E. Good. 2000. Wildlife monitoring studies for the SeaWest windpower project, Carbon County, Wyoming 1995-1999, Final Report. WEST, Inc., 195 pp. Available online at http://www.west-inc.com/reports/fcr_final_baseline.pdf

The Kansas Renewable Energy Working Group. 2003. Siting Guidelines for Windpower Projects in Kansas. Recommendations of the Kansas Renewable Energy Working Group Environmental and Siting Committee. Approved by the Executive Committee of the Kansas Renewable Energy Working Group February 26, 2003. http://www.kansasenergy.org/documents/KREWGSitingGuidelines.pdf

Kerlinger, P. 1989. Flight strategies of migrating hawks. University of Chicago Press, Chicago, Illinois, USA.

Kerlinger, P. and J. Kerns. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Repo for 2003. Prepared for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee: 1-39.

Kingsley, A. and B. Whittam. 2003. Wind Turbines and Birds. A Guidance Document for Environmental Assessment. Phase III (Draft) Report, Canadian Wildlife Service, Environment Canada, Gatineau, Quebec, Canada, Dec. Available at http://www.canwea.ca/downloads/en/PDFS/BirdStudiesDraft_May_04.pdf

Kuenzi, A.J. and M.L. Morrison. 1998. Detection of Bats by Mist-Nets and Ultrasonic Sensors. Wildlife Society Bulletin 26(2): 307-11.

Kunz, T. H., E. B. Arnett, B. M. Cooper, W. P. Erickson, R. P Larkin, T. Mabee, M. L. Morrison, M. D. Strickland, and J. M. Szewczak. 2007a. Assessing impacts of wind-energy development on nocturnally active birds and bats: A guidance document. Journal of Wildlife Management 71: 2449-2486. Available online at http://www.wind-watch.org/documents/wp-content/uploads/wild-71-08- 45.pdf

Kunz, T.H., E. B. Arnett, W. P. Erickson, A. R. Hoar, G. D. Johnson, R. P. Larkin, M. D. Strickland, R. W. Thresher, and M. D. Tuttle. 2007b. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment 5: 315–324. Available online at http://www.windaction.org/?module=uploads&func=download&fileID=1293

Kuvlesky, W. P., L. A. Brennan, M. L. Morrison, K. K. Boydston, B. M. Ballard, F. C. Bryant. 2007. Wind energy development and wildlife conservation: Challenges and opportunities. Journal of Wildlife Management. 71: 2487-2498.

Lamphier-Gregory, West Inc., Shawn Smallwood, Jones & Stokes Associates, Illingworth & Rodkin Inc. and Environmental Vision. 2005. Environmental Impact Report for the Buena Vista Wind Energy Project, LP# 022005. County of Contra Costa Community Development Department, Martinez, California.

Larkin, R.P. 1996. Effects of Military Noise on Wildlife: A Literature Review. Technical Report 96/21. U.S. Army Construction Engineering Research Laboratory, Champaign, Ill.

Longcore, T. and C. Rich. 2004. Ecological light pollution. Fron¬tiers in Ecology and the Environment 2:191–198.

Lyon, L.J. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry 81: 592-595.

Madders, M. and D.P. Whitfield. 2006. Upland Raptors and the Assessment of Wind Farm Impacts. Ibis 148: 43-56.

Manville, A.M., II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Division of Migratory Bird Management, USFWS, Arlington, VA, peer-reviewed briefing paper. 17 pp. Available online at http://www.environment.ok.gov/documents/OKWindEnergy/PrairieGrouseLeks WindTurbines.pdf

Manville, A.M., II. 2009. Towers, turbines, power lines, and buildings – steps being taken by the U.S. Fish and Wildlife Service to avoid or minimize take of migratory birds at these structures. Pp. 262-272, In T.D. Rich, C. Arizmendi, D. Demarest, and C. Thompson (eds.). Tundra to Tropics: Connecting Habitats and People. Proceedings 4th International Partners in Flight Conference, 13-16 February 2008, McAllen, Texas. Partners in Flight.

McCrary, M.D., et al. 1986. Avian Mortality at a Solar Energy Power Plant. Journal of Field Ornithology. 57(2):1355-141.

Miller, A. 2008. Patterns of avian and bat mortality at a utility-scaled wind farm on the southern high plains. Thesis, Texas Tech University, Lubbock, Texas, USA.

Mojica, E. K., J. M. Meyers, B. A. Millsap, and K. T. Haley. 2008. Migration of sub-adult Florida bald eagles. Wilson Journal of Ornithology 120:304-310.

Molvar, E.M. 2008. Wind power in Wyoming: Doing it Smart from the Start. Laramie, WY: Biodiversity Conservation Alliance, 55 pp. Available online at www.voiceforthewild.org/blm/pubs/WindPowerReport.pdf

Morrison, M. L., W. M. Block, M. D. Strickland, and W. L. Kendell. 2001. Wildlife study design. Springer-Verlag, New York, New York, USA.

National Academy of Sciences (NAS). 2007. Environmental Impacts of Wind-Energy Projects. The National Academies Press, Washington, D.C., USA.

National Energy Policy Development (Group NEPDG). 2001. National Energy Policy, Reliable, Affordable, and Environmentally Sound Energy for America's Future. Washington, D.C. May, 2001.

National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press. Washington, D.C., USA. Available online at www.nap.edu

National Wind Coordinating Collaborative (NWCC). 1999. Studying wind energy/bird interactions: a guidance document. Prepared for the Avian Subcommittee and NWCC December 1999.

National Wind Coordinating Collaborative (NWCC). 2002. Permitting of Wind Energy Facilities: a handbook. Funded by the Midwest Research Institute, National Renewable Energy Laboratory under the Subcontract YAM-9-29210-01 and the Department of Energy under Prime Contract No. DE-AC 36-83CH10093. Available at http://www.nationalwind.org/publications/siting.aspx

National Wind Coordinating Collaborative (NWCC). 2006. State Siting and Permitting of Energy facilities. Joint fact Sheet issued by NWCC and National Conference of State legislatures.

National Wind Coordinating Collaborative (NWCC). 2007. Mitigation Toolbox. Compiled by NWCC Mitigation Subgroup and Jennie Rectenwald. May 2007.

National Wind Coordinating Collaborative (NWCC). 2010. Wind Turbine Interactions with Birds, Bats, and their Habitats: A Summary of Research Results and Priority Questions. Fact Sheet: Third Edition. http://www.nationalwind.org/publications/bbfactsheet.aspx

NatureServe. 2011. http://www.natureserve.org/explorer/

Naugle, D. E., K. E. Doherty, B. L. Walker, J. Holloran, and H. E. Copeland. 2011. Energy Development and Greater Sage-Grouse. Chapter 21. Studies in Avian Biology. No. 38.

Noss, R. F. 1983. A regional landscape approach to maintain diversity. BioScience. 33:700-706.

O'Brien, M. 2000. Making Better Environmental Decisions: An Alternative to Risk Assessment. MIT Press. http://mitpress.mit.edu/catalog/item/default.asp?tid=3632&ttype=2

O'Farrell, M.J., B.W. Miller, and W.L. Gannon. 1999. Qualitative Identification of Free-Flying Bats Using the Anabat Detector. Journal of Mammalogy 80(1): 11-23.

Oregon Natural Desert Association (ONDA). 2009. Oregon's high desert and wind energy – opportunities and strategies for responsible development. Bend, OR. 81 pp. Available at www.onda.org.

Organ, A. and Meredith, C. 2004. 2004 Avifauna Monitoring for the proposed Dollar Wind Farm – Updated Risk Modeling. Biosis Research Pty. Ltd. Report for Dollar Wind Farm Pty. Ltd.

Orloff, S., and A. Flannery. 1992. Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamon Pass and Solano County Wind Resource Areas Tiburon, California. Prepared for the Planning Departments of Alameda, Contra Costa, and Solano Counties and the California Energy Commission.

Osborn, R.G., C.D. Dieter, K.F. Higgins, and R.E. Usgaard. 1998. Bird flight characteristics near wind turbines in Minnesota. Am. Midl. Nat. 139: 29-38.

Pagel, J.E., D.M. Whittington, and G.T. Allen. 2010. Interim Golden Eagle technical guidance: inventory and monitoring protocols; and other recommendations in support of eagle management and permit issuance. Division of Migratory Bird Management, U.S. Fish and Wildlife Service.

Patten, D.T., et al. 2008. Isolated Spring Wetlands in the Great Basin and Mojave Deserts, USA: Potential Response of Vegetation to Groundwater Withdrawal. Environmental Management 41:398–413.

PBS&J. 2002. Final Environmental Impact Statement, Table Mountain Wind Generating Facility. BLM Case Nos. N-73726 and N-57100. Prepared by PBS&J, San Diego, Calif., for U.S. Bureau of Land Management, Las Vegas Field Office, Nev. July 2002.

Randall, J. M., S.S. Parker, J. Moore, B. Cohen, L. Crane, B. Christian, D. Cameron, J. MacKenzie, K. Klausmeyer and S. Morrison. 2010. Mojave Desert Ecoregional Assessment. Unpublished Report. The Nature Conservancy, San Francisco, California. 106 pages + appendices. Available at: http://conserveonline.org/workspaces/mojave/documents/mojave-desert-ecoregional-2010/@@view.html

Reed, R.A., et al. 1996. Contribution of Roads to Forest Fragmentation in the Rocky 40 Mountains. Conservation Biology 10(4):1098–1106.

Reijnen, R. and R. Foppen. 1994. The Effects of Car Traffic on Breeding Bird Populations in Woodland: Evidence of Reduced Habitat Quality for Willow Warblers (Phylloscopus trochilus) Breeding Close to a Highway. Journal of Applied Ecology 32:85-94.

Resource Media and Western Resource Advocates. 2008. Smart Lines: Transmission for the renewable energy economy. Boulder, CO. Copyright 2008. http://www.westernresourceadvocates.org/energy/smartlines.php

Reynolds, T.D. 2004. Draft Greater sage-grouse lek surveys and lek counts in the Cotterel Mountains, 2003 Results, Draft Summanry Report. Rigby, ID: TREC, Inc.

Reynolds, T.D., and C.I. Hinckley. 2005. Greater sage-grouse lek surveys and lek counts on Cotterel Mountain. 2005 Results. Rigby, ID: TREC, Inc.

Reynolds R.T., J.M. Scott, R.A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor. 82(3):309–13.

Rowland, M.M., M.J. Wisdom, B.K. Johnson, and J.G. Kie. 2000. Elk distribution and modeling in relation to roads. Journal of Wildlife Management 64: 672- 684.

Rowland, M.M., M.J. Wisdom, B.K. Johnson, and M.A. Penninger. 2005. Effects of roads on elk: implications for management in forested ecosystems. Pages 42-52 in Wisdom, M.J., technical editor, The Starkey Project: a synthesis of long-term studies of elk and mule deer. Reprinted from the 2004 Transactions of the North American Wildlife and Natural Resources Conference, Alliance Communications Group, Lawrence, KS.

Sawyer, H. and F. Lindzey. 2001. Sublette Mule Deer Study, Final Report, Wyoming Cooperative Fish & Wildlife Research Unit, Laramie, Wyo., March. Available at http://www.uppergreen.org/library/docs/Muledeerstudy1.pdf .

Sawyer, H., et al. 2006. Winter Habitat Selection of Mule Deer before and during Development of a Natural Gas Field. Journal of Wildlife Management 70(2):396–403.

Sharp, L, C. Herrman, R. Friedel, K. Kosciuch and R. MacIntosh. 2010. Comparison of pre- and post- construction bald eagle use at the Pillar Mountain wind project, Kodiak, Alaska, Spring 2007 and 2010. Powerpoint Presentation for the National Wind Coordinating Collaborative Wind Wildlife Research Meeting VII October 19-21, 2010. Access on 16 December 2010 at: http://www.nationalwind.org/assets/research_meetings/Research_Meeting_VIII_Sharp.pdf

Simpson, Donald A. 2008. Letter from Simpson, acting BLM state director to Wyoming Governor Dave Freudenthal, June 12.

Smallwood, K.S. 2009a. Comments on third draft of the Wind Turbine Guidelines Advisory Committee Recommendations to the Secretary of the Interior. 24 June 2009.

Smallwood, K.S. 2009b. Wind power company compliance with mitigation plans in the Altamont Pass Wind Resource Area. Report written as an independent consulting ecologist. Davis, CA.

Smallwood, K. S., and L. Neher. 2005. Repowering the APWRA: Forecasting and minimizing avian mortality without significant loss of power generation. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-005.

Smallwood, K. S., L. Neher, D. Bell, J. DiDonato, B. Karas, S. Snyder, and S. Lopez. 2009a. Range Management Practices to Reduce Wind Turbine Impacts on Burrowing Owls and Other Raptors in the Altamont Pass Wind Resource Area, California. Final Report to the California Energy Commission, Public Interest Energy Research – Environmental Area, Contract No. CEC-500-2008-080. Sacramento, California.

Smallwood, K. S., L. Rugge, and M. L. Morrison. 2009b. Influence of Behavior on Bird Mortality in Wind Energy Developments: The Altamont Pass Wind Resource Area, California. Journal of Wildlife Management: 73: 1082–1098.

Smallwood, K. S. and L. Spiegel. 2005. Assessment To Support An Adaptive Management Plan For The APWRA. Unpublished CEC staff report, January 19. 19 pp.

Smallwood, K. S. and C.G. Thelander. 2004. Developing methods to reduce bird mortality in the Altamont Pass Wind Resource Area. Final Report to the California Energy Commission, Public Interest Energy Research – Environmental Area, Contract No. 500-01-019. Sacramento, California. 531 pp.

Smallwood, K.S., and C.G. Thelander. 2005. Bird Mortality at the Altamont Pass Wind Resource Area: March 1998 - September 2001. Subcontract Report NREL/SR-500-36973. Prepared for National Renewable Energy Laboratory, Golden, CO, by BioResource Consultants, Ojai, CA. August 2005. Available online at http://www.nrel.gov/docs/fy05osti/36973.pdf

Smallwood, K.S. and C.G. Thelander. 2008. Bird Mortality in the Altamont Pass Wind Resource Area, California JWM 72: 215–223.

Stewart, G.B., A.S. Pullin, and C.F. Coles. 2004. Effects of wind turbines on bird abundance. Review Report. Centre for Evidence-based Conservation, Systematic Review No. 4, Univ. Birmingham, UK. 49 pp.

Stewart, G.B., A.S. Pullin, and C.F. Coles. 2007. Poor evidence-base for assessment of windfarm impacts on birds. Environmental Conservation. 34: 1-11.

Stoel Rives. 2009. Lex helius: The law of solar energy. Copyright 2009. Stoel Rives LLP. http://www.stoel.com/webfiles/lawofsolarenergy.pdf

Stoel Rives. 2010. The Law of Wind: A Guide to Business and Legal Issues. Copyright 2010 Stoel Rives LLP. http://www.stoel.com/showarticle.aspx?show=1185

Strickland, D. 2004. Non-fatality and habitat impacts on birds from wind energy development. Overview of Non-Collision Related Impacts from Wind Projects. Proc. Wind Energy & Birds/Bats Workshop, Washington, D.C., May 18-19. 2004, pp. 34-38. Available online at http://www.awea.org/pubs/documents/WEBBProceedings9.14.04%5BFinal%5D.pdf

Teitz, Michael. 1985. Rationality planning and the state. Chapter 9 in rationality in planning, critical essays on the role of rationality in urban and regional planning. M. Breheny and A. Hooper editors. Page Bros Limited. London.

Thelander, C.G., and L. Rugge. 2000. Avian Risk Behavior and Fatalities at the Altamont Wind Resource Area, March 1998 to February 1999. NREL Report NREL/SR-500-27545, 22 pp. Available online at http://www.nrel.gov/wind/pdfs/27545.pdf

The Nature Conservancy. 2008. Renewable Energy in the South Coast and Deserts. The Nature Conservancy of California.

The Wilderness Society (TWS). 2008. Geothermal Development on Public Lands. http://wilderness.org/files/Website Geothermal%20Development%20On%20Public%20Lands.pdf

The Wilderness Society (TWS). 2010. IN THE ZONE: Powering the Future and Protecting Wildlands with Guided Solar Development. http://wilderness.org/files/IN%20THE%20ZONE%20Guided%20Solar%20Development.pdf

The Wilderness Society (TWS), Natural Resources Defense Council, Defenders of Wildlife, Sierra Club, and National Wildlife Federation. 2010. Interim Guidance for Evaluating and Approving Renewable Energy Projects on Public Land. May 19, 2010 letter to Bob Abbey, Director, Bureau of Land Management.

Thompson, J.R., et al. 1984. The Effect of Dust on Photosynthesis and Its Significance for Roadside Plants. Environmental Pollution 34:171–190.

Thomson, J.L., et al. 2005. Wildlife at a Crossroads: Energy Development in Western Wyoming—Effects of Roads on Habitat in the Upper Green River Valley. The Wilderness Society, Washington, D.C. Available at http://www.uppergreen.org/library/docs/WildlifeAtCrossroads_report.pdf

Trombulak, S.C., and C.A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1):18–30.

Ugoretz, S. 2001. Avian Mortalities at Tall Structures. In Proceedings of NWCC National Avian-Wind Power Planning Meeting IV, Carmel, Calif., May 16¤17, 2000. Available at http://www.nationalwind.org/pubs/avian00/default.htm

U.S. Department of Energy. 2008. Geothermal Power Plants – Minimizing Land Use and Impact. http://www1.eere.energy.gov/geothermal/geopower_landuse.html

U.S. Department of Energy and U.S. Department of the Interior (USDOE and DOI). 2002. White House Report in Response to the National Energy Policy Recommendations to Increase Renewable Energy Production on Federal Lands. Washington, D.C., Aug. 2002.

U.S. Fish and Wildlife Service (USFWS). 2002. Utah Field Office Guidelines for Raptor Protection From Human and Land Use Disturbances. Written by Romin, Laura A., and James A. Muck U.S. Department of the Interior, U.S. Fish and Wildlife Service, Utah Field Office, Salt Lake City, Utah.

U.S. Fish and Wildlife Service (USFWS). 2007. Effects of Communication Towers on Migratory Birds. Comments of the U.S. Fish and Wildlife Service submitted electronically to the FCC on 47 CFR Parts 1 and 17, WT Docket No. 03-187, FCC 06-164, Notice of Proposed Rulemaking: 32, 12-18.

U.S. Fish and Wildlife Service (USFWS). 2009. Eagle Permits; Take Necessary To Protect Interests in Particular Localities; Final Rules. 50 CFR Parts 13 and 22. CFR Vol. 74, No. 175

U.S. Fish and Wildlife Service (USFWS). 2010a. Wind Turbine Guidelines Advisory Committee Policy Recommendations and

Guidelines. Submitted to the Secretary of the Interior, March 4, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010b. 12-Month Findings for Petitions to List the Greater Sage- Grouse (Centrocercus urophasianus) as Threatened or Endangered. Federal Register / Vol. 75, No. 55 / Tuesday, March 23, 2010. Page 13910.

U.S. Fish and Wildlife Service (USFWS). 2011a. Draft Eagle Conservation Plan Guidance. http://www.fws.gov/windenergy/docs/ECP_draft_guidance_2_10_final_clean_omb.pdf

U.S. Fish and Wildlife Service (USFWS). 2011b. U.S. Fish and Wildlife Service Draft Land-Based Wind Energy Guidelines. http://www.fws.gov/windenergy/docs/WEG_September_13_2011.pdf

Utah Department of Natural Resources (UDNR) – Utah Wildlife in Need Program. 2010. Contemporary Knowledge and Research Needs Regarding the Potential Effects of Tall Structures on Sage-grouse (Centrocercus urophasianus and C. minimus). Published by the UWIN Cooperative and Rocky Mountain Power. September, 2010. Salt Lake City, UT.

Utah Division of Wildlife Resources (UDWR) 2005. Utah Comprehensive Wildlife Conservation Strategy. Utah Division of Wildlife Resources Publication Number 05-19. http://wildlife.utah.gov/cwcs/11-03-09_utah_cwcs_strategy.pdf

Van den Berg, F., E. Pedersen, J. Bouma, and R. Bakker. 2008. Project WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents, Final report. European Union FP6-2005-Science-and-Society-20, Specific Support Action, Project no. 044628, 87 pp. Available online at http://www.windwatch.org/documents/wp-content/uploads/wfp-final-1.pdf

Van Dyke, F., and W.C. Klein. 1996. Response of elk to installation of oil wells. J. Mamm. 77(4):1028-1041.

Walker, D., McGrady, M., McCluskie, A., Madders, M. & McLeod, D.R.A. 2005. Resident Golden Eagle ranging behaviour before and after construction of a wind farm in Argyll. Scottish Birds 25: 24–40.

Weaver Clyde., J. Jessop, and V Das. 1985 Rationality in the public interest: notes toward a new synthesis. Chapter 10 in rationality in planning, critical essays on the role of rationality in urban and regional planning. M. Breheny and A. Hooper editors. Page Bros Limited. London.

Weber M. 1947. The theory of social and economic organizations. Translated by A. M. Henderson and T. Parsons. The Free Press, Glencoe, IL.

Western Electric Coordinating Council's (WECC)'s Environmental Data Task Force. 2011. DRAFT - Preliminary Environmental Recommendations for the Transmission Planning Process.

Willyard, C.J., et al.. 2004. Ecological Effects of Fragmentation Related to Transmission Line Rights-of-Way: A Review of the State of the Science. Report prepared by Resources Strategies, Inc., Madison, Wisc., for Wisconsin Focus on Energy, Environmental Research Program, Madison, Wisc. Available at http://www.rsinc.com/downloads/Ecological_Effects_of_Fragmentation_on_Rights-of-Way.pdf

Wyoming Game and Fish Department. 2010. Wildlife Protection Recommendations for wind energy development in Wyoming. Approved by Wyoming Game Commission, April 23, 2010.

Wyoming Outdoor Council (WOC). 2010. Wind Energy: doing it right in Wyoming. Fact Sheet. Lander, WY.

Young, D.P, W. P. Erickson, R. E. Good, M. D. Strickland, and G,D. Johnson. 2003. Avian and bat mortality associated with the initial phase of the Foote Creek Rim windpower project, Carbon County, Wyoming. Prepared by Western Ecosystems Technology, Inc. for Pacificorp, Inc., SeaWest Windpower Inc. & BLM Rawlins District Office. Cheyenne, Wyoming.

Best Management Practices

for siting, developing, operating and monitoring renewable energy in the Intermountain West:

A Conservationist's Guide

March 2012

Designed as a resource for public land management agency staff, renewable energy developers and citizen groups, this document outlines Best Management Practices (BMPs) to aid in siting, developing, constructing, operating, and monitoring solar and wind projects in the Intermountain West, in a way that is "smart-from-the-start" for wildlife. We hope this set of BMPs and guidances will be an asset to the conservation community in particular, who up until now have had no real "one stop shopping" manual to help them proactively affect all stages of renewable energy development on our western public lands.

WILD UTAH PROJECT

Wild Utah Project

www.wildutahproject.org

824 S 400 W, SUITE B117
Salt Lake City, UT 84101

801-328-3550

To download a free copy, go to www.wildutahproject.org/resources