Guidelines for Assessing the Potential Impacts to Birds and Bats from Wind Energy Development in Northern Arizona and the Southern Colorado Plateau

February 2009

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EXECUTIVE SUMMARY

In northern Arizona and the southern Colorado Plateau, wind energy research is rapidly becoming a foundation for a new industrial sector. Although no commercial wind energy is online in the region as of 2008, several projects have begun permitting and preliminary assessments at several proposed sites. One concern with the construction of wind energy sites is the potential effect on wildlife. In particular, reports of negative impacts to birds and bats from wind energy development have raised concerns. Anticipating, understanding and mitigating such effects are essential to the long-term viability of bird and bat populations within the region. Developable wind lands within the southern Colorado Plateau often encompass large areas located in remote and rugged terrain where reliable data on bird and bat activities and movement patterns are poorly understood. Thus, developing a credible site-specific survey design and engaging the appropriate agency personnel throughout the process is essential to the success of the project.

The following document provides voluntary guidelines that promote scientifically sound, cost-effective methods for assessing and evaluating potential impacts on birds and bats from wind energy development projects within the southern Colorado Plateau. The principal goal is to provide a broadly accepted document, adaptable to locations throughout the region that will encourage wind energy resource assessment and development that is scientifically sufficient and in compliance with laws and regulations in place to protect birds and bats in the region. By employing standardized survey methods and protocols, all interested organizations and individuals can more accurately assess potential risks and calculate impacts to birds and bats from wind development. Methods and protocols necessarily are flexible and general in nature to accommodate for site- specific concerns and project related limitations. These guidelines do not supersede current requirements and regulations imposed by federal, tribal, and state agencies, nor do they reflect the opinion or views of any one agency or organization.

Included in these voluntary guidelines is information on current laws, policies, and existing guidelines in the region, and recommended procedures, protocols and information sources needed to complete preliminary site evaluations, pre-construction surveys, and post-construction and operations monitoring and risk assessment for birds and bats at proposed wind energy facilities in northern Arizona and on the southern Colorado Plateau.

These guidelines were supported, in part, by Grant No. LAM-7-77543-13 entitled *Arizona Wind Energy Outreach Strategy and Implementation* by the U.S. Department of Energy, National Renewable Energy Laboratory. This report is submitted in partial fulfillment of that award.

For comments or questions on this guidance document contact the Northern Arizona University Ecological Monitoring & Assessment Program & Foundation, PO Box 5845, 1298 S. Knoles Dr., Building 56, Flagstaff, Arizona 86011-5845; (phone) 928-523-0716; (fax) 928-523-0717.

CHAPTER 1: INTRODUCTION

In the United States, the U. S. Department of Energy is charged with promoting wind power to meet twenty percent of U.S. electricity generation by 2025. The southern Colorado Plateau, encompassing the southern most corners of Utah and Colorado, the northwestern corner of New Mexico and most of northern Arizona, including the Navajo Nation, has a significant commercial scale developable wind resource. Recent wind data maps indicate a wind capacity for approximately 16,000 MW for northern Arizona alone (Williams et al. 2007). Although no commercial wind energy is online in the region as of 2008, several projects have begun permitting and preliminary assessments for proposed sites. Large wind farms, however, have stimulated other concerns including visual aesthetics, noise and transmission challenges. The most well known concern associated with wind farms is the death of birds (Anderson and Estep 1988; Estep 1989; Orloff and Flannery 1992, 1996) and more recently, bats (Fiedler 2004; Arnett et al. 2007, Barclay et al. 2007). As wind energy development in the region rapidly advances from anecdotal studies to a foundation for a new industrial sector, there is a desire to move forward responsibly in terms of environmental impacts, to create a truly "green" renewable energy alternative in the Southwest.

Spurred by some reports of high mortality at some wind farms and a general lack of knowledge, numerous advisory groups such as the Avian Subcommittee of the National Wind Coordinating Committee (NWCC) and the Bats and Wind Energy Cooperative (BWEC) were created to better understand the interactions between birds and bats and wind energy. The U.S. Fish and Wildlife Service (USFWS) and several state agencies have developed voluntary guidelines and general recommendations for siting wind farms that aim at reducing and avoiding impacts to wildlife. In 2008 a Wind Turbine Guidelines Advisory Committee was appointed to provide advice and recommendations to the Secretary of the Department of Interior on developing effective measures to avoid or minimize impacts to wildlife and their habitats related to land-based wind energy facilities. Following extensive industry consultation and coordination, national and state documents and committees have provided a general foundation and guidance for wind energy developers; however, due to the diversity of landscapes and complexity of landownership across the southern Colorado Plateau, standardized methods and protocols specific to the region will encourage and expedite development of area wind resources.

This document provides guidelines that will promote scientifically sound, cost-effective methods for assessing and evaluating potential impacts on birds and bats from wind energy development projects within the southern Colorado Plateau. It is not meant to duplicate existing guidelines and protocols, but to synthesize the various methods and provide specific yet adaptable procedures for conducting studies for birds and bats within the region. The principal goal is to provide a broadly accepted document, adaptable to locations throughout region that will encourage wind energy resource assessment and development that is in compliance with laws and regulations in place to protect birds and bats in the region. By employing standardized survey methods and protocols, all interested organizations and individuals can more accurately assess potential risks and predict cumulative impacts to birds and bats from wind development.

The Ecological Monitoring & Assessment Program & Foundation at Northern Arizona University (EMA Program) was tasked by the National Renewable Energy Laboratory of the

U.S. Department of Energy to develop these guidelines. This document is meant as an overview for the region and does not reflect the views and recommendations from any one governmental agency or organization. Many interested professionals were consulted, however, and these guidelines were developed with the assistance of government officials, non-profit organizations, businesses, and industries interested in wind development on the Plateau. The most recent research and science were considered and regional specific information has been incorporated. Updates to this document will be made as new research and wind energy related wildlife protocols become available.

Information is included or cited on current laws, policies, and existing guidelines in the region. Also provided are procedures, protocols and information sources needed to complete preliminary site evaluations, pre-construction surveys, and post-construction and operations monitoring for birds and bats at proposed wind energy facilities. The final study design for any planned project in the region should utilize appropriate methods selected from those in these guidelines, and selected following consultation with appropriate agency personnel. These guidelines do not include specific metrics and statistical measures. This information can be found in more detail in complementary guidelines and literature.

CHAPTER 2: CURRENT LAWS, POLICIES AND GUIDELINES

A variety of federal, tribal, state, and county laws and regulations are in place for the protection of wildlife. Such policies and statutes need to be addressed throughout the permitting and development process for wind energy projects located within the southern Colorado Plateau. With regard to wildlife, wind specific policies are few, and existing policies may change. Project developers are advised to consult with the appropriate agencies and area stakeholders early in the process to ensure full compliance with current laws and regulations.

The objective of this section is to provide a summary of current policy and regulations and identify jurisdiction and contacts for agencies that should be engaged. The following laws, policies, and guidelines designed to protect birds and bats are relevant to wind energy development permitting and projects.

FEDERAL

The following federal laws and guidelines pertain directly to wind energy development. Other federal laws and regulations, including the Endangered Species Act and the Migratory Bird Act apply regardless of land ownership. Additional laws such as the Clean Water Act and Federal Aviation Administration (FAA 2000) requirements must be considered prior to development, but do not pertain directly to the protection of birds and bats at wind turbines, and thus, are not included within these guidelines.

National Environmental Policy Act (NEPA), 1969, Title 42 U.S.C. Sections 4321-4345
Where applicable, NEPA requires that all Federal agencies prepare detailed environmental impact statements for every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The statute stipulates the factors to be considered in environmental impact statements, and requires that Federal agencies employ an interdisciplinary approach in related decision-making and develop means to ensure that unquantified environmental values are given appropriate consideration, along with economic and technical considerations. The "NEPA process" consists of an evaluation of the environmental effects of a federal undertaking including its alternatives. These statements are commonly referred to as environmental impact statements (EISs). There are three levels of analysis depending on whether or not an undertaking could significantly affect the environment. These three levels include: categorical exclusion determination; preparation of an environmental assessment/finding of no significant impact (EA/FONSI); and preparation of an environmental impact statement (EIS). If the EA determines that the environmental consequences of a proposed federal undertaking may be significant, an EIS is prepared. An EIS is a more detailed evaluation of the proposed action and alternatives. The public, other federal agencies and outside parties may provide input into the preparation of an EIS and then comment on the draft EIS when it is completed. If a federal agency anticipates that an undertaking may significantly impact the environment, or if a project is environmentally controversial, a federal agency may choose to prepare an EIS without having to first prepare an EA. After a final EIS is prepared and at the time of its decision, a federal agency will prepare a public record of its decision addressing how the findings of the EIS, including consideration of alternatives, were incorporated into the agency's decision-making process.

Federal Endangered Species Act, 1973, Title 16, U.S. Code Section 1531
The Endangered Species Act prohibits unauthorized taking, possession, sale, and transport of endangered species and provides broad protection for bird and bat species and their habitats that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when authorizing, funding or carrying out actions that may affect listed species, and procedures for private or state entities to follow when implementing action that may result in incidental take of listed species. Current federally listed bird species for the southern Colorado Plateau include the southwestern willow flycatcher (*Empidonax trailii extimus*), Mexican spotted owl (*Strix occidentalis lucida*), and California condor (*Gymnogyps californianus*). There are no federally listed endangered bats for this region.

Migratory Bird Treaty Act (MBTA), 1918, Title 16, U.S. Code Section 703 - 712
The Migratory Bird Treaty Act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. The Act prohibits taking, killing or possessing migratory birds or any part, nest, or egg of any such bird.

Bald and Golden Eagle Protection Act, 1940, Title 16, U.S. Code Section 668
This law provides for the protection of the bald eagle and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. The 1972 amendments increased penalties for violating provisions of this Act or regulations issued pursuant thereto and strengthened other enforcement measures. The 1978 amendment authorized the Secretary of the Interior to permit the taking of golden eagle nests that interfere with resource development or recovery operations. In July 2008, a Draft Environmental Assessment (DEA) considered three alternatives for regulations establishing new take permits under the Eagle Act and potential impacts that could result from the implementation of the proposed regulation or alternatives to the proposed regulation within the context of other take already authorized or otherwise occurring (USFWS 2008). The assessment also summarizes the biological foundation for defining take thresholds for bald eagles and golden eagles.

U.S. Fish and Wildlife Service Interim Guidelines
In 2003, the U.S. Fish and Wildlife Service provided voluntary interim guidelines intended to assist the wind energy industry in avoiding or minimizing impacts to wildlife and their habitats. The guidelines recommend proper evaluation of potential Wind Resource Areas (WRAs), proper location and design of turbines and associated structures within WRAs selected for development, and pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife. These guidelines were based on current science and are subject to change as new information becomes available. The guidelines are intended to be general in nature and applied with local interpretation based on local conditions, due to variance in geography and habitats. In 2008, the Secretary of the Interior appointed a Wind Turbine Guidelines Advisory Committee to achieve balanced representation of wind energy development, wildlife conservation, and government. The Committee, composed of 22 members, formed in accordance with the Federal Advisory Committee Act and provides advice and recommendations to the Secretary on developing effective measures to avoid or minimize impacts to wildlife and their habitats related

to land-based wind energy facilities. Some federal and state land and resource management agencies have developed specific directives and statements with regards to wind energy projects.

BLM Programmatic Environmental Impact Statement (PEIS)
In 2004 the Bureau of Land Management (BLM) issued a draft Programmatic EIS for wind energy development (http://windeis.anl.gov/index.cfm). The PEIS assesses the environmental, social and economic impacts of, 1) the proposed action to allow increased wind energy development on BLM lands, 2) a limited action alternative, allowing only for the expansion of certain existing wind farms, and 3) the "no-action" scenario which would allow wind energy development to occur on an ad-hoc basis without the PEIS serving as a program guide, or umbrella document, to streamline the evaluation process. The PEIS does not address site specific issues; however, appropriate PEIS policies will be included with each EIS or EA for specific projects.

U.S. Forest Service Wind Energy Directive (Proposed, August 2008)
The U.S. Forest Service plans to amend its internal agency directives for special use authorizations and wildlife monitoring (http://www.fs.fed.us/recreation/permits/energy.htm). This document may provide direction and guidance specific to wind energy development on National Forest System (NFS) lands. This will supplement, rather than supplant or duplicate, existing special use and wildlife directives to address issues specifically associated with siting, processing proposals and applications, and issuing special use permits for wind energy uses. The proposed directives would ensure consistent and adequate analyses in that agency for evaluating wind energy proposals and applications and issuing wind energy permits. This directive is intended to provide direction for wildlife monitoring requirements at sites on NFS lands that have been identified for potential wind energy development.

TRIBAL

Tribal lands cover large portions of the southern Colorado Plateau that includes 31 federally recognized tribes. With few exceptions, federal laws are applicable on tribal lands. One tribal jurisdiction that is particularly noteworthy is the Navajo Nation. The Navajo Nation, covering 27,673 square miles and parts of three of the four corner states found within the Colorado Plateau, is a sovereign nation with applicable laws, policies and regulations. The following laws and regulations for the protection of birds and bats are relevant to wind energy development on the Navajo Nation.

Navajo Nation Environmental Policy Act, Title 4 -901 of the Navajo Nation Code
In 1995, the Navajo Nation Environmental Protection Agency (NNEPA) was created as a separate regulatory branch of the Navajo National government and charged with protecting human health, welfare, and the environment of the Navajo Nation. In 1995, the Navajo Nation Council approved adoption of the Navajo Nation Environmental Policy Act similar to the U.S. National Environmental Protection Act.

Navajo Endangered Species Act, 17 NNC § 507
It is the responsibility of the Navajo Nation Department of Fish and Wildlife (NNDFWL) to manage, conserve, and protect wildlife on Navajo lands. Navajo Nation Code makes it "unlawful for any person to take, possess, transport, export, process, sell or offer for sale or ship" any species listed on the Navajo Endangered Species List. Current species listed as "Endangered" under this Act include the yellow-billed cuckoo (*Coccyzus americanus*), southwestern willow flycatcher, golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), and the Mexican spotted owl. The bald eagle (*Haliaeetus leucocephalus*), is a proposed addition to the list and is pending approval (NNDFWL 2008).

Navajo Nation Golden and Bald Eagle Nest Protection Regulations
The Navajo Nation provides protection for golden eagles and bald eagles, and their nests, by regulating human activities associated with land use, land development, and other activities within close proximity of all known eagle nests (Pending approval by the Navajo Resource Commission). These regulations are designed to: 1) establish circular buffers around all eagle nests on the Navajo Nation; 2) protect nesting eagles, their eggs and young, from human activities within those buffers during the breeding season; and 3) designate the types of permanent structures that may be constructed within those buffers.

ARIZONA

The Arizona Game & Fish Department (AZGFD) works closely with county supervisors, planning and zoning departments, and city councils as well as federal agencies to protect state wildlife resources and habitat from adverse impacts of wind energy development. To what extent recommendations from AZGFD are incorporated into these local processes varies from county to county. The following Arizona laws and guidelines are relevant to the protection of birds and bats from wind energy projects.

Arizona Revised Statute, Title 17
General provisions under the Arizona Revised Statute, Title 17 provide for the protection of wildlife, both resident and migratory, native or introduced, found in Arizona, except fish and bullfrogs impounded in private ponds or wildlife and birds reared or held in captivity under permit from the State Game Commission. Under this statute it is unlawful to take or injure any bird or harass any bird upon its nest, or remove the nests or eggs of any bird, except as may occur in normal horticultural and agricultural practices and except as authorized by Commission order (17-236). ARS 17-235 authorizes the Commission to regulate the taking of migratory birds in accordance with the federal Migratory Bird Treaty Act. The statute provides similar protection and regulation for bat species prohibiting the take or injury except as authorized by the Commission.

Arizona Game & Fish Department Wind Energy Development Guidelines
Voluntary guidelines by the AZGFD provide recommendations for minimizing the potential impacts of wind development on birds and bats and their habitats. Revised guidelines, anticipated in 2009, likely will recommend 1-4 years of baseline surveys depending on the project category (Ginger Ritter pers comm., December 2008). Project categorization is determined in cooperation with the AZGFD and is based on available information for the project

site and indicators of impacts. These guidelines also may call for an "invasive species management plan". The guidelines outline considerations for site placement, habitat fragmentation, power transmission, tower configuration, and tower design that should be addressed in the pre-construction phase. They describe steps to undertake during construction to reduce disturbance to habitats and birds and bats including siting on previously disturbed areas and avoiding building during breeding periods. Post-construction recommendations may include a monitoring plan that varies in length and scope (depending on the project category) to assess movement, mortality, behavior changes, and abundance of local species for potential future facility design modifications to reduce impacts.

COLORADO

Code of Colorado Regulations for Public Utilities Commission; 4 CCR 723-3656
The Colorado Public Utilities Commission regulates investor owned utilities. For renewable energy resources larger than 2 MW with any wind turbine extending over 50 feet in height, the qualifying utility is required to show that the wind energy developer had included in their bid package documentation that consultation has occurred with the Colorado Division of Wildlife (CDOW) or the USFWS. The current rules require project developers to certify, as a condition precedent to achieving commercial operation, that they have performed and made publicly available site specific avian and other wildlife surveys conducted on the facility's site prior to construction. The developer must further certify that they used the results of these surveys in the design, placement, and management of the facilities to ensure that the environmental impacts of facility development are minimized to state and federally listed species and species of special concern, sites shown to be local bird migration pathways, critical habitat and areas where birds or other wildlife are highly concentrated and are considered at risk.

Code of Colorado Regulations, Division of Wildlife 4 CCR 406
CCR 406 gives general protection to non-game species and subspecies, including threatened or endangered wildlife and prohibits the taking or possession of these species except as under a scientific collecting, rehabilitation, or special use license.

NEW MEXICO

New Mexico Wildlife Conservation Act; NM ST §§ 17-2-37 - 46
This Act provides general protection to, and provides for, an adequate supply of game, fish, and furbearers and applies provisions of the Wildlife Conservation Act to indigenous species of wildlife suspected or found to be threatened or endangered.

New Mexico Game & Fish Department, Wildlife Habitat Handbook
This handbook provides voluntary guidelines based on the USFWS Interim Guidance for impacts of wind energy development on wildlife. The guidelines focus on recommendations for site development and turbine design and operations with regards to impact avoidance and mitigation for birds and bats. Guidelines for all commercial/industrial-sized wind energy development projects must also consider the Department's Trenching and Powerline Guidelines, as well as the standard New Mexico Wildlife of Concern county list. Developers are recommended to consult with state biologists and submit a "fatal flaw" analysis, similar to NEPA requirements.

UTAH

Wildlife Resources Code of Utah; 23-13-1
All wildlife existing within Utah, not held by private ownership and legally acquired, is the property of the state. The law gives general protection to non-game species and subspecies, including threatened or endangered wildlife and prohibits the taking or possession of these species except as under a scientific collecting, rehabilitation, or special use license.

Utah does not currently have recommendations or guidelines specific to wildlife and wind energy development. Developers are responsible for contacting the applicable government agencies such as the Public Service Commission of Utah, Utah Division of Public Utilities, and the Utah Department of Natural Resources, Division of Wildlife Resources to determine the necessary requirements for each specific proposed wind energy development project.

COUNTY

Counties often require permits prior the construction of wind energy development and have planning and zoning ordinances to address land use and development issues in rural, unincorporated, and non-tribal areas that govern the area in which the wind energy development may be located. Plans often provide general guidelines for the conservation and protection of wildlife and can be useful during preliminary project evaluations. With the exception to Colorado, specific language with regard to the assessment and monitoring for impacts to birds and bat at proposed wind energy developments may not be stipulated; however, they are often part of the conditions for permit approval. Applicable county offices should be consulted for further details.

ADDITIONAL GUIDELINES

National Wind Coordinating Committee (NWCC)
The Avian Subcommittee of the NWCC has developed a guidance document for studying wind interactions with regards to birds (Anderson et al. 1999). The document outlines standard metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. It is focused on promoting standard metrics and methods of design for diurnal avian impact studies. The document does not provide specific protocols for conducting studies nor does it address nocturnal birds or bats; however, there are plans to include nocturnal species in the future.

CHAPTER 3: PRELIMINARY SITE EVALUATION

The purpose of the preliminary site evaluation is to provide an early assessment of the potential impacts to bird and bat resources prior to the construction of the proposed wind energy project. More specifically the preliminary site evaluation often can identify conflict areas or "fatal flaws" which may lead to modifications to the proposed project. General guidelines on conducting these evaluations for birds are outlined by Anderson et al. (1999). This process can also be used for preliminary site evaluations for bat species. The following is based upon these guidelines and provides regionally-specific information that will help guide wind energy projects on the southern Colorado Plateau. In some cases existing data or information for a site may be straight forward and readily available. For many sites, however, information is lacking and a more rigorous evaluation may be necessary in order to assess whether significant impacts to sensitive species can be avoided. By conducting a thorough preliminary site evaluation as described below, developers can avoid delays during the permitting and pre-construction process.

AGENCY AND EXPERT CONSULTATION

Federal, tribal, and state agency personnel should be contacted at the onset of the development project to acquire the most recent information regarding listed species, species and habitat of special concern, species distribution and other biological data for birds and bats that may be found within the project area. This is a critical first step. Agency professionals generally have relationships with landowners and neighboring land managers and can provide knowledge that may expedite the development process. During the initial contact with the appropriate agency personnel, formal requests for information can be solicited regarding bird and bat resources and resource management at the site. Agencies databases are often developed and maintained using current data and information for specific species and can provide valuable information. All consultations and interviews should be documented and included within the preliminary site evaluation report.

U.S. Fish and Wildlife Service (USFWS)

Regardless of land ownership or geographic location, developers proposing a wind energy projects within the southern Colorado Plateau should contact the lead biologist at the appropriate regional USFWS Environmental Services Office. For each development project, USFWS professionals can provide site specific information about potential risks to federally listed threatened and endangered species, birds of conservation concern, and designated critical habitat that may be present at and near the proposed site. This is of particular concern for migratory species of special conservation concern that spend the majority of their lifecycle outside of the Southwest and beyond the boundaries of the proposed project area. Federal biologists can assist developers in establishing measures to mitigate potential impacts to wildlife and assure that the project is in compliance with federal laws and regulations. For sites found within federal lands, the appropriate land management agency also should be contacted.

Federal Land Management Agencies

If the wind project, energy transmission, and /or site access require use of Federal lands managed by the USFS, USFWS or BLM, the appropriate agency should be consulted as early as possible to determine the level of compliance with NEPA and any other federal environmental

requirements. USFS, USFWS and BLM biologists can provide information for bird and bat species and habitat management concerns that are specific to their agency. For proposed sites that are not located within federally managed lands but are near these lands, federal biologists including those at the national parks within the southern Colorado Plateau may, in the absence of site specific information, provide general information, species lists and other data for lands bordering the site.

Tribal Governments and Offices
For wind projects located on tribally owned or leased lands, consultation with natural resource managers and biologists is imperative. Information with regards to birds and bats may not be readily available outside of direct contact with tribal officials and local experts.

State Land
If the wind project, energy transmission, and/or site access require use of lands managed by a state, the appropriate agency should be consulted as early as possible to determine the level of compliance with environmental and right-of-way requirements.

State Wildlife Agencies
Formal requests for information from state wildlife database systems should be made as early as possible in the planning process. These resources generally identify key concerns and consolidate information about the distribution and status of bird and bat species throughout the state. Database reports and distribution maps often can be generated to target the needs of project requests, including species lists for a geographic or managed area and data on specific species. Absence or lack of data pertaining to a particular species of bird or bat from state databases should be viewed with caution. It may not indicate the absence of the species from the project area, but a gap in the data. Therefore it is important to keep in mind that use of the online species lists and databases do not equate to a formal consultation. In all cases the lead wind energy professionals should be contacted directly with a formal request for information and consulted with regard to interpretation of the data and review of potential impacts. State biologists also may be available to assist with identifying important habitat features and areas of focus that should be investigated during the preliminary site evaluation.

Local Resources
Additional consultation with local area experts may be useful when data is not readily available from other sources. Bird and bat experts and researchers from area universities and professional organizations such as the Audubon Society and the Western Bat Working Group may have additional helpful information. Local community members and landowners are often knowledgeable about area wildlife and history, providing valuable insight and site specific information.

LITERATURE REVIEW

A comprehensive literature review relevant to the impacts on bird and bat populations from wind energy development projects should be conducted. Sources of information should include peer-reviewed articles in scientific journals, and books, and as well as "gray literature" sources such as federal and state technical reports published for various projects or agencies. State conservation plans for both birds and bats provide information about the biology, status, distribution, and management concerns for species found within each state. Biological data from existing wind energy facilities can provide valuable information and insight into the potential impacts to birds and bats. There are currently no wind energy facilities on the southern Colorado Plateau; however, several proposed projects are underway or in the planning stage. A review also should be conducted on studies within the western U.S. to compare and evaluate what the potential risks and cumulative effects may be to bird and bat populations.

Topographical and vegetation maps coupled with aerial photographs are valuable in understanding the potential presence or absence of species that may or may not have been previously recorded or observed within the proposed project area. Since wildlife habitat relationships are complex, available information should be accompanied by that gathered during an on-site visit and reviewed by an experienced biologist.

Additional sources of information include regional and state on-line databases and organizations, such as the Arizona Wildlife Linkage (http://www.azdot.gov). These resources are useful in understanding potential impacts and identifying sensitive areas within or near the development project, particularly for migratory species. Following are just a few credible sources for review.

North American Breeding Bird Surveys (BBS)
The BBS is a long-term, large-scale, international avian monitoring program initiated in 1966 to track the status and trends of North American bird populations (http://www.pwrc.usgs.gov/bbs/). The USGS Patuxent Wildlife Research Center, the Canadian Wildlife Service, and the National Wildlife Research Center jointly coordinate the BBS program. BBS data provides an index of population abundance that can be used to estimate population trends and relative abundances at various geographic scales and regions and for specific species or group of species.

National Audubon Society (NAS)
National Audubon Society conducts annual Christmas Bird Counts (CBC), an all-day census of winter bird populations. Data from the counts can be searched by state, count location or species and provides information on trends across the Americas (http://www.audubon.org/Bird/cbc/). State Audubon offices also provide the location of Important Bird Areas (IBA), and often can provide additional contacts with area professionals familiar with the flora and fauna of the project area.

Hawk Watch International (HWI)
Hawk Watch International is a non-profit organization that conducts long-term monitoring and scientific research on raptors throughout the United States (http://www.hawkwatch.org/home/). Two fall migration count sites are located in the region in northern Arizona at Yaki Point and Lipan Point on the south rim of Grand Canyon National Park. Information from annual fall

counts, reports, and maps provide long-term regional data on the status, trends, and movement patterns of multiple raptor species.

PRELIMINARY SITE VISIT

Once background information has been gathered and appropriate agencies have been contacted, a preliminary site visit should be conducted to gain an overview of the proposed development site. On-site observations are used to evaluate major land features (e.g., topography, ridge aspect, water bodies, etc.), habitat conditions, land management activities, and the potential occurrence of resources of concern. Specific focus should be given to identifying habitat for bird and bat species use with particular attention to identifying movement corridors and features that may attract birds or bats to the project site such as water sources, nesting and roosting sites, and high concentrations of prey. This initial site visit should be conducted by an experienced biologist familiar with bird and bat species in the area and their habitat. During the site visit biologists should record all birds and dominant plant species and vegetation types observed. All habitat types and major topographical features within and surrounding the project area should be assessed to thoroughly understand the potential for species occurrence. Consideration should be given to the size and configuration of the development "footprint" with relation to surrounding habitat features so that indirect affects due to habitat fragmentation and changes such as changes in prey quantity and quality, perch, nest and foraging sites, and migratory and daily movement patterns can be more accurately predicted. The site visit can also provide basic information that will be helpful in developing future pre-construction surveys and monitoring studies, such as access roads, travel times, and routes to and from the site.

CHAPTER 4: PRE-CONSTRUCTION SURVEYS

Pre-construction surveys are recommended at all proposed wind energy development sites. These surveys may not be required by federal, tribal, and state wildlife and regulatory agencies within the southern Colorado Plateau, but are often required by local authorities as a stipulation of the permitting process. Surveys identify potential impacts prior to construction of the wind facility, and can prevent delays during the permitting, construction and operation phases of the project. It is recommended that pre-construction surveys begin as early as possible to ensure that data is available for review well in advance of the construction of the facility. This will enable developers to make decisions early in the planning process with regard to micro-siting turbines and identifying mitigation measures that may reduce or avoid impacts to birds and bats

The principal goals for pre-construction surveys are; (1) to provide baseline information on avian and bat use of the study area that is useful in evaluating the potential impact to birds from wind energy development prior to installation of wind turbines; (2) to use this information to design a wind energy facility that is less likely to impact bird and bat species; and (3) to serve as a foundation for post-construction studies and contribute to understanding of wind turbine and bird and bat interactions in the U.S. Southwest. The objectives of the pre-construction surveys are guided by information provided by the preliminary site evaluation and a site specific survey design based upon this information. The development of a credible site-specific survey design should use appropriate survey methodology that reflects site-specific concerns and engages appropriate agency personnel.

LEVELS OF EFFORT

The level of effort required to assess potential impacts and document pre-existing conditions at proposed wind development sites will vary according to information gathered during the preliminary site evaluation and after consultation with appropriate agency personnel. Preliminary site evaluations may indicate an unacceptable level of risk that cannot be avoided. In these instances, sites may be deemed inappropriate for wind development. For proposed sites that are appropriate for development, the following levels of effort can provide general guidelines on determining the scope, duration, and intensity needed. Levels of effort listed below are not necessarily static categories. A project may shift from one level to another as information becomes available. It is recommended to periodically review data from ongoing surveys with appropriate agency personnel to determine if the selected study design and level of effort are meeting study objectives or if modifications are required to address any unforeseen issues not previously identified.

Level 1 - Low Site Sensitivity

The preliminary site evaluation indicates a low potential for impacts to birds and bats at the proposed site. The site does not support bird or bat species or habitat of conservation concern, known migration corridors and stopover habitat, or habitat that may attract and concentrate birds or bats. Level 1 project sites most often require a minimum of one year of pre-construction surveys to assess potential impact. For project sites in which little is known about species distributions, site use, and movement patterns, additional surveys may be required, and the level

of effort may change as pre-construction survey results become available. For these reasons, survey results should be reviewed with agency biologists to determine if additional focused survey efforts or changes in the survey design and methodology are needed.

Level 2 - Moderate to High Site Sensitivity
The preliminary site evaluation indicates a moderate to high potential for impacts to birds and bats based upon the presence of species and habitat of special conservation concern, habitat features that concentrate or attract birds and bats, or known migration corridors or stopover sites. Level 2 project sites require a minimum of one year of pre-construction surveys, and generally require more focused efforts to gather additional information. Survey effort will depend upon the species of concern, the magnitude of the assessed risk, seasonal and temporal variations in populations, and results from the first year of surveys. Survey results should be reviewed with agency biologists to determine the level of effort required beyond the initial fist year of pre-construction surveys, and whether changes in methodology are needed to further assess potential risks.

Level 3 - Very High Site Sensitivity
The preliminary site evaluation indicates a very high probability of impacts to birds or bats by the proposed wind energy development. This high level of risk may be due to the presence of threatened or endangered species, habitat features that concentrate or attract high densities of birds or bats species of conservation concern, or known migration corridors and stopover sites that support high densities of birds or bats. A single year of pre-construction surveys may not be adequate. It is recommended to work closely with federal and state agency biologists to determine the level of effort required, and to discuss possible avoidance and mitigation strategies.

SURVEY DESIGN AND METHODS

Defining clear survey objectives is the first step in developing a cost-effective and efficient study design. Well developed pre-construction surveys use a site specific design that matches the needs and resource concerns of the project and takes into consideration impacts to individuals and populations of birds and bats. This is often driven by information gathered during the preliminary site evaluation and consultation with agency personnel.

Potential wind energy project sites within the southern Colorado Plateau often encompass large areas located in remote and rugged terrain where reliable data on bird and bat activities and movement patterns are poorly understood. Thus, developing a credible survey design that will yield defensible, comparable results is essential to the success of the project and will assist in compliance with regulatory constraints, particularly when proposed sites support bird and bat species of concern.

Two documents are available that provide guidance for developing study designs for pre-construction bird and bat surveys at proposed wind energy facilities. Guidelines developed by the NWCC, outline standard metrics and measures of statistically rigorous survey designs for diurnal avian impact studies that result in comparable and defensible data (Anderson et al. 1999). A second guidance document (Kunz et al. 2007), similarly addresses metrics and measures used

for assessing impacts to nocturnally active birds and bats. These documents have been widely used to plan wind energy projects and research studies throughout the U.S. (e.g. Johnson et al. 2000a & b, Kerlinger et al. 2006, Smallwood and Thelander 2004) and to develop individual state guidance documents (e.g. California, Pennsylvania, and Washington). Although techniques and methods continue to improve, these guidelines a foundation with which to create site specific survey designs for planned wind energy facilities. Concepts and principles outlined within these documents should be reviewed and incorporated into site specific study designs.

Standardized survey methods and protocols are described below for surveying and monitoring birds and bats. Site specific information will dictate survey details and appropriate methodology. Site specific protocols will depend upon the issues and concerns identified during the preliminary site evaluation, project location, land ownership, and budget and time limitations.

BIRD SURVEYS

Although fatalities of several species of birds have been reported at wind energy facilities, the number and frequency of raptors killed by wind turbines have raised the greatest concern. Most of these fatalities have occurred at older wind facilities (most notably Altamont Pass, California) involving turbines ranging from 40 kw to 300 kw with lattice support structures and above-ground transmission lines that provide ideal perch sites for raptors. Modern facilities that use larger turbines (600 kw to 3.0 MW) and underground transmission lines, report fatality rates that are significantly lower than those of older facilities (Anderson et al. 2004, 2005, Erickson et al. 2000, 2004, Young et al. 2003, 2005, Johnson et al. 2002, Howe et al. 2002, Jain 2005, Nicholson 2003, Kerns and Kerlinger 2004). Fatality rates for passerines indicate that although 80% of avian fatalities are comprised of passerines, impacts to overall populations are not as critical as those reported for raptors (Osborn et al. 2000, Erickson et al. 2001, Strickland et al. 2001). Patterns of mortality for these species have not been found, however fatality rates reported at western wind energy facilities (California, Oregon, Washington, Wyoming) are lower than those from eastern sites (Erickson et al. 2000, 2003, 2004, Johnson et al. 2003, Young et al. 2002, 2005, Nicholson 2003, Kerns and Kerlinger 2004).

Specific objectives of the following bird survey methods and protocols are to, (1) identify species using the project area during the winter, spring, summer and fall seasons; (2) quantitatively and qualitatively describe the temporal and spatial use within the project area; (3) identify areas of high use or habitat features that may support or attract species of concern; and (4) assess potential impacts related to migrant, winter, and breeding bird use of the site.

Point Count Surveys

Point count surveys are one of the most widely used and efficient methods for monitoring changes in populations, species composition and relative abundance for landbirds. Point count data are used by most government wildlife agencies to track long-term trends and provide a nationally standardized method that is widely accepted as a reliable and comparable technique. Two types of point counts are recommended for surveying and monitoring birds at wind energy development sites. Bird use counts are used to estimate the spatial and temporal use of the site and are most often used to survey for raptors and other large birds. Breeding songbird counts

focus efforts at a smaller scale and are used to determine displacement of breeding passerines due to disturbance and habitat changes from development and activity at the proposed site.

Developing a statistically rigorous survey design for both types of counts poses challenges and considerations that should be addressed by an experienced biologist familiar with the survey methods and protocols. Regardless of site and project limitations survey designs should incorporate some level of randomization (Krebs 1989), replication of the sample unit (i.e. count location, wind turbine, or string of turbines), and control or reference plots (Green 1979, Hurlbert 1984, Stewart-Oaten 1986, Skalski and Robson 1992). Including these basic design principals will reduce bias and avoid error in variance and pseudoreplication. A more in-depth discussion and alternative design options that use various sampling plans and degrees of randomization and replication are described by Anderson et al. (1999). This document should be consulted, and measure and metrics included into the final bird point count survey design to ensure that results will be scientifically credible and defensible.

Changes in bird and bat populations and activity levels at the proposed site may not always be attributed to the wind development. Annual variations and naturally occurring environmental factors such as climate change or stochastic weather events may cause increases or decreases in bird and bat populations. For example, to make accurate inferences about changes in avian and bat use of the area and assess impacts associated with the wind energy facility, "control" or reference plots should be included in surveys whenever possible. A Before-After/Control-Impact (BACI) or paired-plot design is recommended (Anderson et al. 1999, Kunz et al. 2007). Since true "control" plots, those identical to wind development plots or "treatment" plots, are often difficult or impossible to find, reference plots are commonly used. Reference plots should be survey points located in similar habitat in which no wind energy development will occur and serve as a baseline or indices for changes over time that may occur in bird and bat populations. Reference plots are surveyed in conjunction with "treatment" plots during pre-construction activities and again during post-construction. Comparisons in bird abundance, activity patterns, and habitat variables can then be made to determine if the changes can be attributed to development and operation of the wind facility or are natural occurrences (Green 1979, Stewart-Oaten 1986, Anderson et al. 1999). For small project areas where the establishment of reference plots is not possible, plots can be established within the perimeter of the project area and an impact-gradient design can be used. In these instances reference plots should be located at a minimum of 250 m from the nearest "treatment" plots and placed within similar habitat. Impact gradient designs provide similar comparisons as the BACI design, yet impact responses are expressed as a function of distance from the "treatment" plot (Anderson et al. 1999, Strickland et al. 2002

Once a general study design is selected, point count survey and reference plot points are selected and plotted on a map of the project area. The number of point count locations will be dependent upon the proposed turbine layout (number and spacing), survey objectives, accessibility and terrain, and project cost and time constraints. When possible, points should be located at proposed turbine or turbine string locations. For large projects in which time does not permit each turbine or string of turbines to be sampled, a random sample or systematic sample design with a randomized start point can be used to reduce potential sampling bias. If turbine locations are unknown, non-overlapping points can be selected randomly or systematically. Once points

have been mapped, a field visit will ensure that each location is accessible and provides good visibility for 360^{o} around the point. All points should be permanently marked to minimize error in locating the points during subsequent surveys

Bird Use Counts

Bird use counts are widely used to estimate spatial and temporal use by all birds, yet generally focus on large birds such as raptors. Bird use counts are fixed observational points or variable circular plots in which all birds seen or heard are recorded during a fixed time period to determine density estimates and use. Methods for conducting counts are described by Reynolds et al. (1980) and Bibby et al. (1992). Distances between observational points is dependent upon the distance at which each species can be detected with a given habitat type. Bird use counts are used to detect both small and large birds including large raptors; therefore detection distances and point radiuses may be as great as 1 km.

Survey periods at each point are 20 min in duration. Surveyors record the date, start and end time of the observation period, weather information such as temperature, wind speed, wind direction, and cloud cover, and the species, number of individuals, and sex and age class (if possible) for each bird observed. The behavior of each raptor and other birds observed and the habitat in which the bird occurred are recorded. Behavior categories often include perched, soaring, flapping, flushed, hunting, gliding, and other (noted in comments). The initial behavior and habitat (when first observed) is uniquely identified on the data sheet and subsequent behaviors and habitats (if any) recorded. The flight direction of observed birds is mapped. The distance from the point using a laser rangefinder or other reliable method, an approximate flight height at first observation and the approximate lowest and highest flight heights are recorded to the nearest meter or 5-meter interval. Comments or unusual observations should be noted in the comments section

Bird use counts are conducted once every 14-day period, during winter and summer months. During fall and spring migratory periods when frequency of raptor passage over the site is at its peak and highly variable, survey intervals are conducted at least once every 7-day period (HWI 2004). More frequent intervals (at least twice weekly) may be necessary during fall or spring if the site is known or suspected to be located within a migratory corridor or pathway.

Each survey point is visited at least once throughout all daylight hours. To the extent practicable, points should be surveyed about the same number of times each period of the day during each season (morning, 0600-1000; mid-day, 1000-1400; afternoon, 1400-1800). This can generally be achieved by alternating morning and afternoon visits. Schedules should be flexible in response to adverse weather conditions (e.g., rain/snow), and changes in daylight period

Breeding Songbird Counts

To characterize passerine communities and determine if displacement effects are occurring, breeding songbird counts are recommended. Displacement effects can be caused by indirect loss of habitat if birds avoid the area due to the development of the facility.

Because passerines are difficult to detect at great distances, breeding songbird surveys can be centered at the same fixed observational points as the Bird Use Count; however detection

distances are limited to 100 m in radius. Observations of birds beyond the 100 m radius are recorded, but analyzed separately from data within the plot. Counts at point are conducted using methods described by Reynolds et al. (1980) and Bibby et al. (1992). Upon initial approach of each point, observers wait 1 minute before beginning counts to allow birds to settle. After the initial settling period, all individual birds seen or heard within a 10-min period are recorded; subdividing counts into 3 periods: 0-4 min, 4-7 min and 7-10 min. A horizontal distance to each bird is measured to the nearest meter using a laser rangefinder. For many surveys, the majority of birds are heard but not seen, in which case distances are measured to a tree, bush or other object where the bird is located. Flyover species are recorded, but estimates of distance are not necessary. Additional notes include: (1) whether the detection was aural, visual or both; (2) whether detections were songs or calls, and (3) whether the bird was detected at a previous point count station (to avoid double-counting individuals).

Breeding songbird counts should be completed during the breeding season (15 May – 30 June). All points are surveyed at three times during this time period (once every 14-day period). During a survey day, each point should be visited once and start no earlier than 15 min before sunrise and no later than one-half hour after sunrise and finish no later than 1000 hrs. Bird activity levels and song rates tend to decrease as temperatures increase; therefore end times will vary depending upon site specific temperatures and seasonality.

Point Count Data Analysis

For bird use count surveys, all data are to be standardized and calculated from observations recorded within 800 m of the survey point. Relative abundance or use is separated by species, species group, season, and point and calculated as the mean number of observations per 20-minute survey. Frequency of occurrence, species richness and composition will provide additional information about relative bird diversity and use of the project area. The frequency of occurrence by species is calculated as the percent of surveys in which a particular species is observed. Distance data is used to standardizes data by area and effort and when sample size are sufficient it can provide an estimated probability of detection for each species or group of species to correct for errors due to observer and visibility bias (Buckland et al. 1993). Species composition is represented by the mean use for a species divided by the total use for all species and multiplied by 100 to provide percent composition. Other measures to estimate potential risk include flight heights used to calculate collision exposure indices. Exposure indices for each species are expressed as the proportion of birds observed flying within the area occupied by the turbine rotors-swept area (zone of risk). If wind turbine tower heights and rotor diameters are not known an estimated range is used (~25 – 125 m above the ground). Comparison with bird point count data from previously conducted surveys may also be useful.

For breeding songbird counts similar calculations as described above are reported; however, they are standardized for an area within 250 m of the point. Avian use is to be calculated as the mean number of observations recorded within each 10-min survey period. Calculations from reference points are summarized separately from that of the wind facility points to enable comparisons during post-construction monitoring to identify possible displacement effects caused by the wind facility. By definition, reference points must be located within like habitat, and bird use should be similar to that of the wind facility points. A paired t-test is used to determine baseline differences that may exist between treatment and "control" or reference

points. For commonly detected species (>100 detections) estimates of population density are to be calculated using distance sampling methods.

Area Searches

Area searches are thorough searches designed to collect information such as habitat use, breeding activities, migration pathways, and unusual or unique behavior or observations within the project area not identified during point counts. These surveys are also useful in assessing areas within and near the project area such as small riparian zones, wetland areas, and side canyons that may not normally be included in the above count locations. Area searches provide a more complete species list for the proposed project area, as rare and more secretive bird species may also be missed during bird use and breeding songbird counts. Besides collecting bird data, an evaluation of small mammal species presence, activity levels, and suitable habitat should be conducted and recorded. This will provide a better understanding of the sites potential prey abundances that may attract and concentrate raptors into the area. For example, high densities of small mammal burrows or prairie dog colonies that may not have been recorded during bird counts may be observed during area searches.

Duration and size of the search area is standardized to enable comparison of species richness and abundance within the project area and between sites within similar habitat. All birds seen or heard, unusual or unique observations (e.g., large flocks), species of concern, or nest locations are recorded during area searches and plotted on field maps with unique observation numbers. Data similar to bird use counts are recorded for each observation. General wildlife observations that may provide information about potential prey species are recorded during this time period as well as during all other survey activities.

Raptor Nest Searches

The objective of raptor nest surveys is to locate raptor nests within the project area a specified surrounding area so that nests can be monitored for productivity and future use. Results will confirm the presence of nesting raptors, assist in determining the extent of potential impacts such as collision, disturbance, and displacement and provide information for micro-siting turbines, and establishing buffers around nesting territories.

Based on information gathered during consultations with local wildlife agencies and biologists and observations during bird surveys, areas with reported and potential raptor nests are investigated on foot during spring (late March to early May). If the terrain does not allow for adequate coverage of the proposed site, aerial nest searches may be necessary and are often a more effective method. Aerial searches should be conducted by experienced biologists and caution should be taken not to disturb the nest by flying too close. Depending on the size of the home ranges and breeding territories of each target species, raptor nest searches should be conducted throughout the proposed site as well as within a search radius from turbine locations of 0.5 miles for smaller raptor species such as American kestrels to 3 mile for larger species such as golden eagles. Distances may vary depending on local populations and species. For species of concern, consult the appropriate federal, state and tribal personnel.

Upon locating a nest, coordinates (UTMs) are recorded using a hand-held global positioning unit (GPS) for mapping and future monitoring. Sites with evidence of nesting should be visited at

least three times to confirm activity. When an active nest is located, a follow-up survey must be conducted in late May or early June to gather data on nest success and productivity. Locations of any inactive nests are recorded as they may be occupied during future years. All nests, whether active or inactive, are to be given a unique identification number and mapped.

Crepuscular and Nocturnal Breeding Bird Surveys

Crepuscular species (i.e. Caprimulgids, common poor-wills and lesser nighthawks) and nocturnal breeding birds such as owls are not generally detected during daytime point counts and require additional surveys to characterize their use of an area. Crepuscular birds tend to be vocal enough to detect without the use of playback recordings; however owls are more effectively surveyed using tape broadcasts or human vocalization of the owl species songs and calls (Springer 1978, Forsman 1983). At each of the breeding bird count locations, counts should be conducted in all suitable habitats or where historical sightings have been previously noted. Tape broadcasts or vocalizations for targeted species are played for 15 minutes at each designated point. Survey data includes species encountered, habitat, location, dates, and evidence of breeding status (i.e., courtship behavior, nests). All other nocturnal and crepuscular species are also noted. Crepuscular and nocturnal species surveys are conducted year round; at least two surveys must be completed during the breeding season and two during the non-breeding season. Survey times should occur between 1 hour after sunset and 1 hour before sunrise. Project areas that are within known Mexican spotted owl habitat may be required by USFWS to conduct focused surveys that meet protocols outlined for this federally listed threatened species.

Nocturnal Migratory Bird Surveys

Most passerines migrate during the night at high altitudes along migratory pathways and make land fall at dawn to rest and refuel at suitable stopover sights. In the arid Southwest, few studies have been conducted on migratory passerines, although it has been generally assumed that migrating birds concentrate within riparian corridors that provide high quality stopover habitat to rest and refuel (Johnson et al. 1977, Skagen et al. 1998, Kelly and Hutto 2005, Paxton et al. 2007). Use of upland habitat and xeroriparian washes has also been documented, although relative abundances are considerably lower than that of riparian corridors (Kelly and Hutto 2005, Lynn et al. 2006). Their reactions to ridgelines and mountains are less understood. Although European research suggests that migratory birds respond to changes in topography such as mountain ridgelines (Bruderer 1978, Bruderer and Jenni 1988), radar studies conducted at a proposed wind facility in West Virginia report that 90.5% of birds did not alter their flight direction while crossing the ridgeline (Mabee et al. 2006). Use of radar to track nocturnal bird migration has found that, although mean flight altitudes vary, most (~85%) fly at altitudes over 125m; greater than that of the typical turbine blade (Young et al. 2004, Mabee and Cooper 2001, 2002, Cooper et al. 2004a). Inclement weather (i.e. strong winds, fog) may force birds to fly at lower altitudes, exposing them to greater risk of collision (Estep 1989, Johnson et al. 2002). Researchers are just beginning to develop methods that will provide a better understanding of how environmental factors and site characteristics such as wind speed and direction, temperature, and topography affect bird migration decisions about flight speed, height, timing, and direction which ultimately determine a species susceptibility to impacts from wind facilities.

In the Southwest, suitable stopover habitat and known flyways are found within riparian corridors. With less than 1% of the landscape covered in riparian habitat (Knopf et al. 1988), river corridors attract high concentrations of bird and bat species and result in areas of high risk

and impact zones that are not particularly suitable for wind development. Within the southern Colorado Plateau there are no known major migratory pathways that occur beyond these riparian zones, however studies have not thoroughly investigated these upland areas. Therefore, biologists familiar with bird migration should assess the potential of the site as a stopover location or migration corridor. Nocturnal bird surveys may be necessary if the proposed sites are located with known or potential migration corridors and provide suitable stopover habitat.

Methods of nocturnal monitoring for birds include the use of visual methods such as moon watching, ceilometry or night-vision, thermal infrared imaging, acoustic monitoring, or by the use of weather surveillance, tracking or marine radar systems. Each method has its advantages and disadvantages and decision on which methods to use will depend upon the site characteristics, survey objectives, and project budget limitations. Information gathered using these methods includes passage rates and timing, flight altitudes and trajectories. Species identification is not generally possible with most methods and it is often difficult to distinguish birds from bats or flying insects. If nocturnal surveys are warranted at the proposed site, detailed methods and metrics for each are described in Kunz et al. (2008).

BAT SURVEYS

Bats are long-lived (some are known to live 30 years), reproduce at slow rates (as low as 1 young per year) and can move long distances during spring and fall (e.g., hoary bat), making them particularly susceptible to population declines. High bat fatalities at some eastern wind energy facilities (up to 4,000 annual deaths at one facility in West Virginia in 2004) have brought more recent attention to the potential negative impacts to these species posed by wind farms (Kerns and Kerlinger 2004, Arnett et al. 2005). The southwestern United States is rich with bat diversity and the presence of tropical and temperate bat families. Twenty-eight species representing four families have been identified in the region including several species not found at eastern wind energy facilities where the majority of the studies have been conducted. Although the majority of the fatalities at eastern wind farms have been recorded during peak migratory periods (July to Sept), the daily and seasonal activities and migration routes are poorly known for species on the southern Colorado Plateau. Daily elevational movements for some species such as the spotted bat (up to 100 miles or more; C. Chambers, NAU, pers. comm.), have been documented in some areas on the Plateau, however due to the difficultly, cost, and logistics associated within tracking bats through remote canyon terrain, little information is available for most species.

Correlations between pre-construction bat surveys and post-construction fatality rates have also been problematic when predicting impacts from wind farms. As of yet direct correlations have not been identify, and although pre-construction surveys may not be good predictors of the rate (high or low) of fatalities post-construction, they can identify the presence of sensitive species, migratory pathways, or high density roost sites within the project area. Several research projects are working towards developing predictive models that will correlate pre-construction survey results with post-construction mortality (Arnett pers comm.). Until then, collecting quality data using standardized methods during pre-construction can provide comparative results and important baseline information. Due to this lack of knowledge and poor understanding of impacts to bats at wind facilities, developers are encouraged to work closely with agency

biologists to discuss these risks and to decide if mitigation measures are necessary. Developers are also encouraged to participate in research efforts to improve this understanding by making sites and data available to researchers.

To evaluate bat use and movement patterns at proposed wind developments sites, monitoring surveys are designed to (1) assess species composition and relative abundance of bats within the project area; (2) gather data on bats detected in the project area during migration, general timing of probable migration, and relative abundance of bat species during this period; (3) identify patterns of species occurrence, and important habitat features and use such as significant winter roosts (hibernacula) or maternity roosts in the area.

Several methods should be used to identify bats and assess activity levels and use patterns. Acoustic monitoring is the most cost effective and common method. Used in conjunction with mist-net captures is more effective in determining species richness (Flaquer et al. 2007). Since multiple survey methods are more likely to detect bat species, and some bats are easier to detect with one method rather than another, it is recommended to use the following methods in combination to adequately identify bats and levels of activity at proposed sites (Barclay 1999, O'Farrell and Gannon 1999).

The duration of surveys, level of effort and location for each method of survey and monitoring will be dependent upon information gathered during the preliminary site evaluation and by the location and number of the proposed wind turbines. In the absence of existing data, continuous acoustic monitoring during times when bats are active on the Plateau (mid-March through October) is warranted. All survey designs and monitoring should be conducted by trained biologists experienced in bat survey methods and familiar with bat species found within the southern Colorado Plateau. Consultation with federal, state, or tribal biologists is recommended to ensure that the study design is adequate to address area concerns. Detailed discussion on monitoring bat species can be found in Kunz et al. (2008).

Acoustic Monitoring

Echolocation is used regularly by bats to navigate and forage for prey during flight. This acoustic information can be detected by specialized equipment (e.g. ANABAT detectors) that provides practical and effective method to determine relative abundance, baseline patterns in seasonal and daily bat activity levels, and the timing and occurrence of short-term increases in activity such as migration. Acoustic detectors convert ultrasonic vocalizations of bats to time / frequency signals, which are displayed and stored on a laptop computer. Detection systems are designed specifically for recording calls of microchiropteran (insectivorous) bats by the pulse rate and time pattern of the dominant frequency of their calls (Hayes and Hounihan 1994, Fenton 1988). Most of the bats that are known or are likely to occur within the southern Colorado Plateau (with the exception of some of the Myotis spp.) produce feeding calls that can be recorded on acoustic detection systems. Two methods are described below; passive acoustic monitoring and active acoustic monitoring.

Passive Acoustic Monitoring

Passive acoustic monitoring involves placement of multiple acoustic detection stations located throughout the wind energy development site to sample bat activity. Ideally, passive acoustic

monitoring at locations where wind turbines will be placed, however project limitations often restrict full coverage of the project area and exact locations of turbines are not always known during the early phases of the project (Kunz et al. 2007). Regardless, survey data is collected at heights most similar to that of the rotor swept area of the proposed wind turbines and anemometer towers provide a cost effective method for mounting detection equipment at these heights. At each monitoring station, a minimum of two bat detector systems, mounted at the top (~30-60 m upon the tower height) and bottom (~5-7 m) of the tower are recommended (Arnett pers. comm.). If existing towers are unavailable portable towers may be used and detectors mounted at a minimum of 30 m above the ground (Lausen et al. 2006, Kunz et al. 2007). Bat detection equipment can be installed in conjunction with solar panels to enable continuous data recording for approximately two weeks before storage cards must be downloaded, reducing the need for field visits. Housed in a weather-protective shelter, units are to be set out to record for a series of nights, and then retrieved. Detection equipment can be mounted to the towers during the installation process to reduce costs and enable technicians to encase equipment cables within the housing of the tower to provide further protection of the equipment from the elements. Detectors are to be programmed to collect echolocation calls one-half hour after sunset until sunrise. Additional environmental data to be collected in conjunction with monitoring includes temperature, precipitation, and wind speed. More detailed information and guidelines for the use and operation of bat detectors can be found in Reynolds (2006), Lausen (2006), and Rainey et al. (2006).

Active Acoustic Monitoring

Supplemental to passive monitoring, on-the-ground active monitoring can enables surveyors to determine relative activity within areas outside the range of the passive monitoring by recording bat activity during opportunistic driving surveys and during all mist-netting activities. Detection equipment can record echolation calls from a slowly moving vehicle along access roads and during mist net capture activities. All recordings are associated with information on time, location, and species identification and behavior. Frequency and duration of surveys may vary and be conducted as needed to accurately determine species use of the development site in areas not well surveyed by passive monitoring. During driving surveys, surveyors drive at speeds of 10-15 km/hr, while scanning the sky with a hand-held acoustic detection device. When one or more bats are located, the vehicle is to be stopped, a GPS location recorded, and the bat(s) are to be tracked long enough to record a good-quality, identifiable call sequence. During mist-net activities some bats present may not be captured. These individuals can often be detected by active surveys using a hand held detector either by an additional surveyor dedicated to active acoustic monitoring or between net checks.

Acoustic Monitoring Data Analysis

A subset of all echolocation call data from passive monitoring and all data from active monitoring are sampled and visually inspected by a trained and experienced bat biologist. Since migratory bats have been reported to be at most risk from wind facilities and their patterns of migration are poorly understood; a more robust sample size of call data should be selected from this time period (August 16– October 31). Because of the difficulty in identifying calls by species, calls are sorted by frequency group. Commonly used frequency groups include 50 k (>50 kHz calls), 40 k (50 – 40 kHz calls), 25 k (35 – 20 kHz calls), and 20 k (<20 kHz calls). Calls are categorized into 2 types: passes and feeding buzzes. Passes indicate the presence of a

bat. Feeding buzzes indicate active pursuit and possible capture of prey by a bat. To compare activity over time, calls are also sorted by hour to identify use patterns and times of peak activity.

Mist Net Capture

Mist net capture is the method most commonly used in conjunction with acoustic monitoring to positively identify species presence (Kunz and Kurta 1988). On the southern Colorado Plateau, two bat species of concern, Townsend's big-eared bat and spotted bat echolocate at frequencies that are not often detected by acoustic equipment. Mist-net capture also can provide information on the age, sex, and reproductive status of species active within the project site. Bats are often limited by water in the Southwest and commonly visit ponds and other water sources to drink, therefore mist nets placed over water are most effective. Mist netting activities are conducted at select water sources found throughout the project area when water levels and weather conditions allow. Locations should be netted each month of bat activity and during or just after the new moon when bats are less visible to predators and forage more actively. Nets are opened at dusk (~2000 hr) and closed at dawn (~0430 hr). The configuration at which nets are placed can influence capture rates and in forested areas nets can be raised to capture high flying species (See Kunz et al. 1996 for details on net placement and sampling designs). Just as some bat species cannot be easily detected by acoustic monitoring, not all bat species are easily captured with mist nets. Several species are adept at avoiding nets and are able to maneuver around them. Juveniles may be more susceptible to capture than adults, thus biasing population demographics.

All capturing and handling of bats must conform to the guidelines established by the American Society of Mammalogists (1998). Bats are known carriers of rabies. Therefore only experienced personnel that have been vaccinated for rabies or have the proper levels of the vaccine in their system at the time of the survey are authorized to handle bats.

For each bat captured, records include species, sex, reproductive condition, and age. Bats are examined in hand to determine age (juvenile, sub adult, adult) and reproductive status (pregnant, lactating, post-lactating, non-reproductive). Males are considered scrotal if the testes are partly descended. The abdomens of females are palpated for evidence of pregnancy (fetus), and mammary glands checked for evidence of lactation. Other measurements including mass and length of the forearm, thumb, ear, and tragus are recorded to aid in identification of species.

Bat Roost Surveys

Little information exists about roost sites of most species of bats found on the southern Colorado Plateau. Roost sites provide information on species composition, abundance, and activity patterns for bats detected at the site. If bat activity at the project area is high, bat roost surveys may be beneficial in identifying species that are difficult to detect using other methods. When efforts to locate roost sites are warranted, surveyors carefully search caves, crevices in low cliffs, outbuildings, cisterns, and other potential roost sites. Roost searches should be conducted cautiously to reduce disturbance to bats and known maternity roosts should be avoided. During searches, sites are examined for both roosting bats and for other evidence of bat use, such as guano or prey remains. If sites used by bats are located but the species of bat is not identifiable, surveyors should return with acoustic detection equipment or nets to obtain a positive identification. Passive acoustic monitoring can also be set up at locations thought to be possible roost sites to record any activity and numbers at the potential roost sites at different times of the

year. Additional information and further detail on protocols for roost site searches and exit counts is outlined by Pierson et al. (1999), Kunz et al. (1996), Rainey (1995).

Radio Telemetry

For locations in which maternity roosts and highly populated hibernacula (winter roosts) are suspected to concentrate bats within the project area, radio telemetry may be used to identify the locations and bat movement patterns to and from roost sites. Telemetry is not always a viable method for monitoring all species and radio telemetry can be time consuming and costly. For small bat species a ratio of weight of the bat relative to the transmitter >5% impedes flight. Pregnant females and juveniles are also not suited to bare transmitters. Other species are either adept at removing transmitters or their behavior is not compatible with keeping transmitters in place (e.g. species that roost in rock crevices). For sensitive species, consult federal and state agency biologists to determine if the information gained through radio telemetry outweighs any risks that a transmitter may pose to the individual, such as reduced flight performance (Aldridge and Brigham 1988). For species in which radio transmitters can be applied, telemetry can be one of the only methods of identifying roost locations at proposed sites where potential roosts such as caves and rock crevices are abundant. Details on the use of radio transmitters and methods and techniques for collecting telemetry data can be found in White and Garrott (1990) and Millspaugh and Marzluff (2001).

CHAPTER 5: POST-CONSTRUCTION MONITORING

The objectives of post-construction monitoring at wind energy facilities are to; 1) quantify the direct and indirect impacts to birds and bats caused by the wind facility, 2) determine if pre-construction survey estimates of impacts were accurate; 3) document any unforeseen impacts that may not have been identified during pre-construction surveys; 4) assess whether additional mitigation measures are necessary to further reduce direct and indirect impacts to birds and bats; and 5) comply with potential permit requirements such as documentation of endangered species and or migratory bird incidental take. Data obtained from post-construction monitoring will assist biologists to better understand regional bird and bat populations, the connections between pre- and post-construction surveys, and the effect that mitigation measures have on those populations. If standardized methods and protocols are used and the data are comparable between wind energy sites, monitoring data may also provide predictors of cumulative impacts to birds and bats throughout the southern Colorado Plateau.

Protocols and surveys should be consistent with those conducted during the pre-construction surveys to compare changes in species abundance, composition, and movement patterns. The level of effort including the extent, duration, and seasonality of the monitoring and fatality surveys should be based upon the level of activities for birds and bats within the project area and the assessed level of risk as determined by results from the pre-construction surveys. This information will be used in conjunction with fatality surveys to discuss mitigation or changes in operation if necessary. Modifications to the original protocols, duration of the monitoring period, or additional mitigation may be required in cases where impacts to birds and bats are higher than anticipated. Additional post-construction monitoring methods beyond those conducted during pre-construction surveys (e.g., acoustic/RADAR surveys) may be required in some cases where high fatality rates and displacement effects are predicted or apparent within the first year of post-monitoring. Continuous evaluation of monitoring data can therefore help in developing cost-effective low impact post-monitoring plans. Consult applicable agency biologists to determine an appropriate duration and intensity of the post-construction and operations surveys.

Changes in habitat and site conditions, shifts in movement patterns and behavior, and heightened concerns for cumulative impacts to species of concern are factors that may influence post-monitoring surveys and warrant additional long-term monitoring at some wind facilities. Therefore post-construction monitoring over multiple and potentially non-consecutive years is recommended. First year post-construction results may be very different from subsequent years post-construction results as disturbed habitats recover over time. Additional long-term monitoring beyond the required duration and access to the project site by outside researchers is encouraged and information gathered over the life of the project will assist biologists in developing more effective methods of predicting impacts at wind facilities.

Two types of information are necessary to assess post-construction impacts to birds and bats at wind energy facilities; relative abundance and use, and the number of birds and bats killed or injured. These data provide a measure of fatalities that are caused by the wind energy development site.

ABUNDANCE AND USE SURVEYS

Although actual fatalities may be low at the site, habitat changes and increased disturbance to the site may have indirect effects on populations such as decreases in prey availability, perches, nesting and roosting locations, and overall reproductive success. To evaluate changes in bird and bat abundance and site use, surveys conducted during pre-construction of the wind energy facility, including those on reference plots, are repeated during post-construction monitoring. If raptor nests and bat roosts were identified within the study area, monitoring should continue at these sites. Similarly if the site has been identified as a migratory corridor, nocturnal monitoring should continue during post-construction and operations phases of the project. In most cases acoustic monitoring for bats should be continued to provide context to fatality data and useful if changes in operations are necessary to mitigate unanticipated impacts. Similar standardized methods, metrics, and protocols are used for all surveys so that data from post-construction surveys is comparable with baseline information gathered during pre-construction surveys.

FATALITY SURVEYS

Fatality surveys for birds and bats at wind turbines provide a quantitative measure of the direct impacts caused by the development of the wind facility. Standardized metrics and measures for reporting and analyzing results are available (Kern et al 2005, Kunz et al. 2008); however no direct recommended guidelines for standard study designs and search protocols are outlined. The following provides standardized methods and protocols for conducting fatality surveys at wind facilities on the southern Colorado Plateau.

Carcass Searches

Carcass searches for birds and bats should be conducted using the following standard search methods. A systematic sampling design in which most or all turbines are sub-sampled over the course of each season will capture variations among turbine sites and reduce bias (Hulbert 1984). Survey design and sampling schemes should be developed by an experienced biologist and search frequency re-evaluated throughout the survey period to adjust for changes in carcass removal rates. Consultation with agency biologists throughout the process will make certain that the design meets the desired precision for mortality estimates.

For each wind turbine selected to survey, a standard sized rectangular plot is centered on the turbine. Plot size should equal the distance from the tip height of the blade to the ground in width. Some areas within the plot may not be searchable due to limitations from the topography and other habitat features, however the majority (>80%) of bat fatalities during past studies were found within one-half the distance of the standardized plot width. Thus, limitations should not greatly influence estimates if plots are at least searched 40 m from the turbine (Kerns et al. 2005, Erickson et al. 2003, Johnson et al. 2003, Young et al. 2003). In sloped terrain, searchable areas should be extended on the downhill side to account for carcasses that may have fallen outside the initial plot.

Transects, 10 meters in width, are placed 20 meters apart over the search area at each turbine. Searches are conducted during daylight hours. Experienced and trained searchers walk each transect line at a steady pace searching either side of the line for bird and bat carcasses. Search

speed will vary depending upon terrain therefore start and stop times for each transect are recorded. On average, search rates are approximately 20-30 meters/minute requiring anywhere from 0.5 to1.5 hours per turbine. In cases where obstacles impede searchers, it is recommended to continue along the safest possible route. Searchers should return after the plot is completed for a more careful inspection of these areas (Kerns et al. 2005). Subsequently, the time required to search the selected turbines will vary and the personnel will need to be adjusted accordingly so that all selected turbines can be searched within one day.

Frequency intervals between searches will vary (from 1 to 7 days) as estimates of mortality can be highly influenced scavenger removal rates and periodicity of fatalities due to migration events, bad weather or other factors (Arnett et al. 2005). Therefore frequency is determined based upon carcass removal trails (described below) and areas or time periods of particular concerns (e.g., mortality during migration periods). When more frequent intervals are needed, a sub-sample of turbine locations can be searched for 4 consecutive days each week during the survey period or period of focus (e.g. fall and spring migratory periods; Kerns et al. 2005).

For each survey plot searchers recorded the unique site identification name or number, date, start and stop time, observer name, wind direction, and the operation status of the turbine blades (operational, stopped, or removed). Searchers record and collect all bird and bat carcasses encountered within each survey plot. Collection and use permits are required for all bird and bat species and must be obtained through federal and state wildlife agencies. Under agreement of these agencies, collected carcasses may be used in subsequent carcass removal trials and searcher efficiency trails described below. Not all carcasses encountered may be a result of the wind turbine. Each carcass should be carefully examined and its location in relation to other potential sources of danger such as transmission lines, guyed wires, fence lines and roads should be noted so that a probable cause of death may be determined. In most cases structures found within the search area are associated with the wind energy development site and fatalities associated with these structures should be considered during analysis. If a substantial number of fatalities are suspected to be caused by factors other than the wind development, carcass searches can be conducted at reference sites outside the project area to quantify naturally occurring fatality rates. Injured birds or bats should be taken to the nearest rehabilitation center and considered a fatality for analysis purposes.

Each carcass encountered receives a unique identification number and searchers record the date, survey plot, GPS location, perpendicular distance from the transect line and distance and azimuth to the turbine, species, sex and age when possible, time of detection, condition of the carcass, habitat in which carcass was found, probable cause of death, probable scavenger if warranted, and estimated time of death in days. Suggested carcass condition categories are defined as intact, scavenged, or feather spot (Table 1). Searchers should use protective rubber gloves when handling carcasses. For carcasses that will be stored and used during removal trials place carcasses in a sealed plastic bag to reduce human scent biases. Carcasses can either be used within 24 hours for removal trails or frozen for future use. Carcass removal for all federal and state threatened and endangered species is to be coordinated with the appropriate agency personnel.

All carcasses not encountered during formal searches are considered incidental fatalities and are not included in fatality estimates. Wind energy facility personnel should be instructed not to move or disturb any bird or bat carcass encountered on site, but to notify the lead biologist of the time and location where it was found. If the carcass is found within a survey plot, it should be recorded but not removed unless detected during formal surveys of the site. If the carcass is not discovered during the next scheduled survey, information from the initial encounter is recorded as an incidental fatality.

Table 1. Carcass condition categories as suggested by Anderson et al. (1999).

Intact	A carcass that is not badly decomposed and shows no sign of having been fed upon by a predator or scavenger, although it may show signs of traumatic injury such as amputation from a turbine collision
Scavenged	An entire carcass that shows signs of having been fed upon by a predator or scavenger or a partial carcass that has been scavenged, with portions of it (for example, wings, skeletal remains, legs , pieces of skin) found in more than one location
Feather / fur spot	10 or more feathers or pieces of fur from a bat at one location, indicating predation or scavenging

Carcass Removal Trials

Rates at which scavengers (birds, mammals, and insects) remove or damage bird and bat carcasses from the base of wind turbine locations vary widely between sites and rates from one location can not be assumed correct for another (Arnett et al. 2008, Kerns et al. 2005). Habitat type, geographic location, bird and bat species composition, weather, temporal patterns between years, and scavengers present and their behavioural changes over time all may influence removal rates. The objectives of carcass removal trails are to determine the site specific rates of removal in order to more accurately estimate fatality. The rate of carcass removal by scavengers is also used in developing carcass search frequency intervals as described above.

During removal trials, carcasses are randomly placed at randomly selected turbine locations. Trails are conducted throughout each season to include periods of various weather conditions and habitat types (visibility categories) to account for naturally occurring temporal and spatial variations. Use fresh bird and bat carcasses of various sizes and species whenever possible. Studies show that fresh bat carcasses are removed faster than either frozen bat or bird carcasses and most accurately reflect realistic removal rates (Kerns et al. 2005). When fresh carcasses are not available and frozen carcasses must be used, rates may be underestimated and should be corrected to account for this potential bias. The number of carcasses used during trials should be sufficient to calculate recovery rates, however too many carcasses will satiate scavengers and reduce accuracy. Carcasses are marked for individual identification to ensure that they are identified if found during trail periods or formal searches.

At the start of each trail period, record the date and time of placement, species, unique site identification name or number, distance and direction to the turbine, GPS coordinates, habitat surrounding the carcass, and type of carcass used (fresh, frozen, thawed). Carcasses are checked daily until removed or until the end of the trail period. During each visit, observers should record the date and time of the visit, presence or absence of the carcass, condition of the carcass

or degree in which it is scavenged (intact, partially scavenged, heavily scavenged), a description of the scavenging, and probable scavenger. Other additional observations such as signs of scavengers in the area, tracks, scat, or site characteristics are also recorded. Carcasses that are severely decayed and desiccated may no longer be appealing to scavengers (Smallwood 2006) and should be removed and recorded as such.

Searcher Efficiency Trials

Searcher efficiency can be highly variable and estimates of bird and bat mortality can be influenced by 1) observer training, 2) vegetation type, 3) the size of the bird or bat, and 4) condition of the carcass. The objective of searcher efficiency trails is to quantify the percentage of carcasses detected by observers so that estimates can account for these variables. Conducting efficiency trails throughout the course of the post-construction surveys is essential to determining accurate results and measure of fatalities to birds and bats at wind energy facilities.

Inherent differences between observers such as visual and physical ability, experience, and vigilance will influence estimates. Variation in environmental conditions such as weather and vegetation type and height also has been shown to affect mortality estimates. Detection rates for small birds and bats decrease in areas of reduced visibility such as tall dense vegetation (Johnson et al. 2003, 2004, Morrison 2002) and in habitat that closely matches the species coloration (Keeley et al. 2001, Arnett and Tuttle 2004). Variations in the size of the bird or bat and the condition of the carcass can influence estimates. Carcasses that have been heavily damaged either by collision with the turbine or by scavengers or that are highly decomposed are easily missed. Loss, damage or decomposition of carcasses occurs over time and studies indicate that 50%-75% of small to midsize birds are lost within one to four weeks. Observer and search efficiency should therefore be accounted for and corrected to the extent possible in order to obtain a more accurate estimate of bird and bat mortality.

Corrections in observer bias can be reduced with proper initial training, periodic efficiency trails, and by quantifying environmental factors including weather conditions at the time of the search, and vegetation type, height, and density to account for seasonal variations and changes in detection probabilities. Observations by the same field technicians throughout the surveys can further reduce error.

Efficiency trials are conducted at randomly selected turbines throughout each season to include various weather conditions and vegetation heights. Selected trail periods and turbine locations should be unknown to the observer to reduce further bias, as observers often exhibit increased awareness when prior knowledge of trails is given. Carcasses of various sizes, species, and conditions are placed randomly throughout the survey area in numbers that reflect realistic numbers of fatalities. Carcasses are marked for individual identification, and their locations mapped and record using GPS to ensure full recovery following the trail. Initial assistance may be required to obtain carcasses for training while salvaged birds and bats recovered from the site can be used in subsequent trails. Carcasses can be collected for future trails or left on the plot for use during scavenger trials.

The use of trained dogs to recover bat fatalities may improve searcher efficiency. A pilot study conducted by Arnett (2005) at wind energy facilities in Pennsylvania and West Virginia found

that overall dog-handler efficiency was notably higher than human searchers at each of the locations (41% and 83% higher respectively). Efficiency rates were also higher and more consistent during dog-handler searches as distance from the turbine increased and visibility due to habitat conditions decreased. As with humans, search efficiency can vary among dogs and dog-handler teams. Further research is needed to determine the limitation and biases that may be associated with these methods.

Fatality Search Data Analysis

All fatality search data must be corrected for observer efficiency and incorporate scavenging rates. Several documents outline methods and formulae that should be used to make these corrections (Gauthreaux 1995, Orloff and Flannery 1992, Erickson et al. 2004, Kerns and Kerlinger 2004, Smallwood 2006). Once adjusted and corrected for bias, a fatality rate should be reported per MW of installed capacity per year to allow comparisons across wind energy develops with various turbine sizes and capacities.

Incidental Operational Fatality Reporting

Incidental observations and fatality reporting by trained personnel at wind facilities can provide important information about the impacts to birds and bats during the operation of the site. Although not part of formal monitoring, bird and bat behavior, injuries, and fatalities reported by on-site operators and maintenance personnel can supplement formal surveys and monitoring activities, particularly when post-construction monitoring is conducted during non-consecutive years or during brief mortality events. Training should be provided to familiarize site personnel with the appropriate protocols for reporting incidental observations, injuries and fatalities.

CHAPTER 6: RISK ASSESSMENT AND AVOIDANCE

PRE-CONSTRUCTION RISK ASSESSMENT

Correlations between pre-construction risk assessment and post-construction mortality are still unclear. Research has begun to address this issue, and the levels of uncertainty will change as results of ongoing studies become available. Potential risk assessment of pre-construction results is based upon the number of species, type of species present, activity level and behavior documented within the project area. More specifically, the number of birds flying within the "risk zone" or at the rotor swept height in areas where wind turbines will be constructed can also provide an index in which to quantify potential risks. Risk assessment is also based upon the presence of migratory flyways and corridors, species of concern, and the distances to nest and roost locations and hibernacula of bat species. Other site characteristics are also important in assessing risk such as topography, weather, and vegetation type. These factors must be considered when designing the wind facility and for micro-siting turbines.

The following site characteristics and parameters can assist developers in discussing potential risks to birds and bats after preliminary site evaluations and pre-construction surveys have been completed. Consult with appropriate agency personnel to discuss how these factors will affect the level of risk to individuals and populations of birds and bats.

Species Presence – A list of all species documented within the project area are reported during the preliminary site evaluation and pre-construction surveys. Presence of federal, state, and tribal threatened or endangered species or species of concern are of particular importance. Species lists and species composition information should be recorded by species and by season.

Abundance / Use Index – An index of bird and bat relative abundance or use can be calculated as the number of individuals observed or recorded during surveys over time and can be expressed as a percentage of individuals of all species in a community. These data can be separated by time of day, by season, and by area within the proposed project. For birds this is calculated from the number of birds observed during point count surveys, whereas for bats this is calculated from the number of echolocation calls recorded during acoustic monitoring.

Exposure Index – The risk of collision for each species is calculated from temporal and spatial behavioral observations recorded during pre-construction surveys on daily and seasonal use by birds and bats at the proposed project site. Information such as flight heights and patterns can be used to estimate the amount of time a species spends within potential risk zones such as the rotor swept area. An index is calculated by season, turbine and project area.

Nest and Roost Data – The density, location, and distance to the proposed turbine for all active raptor nests and bat maternity roosts and hibernacula within the proposed site and within a determined distance surrounding the site.

Weather Data – Information such as extreme weather events, periods and areas that experience high turbulence, and wind direction and speed are useful in assessing potential risks.

Suitable Habitat and Vegetation Type – Ridgelines, extreme slopes and cliffs, presence of cracks, caves, and mines, wetlands, riparian zones, water sources and other potential suitable habitat features that may support bird and bat populations are mapped and recorded. In cases in which prairie dogs are present, colony densities should be documented. Vegetation types describing dominant plants and their distribution throughout the proposed project area are also important.

Movement Corridors – Known migratory pathways for both spring and fall migration periods for birds and bats as well as daily and season movement corridors and patterns should be documented.

POST-CONSTRUCTION / OPERATIONS IMPACT ASSESSMENT

As mentioned in the previous chapter, post-construction surveys are conducted to quantify the direct and indirect impacts to birds and bats at wind facilities.

Direct Impacts

A direct impact is defined as a death or injury to a bird or bat caused by collision with structures associated with the wind energy facility (i.e. wind turbines, anemometer towers, guy wires). The following monitoring data listed below are necessary to determine the level or severity of the impacts and to determine what type of mitigation measures may be employed to avoid future impacts at existing wind facilities.

Mortality Index - A mortality index is the primary measure of direct impacts to birds and bats during post-construction phase. Mortality is defined as the number of bird or bat deaths caused by collisions with wind turbines, anemometer towers and guy wires or by electrocution from transmission lines specific to the wind facility and is expressed as a rate. An estimate of fatalities that can be reported as the number of dead birds and bats observed per turbine and per unit of rotor swept area (Anderson et al. 1999). All mortality data should be adjusted to account for site specific observer efficiency and removal / scavenger rates.

Species – Besides the rate of fatalities, the species of bird or bat killed will greatly effect decisions on the severity of the impact (i.e. threatened or endangered species, species of conservation concern).

Cause of death – Whether the death occurred due to collision with the turbine, anemometer tower, or guy wires or if it was by electrocution will determine what type of mitigation will be effective in reducing the impacts.

Temporal and spatial data – Information about the season (winter, breeding, fall or spring migratory periods) and the location within the wind facility will assist in decisions about mitigation measures.

Weather data – Extreme weather events, periods of high turbulence surrounding the turbine and wind direction and speed are useful in attributing fatalities at wind facilities.

Abundance / Use Index – An index of bird and bat relative abundance or use should be calculated and reported as described above. This will provide a context of overall bird use that can be used to attribute changes in mortality. This is particularly important if changes in the location or operation of turbines occur. Without an index of relative use by birds and bats within the area, increases or decreases in mortality can not necessarily be attributed to mitigation measures.

Indirect Impacts

Indirect impacts are those caused by the project, but unlike direct impacts that result in immediate injury or death, indirect impacts affect the use and productivity of future generations and are therefore more difficult to measure. Study designs that incorporate "control" or reference plots are necessary to quantify and assess these impacts. Measures of indirect impacts include; 1) species displacement and avoidance of the area caused by increased disturbance, decreases in food availability, or loss of perches and nesting and roosting locations, 2) increases in food availability due to habitat changes, and 3) other changes in factors such as predators, food, nesting habitat all of which may influence reproductive success. Survey data on species abundance, composition, and use gathered during the pre-construction phase are compared with results from the post-construction monitoring to determine indirect impacts. Results should be discussed with the appropriate agency personnel to determine if mitigation measures are required to reduce future impacts.

RISK AND IMPACT AVOIDANCE

Risk and impact avoidance measures should be discussed throughout each phase of project development. As information becomes available during preliminary site evaluations, pre-construction surveys and post-construction and operations monitoring, data should be reviewed and potential mitigation measures should be discussed with agency personnel. Selection and effectiveness of each measure will be dependent upon site specific variables. Positive results of one method used at one wind energy development site may not necessarily be expected to be equally successful at another wind energy development site.

The following are the most common mitigation measures that are recommended by federal and state agencies across the southern Colorado Plateau. For more detailed and alternative measures, consult with agency personnel. Several documents also outline additional mitigation measures and may be helpful in finding solutions to avoiding risk and minimizing impacts to birds and bats from direct and indirect effects of wind energy development. Concern for cumulative impacts are beyond the scope of these guidelines, but may be addressed during consultation with agency personnel.

Bird Diverters **-** Avian mortalities have long been documented at wire guyed towers. When the use of guy wires is unavoidable, bird diverter devices (e.g., Bird Safe ™, Tyco Swan Flight Diverter) may help mitigate these mortalities and are recommended by federal and state wildlife agencies.

Minimize Habitat Disturbance and Fragmentation – It is recommended to site wind development projects in areas with already disturbed lands and lands where access roads are readily available to minimize the need to create additional roads and remove vegetation from undisturbed areas.

Buffer Zones **-** Create buffer zones surrounding known nest, roost and perch locations, movement corridors, and habitats that may attract high densities of birds and bats within or near development sites. The size of the buffer zones will vary depending upon the resource in question and an appropriate area should be discussed with agency biologists.

Turbines Design, Placement and Operation – Several studies indicate that the size, design, and placement of the turbine can affect the severity of the impacts to birds, particularly raptors and migratory species. Turbine micro-siting decisions should consider topographical and habitat features that may concentrate birds and bats such as ridgelines and saddles, along river corridors and other riparian zones, or near known nesting and roosting areas. Increased risk of collision to raptors may be associated with an increase in prey availability. Disturbed land at the base of turbines and other structures can encourage burrowing rodents, thus increasing prey availability within high risk zones.

Lighting – For tall towers that require Federal Aviation Administration (FAA) lighting for pilot safety, only white strobe lights should be used with minimal numbers, intensity, and number of flashes per minutes (FAA 2000). Studies have found that solid red or pulsating red lights may attract nocturnal migratory birds and increase the risk of collision with towers.

Power Lines – Above ground electrical lines can cause increased risk of collision for raptors in particular. To reduce risk, bury transmission and power lines associated with the wind energy development sites when possible. When this is not possible bird diverters and guidelines outlined by the Avian Power Line Interaction Committee (1994, 1996, 2006) should be considered.

Carrion removal –Reduction or removal of carrion from the project area can decrease the potential for attracting eagles, vultures and other raptors that feed on carrion. This is particularly important in areas where California condors may be present.

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