STATEWIDE GUIDELINES FOR REDUCING IMPACTS TO BIRDS AND BATS FROM WIND ENERGY DEVELOPMENT

DRAFT STAFF REPORT

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ABSTRACT

These voluntary guidelines provide information to help reduce impacts to birds and bats from new development or repowering of wind energy projects in California. They include recommendations on preliminary screening of proposed wind energy project sites; assessing direct, indirect, and cumulative impacts to birds and bats in accordance with state and federal laws; developing avoidance and minimization measures; establishing appropriate compensatory mitigation; facilitating completion of the permitting process; and operations monitoring, analysis and reporting methods.

Keywords

Wind energy, wind turbines, avian mortality, avian injury, bird mortality, bird injury, bat mortality, bat injury, carcass count, rotor-swept area, Migratory Bird Treaty Act

PREFACE

On January 10 and 11, 2006, participants at the "Understanding and Resolving Bird and Bat Impacts" conference in Los Angeles encouraged the California Energy Commission and the California Department of Fish and Game to collaborate, with input from all interested parties, to establish voluntary statewide guidelines to promote the development of wind energy in the state, while minimizing impacts to birds and bats. On May 24, 2006, the Energy Commission adopted an Order Instituting Informational proceeding that delegated responsibility for this work to the Energy Commission's Renewables Committee (Docket 06-0II-1). To assist Energy Commission and Department of Fish and Game staff in this endeavor, the Renewables Committee established a science advisory committee. This draft document reflects the close coordination of the Energy Commission, Department of Fish and Game, and the science advisory committee, as well as public input from three staff workshops and a Renewables Committee hearing.

These draft guidelines will be revised after consideration of comments from all interested parties, who are invited to participate in workshops on January 17 and 18, 2007, at the University of California at Riverside, and February 5, 2007, in Alameda County. Written comments on this draft should be submitted by 5:00 p.m. on January 23, 2007. The final document is planned for release in spring of 2007, at which time it will be discussed at a Renewables Committee hearing and considered for adoption at an Energy Commission Business Meeting. Both of these public events will take place at the Energy Commission in Sacramento.

Interested parties can find details on the Order Instituting Informational and the science advisory committee, summaries of past workshops, details on future public events, and instructions for submitting written comments on the Energy Commission Web site (www.energy.ca.gov/renewables/06-OII-1/). For general information on how to participate in an upcoming workshop, please contact Margret J. Kim, Public Advisor of the California Energy Commission, at (916) 654-4489 or (800) 822-6228. For questions on technical subject matter, please contact Rick York, ryork@energy.state.ca.us.

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EXECUTIVE SUMMARY

Californians have high expectations for their state's renewable energy programs. On September 26, 2006, Senate Bill 107[1] was signed by Governor Schwarzenegger, requiring that 20 percent of the electricity sold in California come from renewable energy resources by 2010. Additionally, the California Energy Commission's *2004 Integrated Energy Policy Report Update* recommends a longer-term goal of 33 percent renewable energy by 2020. Wind energy is expected to play a vital role in meeting that goal.

Californians also have high expectations for protection of the state's diverse bird and bat populations. For wind energy to achieve optimal development there must be adequate avoidance, minimization, and mitigation of potential impacts to these populations. The voluntary draft *Statewide Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (Guidelines)* has been developed to help meet both of these expectations and to encourage the development of wind energy in the state while minimizing impacts to birds and bats.

The voluntary *Guidelines* offer a science-based reference for use by California counties, cities, and public utilities that permit wind energy projects. It is also a useful resource for wind energy proponents, consultants, resource agencies, and others involved in wind energy development. The *Guidelines'* goal is the reduction of bird and bat collisions with wind turbines by describing information and methods needed to adequately identify, assess, avoid, minimize, mitigate, and monitor the impacts to birds and bats of developing and operating new wind energy projects and repowering existing wind energy facilities in California.

In California, local agencies issue land use permits for wind energy projects, and the siting and operation of these projects are regulated by state and federal laws and local ordinances, including the California Environmental Quality Act, the Planning and Zoning Law, the California Endangered Species Act, federal Endangered Species Act, and state and federal wildlife protection laws. This document is a tool to help ensure compliance with relevant laws and regulations by recommending methods for conducting site-specific, scientifically sound biological evaluations.

While the guidelines are intended for use throughout the state, they are voluntary and designed to be flexible to accommodate local and regional concerns. They do not duplicate or supercede California Endangered Species Act statutes or other legal requirements, but rather, they complement existing guidance and reduce regulatory uncertainty. This document does not alter a public agency's obligations under the California Environmental Quality Act (CEQA), nor does it limit the types of studies, mitigation, or alternatives that an agency may decide to require under CEQA. The *Guidelines* exclusively addresses the impacts of wind energy development and operation on birds and bats and does not include impacts to other biological

[1]Senate Bill 107 (Simitian and Perata), Chapter 464, Statutes of 2006.

resources, nor does it address air quality, cultural resources, water resources, soils, or issues analyzed in a typical California Endangered Species Act review. All potential project impacts still must be analyzed in accordance with state and federal laws and regulations.

Both wind energy proponents as well as bird and bat populations will benefit from the consistent application of the *Guidelines* by the counties, cities, and other agencies that permit wind energy projects. This document offers uniform methods to study bird and bat movements, conduct carcass searches, design pre- and post-construction monitoring plans, and develop and implement impact avoidance, minimization, and mitigation measures. Using the protocols outlined in the *Guidelines* will promote scientific, cost-effective study designs, produce comparable data among studies within California, allow for analyses of trends and patterns of impacts at multiple sites, and ultimately improve the ability to predict and resolve impacts locally and regionally.

The *Guidelines* reflects close coordination of the Energy Commission, California Department of Fish and Game, and science advisory committee, as well as public input. This document is a preliminary draft, which will be revised after considering comments from all interest parties, who are invited to participate in workshops. For this reason, readers are asked to refrain from citing the *Guidelines* until it is released in final form and formally adopted.

This document is organized into eight chapters.

The “Preliminary Site Screening” chapter discusses methods used to assess the relative sensitivity of a potential wind energy project site and to determine the kinds of studies required to adequately evaluate impacts to birds and bats. Site screening consists of a reconnaissance field survey and a desktop effort to collect data (from databases, agencies, local experts) about the site to determine the potential for bird and bat impacts. The *Guidelines* provides a checklist of questions as a screening tool to assess the potential for birds and bats to occur at the site; how they might be at risk from wind turbine collisions; and whether special-status species could occur there.

The “Science Advisory Committee” chapter encourages establishment of a science advisory committee by the permitting agency and/or wind energy project developer early in the pre-permitting process to assist with determining the level of effort required for pre-permitting field surveys; interpreting survey results and existing data; determining potential impacts; and helping establish appropriate impact avoidance, minimization, and mitigation measures. Depending on the area, there is often value in establishing a standing, regional science advisory committee to advise on multiple projects. However, for cases where a standing science advisory committee does not exist, a project-specific committee is necessary. The recommended core composition of a project-specific science advisory committee includes scientists and technical representatives from the following groups: the “lead agency" (the public agency that has principal responsibility for carrying out or approving a project); wildlife protection agencies (California Department of Fish and Game and U.S. Fish and Wildlife Service); the developer; and a conservation organization, such as Audubon.

The "Pre-Permitting Assessment" chapter recommends field surveys for at least one full year to encompass variation in bird and bat species composition and abundance during all four seasons. Recommended methods include diurnal avian survey techniques such as bird use counts, small bird counts, and raptor nest searches and nocturnal survey methods to assess the presence of migrating songbirds and other nocturnal migrants. Acoustic monitoring for at least one full year is necessary to determine seasonal bat use at a proposed site. Repowering, which refers to replacing old turbines with newer, larger, and more efficient turbines, requires pre-permitting studies similar to those for new projects.

"Impact Analysis and Conformance with Laws" provides background information on laws and recommends approaches to evaluate and determine the level of impacts to birds and bats. An analysis of potential impacts is necessary so that lead agencies can satisfy CEQA and address other state and federal laws that limit or prohibit "take" (to hunt, pursue, catch, capture, or kill an animal). This chapter describes elements of proposed projects (for example, turbine layout and design, lighting) that should be considered in assessing direct impacts. Potential indirect impacts include disturbance of local populations and disruption to migratory or movement patterns. Recommendations on how to prepare an adequate cumulative impact analysis are also discussed. The chapter concludes with a description of state and federal laws that apply to assessment of bird and bat impacts from wind energy development. The Migratory Bird Treaty Act, California Department of Fish and Game Code sections for fully protected species, and federal and state Endangered Species Acts are among those laws.

"Impact Avoidance, Minimization, and Mitigation Measures" discusses impact avoidance and minimization measures for potential bird and bat impacts, the most important of which is appropriate site location and layout of the turbines at the site to avoid impacts identified during the pre-permitting studies. Other mitigation recommendations include minimizing fragmentation and habitat disturbance, establishing non-disturbance buffer zones around sensitive resources to minimize collision hazards, minimizing lighting that attracts birds and bats, minimizing potential impacts due to collisions with power lines and guy wires, and decommissioning non-operational turbines. Operational impact avoidance and minimization options consist of seasonal or permanent turbine shutdowns, changes to cut-in speeds, or modifying habitat to make the turbine site less attractive to certain vulnerable species. This chapter also discusses adaptive management and compensatory mitigation. Compensatory mitigation is used to offset impacts that cannot be avoided or minimized and typically involves purchase of land through fee title or purchase of conservation easements.

The “Permitting” chapter summarizes the entire permitting process and highlights milestones and procedures to follow. It reinforces the need to make appropriate and timely contacts with lead and responsible agencies as well as stakeholders. Early and frequent contact with oversight agencies is essential to expedite the permitting process, as is thorough compliance with CEQA and all other relevant state and federal wildlife laws. Timely and thorough pre-assessment will be necessary to make biologically and economically based decisions about impact avoidance or minimization alternatives during the permitting process.

“Operations Monitoring and Reporting,” also referred to as post-construction monitoring and reporting, discusses the need for collecting data on bird and bat abundance and site use with survey methods consistent with the pre-permitting surveys. It describes standardized protocols for carcass counts including guidelines for establishing carcass search plots and conducting carcass searches once the wind development is actually operating. In addition, it provides recommendations for conducting searcher efficiency trials, developing scavenging estimates, assessing background mortality, and performing data analysis and metrics. The specific recommended protocol for birds and bats is a minimum of two years of carcass and bird/bat use surveys, with carcass searches at least every two weeks. More frequent searches are necessary if the pre-permitting studies indicate potential for impacts to bats or small birds.

Operations monitoring for repowering projects should use the same methods as for new projects. Existing operations data may be available from the site, but if this information is applied to the repowering project, the developer must be able to demonstrate that the studies are recent, credible, and applicable to the proposed repowering project. Operations study designs for repowering projects should address the fact that new turbines are typically taller than the ones they replace, thereby reaching a higher airspace and consisting of a larger rotor-swept area.

“Implementing the *Guidelines*—a Step-by-Step Approach” provides a convenient digest of the *Guidelines* and summarizes the important points for the reader without the supporting rationale. The step-by-step approach uses standard or model protocols that allow for variation depending on circumstances. Each step is presented in the order it would typically occur in a wind energy development project.

These voluntary guidelines reflect the current state of knowledge concerning wildlife impacts at wind power developments. Information about wind-wildlife interactions is accumulating at a rapid rate across the United States as wind power expands. The *Guidelines* will be updated periodically to reflect new developments in monitoring methods, new knowledge about bird and bat behavior around wind turbines, impacts to their populations, and measures to avoid and minimize the effects of turbines on birds and bats.

CHAPTER 1: PRELIMINARY SITE SCREENING

Preliminary information is used to assess the sensitivity of the proposed wind energy project site and is the first step in determining the kinds of studies required to adequately evaluate impacts to birds and bats. Such information is required for the purpose of conducting an informed impact analysis under the California Environmental Quality Act (CEQA) and other state and federal wildlife laws. Data and information gathering should be conducted early in the siting and development process, such as when the wind energy developer is seeking landowner agreements and investigating transmission capacity. Information compiled and analyzed early in the process allows time for breeding bird surveys or raptor nest searches and assessing the potential for site use by migrating or wintering species. Early information gathering also allows time to seek a different site if unavoidable impacts seem likely despite careful turbine siting. The developer should make such decisions early in the process, before committing to substantial investments in a site.

Reconnaissance Site Visit

One of the most important components of preliminary information gathering is a site visit by a qualified wildlife biologist who is knowledgeable about the natural history of the region. The biologist should prepare for the reconnaissance survey by securing recent aerial photography of the site. Aerial photographs are particularly useful if portions of the site are inaccessible or off limits because of private property considerations. Surveys should be of sufficient duration and intensity to allow coverage of all habitat types in and immediately adjacent to the project area and provide a basis for predictions about species occurrence at the site throughout the year.

Databases

The following databases are useful sources of information for site screening.

California Department of Fish and Game's (CDFG's) California Natural Diversity Database (CNDDB), www.dfg.ca.gov/bdb/html/cnddb.html, is an efficient and cost-effective source of biological information. The CNDDB documents records of the location and, when possible, the status of declining or vulnerable species. It is important to note that occurrences are only in the CNDDB if the site has been previously surveyed during the appropriate season, a detection was made, and the observation was reported and entered into the database. As such, absence of a CNDDB occurrence in a specific area should not be used to infer absence of special-status species. It is also important to evaluate known occurrences of sensitive species and habitats near the site and in comparable adjacent areas. The CNDDB is often used to evaluate the eight U.S. Geological Service (USGS) quadrangles surrounding the quadrangle in which the project area is located, in addition to the project area quadrangle.

CDFG's California Wildlife Habitat Relationships (CWHR) system (www.dfg.ca.gov/bdb/html/wildlife_habitats.html) contains life history, geographic range, habitat relationships, and management information for 692 regularly occurring species of amphibians, reptiles, birds, and mammals in the state. CWHR is a community-level matrix model associating the wildlife species to a standardized habitat classification scheme and rates suitability of habitats for reproduction, cover, and feeding for each species.

The CDFG Biogeographic Information and Observation System (BIOS) is a data management system designed to explore the attributes and spatial distribution of biological organisms and systems studied by CDFG and partner organizations. BIOS integrates geographic information systems, relational database management, and Environmental Systems Research Institute's ArcIMS (Integrated Map Server) technology to create a statewide, integrated information management tool. Public users can access BIOS at www.bios.dfg.ca.gov. BIOS and CNDDB are complementary systems; users should consult the table at www.dfg.ca.gov/whdab/html/compare_cnddb_bios.html to determine which database to use.

The National Agriculture Imagery Program (NAIP) was designed to provide the U.S. Department of Agriculture with current digital orthophotography images. These images are high quality, available for the entire state of California and, therefore, may be used for a variety of environmental assessments. California NAIP imagery is currently available in two forms—one-meter digital orthophoto quarter quads and county compressed mosaics—and can be found online at new.casil.ucdavis.edu/casil/remote_sensing/naip_2005/. California NAIP aerial imagery is freely distributed by The California Spatial Information Library (CaSIL). CaSIL, the California Resources Agency, and the State of California are 2005 California NAIP funding partners.

Agency Information

CDFG's Habitat Conservation Branch (www.dfg.ca.gov) offers a wealth of information about the state's threatened and endangered species, fully protected species, and special-status species as well as survey guidelines for some bird species. In addition, many CDFG biologists have extensive knowledge about regional bird and bat populations, declining and vulnerable species, and habitats within their local areas. Early coordination with CDFG is highly recommended during the early site-screening stage, both as a source of information about special-status biological resources and as a way to communicate with those CDFG biologists who might be involved in the CEQA review of the project. In addition, early consultation with both CDFG and U.S. Fish and Wildlife Service (USFWS) will assist project proponents in determining the applicability or need for other state and federal laws, including California Endangered Special Act (CESA), Endangered Species Act (ESA), and Department of Fish and Game Code sections dealing with bird, bat, and raptor protection. Appendix A provides contact information for the seven CDFG regional offices and headquarters.

The USFWS has developed lists of federally threatened, endangered, and candidate species arranged by county or USGS quadrangle that are available from the Ecological Services Offices (see Appendix B for Ecological Services Office contact information). The USFWS also periodically identifies birds that are high priorities for conservation action, www.fws.gov/migratorybirds/reports/bcc2002.pdf, (USFWS, 2002). The USFWS biologists can also offer information about listed species and designated critical habitat.

Early coordination with USFWS biologists is highly recommended to identify potential impacts to federally listed and migratory species that are high priorities for conservation.

Local Experts and Other Sources

Other sources of information that might be helpful include contacts with biologists familiar with the area, including staff from universities, colleges, bird observatories, and Audubon chapters (www.audubon.org/states/index.php?state=CA) as well as local birders and bat experts. National Audubon Society Christmas bird count data (www.audubon.org/bird/cbc) and North American Breeding Bird Survey data (www.mbr-pwrc.usgs.gov/bbs/) can provide useful information about species and abundance of birds during winter and spring in portions of California. Audubon California has mapped approximately 150 areas in the state that it considers "Important Bird Areas" (www.audubon-ca.org/IBA.htm). The Western Bat Working Group (www.wbwg.org) is a source of information on current bat research relating to wind-energy development. The National Wind Coordinating Committee (NWCC), a collaborative that identifies issues affecting the use of wind power, is another valuable resource for reports and updated information about bird and bat interaction issues related to wind energy development (www.nationalwind.org).

Data from Adjacent Wind Farms

If the proposed site is adjacent to one or more existing wind energy facilities, a biologist should critically review the pre-permitting and operational studies completed for the adjacent facilities and compare the conclusions with results of the operational monitoring data at those sites. A site visit is also essential to determine if biological conditions at the proposed site are similar to those described at the existing project or projects. If studies from adjacent sites are used to form the basis of the environmental analyses for new wind energy projects, the developer must be able to demonstrate that those studies are applicable to the proposed project, given that biological and regulatory environments and wind industry technology are always changing. Data from adjacent wind farms should be included in regional or cumulative impact assessments.

Site-Screening and Assessment

The preliminary information gathering phase leads to a critical decision point in project site screening, which is whether or not a project has "fatal flaws" with respect to bird or bat impacts. If a project moves forward despite indications that substantial bird or bat mortality might occur, there may be ongoing impacts throughout the life of the project that must be evaluated on an on-going basis. However, if preliminary information gathering does not reveal potential for substantial bird or bat mortality in the proposed wind energy project area, the next step is to determine the kinds of studies and level of effort needed for the pre-permitting surveys. This assessment involves asking questions about the potential for birds and bats to occur at the site, how they might use it, and if they might be at risk from wind turbine collisions. Pre-permitting studies will provide the basis for an impact assessment and subsequent recommendations for micro-siting or other impact avoidance, minimization, or mitigation measures.

Pre-permitting study design involves considering the checklist questions in Table 1. "Yes" or "Unknown" answers to the questions indicate that the site is or may be sensitive and that studies are needed to assess impacts and develop impact avoidance, minimization, or mitigation measures. Conversely, if the assessment documents recent and comparable field work (within five years) that convincingly supports “No” answers to the checklist questions, relatively little pre-permitting study effort might be required.

Table 1. Checklist to Evaluate Sensitivity of a Proposed Wind Resource Area

	Yes	No	Unknown	Question
1				Could species listed as federal or state threatened or endangered (or candidates for such listing) breed on or near[2] the site or occur there at other times of the year?
2				Could special-status bird or bat species or declining or vulnerable birds or bats breed on or near the site or occur there at other times of the year?
3				Could fully protected bird species occur at the site any time of the year?
4				Is the site near a raptor nest, or could raptors occur at or near the site during portions of the year?
5				Is the site in or near staging or wintering areas for waterfowl, shorebirds, or raptors?
6				Do colonially nesting species (for example, herons, shorebirds, seabirds) occur near the site?
7				Are birds or bats likely to migrate through the site at any time of year during the day or night?
8				Is the site near a bat roost?
9				Could birds or bats “commute” through the area (for example, move through the site on a regular basis between foraging and roosting areas)?
10				Could the site be used by birds whose behaviors include flight displays (for example, common nighthawks, horned larks)?
11				Could the site be used by birds or bats whose foraging tactics put them at risk of collision (for example, contour hunting by golden eagles)?
12				Does the site or adjacent areas include habitat features (for example, riparian habitat, water bodies) that might attract birds or bats for foraging, roosting, breeding, or cover?
13				Does the site contain topographical features that could concentrate bird or bat movements (for example, ridges, peninsulas, or other landforms that might funnel bird or bat movement)?
14				Is the site characterized by seasonal weather conditions such as dense fog or low cloud cover that might increase collision risks to birds, and do these events occur at times when birds might be concentrated?

[2] *“Near” refers to a distance that is within the area used by an animal in the course of its normal movements and activities*.

CHAPTER 2: SCIENCE ADVISORY COMMITTEE

The siting of a wind energy project can be complex when analyzing potential impacts to birds and bats; therefore, advice from scientists with technical expertise is often necessary. This document recommends the formation of a project-specific scientific advisory committee for each wind energy project as early as possible in the project siting process. A properly structured science advisory committee can assist the local jurisdiction in evaluating the types of siting and monitoring studies needed and the proposed impact analyses submitted by project developers, as well as evaluating and recommending scientifically based avoidance, minimization, and compensation measures.

This chapter discusses the need for a science advisory committee, its purpose, and expectations of the committee. Some general guidelines on establishing a science advisory committee and recommended membership are also provided. For additional considerations and details of establishing and managing a science advisory committee, the CDFG guidance document on developing an independent science advisory process is highly recommended (www.dfg.ca.gov/nccp/scienceprocess.pdf).

Scientific advice is particularly important in California wind energy development for a number of reasons. Many questions about the nature and extent of impacts on birds and bats due to wind energy development in California remain unanswered. Also, compared to impacts from other types of development, the chronic nature of the wind energy impacts creates a unique challenge in quantifying impacts to individual species and creating effective mitigation. Finally, the state's diverse landscapes include extremes in climate, geology, and topography, which are linked to greater biodiversity and the need for species-specific advice during the environmental review process. While most wind energy projects could benefit from establishing a science advisory committee, there also could be other situations (for example, small infill projects with adequate data) for which establishing a full science advisory committee would not be necessary.

Purpose and Tasks

The purpose of the science advisory committee is to provide unbiased, technically credible advice to inform all major scientific decision points throughout the life of the project. A science advisory committee facilitates decision-making by advising on the scientific elements of site screening, study design for pre-permitting and operations monitoring, impact determination, and development of impact avoidance, minimization, or mitigation measures. For example, the science advisory committee should be consulted to answer important questions, such as whether to change the duration and level of effort for field surveys from the recommended standard monitoring protocols described later, how many carcass search plots are necessary, or how to evaluate scientific uncertainty and interpret existing data from adjacent wind farms. The science advisory committee will also assist the developer and lead agency with interpreting pre-permitting surveys and operations monitoring data as well as developing micro-siting and management recommendations based on the data.

The intended purview of a science advisory committee will dictate its range of tasks and frequency of activities. For example, if there are numerous proposed wind energy projects in an area, it is useful to establish a standing science advisory committee to assist on an ongoing basis rather than compose separate science advisory committees for each project in a county, region, or wind resource area. A standing science advisory committee will also add efficiency by reducing the learning curve for science advisory committee members as well as increasing consistency across projects. However, depending on the area and specific issues, a project-specific science advisory committee may be more appropriate for some wind energy projects. As more wind energy facilities are built in the state, California could also benefit from a statewide, standing science advisory committee with representatives from each wind resource area. A core group at the state level could offer members to lead agencies and developers wishing to form project-specific science advisory committees to lend consistency and assistance at the local level.

Science advisory committee meetings should focus on scientific elements of the project. While other topics of relevance to the project may need group consideration, these should be covered in a separate forum, which can be more inclusive of different disciplines and not necessarily attended by the whole science advisory committee. Some may choose to make the science advisory committee meetings open to the public or invite non-science personnel to observe. However, others have found it more productive and efficient to have a science advisory committee member or facilitator report the findings and recommendations back to a larger group of interested parties in a workshop or hearing setting. Hiring an experienced facilitator to conduct science advisory committee meetings, organize logistics, and summarize the group's recommendations is advised. Facilitators are particularly helpful with larger groups. A facilitator can also be hired earlier to establish the group and function as a science advisory committee organizer, especially when there are multiple lead agencies or it is difficult to select a science advisory committee organizer.

Guidelines for Establishment

The timing of science advisory committee initiation and consultation is an important consideration. Early in the site selection process, the developer should consult the local land use permitting authority (typically the county) to determine whether a standing science advisory committee exists for the project area. If one exists, the developer should make contact and seek advice regarding site selection. If one does not exist at the time of site selection, developers should seek scientific advice through informal consultation with CDFG and USFWS to identify fatal flaws and potential impacts. Before the decision to pursue a particular project site is made, it is often infeasible to begin assembling a science advisory committee. After final site selection, a science advisory committee should be established as soon as possible (that is, early in the pre-permitting process) to help evaluate existing data for a site. If it is infeasible to establish a science advisory committee until a later stage of the permitting process, frequent and early consultation with CDFG and USFWS is strongly recommended as a minimum precaution.

The CEQA or National Environmental Policy Act (NEPA) lead agency and/or developer are typically responsible for establishing and managing the science advisory committee, depending on its term and scope (for example, standing and regional or short-term and project-specific). For a standing, regional science advisory committee, the lead agency is the logical science advisory committee organizer because it is the primary land use permitting authority for wind energy projects. In this case, the lead agency can work with a core group of members and representatives from developers in the area to establish a committee with a regional scope. This type of science advisory committee could be particularly useful for repowering projects. In areas without a standing science advisory committee, lead agency involvement in preliminary siting considerations is uncommon. In this case, the developer should consult informally with CDFG and USFWS and also establish a project-specific science advisory committee to inform early project decisions.

Membership

Both membership and participation of the science advisory committee need to be consistent throughout the project. To that end, the science advisory committee organizer should develop a scope of work that outlines the expected schedule and term of participation. It is not advisable for agencies and organizations to send different representatives to various science advisory committee meetings because it increases uncertainty and inconsistency in project decisions. Resigning members should suggest a replacement if possible, and the remaining members and science advisory committee organizer will decide whether a replacement is necessary and whom to invite. Great care should be taken when approving a science advisory committee because its recommendations and the resulting decision by the lead agency or developer are likely to be challenged if the members appear to be biased or the conclusions are quite different from nearby projects with similar characteristics. In most cases science advisory committee members from agencies serve *pro bono*; however, the lead agency or developer may need to supply funding to ensure the participation of science advisory committee members who have special expertise and are free of perceived conflicts of interest.

When composing either a project-specific or standing science advisory committee, a group of biologists and environmental scientists with expertise in bird and bat wildlife issues related to wind energy development should be selected along with other technical representatives. It is also important to include experts in avian and bat biology (including migratory and flight behavior), raptor ecology, survey protocols, and study design. Potential science advisory committee members include biologists from the local agency (land use permitting authority), CDFG and USFWS (other bird and bat protection law permitting authorities), developer(s), and wildlife conservation organizations such as Audubon California or Point Reyes Bird Observatory Conservation Science. Depending on the land ownership and local expertise, representatives from the U.S. Bureau of Land Management (BLM), U.S. Forest Service (USFS), military, California Department of Forestry and Fire Protection (CDF), and State Water Resources Control Board are possible additions. Other agencies may also have staff with relevant expertise. A science advisory committee membership that reflects both local and regional expertise is desirable.

The recommended core composition of a project-specific science advisory committee includes one scientist or technical advisor from each of the following groups:

- The lead agency (or its consultants)
- CDFG
- USFWS
- The developer (or its consultants)
- A conservation organization.

Additional members may be necessary as discussed earlier, but limiting the number of members to nine or fewer is recommended for logistical reasons. Standing science advisory committees are usually larger because multiple developers or local agencies will be involved. Again, caution is needed to avoid the group from becoming too large to reach consensus and function productively (that is, more than 20). Even a larger science advisory committee should not include non-scientific, support staff. The science advisory committee organizer should avoid over-representation of certain organizations compared to others and strive for regional and site-specific expertise that is appropriate to cover the bird and bat issues of a particular site.

CHAPTER 3: PRE-PERMITTING ASSESSMENT

This chapter provides guidance on collecting biological information to assess the potential direct and indirect impacts to birds and bats at proposed wind energy development sites. The information collected is used to develop impact avoidance, minimization, or mitigation measures. Recommendations on developing a scientific pre-permitting study and assessing the level of effort required for such studies are included. Finally, this chapter describes the study methods available for bird and bat field studies and recommended protocols for using the methods. The science advisory committee should be consulted during the pre-permitting assessment to develop a scientifically sound study design and to interpret data collected at proposed sites.

Determining the Level of Pre-Permitting Surveys

Most pre-permitting surveys should last a minimum of one year to answer questions about how birds and bats use a site use during spring, summer, winter, and fall. A single season of data from one year may be inadequate to assess relative abundances of some bird and bat species using the site because seasonal populations of some species are highly variable from year to year. For example, in California's Central Valley, wintering populations of rough-legged hawks, short-eared owls, sandhill cranes, and many waterfowl species can vary considerably from year to year depending on weather conditions in the northern portions of their ranges (Hejl and Beedy, 1986; Garrison, 1993; Schlorff, 1994). In his studies of raptor populations at Seal Beach in Orange County, Bloom (1996 and in prep.) reported wintering population of red-tailed hawks ranging from 200 in 1994 to 65 in 2005. The vast majority of the hawks were migrants.

Studies in excess of one year may be necessary in areas lacking baseline information, where considerable annual and seasonal variation in bird and bat populations is suspected, or where there is high potential for declining or vulnerable species to occur at the site. The number and size of turbines and the extent of the area covered by the project will also influence the need for more or less study. A large project (41 turbines or more) presents an increased potential risk to bird and bat populations compared to small projects (10 turbines or less). Large projects require more extensive studies to adequately assess impacts and develop impact avoidance, minimization, or mitigation measures than do small projects. Proposed projects, which are planned to develop multiple groups of turbines over large geographical areas (500 acres or more), may need additional specialized, multi-year studies to examine potential habitat fragmentation effects and potential large-scale effects to species migration and habitat use patterns.

Not all proposed wind energy projects should require a full year of pre-permitting studies. Reduced study effort might be appropriate if recent (within five years), nearby, and comparable studies provide adequate information to make a fully informed and rigorous impact assessment and develop effective impact avoidance, minimization, or mitigation recommendations. Less pre-permitting study might be sufficient for a small project adjacent to an existing, well-studied site for which there is a high level of knowledge about potential impacts to birds and bats and for which operations monitoring studies have confirmed a low level of impacts. A decision to reduce the proposed study duration to less than one year or to use existing data rather than collect new field data should be made with the approval of CDFG, USFWS, other experienced biologists, and the science advisory committee. Caution is warranted in extrapolating existing data to unstudied nearby sites. Slight topographical or habitat variations can make substantial differences in bird and bat site use and potential impacts. In addition, technological changes including use of large turbines, variations in turbine design or layout, increased operating times, and use of different lighting may require new or additional data gathering.

Study Objectives and Design

Development of a pre-permitting study begins with a clear identification of the research questions. The next step is to establish a study design appropriate for answering those questions and deciding on sampling units, parameters, metrics (measurements), and specific methods to employ. A well-designed study will provide the basis to:

- Assess bird and bat risks due to the proposed project.
- Reduce potential risks to birds and bats if possible.
- Establish sampling protocols consistent with and comparable to post-construction monitoring data.

Anderson et al. (1999) provides detailed information about the metrics and methods for designing pre-permitting studies. The discussion below gives an overview of the basic elements needed for a sound study design and sampling protocol.

Study objectives will vary from site to site, but key issues on most wind energy projects in California will typically include at least the following questions:

- Which species use the site?
- What is the seasonal species richness and relative abundance of birds and bats in the project area?
- How much time do birds and bats spend in the vicinity of proposed turbine locations, and how does this vary with season?
- How much time do birds and bats spend in the risk zone (rotor-swept area) by season?
- What key features of the site (habitats, landforms) increase the probability that birds or bats will use certain portions of the project area?
- Are there occupied raptor nests in or near the project area?
- Is the area a known breeding ground for any bird or bat species, or is it near a bat roost?
- How does bird and bat use of the site compare to other wind resource areas that have been studied and assessed for impacts?

Answering these questions involves bird use counts (BUCs), small bird counts (SBCs), acoustic monitoring, raptor nest searches, behavioral assessments, and other methods. These methods are discussed in more detail below, as are other techniques (such as radar, mist-netting, thermal imaging) that may be appropriate to answer specific questions about bird or bat use at the project site.

Standardized BUCs provide baseline data on avian species richness, relative abundance, and bird use in the vicinity of proposed turbine sites. These standardized methods have been used for many wind energy projects throughout the United States and therefore have benefit for comparative purposes. Anderson et al. (1999) describes these methods in detail and discusses standardized metrics and methods that have been endorsed by the NWCC and subsequently used in many studies (for example, Anderson et al., 2005; Johnson et al., 2000; Kerlinger et al., 2006; Smallwood and Thelander, 2004). Standardization promotes comparison capability by employing similar methods and metrics between project and reference sites both before and after construction at wind energy projects throughout California.

Before-After-Control-Impact Study Design

A meaningful impact assessment using BUCs requires Before-After-Control-Impact (BACI) study design. The BACI design recommends data collection in both reference (control) and assessment (impact) areas using exactly the same protocol during both pre-impact and post-impact periods (Anderson et al., 1999). Perfect control sites, which exactly replicate the conditions at the proposed wind turbine site, usually do not exist in a field setting because of inherent natural variation. The “controls” are therefore reference sites that most closely match topographic, wind, and both on-site and adjacent habitat conditions at the proposed wind turbine site. Collecting data at both reference and assessment areas using the same protocol during both pre- and post-impact periods answers questions relating to construction and operation effects on bird and bat abundance. Anderson et al. (1999) provides a thorough discussion of the design, implementation, and analysis of these kinds of field studies and should be consulted when designing the BACI study.

BACI designs with replicated reference sites provide a rigorous basis for statistical analysis and supportable scientific conclusions. Multiple references improve discrimination between project impacts and impacts resulting from natural temporal changes or other factors. This replication provides the basis for formal statistical testing on the impacts of the project and estimates of confidence intervals. A BACI design with only one reference site is not acceptable because it only provides a comparison of data from “before” and “after” sites. Such a weak study design limits the researcher’s ability to make inferences and conclusions about the impact of the project because detection of changes due to impacts could be confounded by natural temporal changes.

Selecting Sampling Points

Selection of sample points is a critical step in developing the study design. On projects in which the turbine locations are known, BUC sample sites should be selected at good vantage points (that is, points that offer unobstructed views of the surrounding terrain) near a turbine location or a sample of turbine locations. Sample sites should also be selected at sites away from proposed turbine locations to establish reference sites. On smaller projects, each turbine site should be selected as a BUC site if the turbine sites are at least 800 meters apart. On large projects, a randomized sampling method, such as a systematic sample with a random start, is one way to help reduce bias and achieve independence of sample points. For example, if the proposed project consists of nine turbines, each turbine site can be sampled. If the proposed project consists of 50 turbines, a systematic sample selecting every third turbine may be used. The goal is to create enough sample points to meet analytical and statistical variance objectives. On sites that support multiple habitat types, sampling should be systematically stratified among the habitats to ensure that habitat variability is sufficiently analyzed. The categorization of habitats should be consistent with the California Wildlife Habitat Classification system (www.dfg.ca.gov/whdab/html/wildlife) or other accepted California vegetation classification system such as the California Native Plant Society's *Manual of California Vegetation* (Sawyer and Keeler-Wolf, 1995).

If a precise estimate of density is required for a particular species (for example, when the goal is to determine densities of a special-status breeding bird species), the researcher should establish enough sample points to have about 100 independent observations of the species because that will provide enough data for a detection function to be estimated. A detection function is the probability of observing an object, such as a bird, given that the bird is a certain known distance from the observer. Detection functions are important for estimating density of a population because they allow estimation of the overall probability of detecting an individual. If variance in the observations is low, a lower number of sample points may provide an adequate detection function. Pooling observations across similar groups and other techniques may yield acceptable results when analyzing data from fewer than 100 observations. For more information on sample size and detection function, see Buckland et al. (2001).

Diurnal Avian Surveys

Diurnal avian survey techniques include BUCs, SBCs, area searches, raptor nest searches, and a variety other methods. BUCs are used for estimating the spatial and temporal use of the site by all birds, including large birds such as raptors, vultures, corvids, and waterfowl, as well as songbirds and other small species. SBCs are BUCs conducted at a greater density of sample sites and are useful for specifically assessing impacts to resident songbirds and other small birds (less than 25 centimeters [10 inches] in length).

To minimize observer bias, avian survey techniques require experienced surveyors who are skilled at identifying the birds likely to occur in the project area and who are proficient at accurately estimating vertical and horizontal distances. Kepler and Scott (1981) provide details on training observers to estimate distances and testing surveyors for their abilities to identify birds by sight and sound. Analysis of data from BUCs, SBCs, and other surveys should include suitable measures of precision of count data such as standard error, coefficient of variation, or confidence interval (Rosenstock et al., 2002).

Bird Use Counts

The bird use count (BUC) is a modified point count that involves an observer recording bird detections from a single point for a specified time period. BUCs are one of the most widely used techniques for pre-permitting monitoring studies of birds at proposed wind energy project sites. Point counts provide an estimate of relative abundance rather than density (Pendelton, 1995) because the probability of detection is not estimated when using standard point count methods (Norvell et al., 2003). BUCs should always include distance sampling, a method that involves recording the distance from the observer to the bird so that bird use can be analyzed at incremental distances. This will allow comparisons between studies that measure varying distances from the bird to the observer (for example, comparing raptor use within 300 meters or within 800 meters). Using both BUCs and distance sampling, it is possible to make density and population size estimates (Somershoe et al., 2006).

BUCs involve counting bird detections from vantage points at the center of observational circles of a fixed radius. The BUC locations should be selected to coincide with proposed turbine or turbine string locations and at the reference sites. If turbine locations are unknown for a proposed project site, the researcher can superimpose a grid over the portion of the site that will support turbines and select sample points either randomly or systematically from the grid. The point location may require minor adjustments to provide an unobstructed view of the surrounding terrain and corresponding airspace. The observation points should be permanently marked in the field with a labeled stake and geo-referenced using global positioning system (GPS).

The number of selected observation points should be based on the number of potential turbines or turbine strings and the ability to observe several potential turbine locations from a single point (Morrison, 1998). The minimum number of samples should be one sample site per turbine for a small project. The minimum number of sample sites depends on the size of project:

- One sample site per turbine for a small project (1-10 turbines).
- 40 percent of the number of turbines, or 10, whichever is larger, for a medium project (11-40 turbines).
- 30 percent of the number of turbines, or 16, whichever is larger, for a large project (41 turbines or more).

The goal of the BUC surveys is to sample bird species composition, occurrence, frequency, and behavior during various times of day as well as throughout the seasons. Observations should be made for 30 minutes once every week during the seasons of interest, which for most projects in California includes all four seasons. Observation times should be sequenced to cover all daylight hours (for example, alternate each week with morning and afternoon surveys).

Data collected during each survey should consist of continuous counts of bird use during the survey period. Flight pattern and flight height or perching should be recorded at the time of first observation and every five minutes during the survey. The distance of the bird to the observer should be recorded at the first observation if the density estimates are needed. Monitoring data collected at each BUC point should also include the number of birds observed and distance and height at which birds pass potential turbine locations. Recording wind speed is also important so that avian usage can be assessed under conditions similar to when the turbines are operating. The data can later be stratified into height and distance categories (below, within, or above the rotor-swept area) based on size and placement of turbines to be constructed (Morrison, 1998).

Small Bird Counts

Small bird counts (SBCs) are BUCs that are useful when a greater number of smaller-radii point count circles are needed to estimate relative density of songbirds and other avifauna in the count circle. The SBCs are only used in special cases, such as when there is concern for loss of special-status bird breeding habitat and are not typically used to assess the status of migratory songbirds in a project area. The goal is coverage of the entire project area, including all habitat types. SBC sampling sites can be the same as BUC sites, but with a smaller radius, ranging from 50 to 100 meters, depending on habitat type. Savard and Hooper (1995) found that a 100-meter radius yielded nearly as many songbird detections as an unlimited radius for most species.

SBC sampling points should be 250 meters apart to reduce the probability of double-counting individual birds (Ralph et al., 1995). If turbine locations are known, SBC sites can be established every 250 meters in a row between turbines. If turbine locations are not known, but the general area where turbines will be placed (such as a ridge top) is known, the SBC sites can be located along the ridge top. If turbine locations are unknown, a grid should be superimposed over a portion of the site that will support turbines, and random or systematic selection can be made. The exact number of required samples sites is difficult to predict without knowing the size and extent of the project site, but the site should be sampled sufficiently to obtain data for answering the research question within acceptable confidence limits. The observation points should be permanently marked in the field with a labeled stake and geo-referenced using GIS.

SBCs should be conducted every two weeks during the seasons of interest and should include at least the breeding season (April through July in much of California). Surveys should be conducted no earlier than a half hour before and no later than four hours after sunrise. Time spent at each count station should be five minutes if travel time between counting stations is less than 15 minutes, or 10 minutes if travel time is greater than 15 minutes (Ralph et al., 1995). At each point, observers should record all birds detected by sight or sound during the survey period. Data recorded for each bird observation should include time, species, number per species, estimated distance from the observer, activity, habitat, flight direction, and estimated flight height. As with the BUCs, the flight heights can be categorized as below, within, or above the rotor-swept area.

Area Searches

Area searches involve intensive searches of a project area with the objective of finding as many bird species as possible. Area searches are infrequently used in wind energy bird studies, but can augment BUCs and SBCs if evidence suggests that use of BUCs and SBCs alone will not adequately characterize the avifauna of the project site. The area search should be standardized by specifying the search duration (“stopping rules”) and the size of the area being searched to quantify species numbers and abundance (Ralph et al., 1993; Watson, 2003). Standardized area searches are useful for providing species richness data that can be compared between different project areas or for sites within a single large wind resource area. Area searches can be used as an adjunct to BUCs to produce more complete lists of species and relative abundance in habitats that may not be represented in the point count circle, but which are part of the wind energy project site. For example, if riparian habitat is not represented in point counts because it constitutes a small, linear proportion of the area, then searches should be done in that habitat. This approach allows the avifauna of entire sites to be sampled.

Migration Counts

If BUCs indicate the proposed wind energy project site is within a migration route for raptors or other diurnal migratory species (for example, gulls, pelicans, ibis, and cranes), migration counts are a relatively simple, inexpensive technique to assess species composition and relative abundance and to estimate flight height of migrants. To conduct a migration count, vantage points that offer wide fields of view should be established at ridges or passes within the wind resource area. Surveyors should be stationed throughout the wind resource area approximately every two miles along an east-west axis. Observations should start around 0900 hours and methodically scan the sky and record all identified species, direction of movement, and estimated distance from the observer and above the ground. Migration counts are typically conducted for an eight-hour period, four days per week for 10–13 weeks to assess large bird migrations during the fall and 8–10 weeks during spring.

Raptor Nest Searches

Raptor nest searches should be conducted in suitable habitat during the breeding season within five kilometers (three miles) of proposed turbine locations. If golden eagles are suspected to nest in the region, the survey area should be expanded to include suitable habitat within 8 kilometers (five miles) because golden eagles can range over 15 kilometers from their nest site (Hunt, 1995). Multiple surveys should be conducted beginning in March and ending in mid-June to cover most nesting owls and diurnal raptors in California. Surveys early in the year, before trees leaf out, are a good time to search for large stick nests such as those of golden eagles and red-tailed hawks. If the area to be covered is large and inaccessible, helicopters can be used to survey for nests. Nest detections during the search, either from the ground or aerial surveys, should be followed by regular visits for the duration of the nesting season to confirm the status of each active nest and determine nest success. For aerial and ground nest searches, researchers should avoid approaching the nest too closely to minimize disturbance, particularly when surveying from helicopters.

Mist-Netting

Mist-netting can be used to augment observational bird data if the BUCs and SBCs are not adequate to characterize the avifauna of the project site or if additional population demographics are needed (Ralph et al., 1993). Mist-netting can also be used to document fall-out or heavy use by migrants at migrant stop-over sites in or near proposed turbine sites. Mist-netting can detect species missed by other techniques, especially secretive or cryptic birds, and provides opportunities to collect condition, age, and sex data. Depending upon habitat heterogeneity, mist-net stations, with 10 nets per station, should be established approximately every two miles in an east-west axis throughout the wind resource area. Operating mist nets requires considerable experience, as well as state and federal permits. Procedures for operating nets and collecting data should be in accordance with Ralph et al. (1993).

Nocturnal Bird Survey Methods

The methods discussed above provide information on daytime breeding, wintering, and diurnal migrant use of a proposed project area. This chapter addresses methods and approaches for sampling nocturnal birds' migration through a proposed project area.

California is part of the Pacific Flyway, one of North America's four major migratory routes between Alaska and Patagonia. Every spring and fall millions of birds make their way through California on their way to and from their breeding and wintering grounds. For some migratory species, including many ducks, geese, swans, shorebirds, and raptors, California is the winter destination.

Most songbirds, waterfowl, shorebirds, herons, and egrets migrate at night (Kerlinger and Moore, 1989). Nocturnal migrants generally take off after sunset, ascend to their cruising altitude between 300 and 2,000 feet (90–610 meters), and return to land before sunrise (Kerlinger, 1995). For most of their flight, songbirds and other nocturnal migrants are above the reach of wind turbines, but they pass through the altitudinal range of wind turbines during ascents and descents and may also fly closer to the ground during inclement weather or when negotiating mountain passes (Able, 1970; Richardson, 2000). As turbines' heights increase, it is unknown whether the interactions between migratory birds and turbines will increase.

If preliminary information indicates potential risks to nocturnal migrants at a proposed wind energy project site, radar and other nocturnal study methods may be employed to determine species composition, abundance, and flight altitude of birds passing through the site. For example, if turbines will be located on ridgelines within a migratory corridor or near a favored migratory stopover, they might pose a risk to nocturnally migrating birds. If project areas are within the range of nocturnal, special-status bird species (for example, marbled murrelet, northern spotted owl), surveyors should use species-specific protocols recommended by CDFG or USFWS to assess potential presence in the project area. The following section describes nocturnal study methods that could help answer questions about migrating birds' use of a proposed site.

In contrast to the diurnal avian survey techniques described above, considerable variation and uncertainty exists on the optimal protocols for using acoustic monitoring devices, radar, and other techniques to evaluate species composition, relative abundance, flight height, and trajectory of nocturnal migrating birds. Additional studies are needed before making recommendations on the number of nights/season or the number of hours/night that are appropriate for radar studies of nocturnal bird migration (Mabee et al., 2006). The discussion below therefore does not make specific recommendations on duration or frequency of sampling or study design. Instead, scientists experienced with the techniques must tailor the study design and sampling protocol to the unique features of each site and to the specific questions that need to be answered. The science advisory committee and CDFG should also be consulted to approve study design and review analytical methods to ensure the proposed research will answer questions about risk to nocturnal migrating birds. The NWCC is developing guidelines that will describe the Metrics and Methods used to study birds and bats to enable site evaluation, available in 2007, as Anderson et al. 1999, does for landbirds.

Radar

Radar surveys are useful for counting nocturnal migrants passing through a proposed project area and for identifying the height and location of flight paths. Low-power surveillance radar can detect movements of birds within a range of a few kilometers (Gauthreaux and Belser, 2003). Horizontally mounted marine navigation radar allows accurate mapping of the trajectories of birds, while vertically mounted scanning radar provides information on flight altitude. Mobile, low-power, high-resolution marine surveillance radar has been used since 1979 to monitor collision risks of birds near power lines (Gauthreaux, 1985). However, radar surveys are expensive and cannot identify birds to species or reliably distinguish birds from bats. Desholm and Beasley (2005) provide a detailed discussion of the available types of radar (such as surveillance radar systems, Doppler and pulse Doppler radar, and tracking radar systems) and analyze the uses and advantages and disadvantages of each.

Acoustic Monitoring

Sensitive microphones aimed at the night sky can be used to record vocalizations of night-migrating birds. The vocalizations can be used to produce a list of species migrating over a site at night. Acoustic monitoring is biased toward detecting species that use contact calls during migration (Farnsworth et al., 2004). Some 200 species are known to give calls during night migration of which approximately 150 are sufficiently distinctive to identify to species under most conditions (Evans, 2000). The remaining species can be lumped into similar-call species groups. Acoustic data can either be processed by ear or analyzed by sound analysis software (Evans, 2000). Nocturnal migrant monitoring systems can consist of single microphones connected to a digital recorder. More complex systems involve four or more microphones connected to a computer, providing an assessment of the height and position of each bird's call. Acoustic monitoring does not provide a complete assessment of the number of birds passing through an area. However, it can provide insight about the regional variation in concentrations of migrants and their relative flight heights, which is useful for assessing potential risk of collision. Acoustic monitoring can be used in conjunction with other nocturnal survey methods as discussed below.

Ceilometers and Moonwatching

A ceilometer is a vertically directed, conical light beam that can be used to sample low altitude bird migration (Able and Gauthreaux, 1975; Gauthreaux, 1969). The beam of light from the ceilometers covers about one-half of one degree and allows detection of birds passing through the beam up to a distance 2,000 feet (610 meters). Kerlinger (1995) provides a detailed description of the techniques for using ceilometers and of their biases and limitations. Ceilometers are an inexpensive and relatively easy tool for sampling nocturnal bird passage and are a useful supplement to radar studies because ceilometers can detect birds below 1,500 feet (460 meters). Using this technique, an experienced observer can, under ideal conditions and during low flight events, distinguish different taxa of small birds. Ceilometers also allow for measurement of bird traffic rates (number of birds per unit time passing through the beam).

Moonwatching is similar to the ceilometer method except that a full or nearly full moon takes the place of the beam of light (that is, birds are observed as they pass between the observer and the moon). Moonwatching is complementary to ceilometer surveys because it is difficult to use ceilometers on bright moonlit nights.

Thermal Animal Detection

Thermal Animal Detection Systems (TADS) use infrared imagery to detect heat emitted from objects in the lower part of the infrared spectrum. Image intensifying devices such as night scopes and night vision goggles detect infrared in the upper part of the spectrum reflected off objects and provide a less expensive option than TADS for identifying bats and nocturnal birds. Images of an object are created by heat radiation within the infrared spectrum (in contrast to conventional photographic images, which result from the reflection of visible light). TADS are effective at all times of day and provide data on nocturnal bird movements that are difficult to obtain in other ways. TADS are also better than radar for species recognition because TADS can assess shape, size, and wing beat frequencies, valuable features at night and under conditions of poor visibility. TADS are expensive, but currently are the only way to obtain data on nocturnal avoidance behavior, flight altitude, species composition, and flock size when visibility is poor. Desholm (2003) provides a detailed discussion of TADS hardware and its uses.

Bat Survey Methods

Avian collisions with wind turbines have been a source of concern for almost two decades, but only recently have researchers turned their attention to the risk of bat fatalities. Compared to birds, much less is known about the life histories, habitat requirements, behavior, and geographic ranges of California's 25 bat species, making impacts to bats a difficult subject to address in pre-permitting studies for wind development projects (California Bat Working Group, 2006). Bats are long-lived mammals with few predators and low reproductive rates (Kunz, 1982). Sustained, high fatality rates from collisions with wind turbines could have potentially significant impacts to bat populations because population growth is slow, and the ability to recover from population crashes is limited (Racey and Entwistle, 2000).

In the United States, bat fatalities at wind farms have been documented in 10 states, mostly in the east and mostly involved solitary, tree-roosting bat species such as the silver-haired, hoary, and eastern red bat (Johnson, 2004 and 2005). Hoary bats have accounted for nearly half of all bat fatalities documented at wind farms (Johnson, 2004), and most known fatalities occur in late summer and early fall during periods coinciding with bat migrations (Johnson, 2004; Kunz, 2004). Some studies have indicated that tree-roosting bats may be attracted to both moving and non-moving wind turbine blades and that many bat kills occur during low wind nights (Arnett, 2005).

In California, studies have only recently begun to address bat fatalities at wind energy project sites. Monitoring studies at the 31-turbine Diablo Winds Energy Project in Alameda County found four bat carcasses over a one-year monitoring period (WEST, 2006). The carcasses were detected incidental to monthly, standardized bird carcass searches. However, a monitoring study of the 90-turbine High Winds Power Project in Solano County detected 116 bat carcasses (hoary, Mexican free-tailed, red, and silver-haired bats) during twice monthly carcass searches over a two-year monitoring period. When corrected for searcher efficiency and scavenger removal (see Operations

Monitoring), the authors calculated that total bat kills were 373 (±47) in year one, and 245 (±31) in year two, most of which occurred between August and October (Kerlinger et al., 2006).

To assess potential impacts to bats and to develop impact avoidance and minimization measures, pre-permitting surveys for bats should be conducted for at least one year. Year-round surveys provide data on species composition and relative abundance of bats in and near the wind facility, assess migration routes and timing of migration, and help researchers understand seasonal and daily activity levels in relation to proposed wind turbine locations (California Bat Working Group, 2006). As described below, passive acoustic surveys are an option for establishing baseline patterns of bat activity over the course of a year. Other research tools (discussed below) are available to complement the information from acoustic surveys. The Western Bat Working Group has developed a recommended survey matrix for western bats (www.wbwg.org/survey_matrix.htm), and the California Bat Working Group (2006) provides information on survey techniques and on potential risk posed by wind turbines to California bat species. All studies discussed below should be designed and conducted by biologists with training in bat identification, equipment use, and data analysis and interpretation. For mist-netting or any other activities that involve capturing and handling bats, a permit is required from CDFG.

Acoustic Detection

Acoustic detection involves specialized acoustic systems (for example, AnaBat©, SonoBat©) that allow an experienced user to identify some bat species by comparing the recorded calls to a reference library of known calls. Because bats usually echolocate as they fly, microphones sensitive to the ultrasound frequency that bats use can provide a measure of bat activity. Acoustic systems designed to monitor birds are not suitable for bats because of differences in the vocalization frequencies of bats and birds. With these acoustic systems, skilled bat biologists may be able to detect and identify some bat species. Acoustic monitoring provides information about seasonal changes in species composition but does not measure species abundance or population density. Furthermore, there is some question about how much bats use echolocation while migrating as opposed to during foraging or while navigating among obstacles, so caution should be used when assessing bat use of an area based on acoustic monitoring data. In addition, the NWCC is developing guidelines that will describe the Metrics and Methods used to study birds and bats to enable site evaluation, available in 2007.

Detectors at ground level do not provide information about bats occurring at the altitude of the rotor-swept area because ultrasound attenuates within tens of meters for many bat species (California Bat Working Group, 2006). Bat detector microphones should therefore be placed on anemometer towers at least 100 feet (30 meters) above the ground in multiple locations in the proposed project area (Lausen et al., 2006). Acoustic monitoring needs to be sustained over a full year to capture the considerable night-to-night and seasonal variation in bat use (Hayes, 1997), including pulsed migration events. Some acoustic monitoring systems have been designed to run unattended for long periods of time using solar power and collect data passively by storing bat calls for later analysis. Rainey et al. (2006) provides a detailed discussion of acoustic monitoring systems.

Mist-Netting

Mist-netting and acoustic monitoring are complementary techniques that can be used together to provide an effective means of inventorying bats (O'Farrell et al., 1999). Information that can be obtained from mist-netting (and from no other source, short of collecting the bat) includes the species, age, sex, and reproductive status of local bat populations. Mist-nets effectively sample only a small area of the space available to flying bats, and some species rarely fly low enough to be captured. Another constraining factor in the use of mist nests at proposed wind energy project sites is that mist-netting must be conducted on low or no wind nights because bats readily detect and avoid moving nets.

Roost Searches

Roost searches can be used to document bat species that are difficult to detect acoustically or with mist-net capture and to determine if the proposed wind energy project site is near a significant bat roost (for example, a maternity colony). Roost searches are conducted by looking into or entering potential bat roosts (usually using a flashlight) with the intent of finding roosting bats or bat "sign," including guano, culled insect parts, and urine staining. Roost searches must be conducted cautiously because roosting bats are sensitive to human disturbance (Kunz et al., 1996). A less invasive technique involves doing an "exit count," in which an observer watches a potential roost site at dusk to see if bats emerge.

Radar, Thermal Imaging

During peak bat migratory periods, August through October, researchers may need to augment the information from acoustic monitoring by using radar or thermal imagers (as discussed earlier) that operate beyond the range of acoustic monitors.

Repowering—Pre-Permitting Assessment

Repowering refers to modernizing a wind resource area by removing old turbines and replacing them with new turbines. The new turbines are generally larger, taller, and more efficient than the old. Repowering requires pre-permitting studies using the same methods as those described above for new projects. Some applicable data may be available from site for the pre-permitting studies of the new turbines. If this information is applied to the repowering project, the developer must be able to demonstrate that the studies are recent, credible, and applicable to the proposed repowering project. Pre-permitting study designs should address the fact that new turbines are typically taller than the ones they replace, reaching a higher airspace, having a much larger rotor-swept area than the old turbines, and potentially affecting different species.

CHAPTER 4: IMPACT ANALYSIS AND CONFORMANCE WITH LAWS

This chapter discusses conformance with laws and approaches to assessing bird and bat impacts during the pre-permitting phase of wind energy development. It also discusses how other state and federal wildlife laws relate to this impact analysis. Pursuant to CEQA, lead and responsible agencies need estimates of potential fatalities and an assessment of the level of risk to individuals and populations to make determinations of significance and to establish impact avoidance, minimization, and mitigation requirements. Assessment of the level of impacts is based on the number of individuals and categories of species at risk, turbine size, design and layout, and the interaction of these attributes with physical factors such as weather and topography. The information gathered during pre-permitting assessment and the impact analysis evaluated during the CEQA process will also provide an assessment of a project's ability to comply with other state and federal wildlife laws.

Early identification of potential adverse impacts provides more opportunities for implementing impact avoidance and minimization measures. An estimation of potential impacts is also the primary factor in determining operational monitoring levels. Operations monitoring provides feedback on the accuracy of impact estimations, allowing improved future impact assessments and contributing to an adaptive management process.

Relationship of Guidelines to Local, State, and Federal Laws

The *Guidelines* provides some information on relevant wildlife laws that apply to the wind development permitting process. The objective of this document, however, is not to determine which bird and bat impacts are "significant" under CEQA, but rather to provide information and guidance that can be useful in evaluating and determining the level of impacts. CEQA significance for a project is typically determined by the local lead agency, with input from the wildlife agencies, scientific experts, and/or a project-specific science advisory committee. Significance must be determined on a project-by-project basis because all potential risk, including cumulative impacts, must be considered within a local and regional context, and lead agencies must evaluate the particular factors in the project area. In this context, what follows is a discussion of CEQA and other applicable local, state, and federal laws.

County Ordinances / Regulations

Some California counties have adopted wind resource elements as part of their general plans and/or wind energy zoning ordinances. County siting elements and zoning ordinances govern the areas in which wind projects may or may not be located, with restrictions to agricultural zones being a common theme. The ordinances generally specify standards for setbacks, height, noise, safety, aesthetics, and other requirements. Most county general plans specify that the processing of discretionary energy project proposals shall comply with CEQA and direct that the environmental impacts of a project must be taken into account as part of project consideration. Typically, general plans also direct planning staff to work with local, state, and federal agencies to assure that energy projects (both discretionary and ministerial) avoid or minimize direct impacts to fish, wildlife, and botanical resources, wherever practical. Some county ordinances include language regarding assessment of avian impacts, but, currently, none provide specific guidance on studies necessary for assessing significance of impacts to bird and bat populations or provide direction for monitoring programs and feasible mitigation options.

State Laws

California Environmental Quality Act

CEQA governs how California counties, cities, and other government entities make permitting decisions for wind energy development. CEQA requires local agencies, those making land use decisions as well as any other agencies issuing permits, to evaluate and disclose the significance of the environmental impact of a project and to implement feasible impact avoidance, minimization, or mitigation measures that reduce and compensate for significant environmental impacts with the goal of reducing impacts to less than significant levels.

CEQA directs lead agencies to assess the significance of the environmental impact of a project and to seek feasible alternatives or implement feasible impact avoidance, minimization, or mitigation measures that avoid or substantially reduce or minimize environmental impacts to less than significant levels. The CEQA Guidelines[3] (regulations implementing CEQA) specify that a project has a significant effect on the environment if, among other things, it substantially reduces the habitat of a fish or wildlife species, causes a fish or wildlife population to drop below self-sustaining levels, or threatens to eliminate a plant or animal community [CEQA Guidelines, § 15065(a)(1)].

The Environmental Checklist Form in the CEQA Guidelines, Appendix G, states that impacts to biological resources are considered significant if, among other things, a proposed project will:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG or USFWS.
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations by CDFG or USFWS.
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

CEQA defines three types of impacts or effects:

- Direct impacts are caused by a project and occur at the same time and place (CEQA Guidelines, § 15358[a][1]).

[3]All citations of "CEQA Guidelines" refer to Title 14, California Code of Regulations, section 15002-15387.

- Indirect or secondary impacts are reasonably foreseeable and are caused by a project but occur at a different time or place. They may include growth-inducing effects and other effects related to changes in the pattern of land use, population density, or growth rate and related effects on air, water, and other natural systems, including ecosystems (CEQA Guidelines, § 15358[a][2]).
- Cumulative impacts refer to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts (CEQA Guidelines, § 15355[b]). Impacts from individual projects may be considered minor, but considered collectively with other projects over a period of time, those impacts could be significant, especially where listed or sensitive species are involved.

Fish and Game Code Wildlife Protection Laws

CEQA applies to CDFG's issuance of permits and other project approvals. In the broadest sense, CEQA and Fish and Game Code require that government agencies develop standards and procedures necessary to maintain, protect, rehabilitate, and enhance environmental quality, including fish and wildlife populations and plant and animal communities, to ensure that projects comply with these laws. For a wind energy project subject to CEQA, CDFG consults with lead and responsible agencies to provide biological expertise. Lead agencies are required to consult with CDFG, pursuant to CEQA Guidelines section 15086, so that CDFG can review and comment upon wildlife impacts arising from the project and make recommendations regarding those resources it holds in trust for the people of California. In addition, CDFG reviews and comments on environmental documents and impacts arising from project activities (Fish and Game Code, § 1802). CDFG is considered a trustee agency under CEQA Guidelines section 15386. CDFG does not approve or disapprove a wind energy project as a trustee agency, but approves projects that implicate one of the statutes that CDFG administers. CDFG, in collaboration with the California Energy Commission (Energy Commission), agrees to support and encourage the use of the *Guidelines* for wind turbine repowering projects and new wind energy projects in California. This document only relates to bird and bat species. Other sensitive species may be impacted by the wind resource area. These impacts must also be analyzed, and in some cases treated as significant, as part of CEQA.

In addition to CDFG's role in the CEQA process, direct consultation with CDFG is required to ensure that a proposed project will comply with Fish and Game Code statutes to ensure the protection of wildlife species. Several California Fish and Game Code sections that relate to protection of avian wildlife resources and are relevant to wind energy projects are described below.

- California Endangered Species Act (CESA), 1984 – Fish and Game Code section 2050 et seq. Species that are protected by the state (listed as endangered, threatened, or as a candidate) cannot be taken without an Incidental Take Permit (ITP) provided by CDFG or other document authorized by CESA. "Take" is defined in section 86 of the Fish and Game Code as hunt, pursue, catch, capture, or kill (and attempts to do so). CESA allows for permitted take incidental to otherwise lawful development projects if all standards in section 2081(b) of the Fish and Game Code are met. In issuing an ITP, CDFG typically requires additional impact avoidance, minimization, or mitigation measures beyond those that may be imposed pursuant to CEQA to ensure that project impacts are minimized and fully mitigated. The issuance of an ITP is a discretionary action by CDFG. When issuing a CESA ITP, CDFG must itself also comply with CEQA. CDFG usually acts as a responsible agency and relies on the lead agency's environmental document for a project to make findings and inform the decision of whether to issue an ITP. CDFG may also be required to act as CEQA lead agency for the project as a whole if there are no other prior local or state approvals required that trigger the CEQA process. Access to the full statute can be obtained from the following link: www.dfg.ca.gov/hcpb/ceqacesa/cesa/incidental/cesa_policy_law.shtml.

- Fully Protected Species, Fish and Game Code sections 3511, 4700, 5050 and 5515 – These statutes prohibit most take of species (using the same "take" definition as in CESA) that are classified as "fully protected." California identifies 13 species of birds as fully protected, including five raptors (American peregrine falcon, California condor, golden eagle, southern bald eagle, and white-tailed kite). No bat species are designated as fully protected. There is no provision for authorizing take of fully protected species, except for scientific research under specified conditions. Therefore, for a project with the potential for take of a fully protected species, no procedure currently exists for which to receive take authorization, and all take must be avoided. A species that is state-listed as threatened and endangered under CESA and also listed as fully protected cannot receive a take authorization. Presence of fully protected species will require close coordination with CDFG to ensure complete take avoidance of the species.
- Migratory Birds, Fish and Game Code section 3513 – This section protects California's migratory birds by making it unlawful to take or possess any migratory non-game bird as designated by the federal Migratory Bird Treaty Act, except as authorized in regulations adopted by the federal government under provisions of the Migratory Bird Treaty Act.
- Birds of Prey and Their Eggs – Fish and Game Code section 3503.5: It is unlawful to take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.
- Unlawful Sale or Purchase of Exotic Birds – Fish and Game Code section 3505: It is unlawful to take, sell, or purchase any aigrette or egret, osprey, bird of paradise, goura, numidi, or any part of such a bird.
- Nongame Birds – Fish and Game Code section 3800 (a): All birds occurring naturally in California that are not resident game birds, migratory game birds, or fully protected birds are nongame birds. It is unlawful to take any nongame bird except as provided in this code or in accordance with regulations of the commission or, when relating to mining operations, a mitigation plan approved by the department.

Federal Laws

The USFWS is responsible for overseeing the following three federal laws that apply to protecting wildlife from impacts from wind energy:

- Endangered Species Act (ESA), 1973 – Title 16, U.S. Code section 1531: The ESA protects 18 bird species/subspecies listed as threatened or endangered in California. No bats are currently listed as threatened or endangered in California. The ESA prohibits the take of protected animal species, including actions that “harm” or “harass”; federal actions may not jeopardize listed species or adversely modify habitat designated as critical. The ESA authorizes permits for the take of protected species if the permitted activity is for scientific purposes, is to establish experimental populations, or is incidental to an otherwise legal activity.
- Migratory Bird Treaty Act (MBTA), 1918 – Title 16, U.S. Code sections 703 to 712: MTBA prohibits the take, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by USFWS. At least 603 migratory bird species have been recorded in California. The MBTA authorizes permits for some activities, including but not limited to scientific collecting, depredation, propagation, and falconry. No permit provisions are available for incidental take. Only criminal penalties are possible, with violators subject to fine and/or imprisonment.
- 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 take, possession, and commerce of such birds. The 1972 amendments increased penalties for violating provisions of the act or regulations issued pursuant thereto and strengthened other enforcement measures. Rewards are provided for information leading to arrest and conviction for violation of the act.

All three federal wildlife protection laws prohibit most instances of take, although each law provides for some exceptions, such as for scientific purposes. The ESA authorizes USFWS to permit some activities that take a protected species as long as the take meets several requirements, including a requirement that the take be incidental to an otherwise legal activity. Permits may be issued under the ESA to a federal permitting agency, or developers may seek an ITP under the ESA for facilities sited on private land or where no federal funding is used or federal permit is required. The MBTA and the Bald and Golden Eagle Protection Act also allow permits for take, but incidental take of migratory birds is not allowed. Under all three statutes, unauthorized take may be penalized, even if the offender had no intent to harm a protected species. Direct consultation with the USFWS should occur early at appropriate points in the project development process, to ensure that projects will comply with these federal laws.

Evaluating and Determining Impacts

Direct Impacts

For purposes of the *Guidelines*, “direct impacts” refers to bird and bat collisions with wind turbine blades, meteorological towers, and guy wires. Potential direct impacts are determined by evaluating all of the pre-permitting data to determine which species might be subject to collision with turbines and which non-biological factors (such as topographic, weather, and turbine design features) may contribute to this risk. The presence of special-status species using areas that put them at risk may be enough to determine that there are potential impacts. Besides presence, other factors should be considered as potentially contributing to collision fatalities. Turbine design characteristics and proposed siting locations are two factors that are known during the impacts analysis and should be evaluated regarding potential contribution to risk. Some factors are presented with the understanding that little is currently known about their contribution to fatality risk, so it is incumbent upon biologists making impact determinations to be up to date on the latest research. Operations monitoring from neighboring projects can also provide some information on potential impacts. The National Wind Coordinating Committee Wildlife Workgroup is an information source that should be consulted regularly regarding research advances (www.nationalwind.org/workgroups/wildlife/).

Turbine Height / Size

It is unclear whether larger (750 kilowatt [kW] or 2+ megawatt [MW]) and smaller (40 kW to 400 kW) wind turbines cause equivalent bird collision fatalities based on rotor-swept area or MW of generating capacity. Fatality rates at small and large turbines also differ between species groups (migrants versus residents, songbirds versus raptors) within and between seasons and years. While use of larger turbines may increase or reduce avian fatality rates for some species, the effects of taller turbines on bats and nocturnal migrants have not yet been investigated with the same level of effort that has been expended on some species of raptors and other diurnal birds. Given the lack of sufficient information about the effects of turbine size, it should not be assumed that placement of larger turbines will reduce avian or bat collision risk.

Turbine Design

There has been considerable discussion regarding the effects of tubular versus lattice towers and whether lattice turbines contribute to higher fatality rates due the to increased availability of perches (Orloff and Flannery, 1992; Hunt ,1995; Smallwood and Thelander, 2004 and 2005). Turbines with guy wires and above-ground transmission lines present additional collision hazards. Newer turbine designs generally do not incorporate guy wires. Although newer, larger turbines have a variable speed design and can operate at lower average revolutions per minute (RPM), they can have a comparable tip speed. A secondary benefit of modern turbines may be the presence of fewer turbines over a given area. For example, some older turbines at the Altamont Pass Wind Resource Area are rated at 100 kW while many of the newer turbines have at least 10 times the power rating. Many of the newer turbines however, operate at both lower and higher wind speeds, significantly increasing the operation time.

Turbine Siting

Assessing the impacts of turbine siting and determining appropriate turbine placement requires a thorough understanding of the distribution and abundance of birds and bats at a proposed site and site-specific knowledge of how wildlife interacts with landscape features at the site. Orloff and Flannery (1992 and 1996), Smallwood and Thelander (2004 and 2005), and Smallwood and Neher (2004) all estimated associations between bird fatalities and attributes of wind turbine locations relative to topography and other factors. They concluded that wind turbine siting contributes substantially to bird mortality and that careful siting of new wind turbines could substantially reduce fatalities; these predicted associations, however, have not been field-tested. Strickland et al. (2001) concluded that wind turbines located away from the edge of the ridge at Foote Creek

Rim, Wyoming, would result in lower raptor fatality rates than turbines located immediately adjacent to the edge. Smallwood and Neher (2004) had similar findings in that they determined that raptors fly disproportionately more often on the prevailing windward aspects of slopes.

Topographical features of a site may increase the risk of migrating nocturnal birds colliding with wind turbines. McCrary et al. (1983) noted that wind turbines on ridges might present a risk of collision because the altitude of birds in relation to ground level decreases when they fly over ridges. Williams et al. (2001) conducted studies in the northern Appalachian Mountains and noted that avian migrants react to local terrain resulting in concentrations of migrants over ridge summits or other topographic features. Similar results have been reported from studies in the Swiss Alps, where researchers observed that landforms have significant guiding effects (Bruderer and Jenni, 1990; cited in Williams et al., 2001). Richardson (2000) also notes that migration altitudes can be lower than cruising altitude when birds are crossing a ridge or pass.

Lighting Impacts

Presence of nocturnal migratory birds raises concerns about tower lighting and its potential to increase collision risk. Questions remain about the impact of facility lighting on night migration of songbirds and other nocturnally flying birds, particularly during poor weather conditions. It is also important to recognize varying taxonomic susceptibility to light and that night-migrating songbirds are apparently attracted to lights, but that shorebirds and waterfowl are probably not (Kerlinger, 2004). Studies at communication towers and other lit structures suggest that birds may become disoriented in poor weather and are attracted to lights, which may increase vulnerability to collision with towers, guy wires, and turbine blades (NWCC, 2004). Current literature suggests that steady-burning bright lights are the most attractive to birds (Kerlinger, 2004; Gehring, 2006).

Weather Events

Weather characteristics in a project area should be considered in assessing potential for bird and bat collisions with wind turbines. Birds can become disoriented in poor weather and fly at lower altitudes during migration due to heavy overcast weather increasing the number of birds potentially flying through the rotor-swept area (Richardson, 2000). Seasonal fog or frequent storm events may impair the ability of birds to detect and avoid turbines, leading to increased impacts. Weather that affects visibility may also increase the attraction of migrating birds to lights (Richardson, 2000).

Risk Assessment

Information on bird and bat use of a proposed wind energy site can be used to perform a qualitative assessment of risks, classified as a Phase I risk assessment (Kerlinger, 2005). A Phase I risk assessment is used to determine if high bird or bat use might represent a fatal flaw of a proposed project and to develop studies to better evaluate risk. The next level of a risk analysis is to make this assessment more quantitative, which involves collecting data on the abundance, spatial, and temporal distribution of birds and bats using the site, as well as behavior and time spent in areas where they might be at risk of collision and comparing this information to existing data on fatalities at wind resource areas. Methods for collecting these data have been described in “Pre-

Permitting Assessment." The analysis of various types of risk to birds due to wind turbines is discussed in Anderson et al. (1999) and more recently in Erickson (2006). The goal of the risk assessment is to determine whether overall avian and bat fatality rates are low, moderate, or high relative to other projects and to provide measures of overall avian and bat casualties attributable to collisions with wind turbines. For all quantification of risk and fatality estimates, a uniform metric of birds or bats per MW of installed capacity per year should be used to express risk or fatality predictions.

Indirect Impacts

Potential indirect impacts to birds and bats from wind energy projects include disturbance of local populations and subsequent displacement or avoidance of the site and disruption to migratory or movement patterns (NWCC, 2004). To date, displacement and site avoidance impacts have not been evaluated as extensively in California as they have been in other areas. Several studies have been published or are ongoing on the displacement and avoidance impacts of wind turbines and associated infrastructure and activities on grassland and shrub-steppe breeding songbirds and other open country birds (for example, prairie chicken and sage grouse, shorebirds, waterfowl). Some studies have documented decreased densities and avoidance by grassland songbirds and other birds as a function of distance to wind turbines and roads (Leddy et al., 1999; Erickson et al., 2003; Schmidt et al., 2003).

Impacts to movement patterns of waterfowl and shorebirds have been a concern in many western European countries where offshore wind farms are in the pathway of daily commutes of seabirds (Guillemette et al., 1999; Dirksen et al., 2000). A few studies have looked at the relationship between nest occupancy and placement of turbines (Howell and Noone, 1992; Hunt et al., 1999; Hunt 2002; and 2002; Erickson et al., 2003) and have documented relatively few impacts. Most of these studies do not conclusively establish that a reduction in use of an area is due to avoidance (indirect impact) versus the reduction in a local population due to collisions with turbines (direct impact).

The BACI study design described earlier allows researchers to assess indirect impacts to determine if wind turbines are affecting bird or bat density. The BACI study design may be particularly important to determine if turbines are attracting specific bat species.

One indirect impact that has been well studied in California is the potential for the turbine base area to become enhanced habitat for raptor prey. Based on data collected at the Altamont Pass Wind Resource Area, Smallwood and Thelander (2004 and 2005) found that fossorial mammals such as ground squirrels burrowed under wind turbine pads. They concluded that the presence of small mammals might have attracted foraging raptors close to the turbines. Biologists should be aware of this kind of potential impact when reviewing the site design. In most instances, they can recommend designs that would minimize the increase in occurrence of fossorial mammals.

Cumulative Impacts

An important provision of CEQA is the requirement for a cumulative impact analysis. This provision requires a determination of whether or not a project's incremental impacts combined with the impacts of other projects are cumulatively considerable.

Assessing cumulative impacts to birds and bats is difficult because population viability data are unavailable for most species. Furthermore, it is difficult to establish an appropriate geographic scope for a cumulative impact analysis, to secure comprehensive information on existing and planned projects, and to gauge the relative contribution of a project's impacts compared to past, present, and future projects.

Cumulative impact analyses for wind energy projects should focus on potential impacts to bird or bat populations over a time span that encompasses the entire estimated operational life of the project. Cumulative impacts could apply to the birds and bats in and immediately adjacent to the wind farm or in populations or subpopulations some distance away due to changes in immigration and emigration. The level of detail in a cumulative analysis need not be as great as for the project's direct impact analysis, but should reflect the severity and likelihood of occurrence of the potential impacts. The cumulative impact discussion should be guided by standards of practicality and reasonableness (CEQA Guidelines, § 15130).

While the cumulative impacts of a project may be difficult to determine, it is important not to discount the impacts of a project based on relative size. The addition of one small wind energy project in an existing wind resource area could be considered trivial, but this is faulty logic with regard to CEQA and trivializes the potential impacts of incremental increases in projects.

An adequate analysis of cumulative impacts on special-status bird or bats species should include the following steps:

1. Identify the species that warrant a cumulative impact analysis, including any species for which a determination of potentially significant impacts has been made. The baseline population of the relevant species should be assessed, as well as whether the population is resident, seasonally breeding, migratory, or wintering and stable, increasing, or decreasing. The assessment should include a discussion of natural and anthropogenic factors contributing to population trends.

2. Establish an appropriate geographic scope for the analysis and provide a reasonable explanation for the geographic limitation used. The geographic scope of the analysis will generally include a much larger area than the project site.

3. Compile a summary list of past, present, and reasonably foreseeable future projects within the specified geographical range that could impact the species, including construction of transmission lines and other related wind energy project infrastructure. The list of projects should include other wind generation projects as well as other projects that may involve habitat loss, collision fatalities, or blockage of migratory routes that could impact species under consideration. The project summary should describe the environmental impacts of each individual project on the species and provide the reader with references as to where information about other projects is available.

4. Assess the impacts to the relevant bird or bat species from past, present, and future projects. The analysis should make use of population trend information and regional analyses that are available for the species. Determinations of population viability and the contribution of the project to the cumulative impact should be made. If, after thorough investigation, the impact is considered too speculative for evaluation, that conclusion should be stated and the cumulative impact assessment can be terminated (CEQA Guidelines, § 15145). The lead agency needs to identify facts and analysis supporting any conclusion that the cumulative impact is less than significant.

5. Identify the impacts and impact avoidance, minimization, or mitigation measures to the species, and make a determination regarding the significance of the project's contributions to cumulative significant impacts. The significance determination should include an evaluation of the cumulative impacts the project and neighboring projects might have on the local or regional species population or the species as a whole. For some projects, the only feasible mitigation for cumulative impacts may involve the adoption of ordinances or regulations or implementation of a regional mitigation plan, rather than the imposition of conditions on a project-by-project basis.

CHAPTER 5: IMPACT AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

This chapter discusses measures that can be implemented at the pre-permitting and operations phases of wind energy projects to mitigate bird and bat impacts, including:

- Siting impact avoidance and minimization.
- Compensation.
- Operations impact avoidance, minimization, and mitigation.

Implementing effective impact avoidance, minimization, and mitigation measures requires the following:

- Obtaining adequate information about bird and bat resources during pre-permitting.
- Adequate operations monitoring.
- Adequate impact assessment (estimate).
- Implementation of adequate impact avoidance and minimization measures.
- Selection and implementation of adequate mitigation/compensation.
- Adaptive management/effectiveness monitoring and feedback loops.

Impact Avoidance and Minimization

The most important decision regarding impact avoidance and minimization comes early in site screening, often prior to stakeholder input. If a site is developed despite indications that substantial bird or bat fatalities might result, problems can continue throughout the life of the project. As discussed in previous chapters, absolute avoidance is required to be in compliance with certain state and federal laws. Avoidance of impacts is best applied during pre-permitting site selection (macro-siting) and during site layout planning (micro-siting). Good macro-siting decisions are essential for choosing an acceptable site or portion of a site.

Once a site is selected, micro-siting efforts, such as appropriate placement of turbines, roads, power lines, and other infrastructure, can avoid or reduce potential impacts to birds, bats, and other biological resources. However, if a wind farm is placed in a poor site such as an area used heavily by raptors, it will be difficult for micro-siting to prevent higher levels of fatalities.

Each wind energy project site is unique, and no one recommendation will apply to all pre-permitting site selection and layout planning. However, the following elements should be considered in site selection and turbine layout and in developing infrastructure for the facility.

Minimize Fragmentation and Habitat Disturbance

Pre-permitting studies must be sufficiently detailed to provide maps of special-status species habitats (such as wetlands or riparian habitat, oak woodlands, large, contiguous tracts of undisturbed wildlife habitat, raptor nest sites) as well as bird and/or bat commuter corridors that are used daily, seasonally, or year-round. The maps should be used to establish the layout of roads, fences, and other infrastructure to minimize habitat fragmentation and disturbance.

Establish Buffer Zones to Minimize Collision Hazards

Buffer zones in which no disturbance is allowed should be established to protect raptor nests, bat roosts, areas of high bird or bat use, or special-status species habitat if pre-permitting studies show that the proposed facility could pose a bird or bat collision hazard. For example, proposed wind energy project sites near water and/or riparian habitat in an otherwise dry area could increase the number of bird and bat collisions, so projects in these types of areas should not be encouraged. The extent of the buffer zone should be determined in consultation with CDFG, USFWS, and the science advisory committee.

Reduce Impacts with Appropriate Turbine Layout

Pre-permitting studies must be sufficiently detailed to establish normal movement patterns of birds and bats to inform micro-siting decisions about turbine configuration. Turbine alignments that separate birds from their daily roosting, feeding, or nesting sites or that are located in high bird use or bat use areas can pose a collision threat.

Reduce Artificial Prey Habitat at Turbine Base Area

Turbine base areas and other structures may provide habitat for fossorial mammals such as squirrels and gophers, which may in turn attract foraging raptors. Designs that minimize the amount of artificial habitat such as disturbed or unvegetated banks should be incorporated into construction of turbine pads. Only benign methods to eliminate or reduce fossorial animals should be used in order to avoid adverse impacts to other special-status species.

Avoid Lighting that Attracts Birds and Bats

How birds and bats respond to lighting is poorly understood. No definitive studies have been conducted that provide conclusive results. What is known is that night migrating songbirds are attracted to steady-burning lights at communications towers and other structures, increasing the potential for large-scale fatality events (Kerlinger, 2004). Steady-burning, bright lights appear to be the most attractive to birds and may also attract insects, which may in turn attract foraging bats.

Until more is known, lights with short flash durations that emit no light during the “off phase” should be used, with the minimum number of flashes per minute (that is, longest pause between flashes) and the briefest flash duration allowable. Strobes and modern light emitting diodes lights are capable of these specifics. Lights on auxiliary buildings near wind turbines and meteorological towers should use motion-sensitive lights rather than steady burning lights and should be downcasting.

Minimize Power Line Impacts

To prevent avian collisions and electrocutions, all connecting power lines associated with wind energy development should be placed underground, unless burial of the lines would result in greater impacts to biological resources. All above-ground lines, transformers, or conductors should fully comply with the Avian Power Line Interaction Committee (APLIC) 2006 standards to prevent avian fatality, including use of various bird deterrents.

Avoid Guy Wires

Guyed structures are known to pose a hazard to birds, especially if lighted for aviation safety or other reasons. Communication towers and permanent meteorological towers should not be guyed at turbine sites. If guy wires are necessary, then bird deterrents should be used.

Decommission Non-Operational Turbines

When wind turbines are no longer operational, they should be removed so they no longer present a collision hazard to bird and bats. As part of permitting applications, developers should submit a decommissioning and reclamation plan that describes the expected actions when some or all of the wind turbines at a wind energy project site are non-operational. The plan should discuss in reasonable detail how the wind turbines and associated structures will be dismantled and removed.

Decommissioning a project typically involves removal of turbine foundations to one meter (three feet) below ground level and removing access roads and unnecessary fencing and ancillary structures. The decommissioning plan should also include documentation showing financial capability to carry out the decommissioning and restoration requirements, usually an escrow account, surety bond, or insurance policy in an amount (approved by the lead agency) sufficient to remove the wind turbines and restore the site.

Compensation

Compensation is a common way to mitigate or offset impacts, including cumulative impacts that cannot be avoided or minimized in other ways. Although impacts still occur, compensating for impacts can determine whether there is no project, a delayed project, or a timely project approval. The decision to require compensatory mitigation is made by the permitting authority, ideally with CDFG, USFWS, and/or the science advisory committee providing input. When a permit is required from CDFG or USFWS, additional compensatory mitigation is included in those permits above what may be required to meet CEQA mitigation obligations. Compensation amount and metrics are site- and species-specific and need to be formulated for each project with input from stakeholders and the science advisory committee. The general terms and funding commitments for compensation should be established during project permitting.

Compensation typically involves purchase of land through fee title or purchase of conservation easements or other land conveyances and the permanent protection of the biological resources on these lands. The land or easements that are purchased should have high biological value for the target species that have been affected by the wind energy project. The land or easements can either consist of a newly established, project-specific purchase or can be part of a well-defined and established conservation program, such as a mitigation bank. Whether land is acquired indirectly through a mitigation bank or directly through a project- specific purchase or easement, the mitigation should be consistent with certain aspects of CDFG's official 1995 policy on conservation banks (ceres.ca.gov/wetlands/policies/mitbank.html). These include, but are not limited to:

- The mitigation site must provide for the long-term conservation of the target species and its habitat.
- The site must be large enough to be ecologically self-sustaining and/or part of a larger conservation strategy.
- The site must be permanently protected through fee title and/or a conservation easement.
- Prior to sale of the property or easement or sale of credits at a mitigation bank, a resource management plan should be approved by all appropriate agencies or a non-governmental organization involved in the property management.
- A sufficient level of funding with acceptable guarantees should be provided to fully ensure the operation and maintenance of the property as may be required.
- Provisions should be made for the long-term management of the property after the project is completed or after all mitigation credits have been awarded for the mitigation bank.
- Provisions should be made for ensuring implementation of the resource management plan in the event of non-performance by the owner of the property or non-performance by the mitigation bank owner and/or operator.
- Provisions should be made for the monitoring and reporting on the identified species/habitat management objectives, with an adaptive management/ effectiveness monitoring loop to modify those management objectives as needed.

Regardless of the form of the compensatory mitigation, a nexus between the level of impact and the amount of mitigation should be established by the permitting agency. Unlike habitat impacts, in which an acre of habitat lost can be compensated with an appropriate number of acres of habitat restored or protected, bird and bat collisions with wind turbines are impacts that do not suggest an obvious compensation ratio. Collision impacts take place in airspace rather than over a specified acreage of land and are chronic impacts occurring each year. The impacts can extend well beyond the local environment because the affected birds and bats are often migratory and far ranging, sometimes coming from out of state or out of country. Finally, fatalities can vary greatly between project sites and from year to year. Under these circumstances, it is difficult to identify acreage of land that offers compensation value for some quantity of bird or bat fatalities.

Given the unusual nature of bird and bat impacts from turbine collision, permitting agencies must consider compensation alternatives to a simple acreage ratio that would only include the footprint of the project. Compensation may be required at some level on a one-time up-front basis and/or at a different level annually for the life of the project.

The level of compensation should be biologically based and reasonable, and should provide certainty in terms of the funds that will be expended over the life of the project and certainty that the mitigation will continue to provide biological resource value over that same period. The science advisory committee should be consulted in development of the ratios and fees to be used in establishing these compensation formulas because all of these methods require some forecasting of impacts over the life of the project based on pre-permitting studies.

Operations Impact Avoidance, Minimization, and Mitigation

Once a project is operating, it is difficult to modify turbine site layout, and operations impact avoidance, minimization, and mitigation options are limited. These options include maintenance activities or habitat modification to make the site less attractive to at-risk species and seasonal changes to cut-in speed. During the bat migratory period, limited and periodic feathering of wind turbines during low wind nights may help avoid impacts to bats. If multi-year monitoring documents high levels of fatalities, removal of problem turbines or seasonal shutdowns of turbines may be options. In some cases, such as mortality in violation of state or federal laws, operational and facility changes may be the only option.

With such limited choices for operational impact avoidance or minimization, it is important to anticipate contingencies to mitigate high levels of unanticipated fatalities. The pre-permit conditions should explicitly establish what the compensatory mitigation range should be for unexpected fatalities and the thresholds that will trigger implementation of that mitigation. Pre-established compensatory mitigation measures for unexpected impacts avoid open-ended conditions that are difficult for developers to include in planning for project costs and timing.

Adaptive Management / Effectiveness Monitoring

Adaptive management and effectiveness monitoring are not mitigation measures, but are analytical processes for adjusting management and research decisions to better achieve management objectives, such as reducing the number of bird and bat collisions with wind turbines. The adaptive management process recognizes the uncertainty in forecasting impacts to birds and bats and allows options to be tested as experiments to achieve a goal and determine impact avoidance, minimization, and mitigation effectiveness. Adaptive management is a tool for implementing and monitoring impact avoidance, minimization, and mitigation goals and efforts and may lead to modifying measures or to additional measures as monitoring effectiveness information is returned via a feedback loop. Adaptive management should not be used as a reason to defer impact analysis and mitigation commitments.

Successful adaptive management requires a firm commitment by project owners to accountability and remedial action in response to new information about the effectiveness of mitigation. This commitment must be included in permit condition(s) during the permitting process so that a mechanism is available to implement mitigation recommendations after the project is permitted. A science advisory committee is essential for interpretation of operations monitoring data and for development of management recommendations based on these data.

CHAPTER 6: PERMITTING

This chapter discusses some of the essential steps in the permitting process that will facilitate completion of important milestones throughout the application process and the life of the project.

The permitting process usually begins with the developer approaching the county or public agency responsible for issuing the land use permit. Typically this agency becomes the lead agency under CEQA. CEQA provides direction on assessment of the significance of impacts and the development of feasible mitigation, but the county or responsible public agency may have its own resource standards as well. It is important to contact the local agency early in the process to determine if it has its own standard conditions for addressing specific resource policies that apply to bird and bat issues.

The developer should contact landowners, local environmental groups, and local, state, and federal wildlife management agencies such as CDFG and USFWS early in the permitting process. Pre-permitting meetings with these groups may provide critical information on which to base site development decisions. There may be a standing science advisory committee that has been involved with an adjacent or nearby wind resource area that can provide information on bird and bat issues that exist in the area. Local environmental groups and wildlife agencies may have relevant information as well as concerns about special-status birds or bats. Early discovery of these issues can give the developer a glimpse of the type and timing of surveys that will be involved.

Pre-Permitting Data Collection and Analysis

Timely and thorough pre-permitting assessment surveys are essential to facilitation of the permitting process. Early discussion of proposed survey protocols with the lead agency, CDFG and USFWS as well as the science advisory committee will allow for an evaluation of the level and timing of the effort in relation to project milestones such as the desired construction start date. The developer should not assume that only the standard, one-year bird and bat assessment (outlined earlier) needs to be performed. Concern over particular bird or bat species that have special monitoring needs may require evaluation beyond the one-year assessment cycle.

All parties involved in planning pre-construction surveys should be aware that following the CEQA Guidelines alone for determination of significance may not highlight all of the species that need to be evaluated. For example, species at potential risk that fall under the protection of the Federal Migratory Bird Treaty or are fully protected species need to be included when designing surveys. Initiating timely and thorough surveys is also important when considering the potential for state or federal listed species, and contacting agencies early in the permitting process can reduce the potential for lengthy delays in securing take permits. Additional mitigation above and beyond that required by CEQA as conditions of the permit may be required to ensure that project impacts are avoided, minimized, and fully mitigated, depending on applicable statutory standards.

The developer may find that initiating assessment surveys early will avoid unnecessary and costly delays in permitting. Adherence to guideline protocols, including standardization of data, will allow for detailed analysis by the science advisory committee and responsible agencies such as CDFG and should increase the speed of the permitting process. Finding suitable habitat for compensatory mitigation if necessary can be time consuming; early and thorough data collection and analysis will aid this process. Inadequate data acquisition may result in more stringent impact avoidance, minimization, or mitigation measures to ensure species protection and will likely result in increased levels of operation monitoring.

Permit Compliance

Frequent consultation with CDFG and USFWS should continue throughout the impact analysis and mitigation development process. After issuance of the permit, compliance with mitigation and operations monitoring requirements as well as all other conditions of the permit are important. Reporting data in a standardized manner will provide necessary information for post-construction comparisons and will aid in determining if impact avoidance, minimization, or mitigation measures are effective. Collecting and reporting operations monitoring data are also important to provide future developers, agencies, and biologists with better information to evaluate future impacts. Using the *Guidelines'* protocols will produce scientifically sound, cost-effective study designs and will produce comparable data among studies within California. This will allow for analyses of trends and patterns of impacts and improve the ability of researchers to predict impacts locally and regionally.

CHAPTER 7: OPERATIONS MONITORING AND REPORTING

This chapter describes the standardized techniques that are recommended for collecting, interpreting, and reporting post-construction operations monitoring data. The rationale for operations monitoring at wind turbine sites is to collect bird and bat use and fatality data and compare that to impact estimates from the pre-permitting studies and other wind energy facilities. This information is required to evaluate, verify, and report on compliance and effectiveness of CEQA avoidance and minimization measures and to document compliance with other applicable permit requirements. Operational monitoring data can provide a means to evaluate the effectiveness of impact avoidance, minimization, or mitigation measures. Monitoring also informs the development of new wind energy facilities in California and provides an opportunity to determine the occurrence and magnitude of unanticipated impacts on birds or bats. On a larger scale, consistently collected monitoring data will provide insight into the reasons for bird and bat fatalities.

Operations monitoring typically consists of ongoing bird and bat use surveys and counts of carcasses in the vicinity of wind turbines. The number of carcasses counted during operations monitoring is an underestimate of the birds and bats actually killed by wind turbines. Searchers will inevitably miss some of the carcasses. In addition, some carcasses may disappear due to scavenging or be destroyed by farming activities such as plowing. Some birds and bats may also be uncounted because they are injured by turbines and fly or hop out of the search area. Most fatality estimates reported for wind energy projects are therefore extrapolations of the number of fatalities with corrections for sampling biases. The methods described below are recommendations for protocols to conduct bird and bat use surveys and carcass counts, quantify and correct for the inherent biases in carcass counts, and analyze and report the data.

The duration of operations monitoring should be sufficient to determine if pre-permitting estimates of bird or bat impacts were reasonably accurate and to determine if turbines are causing unanticipated mortality that requires impact avoidance or mitigation actions. In most situations, two years of operations monitoring is needed so that carcass counts and bird and bat use data can be collected in spring, summer, fall, and winter and capture variability between years. If pre-permitting studies indicate high potential for bird or bat impacts and considerable seasonal or annual variation in bird or bat use, a longer operations monitoring study may be required to determine if pre-permitting estimates of fatalities are accurate, if mitigation is working, and if further operations monitoring is warranted. For example, in their studies at the Altamont Pass Wind Resource Area, Smallwood and Thelander (2004) found that achieving reliable estimates of mortality required at least three years of monitoring and carcass counts. Conversely, minimal operations monitoring would be suitable for a project in which pre-permitting studies indicated that impacts were likely to be low, or if the proposed project is adjacent to an established and well-studied wind farm that had credibly demonstrated minimal levels of bird and bat impacts. For all proposed projects, the science advisory committee, CDFG, and USFWS should be consulted regarding study protocol and the duration of an operations monitoring program.

Upon completion of two years of operations monitoring, the science advisory committee, CDFG, and USFWS should assess whether continued, long-term monitoring is required. Long-term monitoring on a periodic basis (for example, every five years) for the life of the project should occur if the science advisory committee and resource agencies determine, based on operations monitoring, that project operation is likely to result in substantial impacts to birds or bats. Such long-term monitoring could be coordinated with larger, more regional studies within the entire wind resource area if deemed appropriate by the science advisory committee.

Repowering—Operations Monitoring

Operations monitoring needs for repowering projects are based on pre-permitting site screening and monitoring results and decisions like other wind energy projects. Generally, standard protocol monitoring should be conducted to determine operations fatality levels for birds and bats and whether the levels are approximately those estimated during pre-permitting assessment. The discussions in this chapter pertain to repowering projects as well as other wind energy projects.

Bird and Bat Use

Data on bird and bat abundance and site use should accompany all fatality studies at wind energy project sites. Data reporting should be standardized as discussed in "Pre-Permitting Assessment." Bird and bat use surveys characterize bird abundance, flight, and perching behavior and bat use in and around turbines and topographic features of the site. Surveys should be conducted as described earlier to allow comparisons of data before and after the project and with other projects.

BUCs provide information on bird species composition, relative abundance, and bird behavior that might influence vulnerability to collisions with wind turbines. To assess bird behavior near wind turbines, visual scans should be conducted from vantage points for 30 minutes per observation period. Surveyors should be trained in distance and flight height estimation, and flight heights should be categorized to correspond to the height below, within, and above the space occupied by turbine blades. For raptor behavior studies, the surveyor should record locations and behavior at short intervals (30 seconds, for example) noting behavior such as soaring, contour hunting, and flapping flight, as well as height above ground and type of perch being used.

For consistency in comparing bird use, reporting the results of bird use surveys as number of birds per a specified time period and area is recommended—for example, number of raptors per minute observed within the range of the rotor-swept area. The bird use per minute metric (or bird use per 30 minutes) allows comparison with other past studies and can be used to discuss bird use at the project site and in the rotor-swept area out to some distance, time spent in the area of interest, and bird use at some height above ground. This information can be broken down to groups of birds or individual species if desired. It is important to estimate distance to each bird, so that bird use can be analyzed at incremental distances. This will allow comparisons with studies that used a set distance from the observer (for example, raptors within 300 meters or within 800 meters).

Morrison (1998) and others provide sample data sheets that offer a standardized format for data collection during surveys (Appendix F). At a minimum, the data that should be recorded for each observation period include:

- Time
- Species
- Number
- Distance estimated from the observer to each bird
- Activity
- Habitat
- Flight direction
- Distance estimated to turbine
- Flight height estimated to the nearest meter.

Weather/environmental data to be recorded at each visit includes:

- Temperature
- Wind speed and direction
- Cloud cover
- Precipitation
- Moon phase/light intensity (for bat and nocturnal bird surveys).

Two years of acoustic monitoring is recommended. The acoustic monitoring will determine ambient levels of bat and nocturnal bird activity following the commencement of operation, particularly during migration. The pre-permitting surveys should have indicated which seasons are of particular concern for potential bat impacts and which times of the year may warrant more intensive bat and bird monitoring. The methods should be consistent with those used during pre-permitting studies, and the study design should be confirmed in consultation with CDFG and the science advisory committee. Kunz (2004) and the California Bat Working Group (2006) provide a discussion of post-construction survey methods for bats.

Carcass Searches

Establishing Carcass Search Plots

The dimensions of carcass search plots will vary depending on turbine size and configuration and characteristics of the site. If a row of turbines is to be monitored, a rectangular plot encompassing those turbines works well. A circular plot is appropriate for isolated turbines. The size of the search area should be established after experimenting with some pilot carcass searches. A good starting point for the pilot searches is a carcass search plot size with a radius of 1.5 times the rotor diameter. For example, if the rotor-swept diameter is 50 meters, a circular plot with a radius of 75 meters would be established with the turbine base as the center; if a rectangular plot is used, the searches would extend out 75 meters from the base of the turbine on each side. If the site is steep, the search area should be extended on the downhill side because carcasses could fall farther from the turbine. In studies where bats are the sole focus of the search, the search radius can probably be less than for large birds and raptors. Studies conducted at other wind energy facilities indicate that most bat fatalities (more than 80 percent) typically are found within half the maximum distance from the turbine tip height to the ground (Kerns et al., 2005).

A search area can be selected that does not encompass 100 percent of the carcasses, as indicated by pilot searches or incidental observations of carcasses outside the search area. However, that source of error should be quantified and corrections made in the final calculation of fatalities. A search area that includes 80 percent or better of the carcasses is preferred.

Another source of error in carcass counts is crippling bias, the undercounting that occurs because some birds or bats might be injured by turbines and move outside of the search area. Accounting for crippling bias is difficult. No recommendations are provided for methods to estimate crippling bias because in previous studies where attempts were made to do so, relatively little relevant data were obtained per unit time of effort (EPRI et al., 2003).

Conducting Searches

Carcass search and bird and bat use data can be used to estimate the number of bird and bat deaths attributable to collisions with wind turbines or meteorological towers. Carcasses should be located by trained and tested searchers who walk the search area in either linear or concentric circle transects around the turbine. A standard transect six meters wide, three meters on either side of a centerline, (the searcher looking at three meters on either side) is recommended, but the transect width should be adjusted for vegetation and topographic conditions on the site. The rate of searching will also vary depending on terrain and vegetation. A search area at one large turbine can take from one hour to several hours depending on the site conditions.

Evaluating Cause of Death

All carcasses located in the search areas should be recorded and collected (unless they are being used as part of a scavenging trial) and a cause of death determined, if possible. Collected bat carcasses may also provide a source of genetic material for a program currently under development to assess the population size, genetic diversity, and geographic structure of bat populations affected by wind turbines (Simmons et al., 2006). Necropsy may be needed if there is a question of non-turbine caused death. State and federal collecting permits are required to salvage dead birds or bats.

The searcher should not necessarily assume that all carcasses in the search area are the result of turbine strikes and should consider other causes such as wire strikes, vehicle collisions, and electrocutions (Smallwood and Thelander, 2004). The condition of the carcass and location of the bird or bat relative to turbines, transmission lines, and roads can provide vital clues as to the cause of death and should be carefully observed and recorded. For example, birds or bats that have severed body parts and are near turbines are likely turbine kills, whereas electrocuted birds may have singe marks on the body and are typically found under power poles. Carcasses are also found intact with no apparent cause of death, so documentation regarding nearby structures is important. Any injured birds or bats encountered during the search should be considered a fatality. Injured birds or bats should be taken to a nearby rehabilitation center.

The carcass condition can be recorded in one of the following categories (Anderson et al., 1999):

- Intact – a carcass that is not badly decomposed and shows no sign of being 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, which shows signs of being fed upon by a predator or scavenger, or has a portion(s) of a carcass in one location (for example, wings, skeletal remains, legs, pieces of skin, etc.).
- Feather spot – 10 or more feathers at one location indicating predation or scavenging.

Documenting Carcasses

Data collected during each carcass search includes: a unique carcass identification number, site, date, observer, species, sex, and age and, when possible, time, condition (intact, scavenged, feather spot), description of injury(ies), identification of and distance to nearby structures or location recorded with GPS, distance to closest turbine, classification of closest turbine (that is, mid-row or end-row), type/make of nearest turbine, and distance to plot center. A description of the characteristics of the carcass indicating the cause of death or other pertinent information should also be recorded and the carcass should be photographed. Carcasses found by personnel at times other than the scheduled search (incidental find) should also be recorded as noted above and removed from the site. To help identify raptor carcasses to species, searchers can use the Energy Commission's *2005 Guide to Raptor Remains:* A *Photographic Guide for Identifying the Remains of Selected Species of California Raptors* (www.energy.ca.gov/2005publications/CEC-500-2005-001/CEC-500-2005-001.PDF).

Frequency of Carcass Searches

Search frequency will vary depending on the terrain, scavenging rates, target species, and the size of the project. The frequency of carcass searches at a wind energy project site should be established after analyzing the results of pilot scavenging trials and in consultation with the science advisory committee, USFWS, and CDFG. Carcass removal rates can vary greatly between project sites. Therefore, researchers should not rely on removal rates from other projects unless compelling evidence is available to demonstrate that these rates are truly applicable. Most researchers conduct carcass searches on a regular schedule of days (for example, every 3, 7, 14, or 30 days) with the assumption that fatalities occur at uniformly distributed, independent random times between search days.

A standard search frequency should be a minimum of once every two weeks. Searches can be more or less frequent if pilot scavenging trials indicate high or low levels of carcass removal. The search interval can also be decreased if pre-permitting studies indicate high potential for impacts to small birds and bats, which may be scavenged more quickly than large birds (Morrison, 2002). If pre-permitting studies indicate that bat impacts are of concern, daily searches at a subset of turbines (one-third of the turbines) should be conducted during the bat migratory periods (July through October) and weekly during the rest of the year.

Researchers should be aware that if the fatalities are highly clustered, as might be the case with rare periodic fatalities of migratory birds or bats, estimates could be biased, especially if carcass removal rates are high. If most fatalities occur immediately after a search, those carcasses would have a longer time to be removed before the next search, resulting in an underestimate of fatalities. On the other hand, if most fatalities occur before, but close to the next search, the fatality estimate may be an overestimate. One way to compensate for long intervals between searches is to intensively search a small sample area and search the remaining sample area less intensively. This stratified sampling can help clarify the relationship between weather events and fatalities and allow researchers to adjust the scavenging rate. For example, Kunz (2004) recommends post-construction survey protocols for bats that include daily carcass searches at one-third of turbine sites and weekly searches at one-third of the sites. After some trial carcass searches, the study design could involve a shift from looking under every turbine to looking at a sample of turbines. Such stratified sampling protocol should be established only after careful review of pilot scavenger removal studies and in consultation with the science advisory committee, USFWS, and CDFG.

Bias Correction

Researchers have noted numerous sources of bias in the carcass count that can make the extrapolated estimate of bird and bat fatalities too high or too low (Morrison, 2002; Smallwood, 2006). Estimates of fatalities, must, therefore incorporate corrections based on searcher efficiency and scavenging rates, as described below, and these estimates must be statistically independent of each other. Because searcher efficiency and scavenging are influenced by season, topography, and vegetation, these correction factors should be calculated based on season and vegetation-specific data for every study and should not rely on literature values because of substantial variability between studies and sites.

Searcher Efficiency

Searchers will vary in their ability to detect dead bird or bats in the field because of inherent individual differences (visual acuity, physical vigor, motivation, experience, and training) and differences in field conditions (weather, vegetation density, and height). Morrison (2002) found that the number of carcasses that searchers found varied considerably depending on observer training, vegetation type, and size of the bird. Estimates of animal fatalities in wind developments are therefore biased by an unknown amount by inefficiencies of observers, so researchers need to quantify and correct for these variations as much as possible.

Corrections for searcher efficiency need to be based on vegetation type, plant phenology (season), and bird or bat size. Searchers tend to underestimate the number of small bird fatalities, and tall, dense vegetation also decreases detection rates (Morrison, 2002; Kerns et al., 2005). Bats may also be easily overlooked because of their small size and cryptic coloration (Keeley et al., 2001; Arnett and Tuttle, 2004). To correct for variation in searcher efficiency, on-site trials should be conducted to test each searcher using fresh carcasses of species likely to occur in the project area. Personnel conducting searches should not know when trials are conducted because awareness of the trial makes searchers more vigilant and generally improves search results. Trials should be conducted at regular intervals throughout all four seasons to address changes in vegetation and weather. The planted carcasses should be geo-referenced by GPS and marked in a fashion that is not detectable to the searcher. The carcasses should be spread across a large area so that searchers are not "tipped" regarding the trial. If new searchers are added to the search team, additional detection trials should be conducted to ensure that detection rates incorporate searcher differences. Before conducting searcher trials and systematic surveys, the study areas should be subject to a "clean sweep" to remove all existing carcasses and remains from the search area.

Trained search dogs have sometimes been used to enhance the efficiency of carcass searches, particularly in dense vegetation (Gutzwiller, 1990; Homan et al., 2001). While the olfactory abilities of dogs can increase detection rates, relying on dog-enhanced searches can introduce new biases relative to traditional human searches (Arnett, 2005). Searcher efficiency trials should be conducted for the dog-human handler team to evaluate biases and correct for them.

Carcass Removal Estimates

Carcass removal estimates are used to determine how many carcasses are missed by searchers because of removal by scavengers or other means. Carcass removal estimates involve placing recently killed birds of different sizes in known locations and monitoring them regularly to determine the removal rate. Planted carcasses should be checked at least every day for a minimum of the first three days and thereafter at intervals determined by results from pilot scavenger trials. The percentage of carcasses removed should be tracked and used to adjust fatality rates (Gauthreaux, 1995; Erickson, 2004) and to help determine the appropriate search interval.

Researchers should conduct carcass removal trials by planting a sufficient number of carcasses at the site to calculate percent recovery (for example, percent recovery cannot be calculated with just two carcasses) but should not put out so many that scavengers are swamped with a superabundance of food. Trials should be spread over spring, summer, fall, and winter to incorporate effects of varying weather conditions and scavenger densities. Researchers have reported seasonal variation in carcass removal rates (Morrison, 2002). The effects of carcass size must also be considered (Gauthreaux, 1995) and the trials should use different sizes of birds, ranging from large to small. A small bird is defined as a bird 10 inches (25 centimeters) or smaller in body length (beak to tail tip), a large bird as greater than 10 inches. In establishing the scavenging estimates, researchers should be aware that smaller birds may disappear more frequently and more quickly than larger birds (Orloff and Flannery, 1992; Gauthreaux, 1995).

Carcass removal trials should be conducted throughout the monitoring period because removal rates may vary as scavengers come and go and as they learn to search near wind turbines. Ravens, coyotes, and other vertebrate predators are fast learners when it comes to exploiting new food sources (Erickson et al., 2004). A few individual scavengers that have learned to incorporate wind turbines into their daily foraging routine could make large differences in carcass removal rates over the course of a study (Smallwood, 2006). Such changes can only be assessed and corrected if scavenging studies continue throughout the monitoring period.

Fresh carcasses representing local species are often difficult to secure, and permission from USFWS and CDFG is required for use of raptor carcasses. Carcasses for the experiments can be birds collected during carcass searches, road-killed birds (if fresh), and carcasses from veterinary colleges or wildlife rehabilitation centers. Carcasses from the latter sources should be verified as free of disease and poison. House sparrows and brown-headed cowbirds, which are often available from wildlife control programs, are a potential source of surrogates for small bird searches. Finding suitable surrogates for bat carcasses is a particular problem because few studies have addressed bat scavenging. Using domestic species is not recommended because these surrogate carcasses may provide different cues that could affect their detection and appeal to scavengers. Old or long-frozen specimens (more than one month in the freezer) may also be less appealing to scavengers than freshly killed birds or bats, and their use should be avoided if possible.

The rate of decay of the carcasses, which varies seasonally and from site to site, is also important to consider. Some scavengers may not be interested in a carcass if it is maggot-ridden, severely decayed, or desiccated (Gauthreaux, 1995; Smallwood, 2006). Once scavengers ignore a degraded carcass, it will begin to bias the average time a carcass remains in place or carcass removal rate. The number of carcasses used during scavenger trials should also be considered. Putting out many carcasses at one time might saturate the scavenger population in the area, leaving the remaining carcasses to desiccate and become unappealing (Smallwood, 2006). The researcher should establish criteria for removing carcasses when they cease to become attractive to scavengers and report the criteria and removal protocol in the monitoring report.

Background Mortality

Some bird and bat casualties discovered during searches and used in fatality rate estimation may not be related to wind turbine impacts. Natural bird and bat mortality and predation occurs in the absence of wind turbines, but unless background mortality is included in operations monitoring studies, the results may overestimate project-related fatality rates. Background mortality studies should be conducted during the pre-permitting studies or at reference sites during operations monitoring to account for this potential bias in fatality estimates. Background mortality survey methods should be consistent with carcass survey methods used at the turbines.

Data Analysis and Metrics

Estimates of bird and bat fatalities must incorporate corrections based on searcher efficiency and scavenging rates. Corrections for scavenging play an important role in extrapolation of fatality estimates, so it is important that researchers consider all components of the scavenger trials carefully and make a complete disclosure of all assumptions and methods in the monitoring reports. The larger the correction factor, the higher the uncertainty in the fatality estimates. Corrected fatality rates can be calculated as the observed per MW fatality rate divided by the estimated average probability a carcass is available during a search and is found. The denominator in this formula is a function of carcass removal, searcher efficiency, interval between searches, search area visibility index, and other factors. Other analyses might include correlations of fatality metrics with environmental and turbine characteristics such as wind speed, prey availability, turbine rotations per minute, and lighting.

Gauthreaux (1995), Orloff and Flannery (1992), Kerns and Kerlinger (2004), Erickson (2004), Shoenfeld (2004), and Smallwood (2006) provide details on formulae and methods for calculating adjusted fatality rates and other factors affecting fatality rates. Appendix G provides a suggested formula for adjusting fatality rates. In expressing the fatality rate, the metric that should be used is the number of fatalities per MW of installed capacity per year. This avoids the problem of comparing turbines that have substantially different rotor-swept areas and capacities.

Monitoring Reports

CEQA requires a public agency to adopt a program for monitoring or reporting mitigation measures identified in an Environmental Impact Report or Negative Declaration to make sure those measures are being implemented (see CEQA Guidelines, § 15097 and Public Resources Code, § 21081.6[a]). "Reporting" generally consists of a written compliance review that is presented to the decision making body or authorized staff person. A report may be required at various stages during project implementation or upon completion of the mitigation measure. "Monitoring" is generally an ongoing or periodic process of project oversight. Monitoring ensures that project compliance is checked on a regular basis during and after implementation, and reporting ensures that the approving agency is informed of compliance.

Monitoring reports are crucial to improving the ability to estimate pre-permitting fatalities and understand the effect of impact avoidance, minimization, and mitigation measures. Monitoring reports should provide sufficient detail to allow reviewing agencies and peer reviewers to evaluate the methods used and understand the basis for conclusions of the reports and allow those conclusions to be independently checked. The assumptions, methods, study design, analysis, results, and conclusions should be clearly stated in the monitoring report so that others can gain knowledge from each project. The reports should also include in an appendix the tabulated raw data from the carcass counts and use surveys. Public availability of completed operations monitoring reports is valuable because it facilitates the learning process for application on subsequent projects and should be a permit condition of all wind energy projects. Additional study efforts resulting from impact avoidance, minimization, and mitigation monitoring and adaptive management programs should similarly be publicly available. The reports should follow standard scientific report format. Reports should be provided to CDFG and USFWS, and special-status species observations and fatalities should be submitted to CDFG’s CNNDB and BIOS programs.

Self-Reporting Monitoring

Field personnel at wind energy facilities can augment information from operations monitoring programs by reporting incidental findings of dead or injured birds and bats.

Orloff and Flannery (1992) provide guidance and template data sheets for self-reporting monitoring programs. The Avian Powerline Interaction Committee (APLIC, 2006) also offers suggestions on developing avian mortality reporting programs by trained field personnel. Trained operators who record and report bird and bat carcasses discovered in the project area can provide a useful supplement to data from the standard operations monitoring studies. However, the absence of fatality records from self-reporting monitoring programs should not be used to demonstrate absence of fatalities.

CHAPTER 8: IMPLEMENTING THE GUIDELINES—A STEP-BY-STEP APPROACH

This chapter provides a convenient digest of the *Guidelines*, with steps arranged in the order they are likely to occur. Each step provides information regarding a typical wind energy development project's pre-permitting assessment and monitoring; operations monitoring protocol; impact analysis; and impact avoidance, minimization, and mitigation measures.

1. Gather Preliminary Information and Conduct Site Screening

Site screening is the first step to determine potential biological resource issues associated with wind development at a proposed site. A site screening assessment evaluates easily obtainable information about the biological sensitivity of a site, which helps determine the kinds of studies needed during pre-permitting monitoring to adequately evaluate potential impacts to birds and bats. This is an important time for science advisory committee involvement and consultation with U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG). Site screening consists of a reconnaissance field survey and a desktop effort to collect data about the site from databases, agencies, and local experts to determine its sensitivity. The following checklist of questions is provided as a screening tool to assess the potential for birds and bats to occur at the site; how they might be at risk from wind turbine collisions; and whether special-status species could occur there.

Table 1. Checklist to Evaluate Sensitivity of a Proposed Wind Resource Area

	Yes	No	Unknown	Question
1				Could species listed as federal or state threatened or endangered (or candidates for such listing) breed on or near[2] the site or occur there at other times of the year?
2				Could special-status bird or bat species or declining or vulnerable birds or bats breed on or near the site or occur there at other times of the year?
3				Could fully protected bird species occur at the site any time of the year?
4				Is the site near a raptor nest, or could raptors occur at or near the site during portions of the year?
5				Is the site in or near staging or wintering areas for waterfowl, shorebirds, or raptors?
6				Do colonially nesting species (for example, herons, shorebirds, seabirds) occur near the site?
7				Are birds or bats likely to migrate through the site at any time of year during the day or night?
8				Is the site near a bat roost?
9				Could birds or bats “commute” through the area (for example, move through the site on a regular basis between foraging and roosting areas)?
10				Could the site be used by birds whose behaviors include flight displays (for example, common nighthawks, horned larks)?
11				Could the site be used by birds or bats whose foraging tactics put them at risk of collision (for example, contour hunting by golden eagles)?
12				Does the site include habitat features (for example, riparian habitat, water bodies) that might attract birds or bats for foraging, roosting, breeding, or cover?
13				Does the site or adjacent areas contain topographical features that could concentrate bird or bat movements (for example, ridges, peninsulas, or other landforms that might funnel bird or bat movement)?
14				Is the site characterized by seasonal weather conditions such as dense fog or low cloud cover that might increase collision risks to birds, and do these occur at times when birds might be concentrated?

[2] “Near” refers to a distance that is within the area used by an animal in the course of its normal movements and activities.

2. Form a Science Advisory Committee

The lead agency and/or developer should establish a science advisory committee early in the pre-permitting process to assist with all major scientific decision points throughout project development and operation. Depending on the area, a standing, regional science advisory committee to advise on multiple projects provides a valuable and consistent resource for scientific advice on wind-wildlife interactions. However, for cases where a standing science advisory committee does not exist, a project-specific science advisory committee is necessary. The recommended core composition of a project-specific science advisory committee includes scientists and technical representatives from the following groups: the lead agency (or its consultants); wildlife protection agencies (CDFG and USFWS); the developer (or its consultants); and a conservation organization, such as Audubon. For additional considerations and details of establishing and managing a science advisory committee, the CDFG guidance document on developing an independent science advisory process is highly recommended (www.dfg.ca.gov/nccp/scienceprocess.pdf).

3. Collect Data Using Standard Pre-Permitting Monitoring Protocol

Pre-permitting monitoring should be conducted for a minimum of one full year to capture seasonal variation in bird and bat species composition and abundance during all four seasons. Standard bird data collection methods include bird use counts (BUCs), small bird counts (SBCs), and raptor nest searches. Standard bat data collection methods include acoustic monitoring for a minimum of one full year to determine seasonal bat use at a proposed site at a 30-meter height above ground and near the ground.

Study Objectives and Design

Development of a pre-permitting study begins with a clear statement of the questions to be answered. The next step is establishing an appropriate study design that will answer those questions and decide on sampling units, parameters to measure, and specific methods to employ. Study objectives will vary from site to site, but key questions for most wind energy projects in California are:

- Which species use the site?
- What is the seasonal species richness and relative abundance of birds and bats in the project area?
- How much time do birds and bats spend in the vicinity of proposed turbine locations, and how does this vary with season?
- How much time do birds and bats spend in the risk zone (rotor-swept area) by season?
- What key features of the site (habitats, landforms) increase the probability that birds or bats will use certain portions of the project area?
- Are there occupied raptor nests in or near the project area?
- Is the area a known breeding ground for any bird or bat species, or is it near a bat roost?

- How does bird and bat use of the site compare to other wind resource areas that have been studied and assessed for impacts?

Answering these questions involves bird use counts, small bird counts, acoustic monitoring, raptor nest searches, behavioral assessments, and other methods described below. BUCs have been used for many wind energy projects throughout the United States and therefore have added value for comparative purposes. Standardization provides the opportunity to compare data from wind energy project sites in California and throughout the nation.

If preliminary information gathering indicates potential risks to nocturnally active birds and bats, including migrants at a proposed wind energy project site, radar and other nocturnal study methods may be needed to determine composition and abundance of species and flight altitude of birds and bats that might pass through the site. For example, if wind turbines are proposed on ridgelines within a migratory corridor or near a favored migratory stopover, they might pose a risk to nocturnally migrating birds and/or bats. Scientists experienced with these techniques need to be involved in tailoring the study design and sampling protocol to the unique features of each site and to the specific questions that need to be answered. The science advisory committee, USFWS, and CDFG should be consulted to approve the proposed study design and determine if the study will provide adequate information to answer questions about risk to nocturnal migrating birds and bats.

Birds—Standard Pre-Permitting Monitoring Protocol

Study Duration: A minimum of one year.
Sampling Frequency: Once per week.
Area to Study: Observation points located across the potential project area.
Bird Use Counts (BUCs): 30-minute counts at each observation point.
Number of Observation Points: The number of BUC locations will be based on the number of potential turbines or turbine strings and the ability of an observer to watch potential turbine locations from a single point. The minimum number of samples should include one sample site per turbine for a small project (1–10 turbines) provided there is enough distance between turbines to avoid double counting (1,600 meters). The minimum number of sites for a medium-sized project (11–40 turbines) is 40 percent of the number of turbines, or 10, whichever is larger. The minimum number of sample sites for large projects (41 turbines or more) is 30 percent of the number of turbines, or 16, whichever is larger.
BUC Time of Day: All daytime hours.

Small Bird Counts (SBC): The SBCs are only used in special cases, such as when there is concern for loss of special-status bird breeding habitat. Conduct the SBC for 5–10 minutes at each sample point. The sampling points should be separated by a distance of 250 meters to reduce the probability of double-counting individual birds. If turbine locations are known, the SBC sites can be laid out every 250 meters in a row between turbines. If turbine locations are not known, but the general area where turbines will be placed (such as a ridge top) is known, the SBC sites can be selected along the ridge top.
SBC Time of Day: From one-half hour before dawn until four hours after dawn.

Metrics: Bird use at rotor-swept area height per minute, bird use per minute per a defined area.
Background Fatalities: Conduct one year of carcass searches during the pre-permitting monitoring to determine levels of natural or background mortality in the absence of wind turbine impacts if necessary.
Raptor Nest Searches: Raptor nest searches should be conducted in suitable habitat during the breeding season within five kilometers (three miles) of proposed turbine locations.
Repowering: Conduct pre-permitting studies as described above for new sites.

Bats—Standard Pre-Permitting Monitoring Protocol

Study Duration: A minimum of one year of acoustic monitoring.
Sampling Frequency: Every night for one year.
Area to Study: A sample of sites located across the project area. Acoustic monitoring devices placed at varying elevations above the ground (at a minimum at ground level and 30 meters above ground).
Time of Day: All night plus dusk and dawn.
Metrics: Total bat passes; mean passes per detector night and per detector hour (excluding nights with measurable precipitation).
Background Fatalities: Conduct one year of carcass searches during the pre-permitting monitoring to determine levels of natural or background mortality in the absence of wind turbine impacts if necessary.
Bat Roost Searches: Bat roost searches and/or exit counts (if roost is found) should be conducted in suitable habitat near the proposed project site.

Exceptions to Standard Pre-Permitting Monitoring Protocols—Birds and Bats

There may be situations when exceptions can be made to the standard monitoring protocol. The burden of proving that an exception is appropriate and applicable should be on the stakeholder attempting to justify the exception. When deciding whether or not to deviate from the standard protocols, the permitting agency, USFWS, CDFG, and the science advisory committee should be consulted for coordination on the appropriate approach.

When Less Monitoring May Be Appropriate

Less monitoring may be appropriate if field data are already available from an adjacent, similar project. Factors to consider in assessing the amount and quality of those data include: whether the field data were collected within the last five years; where the data were collected in relation to the proposed site; if comparable turbine type, layout, and winds are present; and the scientific rigor of the data. As an example, reduced pre-permitting monitoring might be appropriate for a small project adjacent to or surrounded by an existing wind development project that had been studied sufficiently and for which there is little doubt as to the low level of impact. Such decisions require expert biological input because short distances and slight topographical, wind, or habitat changes within or adjacent to the project can make important differences regarding bird and bat impacts, as can the types of turbines. Approval from the science advisory, CDFG, and USFWS is needed before deciding that existing data are adequate. Seeking approval helps identify potentially overlooked issues that could cause delays in project development.

The size of the project in terms of the number of turbines, the size of turbines, and the extent of the area involved can influence the level and extent of effects and the need for more or less study. A small project generally raises less concern regarding bird and bat impacts, although small projects can also cause unacceptable impacts. Project size is one of numerous considerations regarding the extent of further study. For purposes of the *Guidelines*, project size is defined as follows:

- Small-sized project = 1-10 turbines
- Medium-sized project = 11-40 turbines
- Large-sized project = 41 or more turbines

When More Monitoring May Be Appropriate

If a high level of impact is expected, additional study may be needed to help understand and formulate ways to reduce the number of fatalities. Pre-permitting studies in excess of one year may be necessary in certain situations. For example, more than one year of pre-permitting surveys might be required in unstudied areas with little existing information or where there is a high potential for declining or vulnerable species to occur at the site or in the region. Sites with high raptor use may require more than one year of monitoring to more clearly understand the potential for impacts. The number and size of the turbines and the size of the wind resource area can also influence the need for more study.

Additional Monitoring Needs

Each proposed wind energy project site has its own unique features and suite of species, so the standard methods described above may not meet all the information needs of a particular project. For example, intensive surveys of nearby bird colonies (for example, terns, gulls, burrowing owls) may be needed to determine daily commute patterns and specific site use. Evaluation of prey availability for raptors may be necessary to develop an index for comparison in future years. Pre-permitting studies should rely on the *Guidelines* for direction as to which studies to include. The study designers must use professional judgment in determining whether pre-permitting studies require special monitoring methods in addition to standard methods. Consultation with the science advisory committee, USFWS, and CDFG is recommended.

4. Identify Potential Impacts and Comply With Laws

Impact determination occurs twice in the life of a wind energy project's life. The first is during pre-permitting when impact estimates are made. The second is during or following operations monitoring when actual impacts are determined. Pre-permitting impact estimates are the basis for mitigation actions. Operations impact findings occur following construction and operation and are difficult to reduce.

The kinds of impacts that must be addressed in an impact analysis include the following.

Direct impacts are caused by a project and occur at the same time and place (CEQA Guidelines, § 15358[a] [1]). Direct impacts in this context refer to bird and bat collisions with wind turbine blades, meteorological towers, and guy wires. Potential direct impacts are determined by evaluating all of the pre-permitting data to determine which species might be subject to collision with turbines and which non-biological factors (for example, topographic, weather, and turbine design features) may contribute to this risk.

Indirect or secondary impacts are those that are reasonably foreseeable and are caused by a project but occur at a different time or place. (CEQA Guidelines, § 15358[a] [2]). Potential indirect impacts to birds and bats from wind energy projects include disturbance of local populations and subsequent displacement or avoidance of the site and disruption to migratory or movement patterns. An example of an indirect impact is the potential for the turbine base area to become enhanced habitat for raptor prey.

Cumulative impacts refer to two or more individual effects, which when considered together, are considerable or which compound or increase other environmental impacts (CEQA Guidelines, § 15355 [b]). Cumulative impact analyses for wind energy projects should consider potential impacts to bird or bat species, special-status species, movement or use of the project site and area, local populations, migratory and resident species, high numbers of fatalities, and other bird and bat impacts over the project's life. These impacts apply to the birds and bats in and/or immediately around the wind farm or could be manifested in populations or subpopulations some distance away through changes in immigration and emigration. The level of detail in this cumulative analysis need not be as great as for the project's direct impact analyses, but should reflect the level and likelihood of the potential impacts.

State Wildlife Laws

While CEQA provides guidance for considering impacts, all parties involved in the pre-permitting decision process should be aware of other state and federal laws, which prohibit take and harassment of potentially affected bird and bat species.

CDFG uses CEQA to determine policy in issuing permits and reviewing projects, but several other California Fish and Game Code sections relate to protection of wildlife resources:

- California Endangered Species Act (CESA), 1984 – Fish and Game Code section 2050 et seq.: For species that are protected by the state (listed as endangered, threatened, or as a candidate), these species cannot be taken or harmed without a take permit provided by the California Department of Fish and Game.
- Fully Protected Species – Fish and Game Code sections 3511, 4700, 5050 and 5515: These codes prohibit the take of species (using the same "take" definition as in CESA) that are classified as fully protected. There is no provision for licenses or permits to authorize take of fully protected species, except for scientific research under specified conditions.
- Migratory Birds – Fish and Game Code section 3513: This code protects California's migratory birds by making it unlawful to take or possess any migratory non-game bird as designated by the Migratory Bird Treaty Act. Any exceptions to

this act are based on rules and regulations adopted by the federal government under provisions of the Migratory Bird Treaty Act.

- Birds of Prey and Their Eggs – Fish and Game Code section 3503.5: It is unlawful to take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.
- Unlawful Sale or Purchase of Exotic Birds – Fish and Game Code section 3505: It is unlawful to take, sell, or purchase any aigrette or egret, osprey, bird of paradise, goura, numidi, or any part of such a bird.
- Nongame Birds – Fish and Game Code section 3800 (a): All birds occurring naturally in California that are not resident game birds, migratory game birds, or fully protected birds are nongame birds. It is unlawful to take any nongame bird except as provided in this code or in accordance with regulations of the commission or, when relating to mining operations, a mitigation plan approved by the department.

Federal Wildlife Laws

The USFWS is responsible for overseeing the three federal laws, described below, that apply to protecting wildlife from impacts from wind energy development:

- Federal Endangered Species Act (ESA), 1973 – Title 16, U.S. Code section 1531: The ESA protects the 18 bird species/subspecies listed as threatened or endangered in California. No bats are currently listed as threatened or endangered in California. The act prohibits the take of protected animal species, including actions that “harm” or “harass”; federal actions may not jeopardize listed species or adversely modify habitat designated as critical.
- Migratory Bird Treaty Act (MBTA), 1918 – Title 16, U.S. Code sections 703 to 712: The MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds and their eggs, parts, and nests, except when specifically authorized by USFWS. At least 603 migratory bird species have been recorded in California.
- Bald and Golden Eagle Protection Act (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.

5. Identify Impact Avoidance, Minimization, and Mitigation Measures

Impact Avoidance and Minimization

Impact avoidance is best attained during pre-permitting site selection (macro-siting) and during site layout planning (micro-siting). Good macro-siting decisions are essential for choosing an acceptable site early in the site selection process. Once the site is selected and sensitive resources have been identified and mapped, micro-siting efforts such as appropriate placement of turbines, roads, power lines, and other infrastructure can avoid or reduce some potential impacts to birds, bats, and other biological resources. If a wind energy project is placed in a poor site such as a heavily used raptor area, it will be difficult for "micro-siting" to prevent higher levels of fatalities.

Each wind energy project site is unique, and no one recommendation will apply to all pre-permitting site selection and layout planning. The following elements should be considered in site selection and turbine layout and in developing infrastructure for the facility:

- Minimize fragmentation and habitat disturbance.
- Establish buffer zones to minimize collision hazards.
- Reduce impacts with appropriate turbine layout.
- Avoid lighting that attracts birds and bats.
- Minimize power line impacts.
- Avoid guy wires.
- Decommission non-operational turbines.

Compensation

Compensation should be an important component of a mitigation package and be used to establish or support a well-defined and credible conservation program. Whether land is acquired indirectly through a mitigation bank or directly through a project-specific purchase or easement, the terms of this mitigation in the project permits should be consistent with CDFG's official 1995 policy on conservation banks, which include, but are not limited to:

- The mitigation site must provide for the long-term conservation of the target species and its habitat.
- The site must be large enough to be ecologically self-sustaining and/or part of a larger conservation strategy.
- The site must be permanently protected through fee title and/or a conservation easement.
- Prior to sale of the property or easement or sale of credits at a mitigation bank, a resource management plan should be approved by all appropriate agencies or non-governmental organization involved in the property management.
- A sufficient level of funding with acceptable guarantees should be provided to fully ensure the operation and maintenance of the property as may be required.
- Provisions should be made for the long-term management of the property after the project is completed or after all mitigation credits have been awarded for the mitigation bank.
- Provisions should be made for ensuring implementation of the resource management plan in the event of non-performance by the owner of the property or non-performance by the mitigation bank owner and/or operator.

- Provisions should be made for the monitoring and reporting on the identified species/habitat management objectives, with an adaptive management/effectiveness monitoring to modify those management objectives as needed.

Operational Impact Avoidance, Minimization, and Mitigation

Once a project is operating, it is difficult to modify turbine site layout, and operations impact avoidance, minimization, and mitigation options are limited. These options include maintenance activities or habitat modification to make the site less attractive to at-risk species and seasonal changes to cut-in speed. During the bat migratory period, limited and periodic feathering of wind turbines during low wind nights may help avoid impacts to bats. If multi-year monitoring documents high levels of fatalities, removal of problem turbines or seasonal shutdowns of turbines may be options. In some cases, such as mortality in violation of state or federal laws, operational and facility changes may be the only option.

Adaptive Management / Effectiveness Monitoring

Adaptive management and effectiveness monitoring are analytical processes for adjusting management and research decisions to better achieve management objectives, such as reducing the number of bird and bat collisions with wind turbines. The adaptive management process recognizes the uncertainty in forecasting impacts to birds and bats and allows options to be tested as experiments to achieve a goal and determine impact avoidance, minimization, and mitigation effectiveness. Adaptive management is a tool for implementing and monitoring impact avoidance, minimization, and mitigation goals and efforts and may lead to modifying measures or to additional measures as monitoring effectiveness information is returned via a feedback loop. Successful adaptive management requires a firm commitment by project owners to accountability and remedial action in response to new information about the effectiveness of mitigation.

6. Secure Permits and Construct Project

The developer should contact land owners, local environmental groups, and local, state, and federal wildlife management agencies such as CDFG and USFWS early in the permitting process to secure critical information on which to base site development decisions and to assess the type and timing of surveys that will be needed.

Early discussion of proposed survey protocols with the lead agency, CDFG, and USFWS as well as the science advisory committee will allow for an evaluation of the level and timing of the effort in relation to project milestones such as the desired construction start date. Conducting a determination of CEQA significance alone may not highlight all of the species that need to be evaluated; federal and state listed species, the federal Migratory Bird Treaty Act, and fully protected species also need to be considered when designing surveys. Agency consultations and issuance of take permits can be lengthy, and delays can be avoided by initiating agency contacts early in the permitting process.

Frequent consultation with CDFG, USFWS, and the science advisory committee should continue throughout the impact analysis and mitigation development process. Consistent compliance with all terms and conditions of the permit should occur throughout operations monitoring and in fulfilling avoidance, minimization, and mitigation measures.

7. Collect Data Using the Standard Operations Monitoring Protocol

Operations monitoring, also referred to as post-construction monitoring, includes collecting bird and bat use data and fatality information. BUCs and SBCs should be conducted for two years as well as acoustic monitoring for bats consistent with the pre-permitting count methods. Carcass searches provide an estimate of fatalities to birds and bats but need corrections with information from searcher efficiency trials, scavenging estimates, and background mortality estimates (as needed).

Birds—Standard Operations Monitoring Protocol

Study Duration: Two years.
Bird Use Counts: Conduct two years of BUCs as conducted during pre-permitting monitoring.
Bird Use Count Frequency: Every week as during pre-permitting monitoring.
Bird Use Count Locations: All turbine locations or a sample (30–100 percent) of turbines located across the project area (same as or a sub-sample of pre-permitting monitoring sites).
Carcass Searches: Conduct searches every two weeks for two years at transect widths (6 meters) and speeds that allow detection of most bird and bat carcasses.
Search Plot: 1.5 times the rotor diameter (rectangle, square, or circle depending on turbine locations and arrangements).
Number of Carcass Search Plots: To be determined based on number of turbines and size of site and estimated level of fatalities. For example, higher estimates of fatalities may require more sites and low estimated fatalities may allow for fewer search sites.
Time of Day: All daylight hours.
Metrics: Bird use in rotor-swept area per minute per count and bird use per minute per defined area for bird groups per count. Bird fatalities per MW of installed capacity per year and bird fatalities per rotor-swept square meter per year for bird groups.
Searcher Efficiency Trials: Conduct seasonally over two years.
Carcass Removal Trials: Conduct seasonally over two years.

Bats—Standard Operations Monitoring Protocol

Acoustic Monitoring: Conduct for two years using the same methods as for pre-permitting monitoring.
Acoustic Monitoring Frequency: Every night during the two years.
Acoustic Monitoring Plots: A sample of sites located across the project area (same as pre-permitting).
Carcass Searches: Conduct every night during migration at 30 percent of sample sites and weekly at the remainder of the sample sites at transect widths (6 meters) and speeds that allow detection of most bat species.

Search Plot: 1.5 times the rotor diameter (rectangle, square, or circle depending on turbine locations).
Number of Carcass Search Plots: To be determined based on number of turbines and size of site and estimated level of fatalities. Normally the same as bird carcass search plots since the searches are conducted simultaneously.
Metrics: Total bat passes; mean passes/detector night and per detector-hour (excluding nights with measurable precipitation). Bat fatalities per MW of installed capacity per year and bat fatalities per rotor-swept square meter per year, or other metrics endorsed by the science advisory committee, USFWS, and CDFG.
Searcher Efficiency Trials: Conduct seasonally over two years.
Carcass Removal Trials: Conduct seasonally over two years.

Exceptions—Standard Operations Monitoring Protocol: Birds and Bats

There may be situations when exceptions can be made to standard protocol. The burden of proving that an exception is appropriate and applicable should be on the stakeholder attempting to justify the exception. This holds true for increasing or decreasing the amount of operations monitoring and continued periodic long-term monitoring. When deciding to deviate from the model protocols, the permitting agency, USFWS, CDFG, and the science advisory committee should be consulted for coordination on the appropriate approach.

When Less Monitoring May Be Appropriate

Additional monitoring may not be needed, if the findings from pre-permitting monitoring indicate low bird use and no special-status species or issues of concern, or if the site is near or adjacent to a recently well studied and comparable site with low fatality numbers. Some situations may allow for decisions after one year of operations monitoring as to whether to conduct a second year. A high standard of confidence and certainty is needed to decide on less than two years of monitoring and should be made with approval from the science advisory committee, USFWS, and CDFG.

When More Monitoring May Be Appropriate

If the standard two years of operations monitoring detects unexpectedly high fatalities or other adverse impacts not anticipated in the pre-permitting studies, there may be a need to continue monitoring at some level beyond the second year. The purpose of such monitoring would be to gather information to develop impact avoidance, minimization, and mitigation measures and to verify if these measures were effective in reducing fatalities.

Upon completion of two years of operations monitoring, the science advisory committee, CDFG, and USFWS should assess whether continued, long-term monitoring is required. Long-term monitoring on a periodic basis (for example, every five years) for the life of the project should occur if the science advisory committee and resource agencies determine, based on operations monitoring, that project operation is likely to result in substantial impacts to birds or bats. Such long-term monitoring could be coordinated with larger, more regional studies within the entire wind resource area if deemed appropriate by the science advisory committee.

For all proposed projects, the science advisory committee, or at a minimum, USFWS and CDFG, should be consulted in development of special study protocols and in establishing the duration of an operations monitoring program.

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APPENDIX A: CONTACT INFORMATION FOR THE CALIFORNIA DEPARTMENT OF FISH AND GAME HEADQUARTERS AND REGIONS

Department of Fish and Game Headquarters
1416 9th Street
Sacramento, CA 95814
Information Desk: Room 117
(916) 445-0411
http://www.dfg.ca.gov/direc/contact.html

Northern California – North Coast (Region 1)
601 Locust St., Redding, CA 96001
(530) 225-2300
http://www.dfg.ca.gov/regions/region1.html
Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity counties

Sacramento Valley – Central Sierra (Region 2)
1701 Nimbus Road, Rancho Cordova, CA 95670
(916) 358-2900
http://www.dfg.ca.gov/regions/region2.html
Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento (north of railroad tracks, San Joaquin (east of Interstate 5), Sierra, Solano, Sutter, Yolo (north of railroad tracks), and Yuba counties

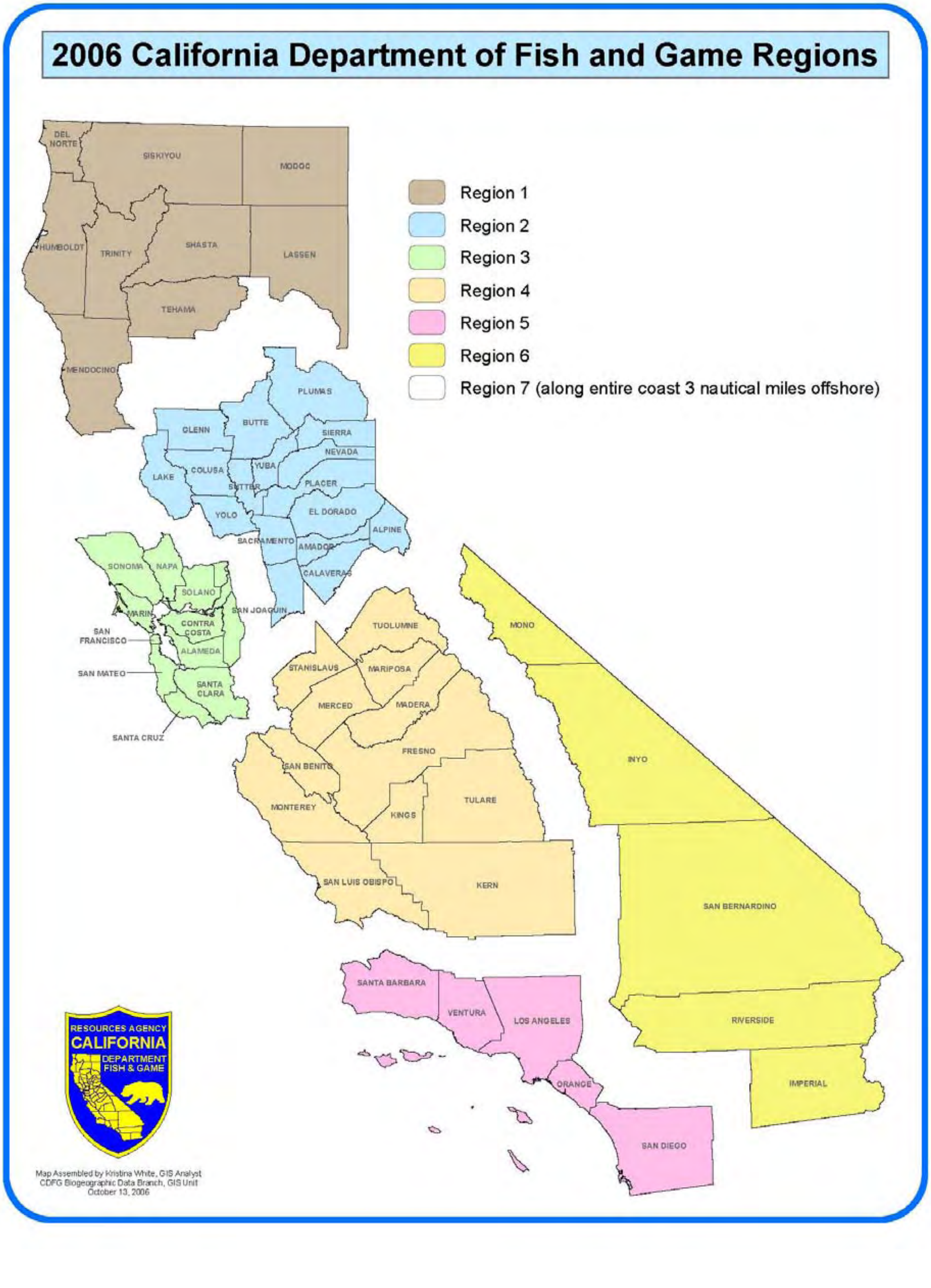
Central Coast (Region 3)
7329 Silverado Trail, Napa, CA 94558
(707) 944-5517
http://www.dfg.ca.gov/regions/region3.html
Alameda, Contra Costa, Marin, Napa, Sacramento (south of railroad tracks), San Joaquin (west of Interstate 5), San Mateo, Santa Clara, Santa Cruz, San Francisco, Sonoma Solano, and Yolo (south of railroad tracks) counties

San Joaquin Valley – Southern Sierra (Region 4)
1234 E. Shaw Ave., Fresno, CA 93710
(559) 243-4014 x 210 http://www.dfg.ca.gov/regions/region4.html
Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare, and Tuolumne counties

South Coast (Region 5)
4949 Viewridge Ave., San Diego, CA 92123
(858) 467-4201
http://www.dfg.ca.gov/regions/region5.html
Los Angeles, Orange, San Diego, Santa Barbara, and Ventura counties

Eastern Sierra – Inland Deserts (Region 6)
3602 Inland Empire Boulevard, Suite C-220, Ontario, CA
(909) 484-0167
http://www.dfg.ca.gov/regions/region6.html
Imperial, Inyo, Mono, Riverside, and San Bernardino counties

Marine Region (Region 7)
Dept. of Fish and Game Headquarters, 1416 Ninth St., Sacramento, CA 95814
http://www.dfg.ca.gov/mrd/index.html


2006 California Department of Fish and Game Regions
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Region 7 (along entire coast 3 nautical miles offshore)
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
MENDOCINO
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
LAKE
COLUSA
YUBA
SUTTER
PLACER
YOLO
EL DORADO
ALPINE
SACRAMENTO
AMADOR
CALAVERAS
SONOMA
NAPA
SOLANO
MARIN
SAN JOAQUIN
SAN FRANCISCO
CONTRA COSTA
ALAMEDA
SAN MATEO
SANTA CLARA
SANTA CRUZ
TUOLUMNE
MONO
STANISLAUS
MARIPOSA
MERCED
MADERA
FRESNO
INYO
SAN BENITO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
IMPERIAL
SAN DIEGO
RESOURCES AGENCY
CALIFORNIA
DEPARTMENT FISH & GAME
Map Assembled by Kristina White, GIS Analyst
CDFG Biogeographic Data Branch, GIS Unit
October 13, 2006

APPENDIX B: CONTACT INFORMATION FOR UNITED STATES FISH AND WILDLIFE SERVICE ECOLOGICAL SERVICES OFFICES WITH JURISDICTION IN CALIFORNIA

Arcata
1655 Heindon Rd.
Arcata, CA 95521
(707) 822-7201
http://www.fws.gov/arcata/

Yreka (Arcata sub office)
1829 S. Oregon St.
Yreka, CA 96097
(530) 842-5763
http://www.fws.gov/yreka/

Sacramento
2800 Cottage Way
Room W-2605
Sacramento, CA 95825
(916) 414-6600
http://www.fws.gov/sacramento/

Red Bluff
10950 Tyler Road
Red Bluff, CA 96080
(530) 527-3043
http://www.fws.gov/redbluff/

Ventura
2493 Portola Road
Suite B
Ventura, CA 93003
(805) 644-1766
http://www.fws.gov/ventura/

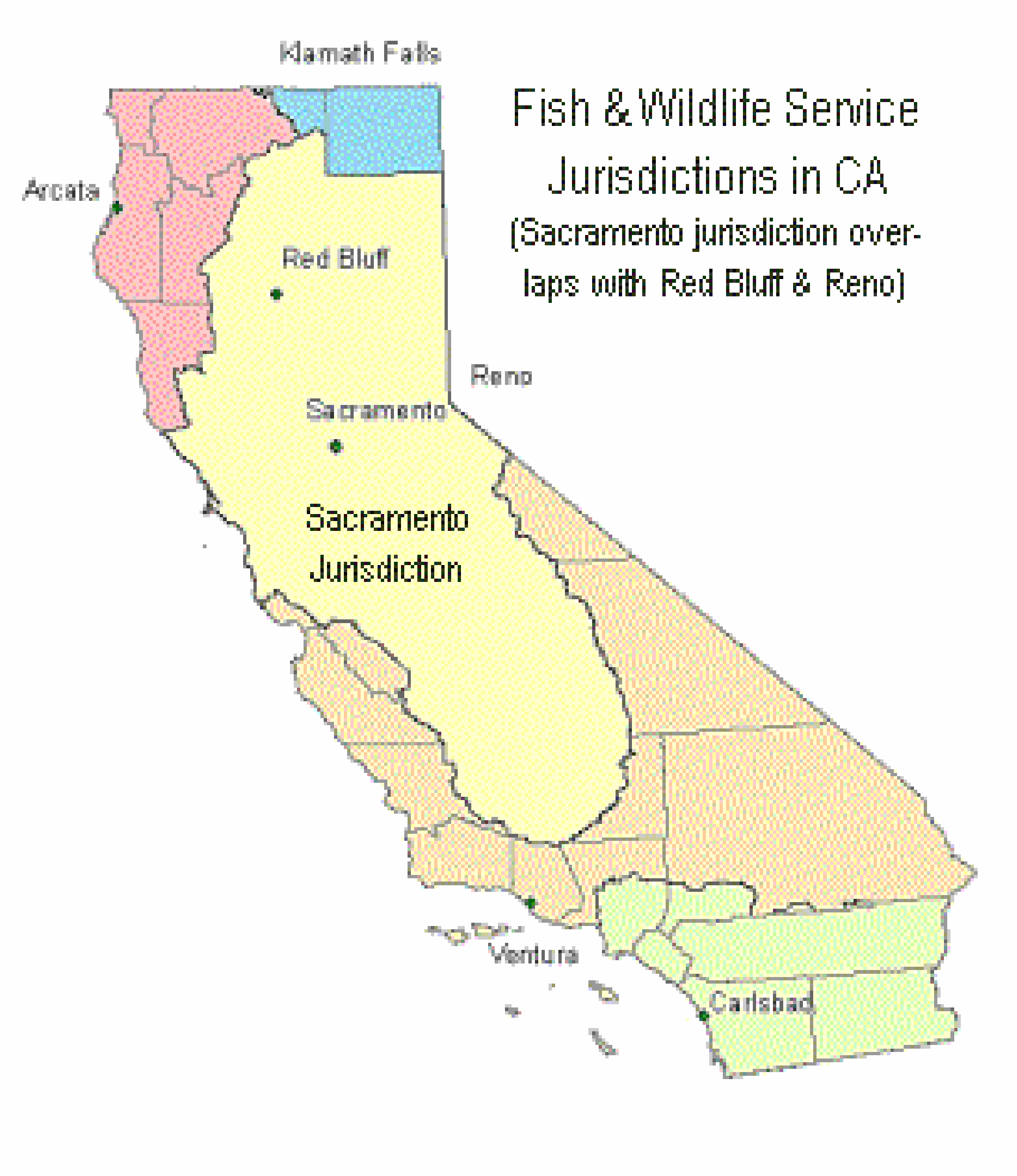
Carlsbad
6010 Hidden Wally Rd.
Carlsbad, CA 92009
(760) 431-9440
http://www.fws.gov/carlsbad/

Klamath Falls, OR
6610 Washburn Way
Klamath Falls, OR 97603
(541) 885-8481
http://www.fws.gov/klamathfallsfwo/

Reno, NV
1340 Financial Blvd.
Suite 234
Reno, NV 89502
(775) 861-6300
http://www.fws.gov/nevada/

Pacific Region Office
911 NE 11th Avenue
Portland, OR 97232
(503) 231-6118
http://www.fws.gov/pacific/

CA/NV Operations Office
2800 Cottage Way
Room W-2606
Sacramento, CA 95825
(916) 414-6464
http://www.fws.gov/cno/


Fish & Wildlife Service
Jurisdictions in CA
(Sacramento jurisdiction over-
laps with Red Bluff & Reno)
Klamath Falls
Arcata
Red Bluff
Reno
Sacramento
Sacramento
Jurisdiction
Ventura
Carlsbad

APPENDIX C: LIST OF ACRONYMS

APLIC	Avian Power Line Interaction Committee
AWEA	American Wind Energy Association
BACI	Before-After/Control-Impact
BIOS	Biogeographic Information and Observation System
BLM	U.S. Bureau of Land Management
BUC	Bird Use Count
CaSIL	California Spatial Information Library
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CNDDB	California Natural Diversity Data Base
CWHR	California Wildlife Habitat Relationships System
EIR	Environmental Impact Report
ESA	Endangered Species Act
FAA	Federal Aviation Administration
GIS	Geographic Information System
ITP	Incidental Take Permit
MBTA	Migratory Bird Treaty Act
NAIP	National Agriculture Imagery Program
NREL	National Renewable Energy Laboratory
NWCC	National Wind Coordinating Committee
PIER	Public Interest Energy Research
RPM	Revolutions per Minute
SBC	Small Bird Count
TADS	Thermal Animal Detection Systems
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

APPENDIX D: GLOSSARY OF TERMS

Adaptive mitigation / management: An analytical process for adjusting management and research decisions to better achieve management objectives, such as reducing bird fatalities from operation of a wind turbine.

Avian: Pertaining to or characteristic of birds.

Before-After/Control-Impact: A study design that involves comparisons of observational data, such as bird counts, before and after an environmental disturbance and in a disturbed and undisturbed site. This study design allows a researcher to assess the effects of constructing and operating a wind turbine by comparing data from the “control” sites (before and undisturbed) with the “treatment” sites (after and disturbed).

Buffer zone: Non-disturbance areas that provides a protected zone for sensitive resources such as raptor nests or bat roosts.

California Environmental Quality Act (CEQA): Refers to California Public Resources Code section 21000 et seq. and the CEQA Guidelines. CEQA was enacted in 1970, and requires California public agency decision-makers to document and consider the environmental impacts of their actions. It also requires an agency to identify ways to avoid or reduce environmental damage and to implement those measures where feasible, and provides a means to encourage public participation in the decision-making process.

Ceilometers: A device used for monitoring the number and types of birds that pass through a given area at night. It uses a conical light beam oriented into the sky so that an observer can count and categorize the birds that pass through the beam.

Coefficient of Variation: The standard deviation expressed as a percentage of the mean used to measure the imprecision in a survey estimate due to sampling error. A high coefficient of variation (for example 50 percent) would indicate an imprecise estimate.

Confidence intervals: A measure of the precision of an estimated value. The interval represents the range of values, consistent with the data, which is believed to encompass the "true" value with high probability (usually 95%).

Contour hunting: A foraging method typical of some raptors, such as golden eagles, in which a bird will fly 1-3 meters above ground, the flight path conforming to features of the landscape.

Cumulative impact: The effect on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseen future actions. Cumulative impacts result from individually minor but collectively significant actions taking place over a period of time.

Decommissioning: The closure of a facility followed by the removal of equipment and structures. For wind turbines, decommissioning involves removal of turbine foundations (to four feet below ground level), as well as other features such as fencing and access roads.

Detectability: A measure of the conspicuousness of a species equal to the proportion of actual units (for example individuals, territorial males, etc.) observed on a given area.

Detection function: The probability of observing an object, such as a bird, given that the bird is a certain known distance from the observer. Detection functions are an important component for estimating density of a population because it allows estimation of the overall probability of detecting an individual.

Distance sampling: Distance sampling is a method for estimating abundance of biological populations. The two most common distance-sampling methods for estimating abundance of wildlife populations are line transects and point counts.

Echolocation: The detection of an object by means of reflected sound. The animal emits a sound, usually at a very high frequency, which bounces off an object and returns as an echo. Interpreting the echo and the time taken for it to return allows the animal to determine the position, distance, and size of the object, and so helps it to orientate, navigate, and find food.

Environmental Impact Report: A detailed document prepared in accordance with the California Environmental Quality Act that describes and analyzes the environmental impacts of a project and discusses ways to mitigate or avoid those impacts.

Exit count: A technique for observing bats in which an observer watches a roost at dusk to count the bats emerging from it.

Feathering: A form of overspeed control for wind turbines that occurs either by rotating the individual blades to reduce their angle into the wind, thereby reducing rotor speed, or by turning the whole unit out of the wind.

Large birds: Birds larger than 25 cm (10 inches) in length.

Fossorial: Adapted for digging or burrowing.

Flyway: A broad-front band or pathway used in migration.

Fully protected: A classification given by the state of California to species that are rare or facing extinction. Permits are not administered for the taking of fully protected species unless it is required for scientific research.

Guy wire: Wires used to secure wind turbines or meteorological towers that are not self-supporting.

Geographic Information System (GIS): A set of computer hardware and software for analyzing and displaying spatially referenced features (that is, points, lines, and polygons) with non-geographic attributes such as species and age.

Habitat: The place where an animal or plant usually lives, often characterized by a dominant plant form or physical characteristic

Indirect impact: Impacts that are caused by a project but occur at a different time or place (for example displacement of local populations).

Large birds: Birds larger than 25 cm (10 inches) in length, as described in the National Geographic Field Guide to the Birds of North America.

Large-sized turbine: A wind turbine capable of generating 750 KW to 2+ MW of electricity.

Lattice design: A wind turbine design characterized by a structure with horizontal bars rather than a single pole supporting the nacelle and rotor.

Lead agency: The public agency that has the principal responsibility for carrying out or approving a project.

Line transect: A method of monitoring, which involves traveling a pre-determined path or 'line' for a pre-determined distance (the transect); counting objects of interest; estimating their absolute or relative distances to the path; and calculating a variety of statistics from these data to characterize the relative abundances, densities, or diversity of the objects of interest. Line transects are often used to estimate relative abundance or densities of birds across multiple sites.

Macro-siting: The selection of large wind resource areas suitable for regional development.

Medium-sized turbine: A turbine that is capable of generating between 400 KW and 750 KW of electricity.

Megawatt (MW): A measurement of electric-generating capacity equivalent to 1,000 kilowatts (kW) or 1,000,000 watts.

Micro-siting: Small-scale site selection for wind turbines, typically involving placement of turbines; involves locating where turbines, roads, power lines and other facilities will be placed.

Migration: Regular, extensive, seasonal movements of birds between their breeding regions and their "wintering" regions.

Monitoring: A continuous, ongoing process of project oversight. Monitoring, rather than simply reporting, is suited to projects with complex mitigation measures which may exceed the expertise of the local agency to oversee, which are expected to be implemented over a period of time, or which require careful implementation to assure compliance.

Negative Declaration: A statement prepared by a lead agency that describes why a project will not have a significant impact on the environment and therefore does not require an Environmental Impact Report.

Pacific Flyway: The westernmost route of North America's four major migratory routes, extending from Alaska to Patagonia,

Parameter: A statistical parameter is a numerical characteristic about the population of interest

Passerine: Describes birds that are members of the Order Passeriformes, typically called "songbirds."

Phenology: The study of the relationship between climate and the timing of periodic natural phenomena such as migration of birds, bud bursting, or flowering of plants.

Point count: A count of bird detections recorded by an observer from a fixed observation point and over a specified time interval.

Population: A group of individuals in a particular location that are of the same species and can reproduce with each other.

Range: The range is the distance between the highest and lowest score. Range is one of several indices of variability that statisticians use to characterize the dispersion among the measures in a given population.

Relative abundance: A percent measure or index of abundances of individuals of all species in a community.

Raptor: Pertaining to eagles, hawks and owls; birds which are predatory, preying upon other animals.

Renewable energy: Energy resources that do not get depleted because they renew themselves. Sources of renewable energy include solar, wind, geothermal hydroelectric, and biomass.

Reporting: A written review of mitigation activities that is presented to the approving body by either staff or the project developer. A report may be required at various stages during project implementation and upon completion of the project.

Responsible agency: A public agency, other than the lead agency, which proposes to carry out a project or has responsibility for discretionary approval over a project.

Riparian: The vegetation, habitats, or ecosystems that are associated with streams, rivers, or lakes, or are dependent upon the existence of perennial, intermittent, or ephemeral surface or subsurface water drainage.

Rotor: The part of a wind turbine that interacts with wind to produce energy. It consists of the turbine's blades and the hub to which the blades attach.

Rotor-swept area: The vertical airspace within which the turbine blades rotate on a pivot point or drive train rotor.

Small birds: Birds 25 cm (10 inches) in length or smaller.

Small-sized turbine: A turbine that is capable of generating between 40 KW and 400 kW of electricity.

Songbird: A bird, especially one of the suborder Oscines of passerine birds, having a melodious song or call.

Species richness: The number of species in a given area

Special-status species: Special-status species are animals or plants in California that belong to one or more of the following categories:

- Listed on CDFG's Special Animals List (www.dfg.ca.gov/whdab/pdfs/spanimals.pdf).
- Officially listed or proposed for listing under the State and/or Federal Endangered Species Acts.
- State or Federal candidate for possible listing.

- Taxa which meet the criteria for listing, even if not currently included on any list, as described in section 15380 of the California Environmental Quality Act Guidelines.
- Taxa considered by the Department to be a Species of Special Concern.
- Taxa that are biologically rare, very restricted in distribution, declining throughout their range, or have a critical, vulnerable stage in their life cycle that warrants monitoring.
- Populations in California that may be on the periphery of a taxon's range, but are threatened with extirpation in California.
- Taxa closely associated with a habitat that is declining in California at an alarming rate (for example, wetlands, riparian, old growth forests, desert aquatic systems, native grasslands, vernal pools, etc.).
- Taxa designated as a special status, sensitive, or declining species by other state or federal agencies, or non-governmental organization.

Standard deviation: A statistical measure of spread or variability defined as the square root of the sum of squared differences between the average value and all observed values.

Standard error: An estimate of the standard deviation of the sampling distribution of means, based on the data from one or more random samples.

Strobe light: Light consisting of pulses (of light) that are high in intensity and short in duration.

Take: CDFG defines *take* as: "To hunt, pursue, catch, capture or kill, or attempt to hunt, pursue, catch, capture, or kill." Under the federal Migratory Bird Treaty Act, *take* means to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect (50 CFR 10.12). Under the Bald and Golden Eagle Protection Act, *take* includes to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, or molest or disturb (50 CFR 22.3).

Taxon: A classification or group of organisms (that is, kingdom, phylum, class, order, family, genus, species). Plural: taxa.

Trustee agency: A state agency such as the Department of Fish and Game that has jurisdiction over natural resources affected by a project, as defined by CEQA.

Tubular design: A turbine is tubular when it is raised above the ground by a cylindrical structure.

Turbine: A device that uses steam, gas, water or wind to turn a wheel, converting kinetic energy into mechanical energy in order to generate electricity.

Turbine height: The distance from the ground to the highest point reached by the blades of a wind turbine.

Use permit. An entitlement granted by the appropriate County agency pursuant to the County Zoning Ordinance, governing the design, operation and occupancy of land uses on a specific property.

Variance: A statistical measure of the dispersion of a set of values about its mean.

Wind Resource Area: The geographic area or footprint within which wind turbines are located and operated. The term may be used to describe an existing facility, or a general area in which development of a facility is proposed.

Wind turbine: A machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity.

APPENDIX E: SCIENTIFIC NAMES OF BIRDS AND MAMMALS MENTIONED IN TEXT

Common Name	Scientific Name
BIRDS	
American peregrine falcon	*Falco peregrinus*
Bald eagle	*Haliaeetus leucocephalus*
Burrowing owl	*Athene cunicularia*
Brown-headed cowbird	*Molothrus ater*
California condor	*Gymnogyps californianus*
Common nighthawk	*Chordeiles minor*
Golden eagle	*Aquila chrysaetos*
Greater prairie chicken	*Tympanuchus cupido*
Horned lark	*Eremophila alpestris*
House sparrow	*Passer domesticus*
Marbled murrelet	*Brachyramphus marmoratus*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Sage grouse	*Centrocercus urophasianus*
Sandhill crane	*Grus canadensis*
Short-eared owl	*Asio flammeus*
Spotted owl	*Strix occidentalis*
White-tailed kite	*Elanus leucurus*
MAMMALS	
California ground squirrel	*Spermophilus beecheyi*
Eastern red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Mexican free-tailed bat	*Tadarida brasiliensis*
Silver haired bat	*Lasionycteris noctivagans*
Western red bat	*Lasiurus blossevillii*

APPENDIX F: SAMPLE DATA SHEETS

The following samples provide suggested data sheets and coding for use when conducting Bird Use Counts or fatality studies and other field surveys.

Appendix 3. Sample data sheet for ten-minute point counts

Location (Site Name): ______________________________UTM Map no.: ________

Date: ____/____/20__ Observer: ____

Wind (Beaufort scale): ____ Sky: _______ Precipitation: ____________ Temp: ____°C

Comments: ____

____

Point Count Station

	1	2	3	4	5	6	7	8	9	10
UTM Easting										
UTM Northing										
Time of visit										

		First five minutes			Second five minutes			
Stn	Species Code	0-50m	51-100m	>100m	0-50m	51-100m	>100m	Total

SAMPLING PROTOCOL

Bird Use at Wind Power Development Sites

Location: ______________________
(Observation point number)
should add types of towers (e.g., lattice or tubular)
Date: ____________________
in a form appropriate for sorting in the data base software (i.e., 021496)

Start time: ________________
24-hour clock

Weather
Temperature: __________°C

Visibility: ________________
Distance bird can be seen, in m

Wind: _____________
Speed and direction; max. gusts can be recorded if desired

Precipitation: ______________
Record as N (none), L (light), M (moderate), H (heavy), F (fog)

Observer: ________________
initials

Primary Data

Species: ________________
4-letter code (e.g., red-tailed hawk = RTHA; golden eagle = GOEA)

No. species in same zone: __________________
Record number of same species at time in same zone

Direction: ________________
Direction of flight (0°-360°)

Zone: _______
A,B,C, and D

Record number: __________________
Record as '1' for each new bird; record as '2' if same bird re-passes rotor plane during same sampling period; and so forth.

Secondary Data

If time allows, can record:

Sex: M (male), F (female), U (unknown).
Age: A (adult), SA (subadult), I (immature), U (unknown)

Bird Mortality

Location: ____________________
Turbine number
should add types of towers (e.g., lattice or tubular)

Date: ________________
in a form appropriate for sorting in the database software (i.e., 021496)

Start time: ___________
24-hour clock

Weather

Temperature: _________°C

Precipitation: ________________
Record as N (none), L (light), M (moderate), H (heavy), F (fog)

Snow cover: __________% ground covered

Observer: ___________________
initials

Primary data

Species: ___________________________
4-letter code

Sex: M or F; unknown

Age: ____
Adult, immature (be as specific as possible)

Dead: Y or N

Estimated time since death: ___________________
in days

Description of bird (e.g., broken or missing body parts): ____

Disposition of bird: ____

Distance of carcass from turbine: _______m

Notes on bird: ____
(e.g., condition and location)

heights of bird movements with reference to the "zone of risk" notwithstanding the number of turbines creating the zone of risk.

Corrections for Bias in Dead Bird Searches.—Several attendees noted that different studies have used or are using different procedures, including different intervals between searches and native vs. non-native "planted" birds. Different investigators have given varying degrees of emphasis to the development of bias corrections. It was recognized that procedures for assessing search, removal and other biases need further discussion, and that a comprehensive assessment would be complex and require much effort.

Appendix: Codes and Explanations for Data Sheets

APPENDIX TABLE 1. Codes and explanations for visual observations data sheet.

Column Number	**Description**
(1)	Location—Use the same digit code (e.g., "1") to indicate the same observation segment.
(2)	Type of Watch—Corridor = 1; Circular Scan = 2; Radar Surveillance = 3.
(3)	Wind Direction: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW
(4-5)	Wind Speed: mph (can get data from meteorological towers)
(6)	Precipitation Type: 1—none, 2—mist, 3—light drizzle, 4—light snow
(7)	Visibility: 1—<100 ft, 2—<500 ft, 3—<1000 ft, 4—<1/2 mile, 5—<1 mile, 6—<2 miles, 7—<5 miles, 8—<10 miles
(8)	Cloud Cover: (tenths) 0—clear to 1—overcast
(9-11)	Temperature: Celsius
(12)	Start Watch: check this column and add information to columns 14-23
(13)	Stop Watch: check this column and add information to columns 14-23
(14-15)	Year—last two digits only (e.g., 94)
(16-17)	Month—01 through 12
(18-19)	Day—01 through 30 or 31
(20-21)	Hour—00 through 24
(22-23)	Minute—00 through 59
(24)	Time Zone: (e.g., Eastern, Central, Pacific)
(25)	Time Basis: (e.g., Standard, Daylight Saving)
(26-29)	Species Code—use letter abbreviation codes derived from common name
(30-33)	AOU Number—use four digit AOU numbers
(34-36)	Number—the number of individuals in a flock

(37) Sex: 1= male, 2=female, 3=unknown

(38) Age: 1=adult, 2=immature, 3=young

(39) Flight Behavior:
1—straight 6—flew up from corridor
2—curved 7—circling
3—zigzag 8—
4—hovering 9—
5—landed in corridor

(40) Height of Flight:
1—0 ft and <30 ft (9 m) 4—200 ft and <400 ft (122 m)
2—30 ft and <137 ft (42 m) 5—400 ft and above
3—137 ft and <200 ft (61 m)

(41-42) Distance from Observer:
01—0 to 500 ft (152 m) 06—2.5k ft to 3k ft (914 m)
02—500 ft to 1k ft (305 m) 07—3k ft to 3.5k ft (1067 m)
03—1k ft to 1.5k ft (457 m) 08—3.5k ft to 4k ft (1219 m)
04—1.5k ft to 2k ft (610 m) 09—4k ft to 4.5k ft (1372 m)
05—2k ft to 2.5 ft (762 m) 10—4.5k ft to 5k ft (1524 m)

(43) Direction of Flight (towards) : 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW

(44) Direction of Bird(s) from observer:
1-N (337.5-22.5°) 5-S (157.5-202.5°)
2-NE (22.5-67.5°) 6-SW (202.5-247.5°)
3-E (67.5-112.5°) 7-W (247.5-292.5°)
4-SE (112.5-157.5°) 8-NW (292.5-337.5°).

(45) Number of Observers

(46) Observer Code: apply individual codes (e.g., a, b) consistently throughout study

(47) Recorder Code: same code letter as used above for observer code

APPENDIX TABLE 2. Additional codes and explanations for radar observations.

Col. (41-42) Distance to Echo:
1—0 to 0.1 nm (185 m) 6—0.5 to 0.6 nm (1111 m)
2—0.1 to 0.2 nm (370 m) 7—0.6 to 0.7 nm (1296 m)
3—0.2 to 0.3 nm (556 m) 8—0.7 to 0.8 nm (1482 m)
4—0.3 to 0.4 nm (741 m) 9—0.8 to 0.9 nm (1667 m)
5—0.4 to 0.5 nm (926 m) 10—0.9 to 1.0 nm (1852 m)

Col. (43) Direction of Flight (towards):
1-N 5-S
2-NE 6-SW
3-E 7-W

Gauthreaux 1995

4-SE 8-NW

Col. (44) Direction to Echo (from radar location):

1-N 5-S
2-NE 6-SW
3-E 7-W
4-SE 8-NW

APPENDIX TABLE 3. Codes and explanations for dead bird searches.

Col. (2)	Type of Search: 1=wind turbine, 2=met tower, 3=power line
Col. (43)	Approximate Time of Death: 1=6-12 hrs, 2=12-24 hrs, 3=1-2 days, 4=1 week, 5=2 weeks, 6=several weeks
Col. (44)	Physical Condition: 1=broken bones, 2=lacerations, 3=abrasions, 4=bloody, 5=discolorations, 6=gun shot wounds, 7=decomposition, 8=scavenger damage
Col. (45)	Probable Cause of Death: 1=collision, 2=electrocution, 3=hunting, 4=predation, 5=unknown
Col. (46)	Necropsy: Y=yes, N=no
Col. (47)	Specimen Number: Whenever specimens are saved for future analysis.

Note: When a dead bird search is along a power line corridor, columns 36-39 are not used and columns 40-42 will indicate distance to power line in meters.

BIRD MOVEMENT OBSERVATION FORM

DEAD BIRD SEARCH FORM

PREV Table of Contents NEXT

Formatted for the Web by:
National Wind Coordinating Committee
c/o RESOLVE, 1255 23rd Street NW, Suite 275, Washington, DC 20037
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Explanations of Fields on Mortality Form (Mortbase File)

1. Record Number	=	Sequential number starting with No. 1 (right justified)
2. Species	=	Common name of bird, unknown raptor, or unknown
3. Number	=	The number of dead or injured birds
4. Age	=	Adult (A) Immature (I) Unknown (U)
5. Sex	=	Male (M), Female (F), Unknown (U)
6. Date Found	=	Date bird was discovered (--/--/--)
7. Estimated time since death	=	Fresh kill - less than 2 days old (FK) Few days - maggots starting to appear (FD) 1 week - maggots over entire body (1W) 2 weeks - flesh at least half gone (2W) 1 month - no flesh left, just bones and feathers (1M) Over 6 months bones and feathers disassembled (6M) Undetermined (UD)
8. Cause of death	=	Collision with turbine (COLT) Collision with wire (COLW) Electrocution (ELEC) Unknown (UNKN)
9. Index of probability (degree of certainty for cause of death)	=	1 thru 10 (1 = low probability, 10 high probability)
10. Condition (Also describe in detail on back of sheet)	=	Dead (D) Injured (I)
11. Injuries (For both dead and alive birds)	=	Wing sheared off (WSO) Head sheared off (HSO) Feet sheared off (FSO) Body sheared in half (BSH) Multiple dismemberment (MUD) Broken wing bone (BWB) Broken neck bone (BNB) Broken leg bone (BLB) Injury to wing (ITW) Injury to legs (ITL) Injury to eyes (ITE) Injury to body (ITB) Injury to head (ITH) Feather damage (FED) Decomposed - body and feathers intact (DBI) Decomposed - feathers and bones disassembled (DBD) Decomposed - just feathers (DJF) Decomposed - just bones (DJB) Wing only (WGO) Electric burns on feet (EBF) Electric burns on wings (EBW) Internal injuries (IIN) Impact, then continued on (ITC)

		Stunned (STU) Entangled in wires (IIW) No obvious signs (NOS)
12. Maximum distance at which bird could be observed	=	In feet
13. Scavenged (at time of discovery	=	Yes (Y), No (N), Unknown (U)
14. Closest Structure to mortality	=	Wind Turbine Machine (WTM) Power line associated with WTM (WPL) General utility power line (GPL) Telephone line (TPL) Large distribution line (LDL) Meteorological tower (MET)
15. If another type of structure is in close proximity and could have caused the mortality - list second structure	=	Wind Turbine Machine (WTM) Power line associated with WTM (WPL) General utility power line (GPL) Telephone line (TPL) Large distribution line (LDL) Meteorological tower (MET)
16. Location	=	Land ownership (Souza) For Biologist: Turbine site and letter (e.g., USW1 Ab)
17. WindFarm Company	=	Fayette, US Windpower, WindMaster, AEC, Flowind, Seawest, Altamont Energy Corp., Zond, Am. Divers.
18. WindFarm Structure Number (closest structure)	=	Tu (turbine) #, Tx (power pole) #
19. Is closest structure an EndRow	=	Yes (Y), No (N)
20. Within CEC study mortality site	=	Yes (Y), No (N)
21. UTM	=	8 digit number
22. Distance to closest Structure	=	Distance (in feet) the bird was from the structure
23. Distance to second type of structure	=	Distance (in feet) the bird was from the structure
24. Aspect from closest structure to site of mortality	=	8 point compass heading (NW, SE) Biologists use degrees also
25. Elevation	=	In feet (from map)
26. Slope Angle of Hill	=	0-10 degrees (1) 11-20 degrees (2) 21-30 degrees (3) 31-45 degrees (4) over 45 degrees (5)

27. Aspect of dominant slope = 8 point compass heading (NW, SE)

28. Configuration of WTM = Vertical axis (VRA)
Three blade lattice - Downwind (3LD)
Three blade lattice - Upwind (3LU)
Two blade lattice (2BL)
Three blade - Guyed wires (3GW)
Steel Tubular - Medium (STM)
Steel Tubular - Large e.g., Howden (STL)
WindWalls (WWS)

29. Configuration of Power Pole = From enclosed diagram, choose the pole number which most closely matches. Place an X on the spots where the bird made contact with structure - there should be darken burned areas (arcs) where contact was made. If burn marks are not obvious, circle any uninsulated wires or conductors that might have caused an electrocution.

30. Riser Pole = Yes (Y), No (N)

31. Number of lines (conductors) = One digit number

32. Number of Cross Beams (arms) = One digit number

Beam A (top)

33. •Length = In feet

34. •Material = Wooden (WO), Metal (ME), Ceramic (CE), Metal with Wooden Braces (MW)

35. •Oriented perpendicular to prevailing wind (at estimated time of incident = Yes (Y), No (N), Unknown (U)

36. •Number of wires that extend upward = One digit

37. •Are these wires insulated = Yes (Y), No (N), Partially (P)

38. •Are wildlife insulation caps used = Yes (Y), No (N), Partially (P)

39. •Perchability = Adequate (A), Little (L), None (N), Unknown (U)

Beam B (middle)

40. •Length = In feet

41. •Material = Wooden (WO), Metal (ME), Ceramic (CE), Metal with Wooden Braces (MW)

42. •Oriented perpendicular to prevailing wind (at estimated time of incident = Yes (Y), No (N), Unknown (U)

43. •Number of wires that extend upward = One digit

44. •Are these wires insulated = Yes (Y), No (N), Partially (P)

45. •Are wildlife insulation caps used = Yes (Y), No (N), Partially (P)

46. •Perchability = Adequate (A), Little (L), None (N), Unknown (U)

Beam C (bottom)

47.	•Length	=	In feet
48.	•Material	=	Wooden (WO), Metal (ME), Ceramic (CE), Metal with Wooden Braces (MW)
49.	•Oriented perpendicular to prevailing wind (at estimated time of incident	=	Yes (Y), No (N), Unknown (U)
50.	•Number of wires that extend upward	=	One digit
51.	•Are these wires insulated	=	Yes (Y), No (N), Partially (P)
52.	•Are wildlife insulation caps used	=	Yes (Y), No (N), Partially (P)
53.	•Perchability	=	Adequate (A), Little (L), None (N), Unknown (U)

54. Are all Cross Beams Parallel	=	Yes (Y), No (N)
55. Shortest distance between lines (conductors)	=	Lines more than 60 inch apart (M60) Lines less 60 inch apart (L60) Lines less 50 inch apart (L50) Lines less 40 inch apart (L40) Lines less 30 inch apart (L30)
56. Are there other manmade or natural perches available in general area (< ¼ mi)	=	Yes (Y), No (N)
57. Frequency of human activity	=	Low - roads seldom used, no building in area (L) Medium - road use occasion, no building in area (M) High - road use common or buildings in area (H)
58. Topography of pole site	=	Top of hill (T) In valley (V) On slope (S)
59. Configuration of Met.Towers	=	Wide Lattice (WL) Narrow Lattice (NL) Guy Wires (GW)
60. Height of Met. Tower	=	In feet
61. Incident Observed	=	Yes (Y), No (N)

If incident observed:

62.	•Time of incident	=	24 hours clock
63.	•Turbine operating during incidence	=	Yes (Y), No (N)

64.	•Adjacent turbines operating	=	Yes (Y), No (N)
65.	•Wind speed at time of incident	=	In MPH
66.	•Describe incident in detail	=	On back of sheet and in memo in DBASE

If incident observed or less than 1 week old record the following information (from the time of discovery to estimated time of death):

67.	•Fog	=	Yes (Y),No (N), Unknown (U)
68.	•Rain	=	No (N), Light (L), Medium (M), Heavy (H), Unknown (U)
69.	•Storm	=	Yes (Y), No (N), Unknown (U)
70.	•Gusty Winds	=	Yes (Y), No (N)
71.	•Maximum Wind Speed	=	In MPH (if incident was observed - record max. MPH for day of incident)
72.	•Average Wind Speed	=	In MPH (if incident was observed - record average MPH for day of incident)
73.	•Wind Direction	=	8 point compass bearings - (e.g. NW). If too variable record (VAR).
74.	•Percent time WTM operating - (from time of discovery to estimated time of death)	=	Percent

75. Other Contributing Factors (can have more than one entry) =

Closest structure within 500 feet of large valley (SNV)
Closest structure within 500 feet of trees (SNT)
Closest structure within 500 feet of wetland or water (SNW)
Closest structure within 500 feet of large drainage or canyon (SNC)
Closest structure within 500 feet of large transmission line (SLT)
First row in area (FRA)
Line parallels road (LPR)
Starvation, weakened condition (STA)
Pesticide poisoning (PPP)

76. Index of Structure Density (within 500 feet of closest structure - includes closest structure row) =

Isolated structure (1)
Short row of structures <4 - [turbines or transmission lines] (2)
One row of structures [turbine or transmission lines] (3)
One row of structures and one single structure [i.e. met tower] (4)
Two rows of structures (5)
Two rows of structures and one single structure (6)
Three rows of structures (7)
Three rows of structures and one single structure (8)
Four rows of structures (9)
Four rows of structures and one single structure (10)

Five rows of structures (11)
Five rows of structures and one single structure (12)
Six rows of structures (13)
Six rows of structures and one single structure (14)

77. Number of isolated structures - i.e., met towers (within 500 feet of closest structure)	=	Number
78. Number of turbines rows (within 500 feet of closest structure)	=	Number (includes the row in which the mortality was found)
79. Number of transmission rows (within 500 feet of closest structure)	=	Number (includes the row in which the mortality was found)
80. Total number of isolated structures or rows (from above three fields)	=	Number
81. Are structure rows all parallel	=	Yes (Y), No (N)
82. Distance from closest structure to next closest row or isolated structure	=	In feet
83. Index of ground squirrel density (within 500 feet of closest structure	=	None (1) Few (2) Scattered (3) Common (4) Abundant (5)
84. Percent of ground surface area with squirrel burrows (within 500 of feet of closest structure)	=	Percent
85. Nearest ground squirrel colony	=	In feet
86. Direction of nearest ground squirrel colony	=	8 point compass heading (NW,SE)
87. Nearest open valley (flat area)	=	1-250 feet (1) 250-500 feet (2) 500 ft - ¼ mi (3) ¼ mi - ½ mi (4) Over ½ mi (5)
88. Direction of nearest valley (only if < ¼ mi away)	=	8 point compass heading (NW,SE)
89. Index of ground squirrel density within nearest valley (only if < ¼ mi away)	=	None (1)

		Few (2) Scattered (3) Common (4) Abundant (5)
90. Nearest Trees	=	1-250 feet (1) 250-500 feet (2) 500 ft - ¼ mi (3) ¼ mi - ½ mi (4) Over ½ mi (5)
91. Direction of trees (only if < ¼ mi away)	=	8 point compass heading (NW, SE)
92. Nearest Water (pond, wetland)	=	1-250 feet (1) 250-500 feet (2) 500 ft - ¼ mi (3) ¼ mi - ½ mi (4) Over ½ mi (5)
93. Direction of water (only if < ¼ mi)	=	8 point compass heading (NW, SE)
94. Nearest Canyon	=	1-250 feet (1) 250-500 feet (2) 500 ft - ¼ mi (3) ¼ mi - ½ mi (4) Over ½ mi (5)
95. Direction of nearest canyon (only if < ¼ mi away)	=	8 point compass heading (NW,SE)
96. Report Completed By	=	Initials of person completing this form
97. Source of Information	=	Person that discovered the bird (full name)
98. Did this incident cause a site event (feeder trip, blown fuse, etc.)	=	Yes (Y), No (N), Unknown (U)
99. Name of Rehabilitation Center (if used)	=	Type name of center
100. Ultimate disposition of bird sent to rehab.	=	Dead (D) Euthanized (E) Released (R)
101. Name of wildlife agency or person contacted	=	Type name of person or agency
102. Comments	=	Place on back of sheet (In memo in dBASE)

Route	A (Southern Route) or B (Northern Route)
Observer	Personal Initials
Foggy	Yes/No and describe in Notes
Cloud Cover	Estimated %
Temperature	°F
Wind Direction	Alpha 8-Point Compass Heading (e.g., NW)
Site #	1-40
Observation #	Each bird sighted is numbered sequentially. (Map)
Military Time	At start of 10-minute interval
Species Abbrev.	AK - American kestrel
	BAO - Barn owl
	BE - Bald eagle
	BO - Burrowing owl
	CH - Cooper's hawk
	FH - Ferruginous hawk
	GE - Golden eagle
	GH - Goshawk
	GBH - Great blue heron
	GHO - Great horned owl
	NH - Northern harrier
	MER - Merlin
	OSP - Osprey
	PR - Prairie falcon
	PGF - Peregrine falcon
	RAV - Raven
	RLH - Rough-legged hawk
	RSH - Red-shouldered hawk
	RTH - Red-tailed hawk
	SEO - Short-earred owl
	SSH - Sharp-shinned hawk
	SWH - Swainson's hawk
	TV - Turkey vulture
	WTK - White-tailed kite
General codes:	ACC - Accipiters
	BUT - Buteos
	DU - Duck
	EAG - Eagles
	FAL - Falcons
	GE - Geese
	UID - Unidentified
Ageclass	A - Adult
	I - Immature
	U - Undetermined

Distance to Observer at First Observation	At 200-foot intervals See scale below: 200 ft.= 1/8in. 1000 ft.=1/2in. 2000 ft.= 1 in.
Height Above Ground at First Observation	0 - On Ground 1 - 1-50 ft 2 - 50-100 ft 3 - 100-200 ft 4 - 200-300 ft 5 - >300 ft
Distance to Closest Structure at First Observation	0 - On Structure 1 - 1-50 ft 2 - 50-100 ft 3 - 100-200 ft 4 - 200-300 ft 5 - >300 ft
Type of Structure (Add "+" to symbol if turbine in running)	TU - Turbine TX - Transmission Line MT - Meteorological Tower
Direction of Movement (For Obvious Flybys Only)	Alpha 8-Point Compass Heading
Notes	Remember to include description of fog

BIRD UTILIZATION COUNT VARIABLES (CEC 4/12/96)

spp. list: Species List: Mark this space when the birds on this sheet have been checked off on the cummulative species list.

check1: First Quality Check: Mark this space when the original data on this sheet has been checked by someone other than the original observer.

comp: Entered Into Computer: Mark this space when the original data on this sheet has been entered into D-Base on the computer. Write "A","B", or "C" for corresponding computer file.

check2: Second Quality Check: Mark this space when the original data from this sheet has been entered into the computer, printed out, and checked by someone.

map: Mapped: Mark this space when this transect has been mapped out.

Date: month/day

Transect #: Transect Number:#001-?

Start Pt.: Starting Point of the transect.

Angle: Random angle taken from the starting point (magnetic bearing) through wind resource area.

Obs: Observer
- 1 = Dick Anderson
- 2 = Natasha Neumann
- 3 = Jennifer Noone
- 4 = Judy Tom
- 5 = Michele Disney
- 6 = John Cleckler

Company/Area:
- 100 = Zond
- 110 = near Zond - Zond side of Cameron Rd.
- 120 = West of Zond - between TWS Rd. and Zond.
- 200 = Cannon
- 210 = near Cannon - Cannon side of Cameron Rd.
- 220 = area between Cannon and Sea West
- 300 = Sea West
- 310 = near Sea West
- 400 = FloWind

Precip: Precipitation. ie. 331 = hard rain all day.
- 100 = no information
- 200 = no precipitation
- 300 = rain - no other info.
  - 310 = sprinkle/mist
  - 320 = moderate
  - 330 = hard
- 400 = snow - no other info.
  - 410 = < 4"
  - 420 = ≥ 4" but ≤ 12"
  - 430 = > 12"
- rain/snow duration:
  - 001 = all day
  - 002 = part of day
  - 003 = most of day
  - 004 = off and on all day
  - 007 = rains and quits - include comments on hours.

Fog:
- 10 = no information
- 20 = no fog
- 30 = light fog
- 40 = dense (visibility < 100m)
- fog duration:
  - 01 = all day
  - 04 = part of day
  - 07 = most of day

Cloud: Cloud Cover.
- 10 = no information
- 20 = clear
- 30 = partly cloudy (>15% cloud cover) - no other info
- 40 = overcast - no other info. (≥80%)
- partly cloudy/overcast duration:
  - 01 = all day
  - 02 = part of day
  - 03 = most of day

Sloc: Sublocation: Each count along transect. (m)= Distance from start point in meters.

TDst: Turbine Distance: The distance(m) between the sublocation and the nearest turbine. Follow the general contour of the landscape. See protocal for exceptions and examples. **Note:** Do not include guy wires of vert. axis turbines in TDst.
- 10 = 0-20m
- 20 = 21-40m
- 30 = 41-60m
- 40 = 61-100m
- 50 = 101-200m
- 60 = 201-400m
- 70 = 401m-1km (if not more specific)
- 71 = 401-600m
- 72 = 601-800m
- 73 = 801m-1km
- 80 = >1km (if not more specific)
- 81 = >1k-1.5km
- 82 = >1.5-2km
- 83 = >2km
- 99 = no information

Op.: Operating. Are turbines within 200m operating?
1 = yes 2 = no 3 = not applicable

Str.1ID: First Structure Identification: Description of the closest structure within a 200m radius of the sublocation. **Note:** Use distance to electrical line itself and number of electrical poles for density. Use in reference to codes 4, 5, 6, & 7.
- 1 = lattice wind turbine
- 2 = tubular wind turbine
- 3 = vertical axis wind turbine
- 4 = distribution line assoc. w/ wind turbine. (usu. 1 wood pole, alum. lines)
- 5 = general distribution line
- 6 = telephone line (mult. lines in 1 cable)
- 7 = large transmission line (usu. metal/mult. wood (H-config.) poles)
- 8 = meteorological tower
- 9 = road - include well traveled roads with vehicles generally traveling ≥ 35mph. Do not include less-traveled dirt roads even if there are no other structures within 200m.
- 10 = other human made structure - i.d. in space. Include fences if no other main structures(ie. turbines, powerlines, met. towers, main roads, and substations) are within 200m
- 11 = none in sight (use dst. & dens. code #99)
- 12 = substation
- 13 = none (use code "0" for dist.& dens)
- 14 = no information (use dst. & dens. code #99)

Str.1Dst: First Structure Distance: Distance between the closest structure and sublocation. Use same codes for T.Dst.

Dens1: Density of first structure: Total number of structure 1 within 100m(1) and 200m(2) of sublocation. For fences and roads, just count each continuous string as one.
c = # structures 99 = no information

Str.2ID & Str.3ID: Secondary & Tertiary Structure Identification: Description of any secondary or tertiary structure in the area. Use same codes used for Str.1ID.

Str.2Dst & Str3.Dst: Distance between the secondary and tertiary structures and sublocation. Use same codes for TDst.

[cut off] : Secondary and Tertiary Structure Density: Total number of secondary or tertiary structure within 100m(1) and 200m(2) of the sublocation. Use same codes used for Dens1.

NCom: Natural Community within a 50m radius of the sublocation. Abbreviations in parenthesis.
- 2 = high desert sub-shrub scrub (HDSSS)
- 3 = annual grassland with component of sub-shrub scrub (AGSSS)
- 4 = oak woodland (OW)
- 6 = hard wood/conifer area (HWCA)
- 7 = other - include description
- 8 = Joshua tree woodland (JTW)
- 9 = high desert sub-shrub scrub with a few (<8) Joshua trees (HDSSSJT)
- 10 = annual grassland (AG)
- 11 = annual grassland with a few (<30%canopy cover)trees (AGT)
- 12 = scruboak chapparal (SC)
- 13 = chapparal/juniper (CJ)
- 14 = high desert sub-shrub scrub with juniper component (HDSSSJ)
- 15 = riparian (R)
- 16 = perennial grassland (PG)
- 17 = perennial grass w/sub-shrub scrub (PGSSS)
- 18 = grassland
- 20 = no information/unknown

Topog: Topography of the sublocation. Use same codes for topography of area which each bird is flying over.
- 10 = ridgetop (top of main ridge - Zond,Cannon,Flowind)
- 20 = midslope (areas between main ridge, not including bottom of valleys)
- 30 = valley (bottom of canyon/ravine)- no more information
- 31 = valley - ≤0.1 km wide
- 32 = valley - >0.1, <0.5 km wide
- 33 = valley - ≥0.5km
- 40 = unknown
- 50 = flat - open land (Mohave, Tehachapi Valley)

Incline: Incline of the sublocation within 50m. Use same codes for incline of area which each bird is flying over.
- 1 = steep (>30°)
- 2 = moderate (5°-30°)
- 3 = flat (<5°)
- 4 = unknown

Tp: Temperature at each sublocation in °F.
- 999 = no information

WdSp: Wind Speed. Use (Beaufort scale + 1)x 10: (c) = code for wind.
- 10 = calm = 0-1mph
- 20 = light air = 1-3mph
- 30 = light breeze = 4-7mph
- 40 = gentle breeze = 8-12mp
- 50 = mod. breeze = 12-18mph
- 60 = fresh breeze = 19-24mph
- 70 = strong breeze = 25-31mp
- 80 = mod. gale = 32-38 mph
- 90 = fresh gale =39-46mph
- 100 = strong gale = 47-54mph
- 110 = whole gale = 55-63mph
- 120 = storm = 64-72mph
- 130 = 72+mph
- 140 = no information

Is the wind constant or gusty? ie. 102 = a gusty strong gale; 10 = calm wind and no other info.
- 01 = constant
- 02 = gusty
- 03 = variable

WdDir: Wind Direction: Circle the direction from which the wind is coming. (c) = the number code.

0 = no information	5 = South
1 = North	6 = South-West
2 = North-East	7 = West
3 = East	8 = North-West
4 = South-East	9 = no wind

Start: Time that count was started, recorded in military (24-hour) time. Start as soon as possible when you hit your sublocation. If you flush a bird out at ≤ 10m from your next sublocation as you are walking towards your next point, include this bird in your count and start your count time at that moment.

Species: The 4-letter acronym for the bird species detected at the sublocation. See bird code list.

#: Number of a certain species at the sublocation which are doing a similar activity.

Dt: Closest distance (as it follows the general contour of the topography)of the area the bird is flying over from the center of the sublocation during the 5 min. count: Use same codes used for structure distance. See protocal for exceptions and examples.

Ht: Height bird is seen from ground. Actual estimated height. Write comments that may help you to code as detailed as possible. Put general height information (100 series) in the first column. Put more specific codes (200 & 300 series) regarding wind turbines/conductors in the second column.

100 general height - no info.(use in 1st coumn)
- 110 = <1m above ground
- 120 = 1-10m above ground
- 130 = 11-50m " "
- 140 = 51-100m " "
- 150 = 100+m " "

If bird flies near significant human-made obstructions excluding turbines and conductors, use:
- 001 = near other obstructions - describe in comments

200 = in reference to turbines within 50m of bird. Use if no info in 2nd column.
- 210 = flying through blades/perched on blades/horiz. blade wires(vert. axis turb.) - *also note in comments
- 220 = within 25% of blade length
- 230 = within 100% of blade length
- 240 = within blade height

Angle at which bird(s) are flying when near turbine(s): ie. 241 = bird(s) flying within blade height perpendicular to blades.
- 001 = parallel (0 - 45°)
- 002 = perpendicular (46 - 90°)
- 003 = perpendicular-upwind
- 004 = perpendicular-downwind

300 = in reference to conductors within 50m of bird.
- 310 = flying through conductors/perched - *also note in comments
- 320 = within 3m above/below conductors
- 330 = within conductor height

MORE ON BACK

the bird(s) identified. If the behavior changes significantly as it is closest to turbines, then record that behavior. If other interesting behavior occurs further from turbines then record that behavior in comments.

10 = other - specify in comments (ie.avoidance of blades, etc.)
20 = soaring
30 = flapping
40 = eating /foraging
50 = perching on ground
51 = " " on vegetation
52 = " " on lattice wind turbine
53 = " " on tubular wind turbine
54 = " " on power pole
55 = " " on conductor
56 = " " on other human-made structure - identify in comments
57 = " " on vertical axis wind turbine
58 = " " on guy wire of vertical axis turbine
60 = gliding
70 = diving

For flying behavior include the following if possible.

01 = into wind (upward)
02 = downwind
03 = crosswind

NCom: Natural Community within a 50m radius of the point the bird is flying over.

WRA: 1st Column: Is bird flying within a cylinder with an ~200m radius that includes or borders a wind resource area (any wind turbine)?

1 = yes
2 = no
3 = unknown

2nd Column: The closest distance (as it follows the general contour of the topography) a bird gets to a turbine within that 5 min. count. See protocal for exceptions & examples. Use codes for TDst. Note: Do not include guy wires of vert. axis turbines in TDst.

Dur.: Duration: How long each bird or group of birds remain in the area.

| = 0-1 min. ; || = 1-2 min.; ||| = 2-3 min.

|||| = 3-4 min.; ||||| = 4-5 min.

(c) = code # (1-5) that corresponds with the number of tick marks.

Comments/Map: Any comments not covered by codes. Also note if significant changes in weather occur. Note any bats flying in area whether or not during point count. Include a map to help map transect if needed.

Dd.#: Number of mortality records (dead/injured birds and/or solitary feather(s)) found within a 50m radius of the sublocation.

c = # mortality records

Mort.Rec.#: Mortality Record Numbers within that sublocation. Use #9999 if no mortality records.

BIRD UTILIZATION COUNT DATA SHEET 1996

check1:____ comp:____ check2:____ map:____

Date _____ Transect # ____ Start. Pt. _____________________ __________ Angle _____ Obs ______ pg ___ of ___

Company/Area ______ Precip. ____|____ Fog ____|____ Cloud ____|____

Sloc: #_____-(m)____ TDst:_____(c)___ Op:___(c)____ Str.1ID:_______#______(c)___ Str.1Dst.:_____ (c)___ Dens1:(1)_____(2)_____

Str.2ID:_______#_____(c)___ Str.2Dst:_____(c)____ Dens2:(1)_____(2)_____ Str.3ID:_______#_____(c)___ Str.3Dst:_____(c)____ Dens3:(1)____(2)____

NCom:________(c)____ Topog:________(c)____ Incline:________(c)_____ Tp:____ WdSp:_____(c)____ WdDir: _____(c)____

Start:

Species	#	Dt (m)	Ht (m)	Behav.	NCom.	Topog.	Incline	WRA	Dur.	Dt.	Ht	Beh	NC	Top	Inc.	WRA	Dur

CODES

Dd#: Mort Rec#(s):
Comments/Map

Sloc: #_____-(m)____ TDst:_____(c)___ Op:___(c)____ Str.1ID:_______#______(c)___ Str.1Dst.:_____ (c)___ Dens1:(1)_____(2)_____

Str.2ID:_______#_____(c)___ Str.2Dst:_____(c)____ Dens2:(1)_____(2)_____ Str.3ID:_______#_____(c)___ Str.3Dst:_____(c)____ Dens3:(1)____(2)____

NCom:________(c)____ Topog:________(c)____ Incline:________(c)_____ Tp:____ WdSp:_____(c)____ WdDir: _____(c)____

Start:

Species	#	Dt (m)	Ht (m)	Behav.	NCom.	Topog.	Incline	WRA	Dur.	Dt.	Ht.	Beh	NC	Top	Inc.	WRA	Dur

CODES

Dd#: Mort Rec#(s):
Comments/Map

1/8/96

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MORTALITY/INJURY STUDY 1996
Field Data Sheet with Variables

(CEC 1/10/96)

Check1___ Comp____
Check2___ Map____
Spp. List___

CODE

______ **Rec.#**: Record Number: sequential number starting with 001.(Will be assigned outside of field.)

______ **Date**: Date bird discovered: month/day

______ **Comp.**:Company/Area:
100 = Zond
110 = near Zond/Zond side of Cameron Rd.
120 = between TWS Rd.& Zond - West of Zond
200 = Cannon
210 = near Cannon/Cannon side of Cameron Rd
220 = area between Cannon & Sea West
300 = Sea West
310 = near Sea West
400 = FloWind

______ **Trans#**: Transect Number or "0" for not applicable.

______ **Subloc.**: Sublocation Number or "0" for not applicable.

______ **Obs.**: Observer:
1 = Dick Anderson
2 = Natasha Neumann
3 = Jennifer Noone
4 = Judy Tom
5 = Michele Disney
6 = John Cleckler

______ **Spp.**: Species: the 4-letter acronym for the species of bird found dead.

______ **Age**:
1 = unknown 2 = immature 3 = adult

______ **Sex**:
1 = unknown 2 = female 3 = male

______ **Time**: Estimated time since death:
1 = undetermined
2 = fresh kill - < 2 days old
3 = few days - maggots starting to appear
4 = 1 week - maggots over entire body
5 = 2 week - flesh at least half gone
6 = 1 month - no flesh left, just bones and feathers
7 = over 6 months - bones and feathers disassembled
8 = bird alive - not applicable
9 = status unknown - not applicable

______ **Cause**: Cause of Death or Injury
1 = unknown
2 = collission with turbine
3 = collission with wire
4 = electrocution
5 = other - explain in comments
6 = not applicable (ie.one feather)

* If bird/feather(s) found in association with a predator/scavenger den (ie. coyote, kit fox) or raptor nest, exclude from study. But be sure to include in an incidental observation report. Make sure to document in mort. rec. only if feather is of resident nester.

CODE

______ **Certain.**: Degree of certainty for cause of death/injury.
1 low 2 3 4 5 high
6 = not applicable

______ **Cond.**: Condition (also describe in detail in comments)
1 = dead
2 = alive
3 = unknown - not applicable

______ **Injur.**: Injuries (For both dead and alive birds)(Can include more than one code)
1 = no obvious signs
2 = wing sheared off
3 = head sheared off
4 = feet sheared off
5 = body sheared in half
6 = multiple dimemberment
7 = broken wing bone
8 = broken neck bone
9 = broken leg bone
10 = injury to wing
11 = injury to legs
12 = injury to eyes
13 = injury to body
14 = injury to head
15 = feather damage
16 = body and feathers intact
17 = feathers and body disassembled
18 = just feathers
19 = just bones
20 = just feathers and bones
23 = wing only
24 = electric burns on feet
25 = electric burns on wings
26 = internal injuries
27 = impact, then continued on
28 = stunned
29 = entangled in wires
30 = other - describe in comments
100 = unknown status - no indication of injury/mortality (ie.single feather; feather(s)of same species found within 1 sublocation.)
200 = unknown status of bird found outside of sublocation (ie. feather found only)
200 + code = injury of bird found outside of sublocation.

______ **Collected**: Was the bird collected?
1 = collected
2 = not collected
3 = partially collected (ie.few feathers)

______ **Mx.Dt.**: Maximum Distance(m)at which bird/bird part/feather could be observed: Refer to feather closest to turbine
1 = <0.5m
2 = 0.5m - 1m
3 = 1.1m - 5m
4 = 5.1m - 10m
5 = >10m

(MORE ON BACK)

RECORD OF DEAD BIRDS - SCAVENGING STUDY # __ __ __ 1996

Date: _________ Obs: _______ [chicken spp. not included in this list] *(CEC 12/12/95)*

Size: 1 = small (ie. sparrow); 2 = medium (ie. dove, kestral); 3 = large (ie.raven, hawk,) Cond(ition): 1 = fresh; 2 = old

Band#	Spp.	Size	Cond.	Band#	Spp.	Size	Cond.	Band#	Spp.	Size	Cond.

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STUDY VARIABLES (CEC 3/4/95)

Scavenging Study#: 01-?

Company/Area:
- 100 = Zond
- 110 = near Zond - Zond side of Cameron Rd
- 120 = West of Zond - between TWS Rd. & Zond
- 200 = Cannon
- 210 = near Cannon - Cannon side of Cameron Rd.
- 220 = area between Cannon & Sea West
- 300 = Sea West
- 310 = near Sea West
- 400 = FloWind

OBS: Observer
- 1 = Dick Anderson
- 2 = Natasha Neumann
- 3 = Jennifer Noone
- 4 = Judy Tom
- 5 = Michele Disney
- 6 = John Cleckler

Date: month/day

Note: Take weather information at the beginning of each scavenging check

Time: Time at which weather information is taken.

Temp.: Temperature from the thermometer (F).

Wind: Use (Beaufort scale + 1) X 10. Obtain information from wind energy companies.
- 10 = calm = 0-1mph
- 20 = light air = 1-3mph
- 30 = light breeze = 4-7 mph
- 40 = gentle breeze = 8-12 mph
- 50 = mod. breeze = 13-18 mph
- 60 = fresh breeze = 19-24 mph
- 70 = strong breeze = 25-31 mph
- 80 = mod.gale = 25-31 mph
- 90 = fresh gale = 32-38 mph
- 100 = strong gale = 47-54 mph
- 110 = whole gale = 55-65 mph
- 120 = storm = 66-72 mph
- 130 = 72+ mph

Is the wind constant or gusty?
ie. 31 = a constant light breeze; 102 = a gusty strong gale
- 01 = constant
- 02 = gusty
- 03 = variable

Cloud: Cloud Cover. Best estimation
- 10 = no information
- 20 = clear
- 30 = partly cloudy (>15% cloud cover)- no other info.
- 40 = overcast (> 80%)- no other info.

Precip.: Precipitation.
- 100 = no information
- 200 = no precipitation
- 300 = rain - no other info.
  - 310 = sprinkle/mist
  - 320 = moderate
  - 330 = hard
- 400 = snow (amount presently on ground) - no other info.
  - 410 = < 4"
  - 420 = ≥ 4" but ≤ 12"
  - 430 = > 12"

Fog:
- 10 = no information
- 20 = no fog
- 30 = light
- 40 = dense (visibility < 100m)

At the bottom of the page. Note any weather changes you feel are significantly different from those recorded (ie. storm comes in on an otherwise sunny day).

Moon:
- 10 = ● new
- 20 = ◐ first quarter
- 30 = ○ full
- 40 = ◑ last quarter

Time & Cond.: See time and conditon further down columnn.

Site#: The site number assigned to where the bird was placed.

Band#: Band placed on dead bird for scavenging study: 001-60.

Spp: Species:4-letter acronym for the bird species. See list of acronyms for local Tehachapi bird species. Use CHIC for domestic chicken.

Size: Bird Size:
- 1 = small (ie. sparrow, chick)
- 2 = medium (ie. dove, kestral)
- 3 = large (ie. raven, hawk, chicken)

Time: Use military (24-hour) time.

Condition:
State of bird:
- 10 = not scavenged
- 20 = partially scavenged
- 30 = removed + scavenged/found
- 40 = removed/not found

Scavenged by: ie. 21 = partially scavenged by insects
- 00 = no other scavenging info.
- 01 = insects
- 02 = rodent
- 03 = mammalian carnivores
- 04 = non-raptor birds (crow/raven)
- 05 = raptors

Comments: Include specific comments regarding the condition of the bird as needed.

___ ___ ___ scavenging study #

SCAVENGING STUDY 1996

Company/Area ________ (c)___ OBS ____________ (c)___ pg — of —

heck 1 ☐
mp ☐
heck 2 ☐

Date																				
Time	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Temp.																				
Wind																				
Cloud																				
Precip.																				
Fog																				
Moon																				

SITE#:
Spp: ______
Size: ______
Bd#: ______

Time																				
Cond.																				

Comments:

SITE#:
Spp: ______
Size: ______
Bd#: ______

Time																				
Cond.																				

Comments:

SITE#:
Spp: ______
Size: ______
Bd#: ______

Time																				
Cond.																				

Comments:

SITE#:
Spp: ______
Size: ______
Bd#: ______

Time																				
Cond.																				

Comments:

SITE#:
Spp: ______
Size: ______
Bd#: ______

Time																				
Cond.																				

Comments:

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Scavenging Study#: 001-?

Date: month/day bird is set out.

Obs: Observer.

1 = Dick Anderson
2 = Natasha Neumann
3 = Jennifer Noone
4 = Judy Tom
5 = Michele Disney
6 = John Cleckler

Comp/Area: Company/Area

100 = Zond
110 = near Zond - Zond side of Cameron Rd.
120 = West of Zond - betwenn TWS & Zond
200 = Cannon
210 = near Cannon - Cannon side of Cameron Rd.
220 = area between Cannon & Sea West
300 = Sea West
310 = near Sea West - East or South of S.W.
400 = Flowind

Site #: Assign this site a number that is preceded with the company's first letter(s). Begin with #1-? for each scavenging study and each area. ie. The first Sea West site in scavenging study #007 = SW1.

Bd.#: Band number placed on dead bird for scavenging study: 001-600.

Spp: Species: the 4-letter acronym for the bird species. See codes for Tehachapi bird species. Use CHIC if domestic chickens used. After "/" put the size code.

1 = small (ie. sparrow, chick)
2 = medium (ie. dove, kestral)
3 = large (ie. raven, hawk, chicken)

Time: Time when bird is set out. Use military (24-hour) time.

NCom: Natural Community. Include abbreviations with code - quick reference.

2 = high desert sub.shrub scrub (HDSSS)
3 = annual grassland with component of sub-shrub-scrub (AGSSS)
4 = oak woodland (OW)
6 = hard wood/conifer area (HWCA)
7 = other - include description
8 = Joshua Tree Woodland (JTW)(>8 Joshua tree clumps)
9 = high desert sub-shrub-scrub with a few joshua trees (<8 Joshua tree clumps)(HDSSSJT)
10 = annual grassland (AG)
11 = annual grassland with a few (<30%canopy cover)trees (AGT)
12 = scruboak chapparal (SC)
13 = chapparal/juniper (CJ)
14 = high desert sub-shrub scrub w/juniper component (HDSSSJ)
15 = riparian (R)
16 = perennial grassland (PG)
17 = perennial grassland w/sub-shrub-scrub (PGSSS)
18 = grassland (G)- no other info.
20 = no information/unknown

TDst: Turbine Distance: The distance(m) between the bird and the nearest turbine.

10 = 0-20m
20 = 21-40m
30 = 41-60m
40 = 61-100m
50 = 101-200m
60 = 201-400m
70 = 401-1km (if not more specific)
71 = 401-600m
72 = 601-800m
73 = 801-1km
80 = >1km (if not more specific)
81 = >1-1.5km
82 = >1.5-2km
83 = >2km
99 = no information

Str1ID: First Structure Identification: Description of the closest significant structure (# 1-9, #12)within a 200m radius of the bird. **NOTE 1:** Include lightly used roads and/or fences in structure i.d. spaces only if other structures (#1-9, #12)do not fill up all of the 3 structure identifications. **NOTE 2:** If other types of turbines w/in 200m are not accounted for in structure i.d. spaces, include descript., dens., and dist. for each type in comments

1 = lattice wind turbine
2 = tubular wind turbine
3 = vertical axis wind turbine
4 = distribution line assoc. w/wind turbine (usu. 1 wood pole , alum. lines)
5 = general distribution line
6 = telephone line (mult. lines in 1 cable)
7 = large transmission line (usu. metal/mult. wood configuration poles)
8 = metereological tower
9 = heavily used road - paved or dirt with vehicles usu. traveling at > 35 mph (ie main entrance road to Zond.)
10 = other human-made structure (ie. fence - see note above)- i.d. in space
11 = none in site (use dst.& dns. code #99)
12 = substation
13 = none (use code "0" for dist. & dens.)
14 = no information/unknown (use dst. & dns. code #99)
15 = moderate-lightly used road - usually dirt roads (see note above)

Str1Dst: First Structure Distance: Distance between the closest structure and the bird. Use same codes for TDst

Str1Dns: Density of first structure : total number of structure #1 within 100m(1) and 200m(2).

c = # structures 99 = no information

Str2ID & Str3ID: Secondary & Tertiary Structure Identification: Description of any secondary/tertiary structures in the area. Use same codes used for Str1ID.

Str2Dst & Str3Dst: Distance between the secondary/tertiary structures and bird. Use same codes for TDst.

Str2Dns & Str3Dns: Secondary & Tertiary Structure Density: Total number of secondary/tertiary structures within 100m(1) and 200m(2). Use same codes used for Dens1.

Bird Loc.: Bird Location. Place a bird within the area you are studying. Identify the closest and easiest identifiable landmark (ie. turbine, fork in road, joshua tree,etc.)to find the bird. Include identification numbers for turbines, roads, etc. Record distance in meters and/or paces and the magnetic bearing of the direction that the bird is located from the landmark. Do not use codes in this space.

Flag Loc.: Flag Location. Place the pin flag 10 m at magnetic north of the bird. Record meters and/or paces used.

Flag Color: The color of the pin flag.

Comments: Include any comments that may help locate the bird and/or describe significant points regarding its original condition.

Map: Map out the location of the birds while labeling significant landmarks, degrees, meters, paces, the direction of magnetic north,etc.

Example:

___ Scavenging study # Date:_____ Obs: _____ Comp/ Area: _______(c)____ pg ___ of ___

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Site#	Bd#: / Spp: /	Time: / NCom: (c)	TDst: (c)	Str1ID: (c)
	Str1Dst: (c)	Str1Dns: (1) (2)	Str2ID: (c)	Str2Dst: (c)
	Str2Dns: (1) (2)	Str3ID: (c)	Str3Dst: (c)	Str3Dns: (1) (2)
Loc:				
& Comments:			Flag Loc:	Flag Color:

Site#	Bd#: / Spp: /	Time: / NCom: (c)	TDst: (c)	Str1ID: (c)
	Str1Dst: (c)	Str1Dns: (1) (2)	Str2ID: (c)	Str2Dst: (c)
	Str2Dns: (1) (2)	Str3ID: (c)	Str3Dst: (c)	Str3Dns: (1) (2)
Bird Loc:				
Map & Comments:			Flag Loc:	Flag Color:

check 1 ☐ comp ☐ check 2 ☐

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DATE:_____ / _____ OSERVER:__________ (c) ____

NCom. Type:_____ (c) _____ SITE #:_____

ORDER: 1st 2nd 3rd

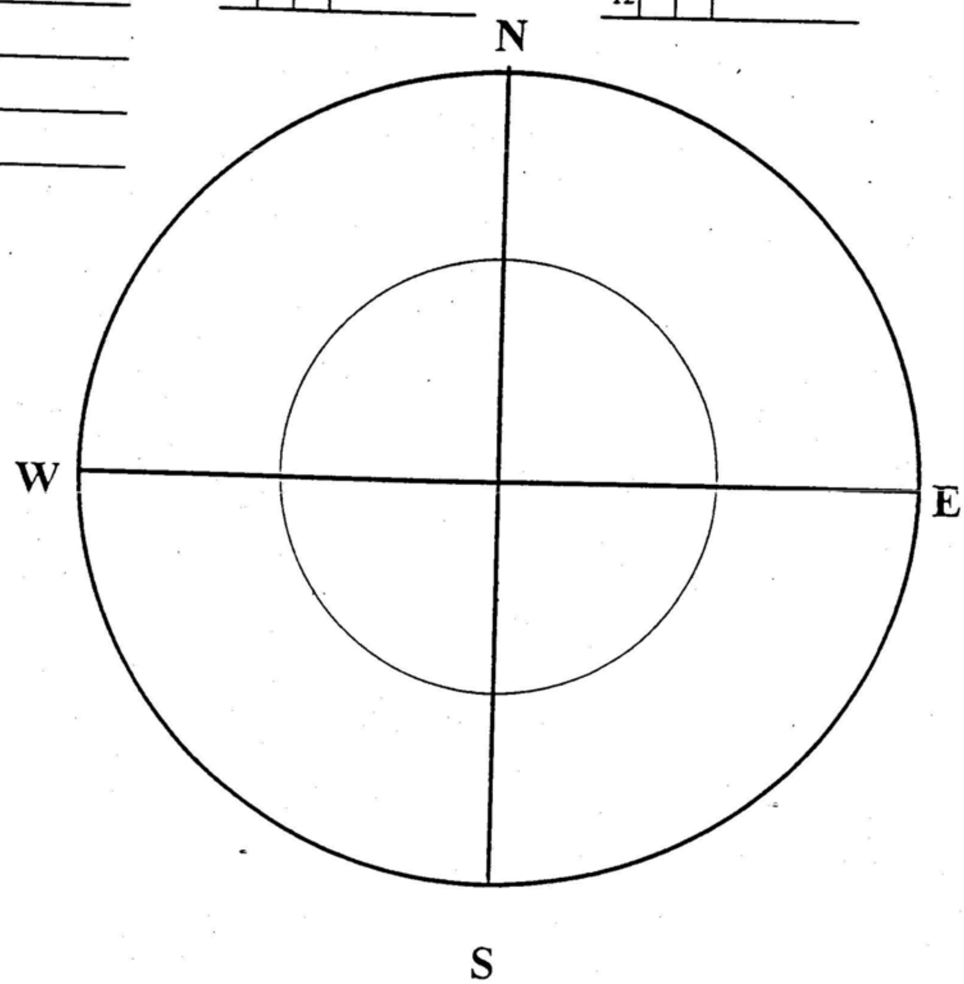
COMPANY:__________ (c) ______ TIME: Start _______ End _______

Bird Mortality Sign Description (small = ≤ 8 in.; large = > 8 in.)
Distance at which sign was first observed

	sm	lg	dist.
1.			
2.			
3.			
4.			
5.			
6.			

	sm	lg	dist.
7.			
8.			
9.			

	sm	lg	dist.
10			
11			
12			



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APPENDIX G: RECOMMENDED FORMULAS FOR ADJUSTING FATALITY RATES

Conceptual Adjusted Fatality Equation

The conceptual equation for the adjusted fatality rate per megawatt of installed capacity per search interval estimate is:

$$\hat{M}_A = \frac{\hat{M}_U}{\hat{S}_{nr}\,\hat{p}_d}.$$

$\hat{M}_U$ -is the unadjusted fatality rate, the number of fatalities per megawatt of installed capacity per search interval. The standard interval recommended in the *Guidelines* for bird carcass searches is every two weeks. If intervals are of differing time periods the estimates should account for this variation.

$\hat{S}_{nr}$ -is the probability that a carcass has not been removed in an interval.

$\hat{p}_d$ -is the probability that a carcass present at the time of a count period is detected.

Carcass Removal Rate Estimation

6. The estimation of carcass removal rate based on birds or bats planted by the researcher should be designed so that the estimate is statistically independent of the detection probability by the searcher.
7. The estimation of carcass removal rates should be repeated in all seasons because vegetation heights will vary and scavengers move in and out of the area.
8. Estimate the removal rate per interval based on the simplifying assumption that the removal rate is constant over time. Two estimation methods are given here, one for the removal rate being variable over time and the second for the removal rate being constant over time (modified from Seber, 1982, p.408-414).

Estimation Procedure - In this situation a cohort of planted carcasses is followed over various time intervals and the number remaining is analogous to a cohort age specific life table approach described on page 408-414 of Seber (1982). Therefore the estimates and standard errors presented there can be used to solve this estimation problem.

Let S_x be the probability that a carcass is not removed in an interval x, l_0 be the number of carcasses planted at the beginning, and l_x the number of carcasses remaining at the end of each interval x = 1,2,..w. Then following Seber (1982, p. 408)

$$\hat{S}_x = l_{x+1} / l_x.$$

Now consider the special case where S_x is constant (that is, $\hat{S}_{nr}$ in our original notation). This as a geometric model, which is just the discrete analogue of the exponential model. The maximum likelihood estimator is

$$\hat{S}_{nr} = 1 - (l_0 - l_w) / \sum_{x=0}^{w-1} l_x \ ,$$

and this can be rewritten as

$$\hat{S}_{nr} = \sum_{x=1}^{w} l_x / \sum_{x=0}^{w-1} l_x \ ,$$

with

$SE(\hat{S}_{nr}) = \sqrt{(l_0 - l_w) \sum_{x=1}^{w} l_x / [\sum_{x=0}^{w-1} l_x]^3}$. These equations are from Seber (1982 p. 413).

Estimation of Searcher Efficiency Trials

1. Searcher efficiency trials (also called carcass detection probability) should be repeated in all seasons since detection probability can vary during different seasons. Each estimate will be of a simple binomial form:

   $\hat{p}_d = x / n, SE(\hat{p}_d) = \sqrt{\hat{p}_d (1 - \hat{p}_d) / n}$. Here x is the number of planted carcasses detected and n is the number planted.

2. It is assumed that the detection probabilities estimated from the planted carcasses are an unbiased estimate of the detection rates for real bird fatalities.

3. The carcasses used should be native species and as fresh as possible.

APPENDIX H: RESEARCH AND REVISIONS

Bird and bat interactions with wind turbines is an area of active research in this country and internationally. The National Wind Coordinating Committee (NWCC) (www.nationalwind.org), a diverse collaborative that includes representatives from the developers, utilities, environmental and consumer groups, and state and federal government, provides a forum for this research with their Wildlife Workgroup. In California, the Energy Commission's Public Interest Energy Research (PIER) Program supports energy research, development and demonstration projects to advance science and technology that seeks to provide environmentally sound, efficient, and reliable energy sources. PIER is planning a research effort that will develop products to inform the siting of new wind energy projects, improve methods to assess impacts of wind development on birds and bats, and evaluate the effectiveness of impact avoidance, minimization, or mitigation measures. Numerous other private-public research partnerships are underway elsewhere in the United States that will also provide new findings on how to reduce the impacts of wind development on wildlife, including the National Research Energy Laboratory (www.nrel.gov/wind) and the Bat and Wind Energy Collaborative (see NWCC web page for more information).

The recommendations in these guidelines reflect the current state of knowledge about the interactions of wind turbines with birds and bats, but these recommendations may need to be revised as new research provides insight on how to improve survey protocols and mitigation recommendations. After the *Guidelines* have been in place and used for a few years, periodic revisions may also be needed as users gain a broad spectrum of experience and develop suggestions for improvement.