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

COMMITTEE DRAFT 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; pre-permitting study design and methods; 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; and post-construction operations monitoring, analysis, and reporting methods.

Key Words: Avian fatality, avian injury, avian mortality, bat fatality, bat injury, bat mortality, bird fatality, bird injury, carcass count, Migratory Bird Treaty Act, rotor-swept area, wind energy, wind siting guidelines, wind turbines.

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EXECUTIVE SUMMARY

Wind energy is expected to play a vital role in meeting California's renewable energy standards, which require that 20 percent of the electricity sold in California come from renewable energy resources by 2010. The California Energy Commission's *2004 Integrated Energy Policy Report Update* recommends a longer-term goal of 33 percent renewable energy by 2020. At the same time California moves to achieve its renewable energy commitments, it must also maintain and protect the state's wildlife resources. Specifically, wind energy development projects in California must avoid, minimize, and mitigate potential impacts to bird and bat populations. *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (Guidelines)* was developed to address these coexisting and sometimes conflicting objectives: to encourage the development of wind energy in the state while minimizing and mitigating harm to birds and bats. Following the *Guidelines* is voluntary; this document is available as a resource for agencies that issue permits for wind facilities and for other parties involved in the permitting process.

This document is a collaboration of the California Energy Commission (Energy Commission) and the California Department of Fish and Game (CDFG). In its *2005 Integrated Energy Policy Report*, the Energy Commission recommended the development of statewide protocols to address avian impacts from wind energy development. In 2006, many stakeholder participants at a workshop, "*Understanding and Resolving Bird and Bat Impacts,"* collectively requested such guidance. The resulting document provides a science-based approach for assessing the potential impacts that a wind energy project may have on bird and bat species and includes suggested measures to avoid, minimize, and mitigate identified impacts. CDFG and the Energy Commission encourage the use of the *Guidelines* for the biological assessment, mitigation, and monitoring of wind energy development projects and wind turbine repowering projects in California.

The objectives of the *Guidelines* are to provide information and recommend protocols for assessing, evaluating, and determining the level of project effects on bird and bat species, and to develop and implement impact avoidance, minimization, and mitigation measures. The document is organized around five basic steps:

1. Gather preliminary information and conduct site screening.
2. Consider the California Environmental Quality Act (CEQA), wildlife protection laws, and permitting requirements.
3. Collect pre-permitting data using standardized monitoring protocol.
4. Identify potential impacts and mitigation.
5. Collect operations monitoring data using the standardized monitoring protocol.

Information in the *Guidelines* was specifically designed to be flexible to accommodate local and regional concerns. The standardized protocols in the document are adaptable to address the specifics of each site such as frequency and type of bird and bat use, terrain, and availability of scientifically accepted data from nearby sources. For most projects, one year of pre-permitting surveys and two years of operations monitoring data collection are recommended. However, a reduced level of survey effort may be warranted for certain categories of projects, such as infill development or projects contiguous to existing low-impact wind facilities. On the other hand, survey duration and intensity may need to be expanded for other kinds of projects, such as those with potential for impacts to special-status species, or for sites near wind energy projects known to have high impacts to birds or bats. Decisions on the level of survey effort need to be made in consultation with the CEQA lead agency, CDFG, U.S. Fish and Wildlife Service, and local conservation groups.

California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development does not duplicate or supersede CEQA, the California Endangered Species Act statutes or other legal requirements. This document does not alter a lead agency's obligations under CEQA, nor does it mandate or limit the types of studies, mitigation, or alternatives that an agency may decide to require. Because this document complements existing CEQA guidance, following these *Guidelines* will support efforts to comply with CEQA and other local, state, and federal wildlife laws and will facilitate the issuance of required permits for a project, providing a measure of regulatory certainty for wind energy developers.

This document reflects close coordination of the Energy Commission and California Department of Fish and Game and advice from scientists and legal experts, as well as public input from wind energy development companies, counties, conservation groups and other non-governmental organizations, and private citizens. The Energy Commission and CDFG thank all those who participated in the development of these *Guidelines* and encourage lead agencies and all parties interested in the development of California's wind energy resources to use the *Guidelines* as a resource on all future wind energy projects.

INTRODUCTION

Californians have high expectations for their state's renewable energy programs. On September 26, 2006, Governor Schwarzenegger signed Senate Bill 107 (Simitian and Perata) Chapter 464, Statutes of 2006, requiring that 20 percent of the electricity sold in California come from renewable energy resources by 2010.[1] 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 both goals.

Californians have equally high expectations for protection of the state's diverse bird and bat populations. Optimal development of the state's wind energy resources requires adequate measures to avoid, minimize, and mitigate potential impacts to these populations. The voluntary draft *California 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.

In its *2005 Integrated Energy Policy Report*, the California Energy Commission (Energy Commission) recommended the development of statewide protocols to address avian impacts from wind development. The *Guidelines* effort originated in January of 2006 at the "*Understanding and Resolving Bird and Bat Impacts*" conference in Los Angeles. Many participants at the conference encouraged the Energy Commission and the California Department of Fish and Game (CDFG) 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 assigned the task to the Energy Commission's Renewables Committee.[2] To assist Energy Commission and CDFG staff in this endeavor, the Renewables Committee established a science advisory committee and solicited suggestions from stakeholders on how to incorporate public input into the guidelines development

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[1] The Renewable Portfolio Standard was originally placed in statute in 2002 with the passage of Senate Bill 1078 (Sher) Chapter 516, Statutes of 2002, calling for 20 percent renewable energy by 2017. The *Energy Action Plan*, adopted by the California Public Utilities Commission and the California Energy Commission, accelerated the Renewable Portfolio Standard target to achieve 20 percent renewable energy by 2010.

[2] California Energy Commission Docket 06-0II-1. Interested parties can find details on the Order Instituting Informational proceeding, comment letters, and summaries or transcripts of past workshops on the Energy Commission Web site, <www.energy.ca.gov/renewables/06-OII-1/>.

process. As a result, the Energy Commission has hosted numerous public workshops throughout the state and solicited written comments on draft *Guidelines* to make sure all interested parties have input on development of this document.

Securing Wind Energy Development Permits

In California, development of wind energy projects requires land use permits from local agencies such as counties and cities, many of which have ordinances that regulate the permitting and operation of these projects. State and federal laws regulate certain aspects of wind energy projects, including their impacts to special status species and other biological resources. The California Environmental Quality Act (CEQA), the Planning and Zoning Law, the California Endangered Species Act, Federal Endangered Species Act, and state and federal wildlife protection laws are the primary laws and regulations that govern the process. This document is a tool to facilitate compliance with relevant laws and regulations by recommending methods for conducting site-specific, scientifically sound biological evaluations. Much of the information required to satisfy CEQA is also needed to comply with other state and federal wildlife laws; using the *Guidelines* for standardized guidance on how to collect information on potential bird and bat impacts will facilitate compliance with all of these laws.

Status of Wind Energy Research

Bird and bat interactions with wind turbines is an area of active research and collaboration in this country and internationally. The National Wind Coordinating Committee (NWCC) <www.nationalwind.org>, a diverse collaborative that includes representatives from developers, utilities, environmental and consumer groups, and state and federal government, provides a forum for this research with its Wildlife Workgroup. Elsewhere in the United States, numerous other public-private research partnerships are underway that will also provide new findings on how to reduce the impacts of wind development on wildlife, including the National Renewable Energy Laboratory, <www.nrel.gov/wind>, and the Bat and Wind Energy Collaborative (refer to <www.nationalwind.org> for more information).

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 provide environmentally sound, efficient, and reliable energy sources <www.energy.ca.gov/pier/environmental/index.html>. The Energy Commission has undertaken research efforts that will help 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. The PIER research is guided by a research plan, developed with stakeholder input, which identifies research priorities pertinent to California. This research plan includes a description of major research issues; an assessment of ongoing, research; and provides recommendations for financial support of specific research activities by the

Energy Commission. The research plan also identifies opportunities to leverage research funds and support collaborative efforts with stakeholders, including government agencies, conservation groups, and industry. PIER is currently developing an update to its research plan that will focus on research needed to help strengthen future versions of the *Guidelines*.

In addition to PIER's research efforts, the Energy Commission and CDFG are interested in supporting further studies that might increase the certainty in methods and metrics to assess and mitigate potential impacts to birds and bats from wind energy development. These agencies intend to work with wind energy developers and non-governmental organizations interested in wind-wildlife interactions to explore a public-private partnership and funding mechanism to support collaborative, regional research efforts. The objective of this research would be to improve the reliability and accuracy of pre-permitting studies and develop effective impact avoidance and minimization strategies.

Purpose of This Document

The purpose of this document is to provide recommendations on methods to assess bird and bat activity at proposed wind energy sites, design pre-permitting and operations monitoring plans, and develop and implement impact avoidance, minimization, and mitigation measures. Both wind energy proponents and bird and bat populations will benefit if agencies that permit wind energy development projects apply the methods recommended in the *Guidelines*. Using these protocols will promote scientifically sound, 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 estimate and resolve impacts locally and regionally.

Organization of the Document

The *Guidelines* opens with a step-by-step implementation guide that highlights the recommended process and protocols for successfully gathering information useful to the permitting process. The following chapters provide greater detail as well as the scientific background and rationale for the steps necessary in assessing a potential wind energy site, successfully securing the information needed for project permits, and continuing to monitor impacts to birds and bats once the project has launched.

- Chapter 1, "Preliminary Site Screening," discusses the initial actions a developer should take to assess the relative sensitivity of a potential wind energy project site and to determine the kinds of studies that will be required to adequately evaluate the impacts such a project could have on birds and bats.
- Chapter 2, "CEQA, Wildlife Protection Laws, and Permitting Requirements," offers information on impacts and mitigation that can apply both to CEQA and to other wildlife protection laws and makes recommendations to facilitate completion of important milestones throughout the permit application process and the life of the project.

- Chapter 3, "Pre-Permitting Assessment," offers standardized survey methods, protocols, and recommendations for conducting the studies identified by preliminary site screening, both for new projects and for repowering.
- Chapter 4, "Assessing Impacts and Selecting Measures for Mitigation," discusses how to assess impact findings discovered during the pre-permitting studies and suggests avoidance and minimization measures to incorporate into the planning and construction of the wind energy development. It also discusses adaptive management and compensatory mitigation.
- Chapter 5, "Operations Monitoring and Reporting," recommends standardized techniques for collecting, interpreting, and reporting bird and bat fatalities and use data once a project has begun operation.

The Future of This Document

This document reflects the current state of knowledge about the interactions of wind turbines with birds and bats. Ongoing and future research and actual experience in preliminary site screening, pre-permitting assessment, and operations monitoring of wind energy projects will refine, expand, and alter that knowledge. The Energy Commission and the CDFG will update and revise portions of the document as new research findings and feedback from users of the *Guidelines* indicate that current recommendations, such as those for bat and nocturnal bird survey methods, may need revision. The entire document will be reviewed and revised, if necessary, approximately every five years. Interested parties will have the opportunity to participate in the update and revision process. Consult the Energy Commission Web page for information about proposed updates or revisions <www.energy.ca.gov/renewables/06-OII-1/>. For questions about this document or to contribute information to the current body of knowledge, please contact the Biology Unit Supervisor at the Energy Commission, (916) 654-4160.

A STEP-BY-STEP APPROACH TO IMPLEMENTING THE GUIDELINES

This step-by-step guide summarizes the actions project developers should take to assess the impacts a typical wind energy project may have on birds and bats and to avoid, minimize, and mitigate those impacts. The section focuses on:

- Preliminary site screening
- Permitting requirements and compliance with laws
- Pre-permitting assessment methods
- Impact analysis and mitigation
- Operations monitoring

While the other chapters of the *Guidelines* present scientific research and rationale for recommended actions, this section takes a "how to" approach, with the steps arranged in the order they are likely to occur. Each step corresponds to a chapter that provides additional details and background information.

Step 1: Gather Preliminary Information and Conduct Site Screening

Site screening is the first step to assess biological resource issues and potential impacts associated with wind development at a proposed site and to develop a "pre-permitting" study plan. Site screening consists of a reconnaissance field survey and a desktop effort to collect data about the site from databases, reports from nearby projects, agencies, and local experts. Based on the site reconnaissance and review of existing data, a preliminary list of impact questions can be developed, including which species are likely to occur at the site and which are likely to be affected by the project. The site's sensitivity will determine what kind of species-specific data should be collected and determine the kinds of studies the developer should conduct during the pre-permitting assessment to adequately evaluate a wind energy project's potential impacts to birds and bats. Consultation with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), CEQA lead agency, and other appropriate stakeholders is an important step during this process, yielding valuable information and establishing contacts with key individuals and organizations.

Study plans for pre-permitting and operations monitoring should be tailored specifically to the unique characteristics of each site. Consider the following questions when assessing the potential for birds and bats (including special-status species) to occur at the site, when making a preliminary evaluation of collision risk, and in designing the pre-permitting studies discussed in Chapter 3.

1. Are any of the following species known or likely to occur on or near the proposed project site ("near" refers to a distance that is within the area used by an animal in the course of its normal movements and activities.):
   a. Species listed as federal or state "Threatened" or "Endangered" (or candidates for such listing)?
   b. Special-status birds or bats?
   c. Fully protected birds?
2. Is the site near a raptor nest, or are large numbers of raptors known or likely to occur at or near the site during portions of the year?
3. Is the site near important staging or wintering areas for waterfowl, shorebirds, or raptors?
4. Are colonially breeding species (for example, herons, shorebirds, seabirds) known or likely to nest near the site?
5. Is the site likely to be used by birds whose behaviors include flight displays (for example, common nighthawks, horned larks) or by species whose foraging tactics put them at risk of collision (for example, contour hunting by golden eagles)?
6. Does the site or do adjacent areas include habitat features (for example, riparian habitat, water bodies) that might attract birds or bats for foraging, roosting, breeding, or cover?
7. Is the site near a known or potential bat roost?
8. 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)? Is the site near a known or likely migrant stopover site?
9. Is the site regularly characterized by seasonal weather conditions such as dense fog or low cloud cover that might increase collision risks to birds and bats, and do these events occur at times when birds might be concentrated?

Step 2: Consider CEQA, Wildlife Protection Laws, and Permitting Requirements

Permitting for wind energy projects is primarily handled by lead agencies (mostly counties and cities) in accordance with the California Environmental Quality Act (CEQA). In addition to complying with CEQA, lead agencies and project developers should consider the local, state, and federal wildlife protection laws in assessing and mitigating impacts to birds and bats. The following list of laws includes those most commonly addressed on a wind energy project.

State Laws

California Environmental Quality Act

The California Environmental Quality Act governs how California counties, cities, and other government entities evaluate environmental impacts in making discretionary permitting decisions for wind energy development.

Fish and Game Code Wildlife Protection Laws

In the broadest sense, CEQA and Fish and Game Code wildlife protection laws require that government agencies develop standards and procedures necessary to maintain, protect, restore, and enhance environmental quality, including fish and wildlife populations and plant and animal communities, and to ensure that projects comply with these laws. 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
- Fully Protected Species, Fish and Game Code sections 3511, 4700, 5050, and 5515
- Migratory Birds, Fish and Game Code section 3513
- Birds of Prey and Their Eggs, Fish and Game Code section 3503.5
- Unlawful Sale or Purchase of Exotic Birds, Fish and Game Code section 3505
- Nongame Birds, Fish and Game Code section 3800 (a)

Federal Laws

The following federal laws may apply to protecting wildlife from impacts from wind energy:

- National Environmental Policy Act
- Federal Endangered Species Act (FESA), 1973, Title 16, U.S. Code section 1531
- Migratory Bird Treaty Act (MBTA), 1918, Title 16, U.S. Code sections 703 to 712
- Bald and Golden Eagle Protection Act, 1940, Title 16, U.S. Code section 668

While CEQA compliance will be the primary focus of the impact assessment for a wind energy project, focusing on CEQA significance alone may not address all of the species and issues that need evaluation and mitigation; impacts prohibited by state and federal wildlife protection laws must be assessed and minimized throughout project construction and operation, whether or not such impacts rise to the level of CEQA significance. Wind energy developers who use the methods described in the *Guidelines* will secure information on impact assessment and mitigation that would apply to CEQA and to the other wildlife protection laws and will demonstrate a good faith effort to develop and operate their projects in a fashion consistent with the intent of local, state, and federal laws. Such good faith efforts would be considered by CDFG before taking enforcement actions for violation of a California wildlife protection law.

Contact land owners, local environmental groups, the CEQA lead agency, and 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 necessary surveys. Agency consultations, issuance of take permits, and securing lands or easements for compensatory mitigation can be lengthy processes; initiating agency contacts early in the permitting process can avoid delays.

Step 3: Conduct Pre-Permitting Assessment

Framework for Determining Bird and Bat Study Effort

With information from the preliminary site assessment, proposed project sites can be grouped into one of four categories to provide a general framework for determining the duration and intensity of study needed for pre-permitting and operations monitoring.

Category 1 – Project Sites with Available Wind-Wildlife Data

Some proposed projects have the advantage of an existing foundation of data on bird and bat use and potential impacts from nearby similar projects. For these Category 1 projects, a reduced study effort may be appropriate. Projects potentially falling into Category 1 would include infill development and those near existing low-impact wind facilities. Factors to consider in determining whether or not data from an adjacent facility would allow a project to be classified as Category 1 include:

- Whether the field data were collected using a credible sample design
- Where the data were collected in relation to the proposed site
- Whether the existing data reflect comparable turbine type, layout, habitat, physical features, and winds
- Whether the data are scientifically defensible and still relevant

Category 1 projects may not need a full year of pre-permitting studies to answer questions about potential collision risk because of the availability of existing data. 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.

Category 2 – Project Sites with Little Existing Information and No Indicators of High Wildlife Impacts

Projects in Category 2 have no obvious "red flags" that emerge from the preliminary site assessment (for example, "red flags" might be known occurrences of special-status species or high levels of fatalities at nearby wind facilities) and no substantial body of information from nearby projects that could provide information for an impact assessment. Pre-permitting surveys should last a minimum of one year to document how birds and bats use a site during spring, summer, fall, and winter.

Category 3 – Project Sites with High or Uncertain Potential for Wildlife Impacts

Projects with high levels of bird and/or bat use or considerable uncertainty regarding bird and bat use or risk will need more study than Category 2 projects to help understand and formulate ways to reduce the number of fatalities. Characteristics of a site that might put a proposed project in Category 3 are:

- Known avian migration stop-over destinations such as water bodies within or immediately adjacent to the project
- Special-status species occurring on or adjacent to a proposed site
- High concentrations of wintering and/or breeding raptors
- Sites near or contiguous to wind projects that have experienced high bird or bat fatalities that cannot be avoided or minimized

Pre-permitting studies in excess of one year may be necessary for Category 3 projects when baseline information is lacking and when considerable annual and seasonal variation in bird and bat populations is suspected or when there is potential for declining or vulnerable species to occur at the site. Base the duration and focus of pre-permitting studies on the availability of site-specific, baseline data needed to answer impact questions; the species potentially affected; and the magnitude of the anticipated effect.

Category 4 – Project Sites Inappropriate for Wind Development

Wind development should not be considered on land protected by local, state, or federal government as: designated wilderness areas, national parks or monuments, state parks, regional parks, and wildlife or nature preserves. Sites for which existing data indicate unacceptable risk of bird or bat fatalities might also be appropriately classified as Category 4, particularly if no feasible avoidance or mitigation measures are available to reduce impacts.

Study Objectives and Design

The primary objective of bird and bat studies is to collect information useful for estimating the direct and indirect impacts of the project on birds and bats. With this objective in mind, development of a pre-permitting study begins with a clear statement of the questions to be answered. Specific study objectives will vary from site to site, but key issues will typically include at least the following questions:

- Which species of birds and bats use the project area, and how do their numbers vary throughout the year?
- How much time do these birds and bats spend in the risk zone (rotor-swept area), and does this vary by season?
- What is the estimated range of bird and bat fatalities from the project? How does bird/bat use of the site compare to use data from other wind power sites that also have fatality information?
- What design and mitigation measures could reduce impacts?

Repowering

Repowering refers to modernizing an existing wind resource area by removing old turbines and replacing them with new turbines that are generally larger, taller, and more efficient than the old ones. Pre-permitting studies for repowering involves the same methods as for new projects. Data for repowering projects may be available from nearby existing wind projects. The lead agency should consult with CDFG, USFWS, and other experts to assess whether these data are credible, scientifically defensible, and applicable to the repowering site. If so, developers may use the data to reduce the extent of new field studies needed to assess impacts and develop mitigation measures. Evaluate the applicability of the existing data in light of design and operational differences between the old and replacement turbines. Determine the adequacy of this information in consultation with the CEQA lead agency, USFWS, CDFG, and other appropriate stakeholders (such as a conservation organization representative).

General Pre-Permitting Monitoring Considerations

The standardized data collection method for diurnal birds is the bird use count; most projects will also need raptor nest searches. Depending on characteristics of a proposed project site and the bird species potentially affected by the project, additional pre-permitting study methods may be necessary.

For bats, the standardized recommended method is one year of acoustic monitoring with specialized acoustic systems to determine the presence and activity levels of resident and migratory bats at proposed project sites. Other bat research tools are available to complement the information from acoustic surveys but are not recommended on every project.

For nocturnal migratory birds, conduct additional studies as needed if characteristics of the project site and surrounding areas potentially pose a high risk of collision to migrating songbirds and other species. This document discusses some of the primary tools available to study nocturnal birds (radar, acoustic monitoring, visual monitoring) but does not provide standardized recommendations on duration or frequency of sampling or study design.

Early consultation with the lead agency, CDFG, USFWS, and local environmental groups is a crucial step in designing pre-permitting studies and deciding whether or not modifications to the standardized methods are warranted. The Energy Commission and CDFG propose to establish a statewide standing science advisory committee that could also provide information to lead agencies seeking additional scientific expertise. The advisory committee will be established through an open process that encourages input from all interested parties.

Bird Use Counts

The bird use count (BUC) is a modified point count that involves an observer recording bird detections from a single vantage point for a specified time period.

Sampling Duration/Frequency. Conduct BUCs for 30 minutes once a week for one year, covering most daylight hours and weather conditions.

Number/Distribution of Sample Points. Select BUC sample sites at vantage points that offer unobstructed views of the surrounding terrain and that are at least 5,200 feet (1,600 meters) apart, coinciding with proposed turbine sites. Establish sufficient sample points to achieve an average minimum density of 1 to 1.5 sample points every 1 square mile (2.6 square kilometers). Distribute sample points to cover areas of the project site where turbines will be located.

Variables. Record number and species of birds observed, distance from bird to observer, flight height above ground, and environmental variables (for example, wind speed). The surveyor should record locations and behavior at short intervals (for example, 30 seconds), noting behavior such as soaring, contour hunting, and flapping flight.

Metrics. Record bird use within the proposed rotor-swept area height per 30-minute count and bird use per 30-minute count per a defined area.

Raptor Nest Searches

Raptor nest searches provide information for micrositing decisions, to aid in estimating impacts, to establish an appropriately sized non-disturbance buffer around the nesting territory, and to develop compensatory mitigation measures, if needed. Consult with the USFWS, CDFG, raptor biologists, and appropriate stakeholders to establish which species to search for and to develop the site-specific survey protocol.

Search Area. Conduct searches for raptor nests or raptor breeding territories on projects with potential for impacts to raptors in suitable habitat during the breeding season within a range of 0.5 to 3 miles (0.8 to 4.8 kilometers) from proposed turbine locations.

Use the larger search radii for wide-ranging species such as bald or golden eagles if they are known or likely to nest within 3 miles (4.8 kilometers) or for known or likely red-tailed hawk nests within 2 miles (3.2 kilometers) of the proposed turbine sites. Reduce the search area for species with smaller home ranges (for example, American kestrel) or for species that generally stay within the forest canopy and are unlikely to venture far into the open terrain of a wind resource area (for example, Coopers' hawk, spotted owl, and some species of small owls).

Search Protocol. Conduct nest surveys from the ground or air, using helicopters if necessary for large and inaccessible areas and in open country such as grassland or desert. Avoid approaching the nest too closely to minimize disturbance, particularly when surveying from helicopters. Use existing survey protocol (refer to <www.dfg.ca.gov/hcpb/species/stds_gdl/survmonitr.shtml>) for special-status raptor species, including Swainson's hawk, northern goshawk, bald eagle, burrowing owl, and northern spotted owl.

Bats—Pre-Permitting Monitoring Protocol

Duration of Monitoring. Conduct acoustic monitoring at all sites for one year, except in areas characterized by cold winters where bats are absent during the coldest months (higher elevations and portions of northern California). Consult with bat experts, CDFG, and USFWS before reducing acoustic monitoring during any portion of the one-year monitoring period.

Number and Distribution of Monitoring Stations. Place bat detection systems at 100 feet (30 meters) above the ground and at ground level. Try to maintain a density of at least 1 to 1.5 acoustic monitoring stations every 1 square mile (2.5 square kilometers). Distribute sample points to cover areas of the project site where turbines will be located. Logistical constraints (location of existing meteorological towers and roads) will limit the number of potential monitoring sites, so this density of monitoring stations may not be achievable on all projects.

Data Collection and Analysis. Monitor all night and at dusk and dawn. Consult with a bat biologist with experience in acoustic analysis and with CDFG and USFWS before making decisions on the level of effort needed for screening and analyzing the pre-permitting acoustic data.

Metrics. Record total bat passes and mean passes per detector night and per detector hour (excluding nights with measurable precipitation).

Step 4: Assess Potential Impacts and Identify Mitigation Measures

To comply with CEQA and address other wildlife protection laws, lead and responsible agencies make estimates of potential fatalities and risk to individual species and populations to determine the level of impact and to develop avoidance, minimization, and mitigation actions. It is important to use the pre-permitting impact assessment to determine the operations monitoring protocols that would be used to confirm the impact estimates. Address direct, indirect, and cumulative impacts to conduct an adequate CEQA analysis of impacts and other wildlife protection laws.

Impact Avoidance and Minimization

Consider the following elements 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 (for example, avoiding placement of turbines within 100 meters of a riparian area).
- Reduce impacts with appropriate turbine design and layout.
- Reduce artificial habitat for prey at turbine base area.
- Avoid lighting that attracts birds and bats.
- Minimize power line impacts by placing lines under ground whenever possible.
- Avoid using structures with guy wires.
- Decommission non-operational turbines.

Compensation

Project developers and permitting agencies should ensure that appropriate measures are incorporated into the planning and construction of the project to avoid or minimize impacts as much as possible. If these measures are insufficient to avoid or minimize estimated impacts to birds and bats, compensation can be used to mitigate or offset such impacts, including cumulative impacts. Development of effective compensation measures should involve the CEQA lead agency, project proponent, wildlife agencies, and the affected public stakeholders through the CEQA process. Project applicants need to know mitigation and compensation requirements at the time of permitting so that project investors can reasonably anticipate costs; therefore lead agencies should establish well-defined terms along with any funding commitments for compensation prior to issuing final project permits. Early planning for compensatory mitigation provides project developers with upfront information of mitigation costs and assurance of adequate funding to fulfill the required mitigation program. Triggers for additional compensatory mitigation beyond that required at project approval should be well defined, bounded, and feasible to implement, so the permittee will have an understanding of any potential future mitigation requirements.

Establish a biologically meaningful nexus between the level of impact and the amount of compensatory mitigation required. Unlike habitat impacts, in which an acre of habitat lost can be compensated with an appropriate number of acres of habitat restored or protected, no obvious compensation ratio will offset bird and bat collisions with wind turbines. Therefore, consult with CDFG, USFWS, and species experts in the development of site-specific ratios and fees to use in establishing compensation formulae. The compensation must be biologically based, reasonable, and provide certainty in terms of the funds that will be expended and certainty that the mitigation will continue to provide biological resource value over the life of the project. Consider the following list of potential options in developing compensatory mitigation:

- Offsite conservation and protection of essential habitat
  - Nesting and breeding areas
  - Foraging habitat
  - Roosting or wintering areas
  - Migratory rest areas
  - Habitat corridors and linkages
- Offsite conservation and habitat restoration
  - Restored habitat function
  - Increased carrying capacity
- Offsite habitat enhancement
  - Predator control programs
  - Exotic/invasive species removal

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 can either consist of a newly established, project-specific purchase or be part of a well-defined and established conservation program, such as a mitigation bank. Before approving proposed compensatory mitigation involving mitigation banks or conservation programs, the lead agencies should determine whether such proposals are consistent with the following components of CDFG's official 1995 policy on mitigation programs:

- 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 organizations 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.

Operations Impact Mitigation and Adaptive Management

Operations impact mitigation and adaptive management generally occur only if the level of fatalities at a project site was unanticipated when the project was permitted, and therefore, measures included in the permit are inadequate to avoid, minimize, or compensate for bird or bat fatalities. Once a project is operating, options for impact avoidance and minimization are very limited. Therefore, the lead agency and developer should develop contingency plans to mitigate high levels of unanticipated fatalities before issuing permits. Permit conditions should explicitly establish a range of compensatory mitigation options to offset unexpected fatalities and the thresholds that will trigger implementation. In extreme cases, additional compensatory mitigation may not be adequate for high levels of unanticipated impacts, and project operators may need to consider operational and facility changes such as habitat modification, seasonal changes to cut-in speed, limited and periodic feathering of wind turbines during low-wind nights, seasonal shutdowns, or removal of problem turbines.

Use the adaptive management process as a means of testing these operational and facility changes as experimental options to determine their effectiveness in reducing fatalities. Establish the following elements for a successful adaptive management program: clear, objective, and verifiable biological goals; a requirement to adjust management and/or mitigation measures if those goals are not met; and a timeline for periodic reviews and adjustments. Successful adaptive management requires a firm commitment by project owners to accountability and remedial action in response to new information that pre-determined bird and bat fatality thresholds are being exceeded. This commitment must be included in the permit condition(s) during the permitting process so that a mechanism is available to implement mitigation recommendations after the project is permitted. Permit conditions should also include language providing reasonable access to project sites for monitoring of mitigation.

Step 5: Collect Operations Monitoring Data Using the Standardized Monitoring Protocol

Operations monitoring, also referred to as post-construction monitoring, involves searching for bird and bat carcasses under turbines to determine fatality rates and continuing the collection of bird and bat use data, consistent with pre-permitting study methods. At a minimum, the primary objectives for operations monitoring are to determine:

- Whether estimated fatality rates from the pre-permitting assessment were reasonably accurate
- Whether the avoidance, minimization, and mitigation measures implemented for the project were adequate or whether additional corrective action or compensatory mitigation is warranted
- Whether overall bird and bat fatality rates are low, moderate, or high relative to other projects

Standardized Operations Monitoring Protocol for Birds and Bats

Study Duration. 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. Consult the CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders regarding study protocol and the duration of an operations monitoring program.

Category 1 projects need a minimum of one year of operations monitoring to assess whether pre-permitting impact estimates were as low as expected, and to evaluate effectiveness of mitigation measures. Reducing or dispensing with the second year of operations monitoring may be appropriate in a situation where:

- Bird and/or bat use was low or moderate and raptor use was low during pre-permitting monitoring and during the first year of operations monitoring, and
- Fatalities were, as estimated, low to moderate.

Category 2 and 3 projects need the full two years of operations monitoring. Results of the first year of data should be assessed to determine whether modifications to the second year of study are warranted. For example, the second year of fatality monitoring may need to focus more effort on turbines or habitat types where impacts were higher than expected, or less on areas that showed little or no fatalities. Similarly, first year monitoring results might indicate that a reallocation of study efforts to those seasons where more impacts were recorded, and less study effort when fatalities were low. Category 2 projects in particular may be able to reduce the level of study effort for year two if the results of year one monitoring indicate that fatality rates are equal to or lower than the range estimated during pre-permitting studies. Category 3 projects may need additional study effort in year two and possibly beyond if the first year of data shows fatalities higher than expected and/or to different species than anticipated.

Number of Carcass Search Plots. Search approximately 30 percent of the turbines (the percent of turbines can vary as appropriate), selecting this subset of turbines either randomly, via stratification, or systematically. The selection process must be scientifically defensible and should be developed in consultation with CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders.

Search Plot Size. Configure search plots at selected turbine sites so that search width is equal to the maximum rotor tip height. For example, for a turbine with a rotor tip height of 400 feet (120 meters), the search area would extend 200 feet (60 meters) from the turbine on each side. The search area may be a rectangle, square, or circle depending on turbine locations and arrangements and adjusted as needed to accommodate variations in terrain and other site-specific characteristics. Searches beyond boundaries of the proposed search area may be needed in some situations to make sure they encompass approximately 80 percent of the carcasses. Consult CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders before modifying search plot size.

Search Protocol. Search for bird and bat carcasses using trained and tested searchers. Search a standardized transect width of 20 feet (6 meters), the searcher looking at 10 feet (3 meters) on either side. Adjust the transect width as necessary for vegetation and topographic conditions on the site. Record and collect all carcasses located in the search areas (unless they are being used as part of a scavenging trial) and determine a cause of death, if possible.

Frequency of Carcass Searches. Conduct searches every two weeks for two years. Search frequency may need adjustment depending on rates of carcass removal (high scavenging rates warrant more frequent searches), target species, terrain, and other site-specific factors. Establish the frequency of carcass searches after analyzing the results of pilot scavenging trials and in consultation with USFWS, CDFG, and other knowledgeable scientists and appropriate stakeholders.

Searcher Efficiency Trials. Conduct searcher efficiency trials seasonally during operations monitoring. Test each searcher by planting carcasses of species likely to occur in the project area within the search plots and monitoring searcher detection rates. Geo-reference the planted carcasses by global positioning system (GPS) and mark them in a fashion undetectable to the searcher. Test new searchers when they are added to the search team.

Carcass Removal Trials. Conduct carcass removal (scavenging) trials seasonally during operations monitoring. Place carcasses in known locations in the search plots and monitor to determine removal rate. Check planted carcasses at least every day for a minimum of the first three days and thereafter at intervals determined by results from pilot scavenger trials. Where possible, use fresh carcasses of different sized birds and bats likely to occur in the project, avoiding old or long-frozen specimens and exotic species.

Bird Metrics. Record bird fatalities per MW of installed capacity per year and bird fatalities per rotor-swept square meter per year. Additionally, analyze data from different bird groups (such as raptors) separately.

Bat Metrics. Record bat fatalities per MW of installed capacity per year and bat fatalities per rotor-swept square meter per year, or per other metrics endorsed by USFWS and CDFG.

Monitoring Reports. Follow standard scientific report format in operations monitoring reports and provide sufficient detail to allow agency and peer reviewers to evaluate the methods used, understand the basis for conclusions, and independently check conclusions. Append the tabulated raw data from the carcass counts and bird use surveys. Monitoring data may be submitted to the CDFG's Biogeographic Information and Observation System (BIOS) program, <www.bios.ca.gov>. Chapter 5 provides details on submittal procedures to BIOS.

Bird Use Counts. Conduct two years of BUCs, as conducted during pre-permitting monitoring (that is, every week, at sample sites established during pre-permitting studies), unless more or fewer years are determined to be satisfactory by the lead agency, CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders.

Bat Acoustic Monitoring. Conduct bat acoustic monitoring nightly for two years using the same methods as for pre-permitting monitoring if CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders consider this information a necessary adjunct to the bat fatality data.

When Long-Term Monitoring May Be Appropriate

Upon completion of two years of operations monitoring, CDFG, USFWS, and other scientists and stakeholders who may have been involved in developing the operations monitoring protocol should assess whether continued, long-term monitoring of fatalities is warranted. Monitoring at some level beyond the second year may be justified if operations monitoring detects fatalities unexpectedly higher than estimated during pre-permitting studies. The purpose of such monitoring would be to gather information to develop impact avoidance, minimization, and mitigation measures and to verify whether these measures were effective in reducing fatalities. Factors to consider in assessing the potential for unanticipated impacts include changes in bird and bat use of a site due to changes in habitat conditions or shifts in migratory and movement patterns due to climate change that might affect collision risk. Permit conditions should include access to the project site for such long-term monitoring.

CHAPTER 1: PRELIMINARY SITE SCREENING

Wind energy developers need information to assess the biological sensitivity of the proposed project site early in the development process. This preliminary information gathering, or site screening, consists of a reconnaissance field survey and a desktop effort to collect data about the site from databases, agencies, and local experts. This information is used to identify species potentially at risk and the impact questions that must be addressed. Site screening is the first step in determining the kinds of studies developers will need to conduct during the "pre-permitting" phase to adequately evaluate a wind project's impacts to birds and bats.

Site screening information is required to conduct an informed impact analysis under the California Environmental Quality Act (CEQA) and other state and federal wildlife laws. Conduct data and information gathering ("desktop effort") 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/or analyzed early in the process allows time for conducting breeding bird surveys or raptor nest searches and assessing the potential for site use by migrating or wintering species. Early information gathering also allows the project proponent the opportunity to seek a different site if unavoidable impacts seem likely despite careful turbine siting.

Reconnaissance Site Visit

Once the landowner has granted permission to access the proposed wind energy site, arrange for a qualified wildlife biologist who is knowledgeable about the biology of birds and bats in the region to conduct a reconnaissance survey of the site. The biologist should prepare for the survey by securing recent, available aerial photography of the site. 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 for Gathering Site Information

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. Be aware that occurrences are only noted 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, do not use the absence from the CNDDB of an occurrence in a specific area 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. Conduct the CNDDB search in the eight U.S. Geological Service (USGS) quadrangles surrounding the quadrangles in which the project area is located.

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. Chapter 5 discusses the utility of BIOS as a repository for wind-related wildlife data.

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 and 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 <http://gis.ca.gov/>. The California Spatial Information Library (CaSIL) freely distributes California NAIP aerial imagery. CaSIL, the California Resources Agency, and the State of California are 2005 California NAIP funding partners.

Federal and State Agencies as Resources

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 of 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 of other state and federal laws, including California Endangered Special Act (CESA), Federal Endangered Species Act (FESA), 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 biologists can also offer information about listed species and designated critical habitat. Coordinate early with USFWS biologists to identify potential impacts to federally listed and migratory species that are high priorities for conservation.

Local Experts and Other Resources

Other helpful sources of information 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>. Cities and counties may also have adopted wind energy ordinances or elements that may contain useful information on local bird and bat populations.

Evaluating Data from Nearby Wind Energy Facilities

If the proposed site is near one or more existing wind energy facilities, a biologist should critically review the available pre-permitting and operational studies completed for the nearby 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 nearby 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. Include data from nearby wind farms in regional or cumulative impact assessments. Regularly contributing wind-related wildlife data to BIOS, as described in Chapter 5, will facilitate such assessments and the general accessibility of biological data from nearby wind energy facilities.

Regardless of the category into which a project is placed, study plans for pre-permitting and operations monitoring will have to be tailored specifically to the unique characteristics of each site. Developing a detailed pre-permitting study plan involves asking questions about the potential for birds and bats to occur at the site, how birds and bats might use the site, and whether they might be at risk from wind turbine collisions. Pre-permitting studies will provide the basis for an impact assessment and subsequent recommendations for micrositing or other impact avoidance, minimization, or mitigation measures. Consider the following questions when assessing the potential for birds and bats to occur at the site, making a preliminary evaluation of collision risk, and designing the pre-permitting studies discussed in Chapter 3.

1. Are any of the following known or likely to occur on or near the proposed project site? ("Near" refers to a distance that is within the area used by an animal in the course of its normal movements and activities.)
   a. Species listed as federal or state "Threatened" or "Endangered" (or candidates for such listing)?
   b. Special-status bird or bat species?
   c. Fully protected bird species?
2. Is the site near a raptor nest, or are large numbers of raptors known or likely to occur at or near the site during portions of the year?
3. Is the site near important staging or wintering areas for waterfowl, shorebirds, or raptors?
4. Are colonially breeding species (for example, herons, shorebirds, seabirds) known or likely to nest near the site?
5. Is the site likely to be used by birds whose behaviors include flight displays (for example, common nighthawks, horned larks) or by species whose foraging tactics put them at risk of collision (for example, contour hunting by golden eagles)?
6. Does the site or do adjacent areas include habitat features (for example, riparian habitat, water bodies) that might attract birds or bats for foraging, roosting, breeding, or cover?
7. Is the site near a known or potential bat roost?
8. 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)? Is the site near a known or likely migrant stopover site?
9. Is the site regularly characterized by seasonal weather conditions such as dense fog or low cloud cover that might increase collision risks to birds and bats, and do these events occur at times when birds might be concentrated?

A “yes” answer to question #1 should prompt early and close consultation with CDFG and USFWS to develop a study plan that addresses potential impacts of constructing and operating the project on listed or special-status species. Advance planning is needed in particular for studies with a seasonal component (for example, nest searches or evaluating potential bat hibernacula). Allow ample time for planning field evaluations when special-status species are involved because survey protocols for a number of listed and special-status species specify a limited window of time during which surveys must be conducted.

“Yes” answers to questions #2 through #6 call for further investigation with the techniques described in Chapter 3. The standardized bird use counts discussed in Chapter 3 provide methods to assess the species composition and seasonal relative abundance of birds present in the vicinity of proposed wind turbine sites, but additional studies might also be needed to further investigate these questions. For example, a project proponent may want to intensify the level of survey effort in the vicinity of raptor nests, breeding colonies, or habitat elements (riparian habitat, stands of trees in otherwise treeless areas) that might attract birds or bats. Such studies would provide information to determine whether a non-disturbance buffer might be warranted in the vicinity of the sensitive feature, determine the appropriate size of the buffer zone, and develop appropriate compensatory mitigation.

“Yes” answers to questions #7 through #9 should prompt consultation with CDFG, USFWS, and scientists with expertise in migratory birds and bat biology. The nocturnal survey methods described in Chapter 3 discuss techniques to assess nocturnally active species in the project area.

“No” answers to these questions might indicate that a more limited site evaluation is warranted, but exercise caution before assuming a site will not result in high impacts to birds and bats based solely on preliminary site screening

CHAPTER 2: CEQA, WILDLIFE PROTECTION LAWS, AND THE PERMITTING PROCESS

Numerous regulatory requirements and wildlife protection laws govern the permitting process for locating a wind energy project. Approached individually, these regulatory requirements may seem daunting to wind energy project developers. Therefore, this chapter intends to clarify the permitting process and offer suggestions for successfully completing the process and conforming to all appropriate laws and regulations by:

- Providing an understanding of the regulatory framework of environmental laws and processes that govern project siting and permitting
- Providing an understanding of the agencies and other stakeholders that should be engaged in these processes
- Encouraging consistent use of pre-permitting assessment methods recommended in these *Guidelines* to secure information on impacts and mitigation that will apply both to the CEQA review and permitting process and wildlife protection laws

Initiating the Permitting Process

In California, it is primarily the local agencies that handle the permitting process for wind energy facilities under the mandates of their various land use authorities. Discretionary decisions by local agencies to permit wind energy projects trigger the application of CEQA requirements to the permitting process. The permitting process usually begins with the project developer approaching the county or other local public agency responsible for issuing a 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. Contact the local agency early in the process to determine whether it has its own standard conditions for addressing specific resource policies that apply to bird and bat issues.

Wind energy facilities which have potential for take of state-listed Threatened or Endangered species may require an additional permit under the California Endangered Species Act (CESA). If the affected species are also federally listed, the facilities may also require permits under FESA.

Other state and federal protective wildlife laws, some of which mandate avoidance of "take"[3] without options for permitting, can also influence project siting and operations. Project developers, permit decision makers, and the resource agencies involved should consider these strict liability laws during the permitting process to ensure that impacts to bird and bat species are minimized and mitigated to offset impacts. Compliance with the *Guidelines* during the permitting process will demonstrate a good faith effort to develop and operate projects in a fashion that is consistent with the intent of these state and federal wildlife protection laws. Such good faith efforts will be considered by CDFG before taking enforcement actions for violation of a California wildlife protection law.

Involving and Communicating with Regulatory Agencies and Stakeholders

Timely and thorough pre-permitting assessment surveys are essential to facilitate the permitting process. 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 discussions with these groups may provide critical information on which to base site development decisions. There may be an existing science advisory committee that has been involved with a nearby wind resource area and that can provide information on bird and bat issues of local concern. 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 project developer a glimpse of the type and timing of surveys that may be necessary. Early discussion of proposed survey protocols also 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.

Further, initiating assessment surveys early will help to avoid unnecessary and costly delays during permitting. These early assessment surveys will facilitate the necessary detailed analysis by the CEQA lead agency, responsible agencies such as CDFG, and public stakeholders and should increase the speed of the permitting process. If review under the National Environmental Policy Act (NEPA) as well as CEQA is required, then efficient coordination of the combined CEQA/NEPA process can prevent redundancies and ensure complete coverage of the joint review requirements.

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 monitoring levels once operation of the project has begun. Finding suitable habitat for compensatory mitigation, if necessary,

[3] "Take" is defined in section 86 of the California Department of Fish and Game Code as "hunt, pursue, catch, capture, or kill (and attempts to do so)."

can be time consuming; early and thorough data collection and analysis will aid this process. Inadequate data acquisition may prompt a lead agency to apply more stringent impact avoidance, minimization, or mitigation measures to ensure species protection and may result in increased levels of operations monitoring.

Establishing Permit Conditions and Compliance

The CEQA lead agency and project proponent should consult frequently with CDFG and USFWS throughout the impact analysis and mitigation development process and particularly during development of permit conditions. Lead agencies should structure permit conditions to clearly define the obligations of the operator and to solidly establish triggers for additional mitigation beyond that required upon project approval. For example, the permit could specify a range of expected impacts based on pre-permitting studies and existing data from other wind energy projects; requirements for additional compensatory mitigation, described in the permit, would be triggered if operations monitoring data revealed impacts in excess of the expected range. Compliance with mitigation and operations monitoring requirements, as well as all other conditions of the permit, are equally important after permits are issued.

Navigating CEQA Requirements and Local, State, and Federal Laws

The California Environmental Quality Act, or CEQA, governs how California counties, cities, and other government entities evaluate environmental impacts in making discretionary permitting decisions for wind energy development. The CEQA process is key to achieving environmental compliance for a project, but all parties involved in planning pre-construction surveys should be aware that following the CEQA Guidelines alone may not highlight all of the species and issues that need evaluation. A single, coherent analysis of impacts to biological resources sets the stage for both CEQA analysis and agency review of permit applications. To streamline the permit application process, consider other state and federal wildlife protection laws, discussed below, early in the process and integrate them into the pre-permitting study design. For example, species at potential risk that are fully protected or that fall under the protection of the federal Migratory Bird Treaty Act should be included in surveys, whether or not such studies might be required to assess CEQA significance. 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. The permit conditions may have to include mitigation measures that address the other wildlife laws discussed below, in addition to those required by CEQA, to avoid, minimize, and fully mitigate impacts to birds and bats.

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 ensure 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 impacts to birds and bats, 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

The California Environmental Quality Act (CEQA) requires lead agencies—that is, those making land use decisions—as well as any other responsible state agencies issuing discretionary permits, to evaluate and disclose the significance of all potential environmental impacts of a project. The lead agency is also responsible for implementing feasible impact avoidance, minimization, or mitigation measures that reduce and compensate for significant environmental impacts with the goal of reducing those impacts to less than significant levels. Lead agencies determine significance on a project-by-project basis because they must consider all potential risk, including cumulative impacts, within a local and regional context, as well as evaluate unique factors particular to the project area when exercising their discretion to approve or disapprove a project.

The CEQA Guidelines[4] specify that a project has a significant effect on the environment if, among other things, it has the potential to "substantially degrade the quality of the environment; substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species…" (CEQA Guidelines §15065[a][1]).

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

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, all of which must be evaluated for each wind energy project:

- “Direct or primary effects which are caused by the project and occur at the same time and place“ (CEQA Guidelines §15358[a][1])
- “Indirect or secondary effects which are caused by the project and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect or secondary effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems“ (CEQA Guidelines §15358[a][2])
- “The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time” (CEQA Guidelines §15355[b])

Fish and Game Code Wildlife Protection Laws

In the broadest sense, CEQA and Fish and Game Code require that government agencies develop standards and procedures necessary to maintain, protect, restore, and enhance environmental quality, including fish and wildlife populations and plant and animal communities, to ensure that projects are consistent with the intent of these laws.

For wind energy projects subject to CEQA, lead agencies are required to consult with CDFG, pursuant to CEQA Guidelines section 15086. CDFG uses its biological expertise to review and comment upon impacts to wildlife arising from the project and will make recommendations regarding the protection of 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 in the CEQA process but does have authority to regulate activities that implicate one of the statutes that CDFG administers. CDFG and the Energy Commission encourage the use of the *Guidelines* for the biological assessment, mitigation, and monitoring of wind energy development projects and wind turbine repowering projects in California. The CDFG is aware that wind energy projects may result in bird and bat fatalities despite avoidance and minimization measures. For projects that impact listed species, project developers will need to consult with CDFG and may consider preparing a regional conservation plan or Natural Community Conservation Plan to seek permit coverage. For projects that have impacts to non-listed species, CDFG will consider working with project proponents to develop site-specific mitigation agreements that include avoidance, minimization, and compensation measures based on the guidance provided in this document.

This document only relates to bird and bat species, but a wind energy project may impact special-status species other than birds or bats. These impacts must also be analyzed, and in some cases treated as significant, as part of CEQA. Construction-related impacts at wind energy facilities which affect listed "Threatened" and "Endangered" species and other wildlife may also (and often do) trigger state and federal permit requirements.

When CDFG is required to make a discretionary decision to permit a project under its regulatory authority, CDFG must also comply with CEQA in the issuance of these permits and other project approvals. When the project CEQA document is developed in consultation with CDFG and fully addresses the related resource impacts and mitigation, CDFG can use the document as a basis for CEQA compliance, thereby accelerating any subsequent permit processes.

In addition to CDFG's responsible and trustee role in the CEQA process, direct consultation with CDFG is required to ensure that a proposed project will meet the intent of Fish and Game Code statutes for 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 Incidental Take Permit, CDFG must itself also comply with CEQA. The following link provides access to the full statute: <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. No provision authorizes take of fully protected species, except for scientific research and management activities for species recovery 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. A species that is state-listed as Threatened and Endangered under CESA and also listed as fully protected cannot receive a take authorization under CESA. Presence of fully protected species will require close coordination with CDFG to ensure impacts are minimized.

- 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 Fish and Game Commission or, when relating to mining operations, a mitigation plan approved by CDFG.

Federal Laws

The following federal laws apply to protecting wildlife from impacts from wind energy development.

- The National Environmental Policy Act (NEPA) is similar to CEQA, governing how federal actions that may result in environmental impacts are evaluated. NEPA (42 USC 4321, 40 CFR 1500.1) applies to any action that requires permits, entitlements, or funding from a federal agency; is jointly undertaken by a federal agency; or is proposed on federal land. Specifically, all federal agencies are to prepare detailed Environmental Impact Statements assessing the environmental impact of, and alternatives to, major federal actions significantly affecting the environment. The law applies to federal agencies and the programs that they fund, including projects for which they issue permits. An example of a wind development project falling under NEPA jurisdiction would be the proposed placement of wind turbines or associated transmission lines on U.S. Forest Service or Bureau of Land Management land.

  Recent amendments to NEPA require federal agencies to cooperate with state and local agencies to eliminate duplication of procedures such as those that might result from fulfilling CEQA requirements. More details on the National Environmental Policy Act can be found at <www.nepa.gov/nepa/regs/nepa/nepaeqia.htm>.

- Federal Endangered Species Act (FESA), 1973, Title 16, U.S. Code section 1531 – FESA protects 18 bird species/subspecies listed as Threatened or Endangered in California. No bats are currently listed as Threatened or Endangered in California. FESA 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. FESA 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 – MBTA 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.

Like the California laws, the latter three strict-liability federal wildlife protection laws prohibit most instances of take, although each law provides for exceptions, such as for scientific purposes. FESA 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 FESA to a federal permitting agency, or developers may seek an Incidental Take Permit under FESA for facilities sited on private land or where no federal funding is used or no other 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 be as consistent as possible with these federal laws.

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 and to develop impact avoidance, minimization, or mitigation measures. The chapter includes recommendations on developing a scientific pre-permitting study and assessing the level of effort required for such studies. Finally, the chapter describes the study methods available for bird and bat field studies and recommended protocols for using the methods.

Framework for Determining Bird and Bat Study Effort

With information from the preliminary site assessment, proposed project sites can be grouped into one of four categories to provide a general framework to assist in determining whether there should be any deviation from the standardized duration and intensity of study needed for pre-permitting and operations monitoring. Assigning projects to categories may not always be a clear-cut process, and projects may shift from one category to another as information from the pre-permitting studies either reveals unanticipated issues or resolves expected concerns about potential impacts. In deciding how to categorize a proposed project and when proposing to deviate from the standardized monitoring level, consult with the CEQA lead agency, USFWS, CDFG, biologists with specific expertise, and other appropriate stakeholders.

Category 1 – Project Sites with Available Wind-Wildlife Data

Some proposed projects have the advantage of an existing foundation of data on bird and bat use and potential impacts from nearby similar projects. For these Category 1 projects, reduced pre-permitting study effort may be appropriate. Category 1 might be appropriate for a project surrounded by or near an existing wind development project that had been studied sufficiently and for which there is little uncertainty as to the level of impact. Factors to consider in determining whether or not data from an adjacent facility would allow a project to be considered for Category 1 include:

- Whether the field data were collected using a credible sample design
- Where the data were collected in relation to the proposed site
- Whether the existing data reflect comparable turbine type, layout, habitat, physical features, and winds
- Whether the data are scientifically defensible and still relevant

Consultation with the lead agency, USFWS, CDFG, biologists with specific expertise, and other appropriate stakeholders (such as a conservation organization representative) is recommended when considering whether a project qualifies as Category 1. 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. Pre-permitting studies for Category 1 projects should focus on information gaps and particular species of concern, if any. These studies should build upon and expand existing data about those species from nearby wind resource areas.

Category 2 – Project Sites with Little Existing Information and No Indicators of High Wildlife Impacts

Category 2 projects have no obvious "red flags" that emerge from the preliminary site assessment (for example, "red flags" might include known occurrences of special-status species or high levels of fatalities at nearby wind facilities) and no substantial body of information from nearby projects that could provide information for an impact assessment. Pre-permitting surveys should last a minimum of one year for Category 2 projects to document how birds and bats use a site during spring, summer, fall, and winter.

Pre-permitting and operations monitoring may indicate that some project sites may require additional study duration or specific study protocols focused upon a certain species or type of impact. Caution is warranted in concluding that a project will have low impacts to bats based on preliminary site screening data because currently little is known about the range and distribution of California bat populations, their migratory routes, and population variation from year to year.

Category 3 – Project Sites with High or Uncertain Potential for Wildlife Impacts

Projects with high levels of bird and/or bat use or considerable uncertainty regarding bird and bat use or risk will need more study than Category 2 projects to help understand and formulate ways to reduce the number of fatalities. Characteristics of a site that might put a proposed project in Category 3 are known avian migration stop-over destinations such as water bodies within or immediately adjacent to the project; special-status species occurring on or adjacent to a proposed site; high concentrations of wintering and/or breeding raptors; sites near or contiguous to wind projects which have experienced high bird or bat fatalities that cannot be avoided or minimized. Projects for which little information is available on bird and bat use and potential risk might also be appropriately included in Category 3.

For some Category 3 projects one year of data may not adequately characterize the relative abundances of some bird and bat species at a project site because of high variability in seasonal populations 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). Base the duration and focus of pre-permitting studies on the availability of site-specific baseline data needed to answer impact questions; the species potentially affected; and the magnitude of the anticipated effect.

The number and size of turbines and the extent of the area covered by the project may also influence the need for more or less study because as the number of turbines increases, the magnitude of the potential impact to bird and bat populations will also increase. Proposed projects that involve developing multiple groups of turbines over large geographical areas or those that cover a heterogeneous mix of habitats and terrain may need additional specialized, multi-year studies if these areas have never been surveyed. Such large-scale studies may be best addressed with a collaborative research approach that encompasses a number of different projects within a region.

Category 4 – Project Sites Inappropriate for Wind Development

Wind development should not be considered on land protected by local, state, or federal government, such as designated wilderness areas, national parks or monuments, state parks, regional parks, and wildlife or nature preserves. Some projects for which preliminary information gathering or existing data indicates potential for unacceptable risk of bird or bat fatalities might also be appropriately classified as Category 4, particularly if no feasible avoidance or mitigation measures are available to reduce impacts. If such a project moved forward despite indications that high levels of bird or bat fatalities might occur, operations avoidance and minimization options to reduce the impacts are limited, and the project may require costly, ongoing reassessment of impacts and adjustment of mitigation.

For all categories of projects, recommendations to conduct more or less than one year of pre-permitting surveys should be accompanied by a well-supported rationale and justification for the recommendation. The burden of proof for providing that justification rests with the party advocating the deviation from the standardized pre-permitting survey effort.

Securing Appropriate Expertise to Develop the Studies

An important component in the development of pre-permitting studies is early consultation with the lead agency, CDFG, USFWS, local environmental groups, and any other stakeholders with an expressed interest in the project. The lead agency needs to know that the pre-permitting study design has incorporated input from appropriate scientists and from interested parties. Lead agencies generally rely on experts hired by the project proponent and on biologists from USFWS and CDFG when they evaluate the pre-permitting study design, assess impacts, or establish permit conditions for operations monitoring protocol and mitigation. Most scientific questions arising on wind energy development project can be resolved with input from these scientists, but for some projects, lead agencies may want additional scientific input and opinions from recognized experts and researchers in the field of wind-energy and wildlife interactions.

To provide this resource to lead agencies, the Energy Commission is working with the CDFG to establish a statewide standing science advisory committee. The committee would be available to lead, state, and federal agencies seeking expert advice on data interpretation, study design recommendations, and other scientific issues relating to the permitting of a wind energy project. Occasionally lead agencies may have information needs that require input from a scientist with a specific subject-matter expertise not represented on the standing committee or a familiarity with a specific regional or local issue(s). In these unique circumstances, the Energy Commission and the CDFG would work with the lead agency to ensure that appropriate members are included in the standing science advisory committee. The science advisory committee would function solely as an advisory body; lead agencies are under no obligation to consult the science advisory committee for any wind energy development project or to accept advice received from the committee.

Committee members would include only those scientists who are widely recognized by their peers for their technical expertise, objectivity, and professionalism and who have demonstrated their commitment to keeping current in the field of wind-wildlife research nationwide and in California. Members should also have experience with designing and conducting studies on the effects of wind development on wildlife and be free from conflict of interest relevant to the proposed committee tasks. The Energy Commission and the CDFG will provide opportunities for all interested parties to have input in establishment of the science advisory committee.

Study Objectives and Design

Development of a pre-permitting study begins with a clear identification of the impact questions that must be addressed, and then establishing a study design appropriate for answering those questions, including sampling units, parameters, metrics (measurements), and specific methods to employ.

The National Wind Coordination Committee (NWCC) provides detailed information about the metrics and methods for designing pre-permitting studies (Anderson et al., 1999). Because that information focuses mostly on diurnal birds, the NWCC is currently developing complementary guidelines to address nocturnally active species in relation to wind power development (Kunz et al., in prep). Consult both documents in the course of developing pre-permitting and operations study design.

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 of birds and bats use the project area, and how do their numbers vary throughout the year?
- How much time do birds and bats spend in the risk zone (rotor-swept area), and does this vary by season?
- What is the estimated range of bird and bat fatalities from the project, and how does bird/bat use of the site compare to use data from other wind power sites that also have fatality information?
- What potential design and mitigation measures could reduce impacts?
- What pre-permitting data are needed for an operations monitoring impact assessment?

Answering these questions can involve a variety of diurnal and nocturnal bird survey techniques as well as bat survey methods. The bird use count to assess bird species composition and seasonal relative abundance is one of the most commonly used bird survey methods. Acoustic monitoring is currently the most frequently used method to assess species composition and activity levels of bats. Other techniques include raptor nest searches, which should be conducted on most wind energy development projects in California, and a variety of less frequently used methods such as small bird counts, area searches, migration counts, radar, mist-netting, and visual imaging. Some of these additional methods may be useful depending on the particular concerns at each project site. The remainder of the chapter details the various methods and how to select the most appropriate and useful method based on the concerns for each project site.

The study methods recommended below offer a standard set of protocols for collecting data about birds and bats at a project site. Standardization in survey techniques promotes comparison capability at wind energy projects throughout California by employing similar methods and metrics at wind energy projects throughout the state. For example, standardized bird use counts provide baseline data on avian species richness, relative abundance, and diurnal 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) describe these methods in detail and discuss standardized metrics and methods 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).

Diurnal Avian Surveys

The primary diurnal avian survey technique for pre-permitting studies at wind energy project areas is the bird use count (BUC). Small bird counts (SBCs), area searches, raptor nest searches, and a variety of other methods may also be needed if BUCs are not adequate to answer questions about bird use and potential impacts. BUCs estimate 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. Table 1 summarizes the diurnal avian survey techniques discussed below and when to use them.

All of these 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).

Table 1. Comparison of Diurnal Bird Survey Techniques for Pre-Permitting Studies

Technique	Purpose	When to Use
Bird Use Counts	To provide baseline data on bird species composition, occurrence, frequency, and behavior to compare with operations use and fatality data; to inform micrositing decisions; to provide estimate of potential collision risk based on time spent in rotor-swept area; to provide an estimate of spatial and temporal use of site by all diurnal birds, including large birds (raptors, vultures, corvids, and waterfowl), songbirds, and other small diurnal bird species.	Use on all proposed wind energy projects to provide standardized baseline data on bird use and estimate collision risk.
Raptor Nest Searches	To provide baseline data on location and activity level of nesting raptors in relation to proposed wind turbine sites.	Use on all proposed projects where raptors are present to microsite turbines to reduce potential impacts to nesting raptors, to develop appropriate buffer zones around breeding territories, and to develop compensatory mitigation measures for impacts to raptors.
Small Bird Counts	To provide a relative density estimate of resident breeding songbirds.	Use if project poses a significant indirect impact to resident songbird populations, such as displacement, avoidance, or loss of special-status bird breeding habitat.
Area Searches	To sample the entire avifauna of a wind resource area, including habitats not represented in BUC sample areas.	Use if BUCs might miss special-status species potentially impacted by the proposed project.
Migration Counts	To provide a more complete picture of species composition, passage rates, and flight height of diurnal migrants.	Use if project site is within a known or likely migration corridor and BUCs are insufficient (too brief in duration or infrequent) to assess potential collision risk to diurnal migrants.
Mist-Netting	To detect secretive, cryptic, rare, or hard to identify species; to collect data on condition and age of birds in the project area; to document species composition at migrant stopover sites; to distinguish between wintering and migrant birds.	Use if near a known or likely migratory stopover/fallout site to assess species composition of migrants or if demographic information is needed to make impact assessment to special-status bird population potentially affected by the proposed project.

Bird Use Counts

The bird use count (BUC) is a modified point count that involves an observer recording bird detections from a single vantage point for a specified time period. This survey technique provides information on bird species composition, relative abundance, and bird behavior that might influence vulnerability to collisions with wind turbines. Bird use counts are especially useful to provide quantitative data on larger birds like raptors, waterfowl, and other waterbirds, but provide less precise information on smaller birds.

Conduct BUCs for 30 minutes once every week during the seasons of interest, which for most projects in California includes all four seasons. Sequence observation times to cover most daylight hours (for example, alternate each week with morning and afternoon surveys) and different weather conditions, such as windy days. Monitoring data collected at each BUC point should include the number and species of birds observed during the survey and, using surveyors trained in distance and flight height estimation, the distance and height at which birds pass potential turbine locations. The height and distance 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 as well as topographic location (for example, level, sloping, ridge top) (Morrison, 1998).

During the BUCs, record flight pattern and flight or perching height. 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. Recording wind speed at the start of the survey is also important so that avian usage can be assessed under conditions similar to those when the turbines are operating.

For consistency in comparing bird use, report the results of bird use surveys as number of birds per a specified time period and area—for example, number of raptors per 30 minutes observed within the range of the rotor-swept area. The bird use per 30-minute metric allows for comparison with other past studies. This metric 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 during BUCs to analyze bird use at incremental distances from the observer. Distance estimation facilitates comparisons with studies that record bird use within a set distance from the observer (for example, raptors within 1,000 feet [300 meters] or within 2,600 feet [800 meters]). 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). Using both BUCs and distance sampling, it is also possible to make density and population size estimates for breeding songbirds (Somershoe et al., 2006). For birds with large home ranges, like raptors, metrics such as use estimates (for example, observations/unit time) provide a better measure of relative abundance and density.

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

- Time
- Species
- Number
- Estimated distance from the observer to each bird
- Activity
- Habitat
- Flight direction
- Estimated distance of each bird to the turbine
- Flight height estimated to the nearest meter

Weather and environmental data to record at each visit include:

- Temperature
- Wind speed and direction
- Cloud cover
- Precipitation

Selecting Sampling Points

Select BUC sample sites at vantage points that offer unobstructed views of the surrounding terrain. The sample sites should be approximately 5,200 feet (1,600 meters) apart for large wind resource areas with good viewsheds. The spacing of sample sites can vary, as needed, depending on topography and on which species or species groups are the targets of the surveys. The BUC locations should coincide as much as possible with proposed turbine or turbine string locations. To establish reference sites, also select sample sites away from proposed turbine locations. 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. Mark the observation points in the field with a labeled stake and geo-referencing using global positioning system (GPS).

The number of selected observation points depends on the number and spacing of potential turbines or turbine strings, the ability to observe several potential turbine locations from a single point (Morrison, 1998), whether large or small birds are the study focus, and the heterogeneity of terrain and habitats. Establishing sufficient sample points to achieve an average minimum density of 1 to 1.5 sample points every 1 square mile (2.6 square kilometers) is normally adequate for both large and small birds. If this sampling design results in overlap of viewsheds, the number of points can be reduced but should be sufficient in number to achieve the monitoring goals.

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 or fewer turbines, sample each turbine site; however, if the proposed project includes many turbines (for example, 50 or more), 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 and to completely cover the area occupied by the proposed turbine locations. On sites that support multiple habitat types, systematically stratify sampling among the habitats to ensure sufficient analysis of habitat variability. Categorize habitats consistently 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).

Other Diurnal Bird Survey Techniques

Raptor Nest Searches

Raptor use of the project site is obtained through the BUCs, but if potential impacts to raptors are a concern on a project, raptor nest searches will be necessary. They will provide information to estimate impacts to raptors, for micrositing decisions, and for developing an appropriately sized non-disturbance buffer around the nesting territory, as well as baseline data to develop compensatory mitigation measures for impacts to raptors. Consult with the CEQA lead agency, USFWS, CDFG, and conservation organizations to establish the list of target raptor species for nest surveys and to develop the appropriate search protocol for each site, including timing and number of surveys needed, search radius, and search techniques.

Raptor nest search protocol will vary considerably from site to site depending on the target raptor species and the habitat. For most projects in California, conduct raptor nest searches in suitable habitat during the breeding season within a range of 0.5 to 3 miles (0.8 to 4.8 kilometers) from proposed turbine locations. Expand the search radius to 3 miles (4.8 kilometers) for wide-ranging species such as bald or golden eagles if they are known or likely to nest in the area. Red-tailed hawks also have large home ranges; expand nest search radius to 2 miles (3.2 kilometers) if this species is known or likely to nest in the area. Conversely, reducing the search radius is appropriate in other situations and can still provide adequate information about the appropriate size for a non-disturbance nest buffer. For example, researchers can reduce the search area for some forest dwelling raptors such as Cooper's hawk, spotted owl, and some species of small owls because they generally stay within the forest canopy and are unlikely to venture far into the open terrain of a wind resource area. For these and some other raptors with smaller home ranges (for example, American kestrel), identifying the active breeding territory within 0.5 miles (0.8 kilometers) of proposed turbine locations will provide adequate information for developing appropriate buffer areas around the nest area.

Nest surveys can be conducted from the ground or air. If the area to be covered is large and/or inaccessible due to difficult terrain or private property considerations, helicopters are a useful way to survey for nests. Helicopters are also a particularly efficient means of surveying for nests in open country such as grassland or desert. For both aerial and ground nest searches, researchers should avoid approaching the nest too closely to minimize disturbance, particularly when surveying from helicopters.

Wildlife resource agencies have developed survey protocol for several listed or special-status raptor species such as Swainson's hawk, northern goshawk, bald eagle, burrowing owl, and northern spotted owl <www.dfg.ca.gov/hcpb/species/stds_gdl/survmonitr.shtml>. Consult these references and the CDFG and USFWS if the project area could provide breeding habitat for any of these special-status species.

Small Bird Counts

Small bird counts (SBCs) are essentially BUCs conducted at a greater density of smaller-radii point count circles. This technique is useful for assessing displacement effects and habitat losses to resident songbirds and other small birds (less than 10 inches [25 centimeters] in length) but is less useful for estimating fatality rates because studies have not shown a strong correlation between songbird use of the wind site and songbird fatalities. SBC sampling sites can be the same as BUC sites, but with a smaller radius, ranging from 160 to 330 feet (50 to 100 meters), depending on habitat type. Savard and Hooper (1995) found that a 300-foot (100-meter) radius yielded nearly as many songbird detections as an unlimited radius for most species.

SBC sampling points should be 820 feet (250 meters) apart to reduce the probability of double-counting individual birds (Ralph et al., 1995). If turbine locations are known, establish SBC sites every 820 feet (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, locate the SBC sites along the ridge top. If turbine locations are unknown, superimpose a grid over a portion of the site that will support turbines, thus enabling random or systematic selection. The exact number of required sample sites is difficult to determine without knowing the size and extent of the project site, but sample the site sufficiently to obtain data for answering the research question within acceptable confidence limits. Permanently mark the observation points in the field with a labeled stake and geo-referencing using GPS.

To determine which birds are breeding on the project site, conduct SBCs three times at approximately two-week intervals during the appropriate time of year (April through July is the breeding season in much of California). Conduct surveys no earlier than a half-hour before and no later than four hours after sunrise. Time spent at each count station should be 10 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.

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 to estimate a "detection function." 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 birds that are detected both individually and in flocks, more than 100 detections may be needed to smooth out the anomalies for distance observations of flocking birds. For more information on sample size and detection function, see Buckland et al. (2001).

Study Design

Use the study designs described below, before-after/control-impact (BACI) and impact gradient, for proposed projects that need to address displacement effects. Small bird counts are typically used for studies where displacement is a concern on a proposed project. Displacement refers to the indirect loss of habitat if birds avoid the project site and its surrounding area due to turbine operation and maintenance/visitor disturbance. Displacement can also include barrier effects in which birds are deterred from using normal routes to feeding or roosting grounds.

A meaningful impact assessment requires BACI study design for projects where displacement or avoidance by bird or bat populations is a source of concern. BACI designs use data collected before and after a treatment (for example, construction of a wind project) at both the treatment sites and reference sites. 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) provide 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 a single site, the site that will be developed but no reference site, only provides a comparison of data from before and after construction of the project. Such a weak study design limits the researcher's ability to make inferences and conclusions about the impact of the project because natural temporal changes could confound detection of changes due to impacts.

A BACI study design is not always possible because locating appropriate reference areas that are not already planned for wind turbine development may be difficult. Furthermore, alterations in land use or disturbance over the course of a multi-year BACI study may complicate the analysis of study results. Researchers should be aware, however, that failure to use BACI design when determining displacement effects could diminish confidence in the study result.

In certain situations, such as for a proposed wind development site that is small and homogeneous, an impact gradient design may be a more appropriate means to assess impacts of wind turbines on resident populations (Strickland et al., 2002). Data collected at far distances from turbines are the "reference data." This approach not only provides information on whether there is an effect, it also attempts to quantify the distance at which the effect no longer exists. The assumption is that the data collected at the farthest distances from turbines are not impacted by the turbines, and these data farthest from turbines are the reference sites (Erickson et al., 2007). For example, a 10-turbine project located in homogeneous grasslands might use impact gradient analysis to assess project impacts to resident songbirds. An impact gradient analysis would involve measuring the density of breeding grassland birds as a function of distance from the wind turbines.

Area Searches for Birds

Area searches involve intensive searches of a project area with the objective of finding as many bird species as possible. Area searches are used infrequently in wind energy bird studies but can augment BUC data on species presence if the avifauna of the project site need more thorough documentation. These searches are generally conducted only if it is important to identify any threatened or endangered species that might occur near the turbines. For example, researchers might use an area search if they are concerned that a special-status bird species might be present in the project area but undetected by BUCs because the bird is secretive or because the sampling sites do not include habitat that might support the bird. Standardize the area search by specifying the search duration and the size of the area being searched to quantify species numbers and abundance (Ralph et al., 1993; Watson, 2003).

Standardized area searches are also useful for providing species richness data that can be compared between different project areas or for sites within a single large wind resource area. Use area searches 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 project area, conduct an area search in that habitat. This approach allows sampling of the avifauna of entire sites.

Migration Counts for Birds

Birds flying through the project site on migration may be at risk of colliding with turbines. Estimating risk to nocturnal migrants requires specialized techniques, which are discussed below, but daytime migration counts can help assess the number and flight height of diurnal birds flying through or over an area. Migration counts are generally used in cases where there is evidence to support the suggestion that the site has potential for high rates of bird migration (for example, along coastal migratory corridors). Migration rates vary considerably from one day to the next, depending on weather conditions; therefore, conducting several surveys per week for the migration counts provides a more complete picture of risk to diurnal migrating birds than using only BUCs. If the project site is within a known or likely 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, establish vantage points at ridges or passes within the wind resource area that offer wide fields of view. Station surveyors throughout the wind resource area approximately every two miles along an east-west axis. Start observations 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 to 13 weeks to assess large bird migrations during the fall and 8 to 10 weeks during spring.

Mist-Netting for Birds

Use mist-netting 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 cannot generally be used to develop indices of relative bird abundance, nor does it provide an estimate of collision risk. However, it can document fallout or heavy use by migrants at migrant stopover sites in or near proposed turbine sites. Mist-netting detects species missed by other techniques, especially secretive or cryptic birds, and provides opportunities to collect condition, age, and sex data and therefore can be useful in situations where more detailed information is needed to assess potential project impacts on a particular bird population (for example, if detailed demographic information is needed on a special-status species occurring within the project area). Mist-netting is also useful for detecting rare song birds and those species that are difficult to identify (for example, *Empidonax* flycatchers) and allows a researcher to distinguish wintering birds from those that are migrating. If mist-netting is to be used for complete coverage of a project area, establish mist-net stations, with 10 nets per station, approximately every two miles in an east-west axis throughout the wind resource area. Take habitat heterogeneity into account in establishment of mist-net stations. Operating mist-nets requires considerable experience, as well as state and federal permits. Follow procedures for operating nets and collecting data in accordance with Ralph et al. (1993).

Nocturnal Bird Survey Methods

California is part of the Pacific Flyway, one of four major north-south migratory corridors that cross the North American continent between Alaska and Central America. The Pacific Flyway encompasses a broad geographical area that extends from the California coast to the west slope of the Rocky Mountains. Every spring and fall millions of birds fly 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. Others continue on to winter in Mexico, Central America, or even South America.

Most songbirds, waterfowl, shorebirds, herons, and egrets migrate at night (Kerlinger and Moore, 1989), and radar studies yield some insight into general patterns of night flying behavior. Nocturnal migrants generally take off after sunset, ascend to their cruising altitude between 300 and 2,000 feet (90 to 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). In general, studies show that the paths of high elevation nocturnal migrants are little affected by topography or habitat beneath, but some studies suggest that landforms can have a significant guiding effect for birds flying below 3,300 feet (1,000 meters) (Williams et al., 2001). Radar studies reveal that major nocturnal migrations are triggered by weather (Gauthreaux and Belser, 2003) and often occur on nights with light tail winds. Low cloud cover or head winds can reduce the above-ground-level altitudes of migrants, bringing more birds within range of turbine blades (Richardson, 2000). Under certain conditions, such as low-lying fog, cloud cover might increase the flying height of birds that might find clear skies above.

Once nocturnal migrants descend from their night's flight and select a site for cover, foraging, and resting, local landforms and habitat conditions may play a role in determining where they alight (Mabey, 2004). Biologists knowledgeable about nocturnal bird migration and familiar with patterns of migratory stopovers in the region should assess the potential risks to nocturnal migrants at a proposed wind energy project site. In general, pre-permitting nocturnal studies are warranted only at sites with features that might strongly concentrate nocturnal birds, such as along coastlines that are known to be migratory songbird corridors. If warranted, employ radar and other nocturnal study methods to determine species composition, abundance, and flight altitude of birds passing through the site to assess risk to migrating birds. If project areas are within the range of nocturnal, special-status bird species (for example, marbled murrelet or northern spotted owl), surveyors should use species-specific protocols recommended by CDFG or USFWS to assess the species' 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 previously described, considerable variation and uncertainty exist 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. The use of radar for determining passage rates, flight heights and flight directions of nocturnal migrating animals has yet to be shown as a good indicator of risk of collision, and additional studies are needed before making recommendations on the number of nights per season or the number of hours per 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 to be answered. Also consult the USFWS, CDFG, and migratory bird experts to review study design and analytical methods to determine whether the proposed studies would answer questions about risk to nocturnal migrating birds.

The NWCC is developing guidelines that describe the metrics and methods used to study nocturnal birds and bats (Kunz et al., in prep.). Consult these guidelines, which will be available at the NWCC Web site, before developing pre-permitting studies of nocturnal migration. Each of the methods described here has strengths and weaknesses for answering questions about collision risk. No one method by itself can adequately assess the spatial and temporal variation in nocturnal bird populations or the potential collision risk. The methods or combinations of methods to be used at a proposed project site will depend on the recommendations of experts familiar with the operation and limitations of these tools and with the particular questions at issue about potential impacts of the project to nocturnal birds.

Nocturnal bird study methods and collision risk are areas of active research and worthy of investigation by the collaborative, public-private research partnership being considered by the Energy Commission, CDFG, wind energy developers and non-governmental organizations interested in wind-wildlife interactions. New information from such research may warrant revisions to the recommendations in this section. Consult the Energy Commission Web site, <www.energy.ca.gov/renewables/06-OII-1/>, to see whether *Guidelines* updates have been posted on study methods for nocturnal migrating birds.

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). NEXRAD Doppler radars are weather surveillance tools that can determine general migratory pathways, migratory stopover habitat, roost sites, nightly dispersal patterns, and the effects of weather on migration (Gauthreaux and Belser, 2003; Kunz, 2004). NEXRAD is not useful for characterizing high resolution passage rates or altitude data over small spatial scales. Radar surveys are expensive and cannot identify birds to the species level or reliably distinguish birds from bats but can help identify use of a site by nocturnal migrants. Desholm and Beasley (2005) and Kunz et al. (in prep.) provide detailed discussions of available and emerging radar technology (such as surveillance radar systems, Doppler and pulse Doppler radar, and tracking radar systems) and analyze the uses, advantages, and disadvantages of each.

Acoustic Monitoring

Sensitive microphones aimed at the night sky can record vocalizations of night-migrating birds. The vocalizations can 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, has a limited range, and can be confounded by background noise such as insects. However, it can provide insight about the regional variation in concentrations of migrants and their relative flight heights, which are useful for assessing potential risk of collision. Acoustic monitoring can be used in conjunction with other nocturnal survey methods as discussed below.

Visual Monitoring

Ceilometers and moonwatching are two visual techniques used by early investigators to monitor nocturnal birds. A ceilometer is a vertically directed, conical light beam that can sample low altitude bird migration (Able and Gauthreaux, 1975; Gauthreaux, 1969). Kerlinger (1995) provides a detailed description of the techniques for using ceilometers and of their biases and limitations. Ceilometers can detect birds below 1,500 feet (460 meters), and an experienced observer can, under ideal conditions, 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) and direction of flight. 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. While these are inexpensive options to secure some information about passage rates within the rotor swept area, they sample only a very small area relative to the area potentially occupied by nocturnal migrants, and it is difficult to accurately estimate flight altitude. Ceilometer results may also be biased because the ceilometer itself may alter the flight behavior of birds by either attracting or repelling them.

More recent innovations for enhancing visual observations of nocturnal species are image intensifying devices and thermal animal detection systems. Image intensifying devices such as night scopes and night vision goggles detect infrared in the upper part of the spectrum reflected off objects. These passive image intensifiers are often used with powerful (three million candle power) spotlights with infrared filters to avoid attracting insects, birds, and bats. These devices allow the researcher to estimate the overall proportions of birds flying at low altitudes (less than approximately 500 feet [150 meters]) and the relative number of birds and bats observed per hour. Cloud cover, fog, and wet weather can interfere with detections of birds (and bats) using these visual methods.

Whereas image intensifying devices such as night scopes and night vision goggles detect infrared reflected off objects in the *upper* part of the spectrum, thermal animal detection systems (TADS) use infrared imagery to detect heat emitted from objects in the *lower* part of the infrared spectrum. TADS are better than radar for species recognition because TADS can assess shape, size, and wing beat frequencies at night, providing information on nocturnal avoidance behavior, flight altitude, species composition, and flock size. Desholm (2003) provides a detailed discussion of TADS hardware and its uses.

These visual sampling methods are rarely used for pre-permitting studies because they have not been demonstrated to be useful in estimating collision risk. However, these techniques can provide information about species composition and relative flight heights of migrants. Visual sampling is useful for making behavioral observations of how birds or bats interact with wind turbines, so these techniques are generally more valuable for operations studies rather than for pre-permitting surveys.

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 (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 involving tree-roosting bat species such as the silver-haired, hoary, and eastern red bats (Johnson, 2004 and 2005). Hoary bats account for nearly half of all bat fatalities documented at wind farms (Johnson, 2004). 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).

California has a different bat species assemblage than the Northeast, where most of the bat fatality studies have been conducted. In addition to hoary, red, and silver-haired bats, other migratory or potentially migratory species occur in the West but not in the Northeast. These western migratory species include the Mexican free-tail bat, which has been found as a fatality at a wind energy project in Solano County, California, as have hoary, silver-haired, and western red bats (Kerlinger et al., 2006). While north-south bat migration has been at least locally documented for several species, flyways are poorly known, and trans-Sierra, elevational, as well as interior-to-coast migrations apparently also occur. California's large latitudinal range means that it provides both migratory pathways and migratory destinations, with some species likely raising young in Northern and Central California. Given the diversity and complexity of bat movements within the state and the uncertainty surrounding potential impacts of wind turbines on bat populations, pre-permitting studies are needed at all proposed wind energy sites to investigate the presence of migratory or resident bats and to assess collision risk.

Acoustic Detection

Acoustic detection involves specialized acoustic systems 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, broadband detection systems covering the frequency range that bats use can provide an index of activity from echolocation calls. Acoustic systems designed to monitor birds are not suitable for bats because of differences in the vocalization frequencies of bats and birds.

Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species composition, but does not measure the number of individual bats or population density. Acoustic monitoring only records detections, or bat passes, defined as a sequence of two or more echolocation calls, with each sequence or pass, separated by one second or more (Hayes, 1993). 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 is necessary when assessing bat use of an area based only on acoustic monitoring data. Passive acoustic surveys can establish baseline patterns of bat activity over the course of a year, but researchers should be aware that with the current state of knowledge about bat-wind turbine interactions, a fundamental gap exists regarding links between pre-permitting assessments and operations fatalities.

Conduct acoustic monitoring at all proposed wind energy sites to determine the presence, ambient activity levels, and the timing of short-term increases in activity (migratory pulses and swarming activity). Collect data on environmental variables such as temperature, precipitation, and wind speed concurrent with the acoustic monitoring so these weather data can be correlated with bat activity levels. Pre-permitting surveys for bats with acoustic monitors are recommended for one year and should be developed in consultation with bat experts, CDFG, and USFWS. 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).

Detectors at ground level do not provide information about bats at the altitude of the rotor-swept area because ultrasound attenuates within tens of meters for many bat species (California Bat Working Group, 2006). Therefore, place bat detection systems at least 100 feet (30 meters) above the ground in multiple locations in the proposed project area (Lausen et al., 2006) and at ground level. Distribute the detectors to cover the areas where turbines will be located as completely as possible (Lausen et al., 2006). Establish additional stations as needed to encompass diverse terrain or habitats and try to maintain a density of at least 1 to 1.5 acoustic monitoring stations every 1 square mile (2.5 square kilometers). The placement of acoustic monitoring stations will be limited by logistical constraints because stations must either be located where existing meteorological towers are available or along existing roads so that material and equipment to construct temporary towers can be brought to the site. Reynolds

(2006) describes information on tower deployment at an eastern U.S. wind development site and also discusses the conduct and results of acoustic monitoring and mist-netting. Reynolds (2006) and Lausen (2006) also provide detailed guidelines for detector deployment and operation. Rainey et al. (2006) provide an in-depth discussion of acoustic monitoring systems.

Acoustic monitoring should be sustained over a full year to capture the considerable night-to-night and seasonal variation in bat use (Hayes, 1997), including pulses of activity that might represent migration events. However, areas characterized by cold winters (higher elevations and portions of northern California) may not need acoustic monitoring during the coldest months when bats are absent. Make decisions on refraining from acoustic monitoring during any portion of the one-year monitoring period only after consulting a bat biologist, CDFG, and USFWS.

Some acoustic monitoring systems are designed to run unattended for long periods of time using solar power and collect data passively by storing bat calls for later analysis. Once the detectors have been established on towers, monitor nightly. Analysis of the data, however, can be conducted on a subset of the recordings by making a preliminary screening of the data to look for spikes of activity, with the remainder stored for later analysis if warranted. Make decisions on the level of effort needed for screening and analyzing the pre-permitting acoustic data in consultation with a bat biologist experienced in acoustic analysis.

Acoustic monitoring for bats is currently the most common method used for assessing bat activity at proposed wind developed sites but has yet to be shown to be strongly associated with estimates of collision risk or impacts. The correlation of pre-permitting acoustic data with collision risk is an area of active research and a topic worthy of further investigation by the collaborative, public-private research partnership being considered by the Energy Commission, CDFG, wind energy developers and non-governmental organizations interested in wind-wildlife interactions. A lead agency may choose to include contributions to this research fund as a permit condition for proposed wind energy projects. These contributions would be in addition to the pre-permitting monitoring recommended here.

Other Bat Survey Techniques

Other research tools are available to complement the information from acoustic surveys. The Western Bat Working Group has developed a matrix summarizing recommended survey techniques for western bats <www.wbwg.org/survey_matrix.htm>. The California Bat Working Group (2006) provides information on survey techniques and on potential risk posed by wind turbines to California bat species. Kunz et al. (in prep.) also provides a comprehensive description of bat survey techniques in relation to wind turbines sites. Biologists with training in bat identification, equipment use, and data analysis and interpretation should design and conduct all studies discussed below. Mist-netting and other activities that involve capturing and handling bats require a permit from CDFG.

Mist-Netting

Bat biologists and experts generally do not consider mist-netting for bats to be an effective method for assessing potential risk to bats at a proposed wind energy site (Kunz et al., in prep.).

Mist-netting samples only a small area well below rotor height and must be conducted on no- or low-wind nights (which are rare at wind resource areas) because bats detect and avoid moving nets. However, this capture technique can help to distinguish species that are difficult to identify or detect acoustically and to gather additional information such as species, age, sex, and reproductive status of local bat populations that no other source, short of collecting the bat, can provide. Such information may be relevant in pre-permitting studies if the goal is to evaluate potential project impacts to a local bat population.

Mist-netting and acoustic monitoring are complementary techniques that, used together, can provide an effective means of inventorying the species of bats present at a site (O'Farrell et al., 1999). If mist-netting is to be used to augment acoustic monitoring data at a project site, trapping efforts should concentrate on potential commuting, foraging, drinking, and roosting sites. Methods for assessing colony size, demographics, and population status of bats can be found in O'Shea and Bogan (2003). Kunz et al. (1996) provide detailed guidelines on capture techniques for bats, including mist-nets and harp traps.

Exit Counts / Roost Searches

Pre-permitting survey efforts should include an assessment of known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites near proposed wind turbine sites. An exit count can assess the size, species composition, and activity patterns for any bat-occupied features near project areas. An exit count involves a skilled observer watching a bat roost exit at dusk when bats are leaving for their nightly foraging. Exit counts require a skilled observer equipped with a bat detector and call storage system, plus night vision equipment and supplemental infrared illumination. Recording and later viewing of the exodus with one or more properly placed infrared video cameras (with supplemental infrared illumination) can allow a single biologist to cover large structures or abandoned mines with several portals. Rainey (1995) provides a guide to options for exit counts.

Roost searches can also document bat species that are difficult to detect acoustically or with mist-net capture. Roost searches are conducted by looking into or entering potential bat roosts (usually using artificial illumination) with the intent of finding roosting bats or bat "sign," including guano, culled insect parts, and urine staining. Conduct roost searches cautiously because roosting bats are sensitive to human disturbance (Kunz et al., 1996). Never conduct a roost search at known maternity roosts. Searches of abandoned mines or caves can be dangerous and should only be conducted by experienced researchers. For mine survey protocol and guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999).

Radar, Infrared Imaging

During peak bat migratory periods, August through October, researchers may need to augment the information from acoustic monitoring by using radar, near infrared 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 the site of the pre-permitting studies of the new turbines. If this information is applied to the repowering project, the lead agency, CDFG, and USFWS should determine whether 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, reach a higher airspace, and have a much larger rotor-swept area. New turbines also have a longer operating time, operate at lower and higher wind speeds, and may have increased blade tip speed, all of which potentially affect different species (Barclay et al., 2007).

CHAPTER 4: ASSESSING IMPACTS AND SELECTING MEASURES FOR MITIGATION

This chapter discusses approaches to assessing impacts to birds and bats that surveys revealed during the pre-permitting phase of wind energy development and to selecting the best measures for avoiding, minimizing, or mitigating those impacts.

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 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 agency permits besides CEQA requirements. Mitigation at project sites is also essential to ensure that projects will be as consistent as possible with fish and wildlife protection laws.

The chapter is organized into four sections:

- Evaluating and Determining Impacts
- Impact Avoidance and Minimization
- Compensation
- Operations Impact Mitigation/Adaptive Management Measures

Types of Impacts

CEQA lead and responsible agencies categorize impacts into one of three categories: "direct," "indirect," and "cumulative."

Direct Impacts

For purposes of the *Guidelines*, "direct" impacts refer to bird and bat collisions with wind turbine blades, meteorological towers, and guy wires. Potential direct impacts are determined by reviewing all of the pre-permitting data to evaluate which species might collide with turbines and which non-biological factors (such as topographic, weather, and turbine design features) might 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. Turbine design characteristics and proposed siting locations are two factors that are known during the impacts analysis and should be considered in assessing 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. To learn of research advances, regularly consult the National Wind Coordinating Committee Wildlife Workgroup Web site, <www.nationalwind.org/workgroups/wildlife/>.

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; 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 before after/control impact (BACI) study design described in Chapter 3 enables researchers to assess indirect impacts to determine whether wind turbines are affecting bird or bat density. The BACI study design may be particularly important to determine whether turbines are attracting bat species at a project site.

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. If the analysis finds a particular project's incremental impacts to be significant, then the project developer is responsible for mitigating its portion of the cumulative effect.

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 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. Standards of practicality and reasonableness should guide the cumulative impact discussion (CEQA Guidelines §15130).

While the cumulative impacts of a project may be difficult to determine, do not discount the impacts of a project based on relative size. The addition of one small wind energy project in an existing wind resource area may seem trivial, but CEQA requires evaluation of the potential cumulative impacts of an increasing number of projects, regardless of project size.

An adequate analysis of cumulative impacts on special-status bird or bat 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. Assess the baseline population of the relevant species, as well as whether the population is resident, seasonally breeding, migratory, or wintering and whether it is 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 larger area than the project site.

3. Compile a summary list of past and present projects and projects in the reasonably foreseeable future 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 for information about other projects.

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. Make determinations of population viability

and the contribution of the project to the cumulative impact. If, after thorough investigation, the impact is considered too speculative for evaluation, state that conclusion, 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.

Impact Assessment Approaches

One tool that other studies have used to assess direct impacts is collision risk assessment. 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. 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 determines whether high bird or bat use might represent a fatal flaw of a proposed project and helps to develop studies to better evaluate risk. The next level of a risk analysis is to make the assessment more quantitative by collecting data on the abundance and spatial and temporal distribution of birds and bats using the site, as well as data on their behavior and on the time birds and bats spend in areas where they might be at risk of collision and then comparing this information to existing data on fatalities at wind resource areas. The "Pre-Permitting Assessment" chapter describes methods for collecting these data. Anderson et al. (1999) and Erickson (2006) discuss the analysis of various types of risk to birds due to wind turbines.

For all quantification of risk and fatality estimates, apply a uniform metric of bird or bat fatalities per megawatt (MW) of installed capacity per year. Refer to Appendix H for a discussion of raptor use and fatality data from studies at existing wind resource areas.

Impact Avoidance and Minimization

The most important decision regarding impact avoidance and minimization comes early in site screening, often prior to stakeholder input. For example, if a Category 4 project site is developed despite indications that high levels of bird or bat fatalities might result, problems can continue throughout the life of the project. As discussed in previous chapters, compliance with state and federal laws requires both avoidance and minimization of project impacts. Avoidance is best applied during pre-permitting site selection (macrositing) and during site layout planning (micrositing). Good macrositing decisions are essential for choosing an acceptable site or portion of a site.

Once a site is selected, micrositing 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, micrositing may not help reduce fatalities if a wind farm is placed in a region with high levels of bird or bat use, such as an area used heavily by breeding and wintering raptors.

Each wind energy project site is unique, and no one recommendation will apply to all pre-permitting site selection and layout planning. However, consideration of the following elements in site selection, turbine layout, and development of infrastructure for the facility can be helpful to avoid and minimize impacts. In addition to the recommendations described below, consult the NWCC's *Mitigation Toolbox,* a recent compilation of mitigation measures that can be used to minimize or eliminate impacts to wildlife resulting from the design, construction, and operation of wind farms (NWCC, 2007).

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 movement corridors that are used daily, seasonally, or year-round. Use maps that show the location of sensitive resources to establish the layout of roads, fences, and other infrastructure to minimize habitat fragmentation and disturbance.

Establish Buffer Zones to Minimize Collision Hazards

If pre-permitting studies show that the proposed facility could pose a bird or bat collision hazard, establish non-disturbance buffer zones to protect raptor nests, bat roosts, areas of high bird or bat use, or special-status species habitat. 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; therefore, do not encourage projects in these types of areas. Determine the extent of the buffer zone in consultation with CDFG, USFWS, and biologists with specific knowledge of the affected species.

Reduce Impacts with Appropriate Turbine Design

It is unclear whether larger and smaller wind turbines cause equivalent bird collision fatalities based on rotor-swept area or MW of generating capacity. For purposes of this document and the current state of the technology, "large" turbines are defined as 750 kilowatt (kW) and larger, and "small" as 40 kW to 400 kW.

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 large 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 and data suggesting that taller turbines can increase the risk to bats (Barclay et al., 2007), one should not assume that placement of large turbines will reduce avian or bat collision risk.

There has been considerable discussion regarding the effects of tubular versus lattice towers and whether lattice turbines contribute to higher fatality rates due to the 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, large turbines have a variable speed design and can operate at lower average revolutions per minute, 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 15 times the power rating. Many of the newer turbines, however, operate at both lower and higher wind speeds, significantly increasing the operation time. Preliminary research indicates that turbines operating at low speeds may pose a threat to some bat species (Arnett, 2005).

Reduce Impacts with Appropriate Turbine Layout

Pre-permitting studies must be sufficiently detailed to establish normal movement patterns of birds and bats to inform micrositing decisions about turbine configuration. Turbine alignments that separate birds or bats 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.

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 as well as 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 fatalities 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.

The topographical features of a site may or may not increase the risk of migrating nocturnal birds colliding with wind turbines. Evidence for deviation of nocturnal flights along features of terrain such as rivers, coastlines, or hills is rare in North America (Richardson, 1978). However, some studies suggest that landforms can have a significant guiding effect for birds flying below 3,300 feet (1,000 meters) (Williams et al., 2001). 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 the birds 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. Richardson (2000) also noted that migration altitudes can be lower than cruising altitude when birds cross a ridge or pass.

Reduce Artificial Habitat for Prey 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. Incorporate into construction of turbine pads designs that minimize the amount of artificial habitat such as disturbed or unvegetated banks. Use only benign methods to eliminate or reduce fossorial animals 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. Night-migrating songbirds are apparently attracted to steady-burning lights at communications towers and other structures, increasing the potential for large-scale fatality events (Kerlinger, 2004). Research by Evans et al. (2007) indicates that the color of light and whether it is steady-burning or flashing makes a significant difference in whether night-migrating birds aggregate around tall, lit structures. While red light has been blamed for bird fatalities at tall TV towers, the Evans et al. (2007) study indicates that for birds migrating within cloud cover, blue, green, or white light would be more likely to induce bird aggregation and associated fatality. Evans et al. concluded that while white flashing lights are relatively safe, red flashing lights with a long dark interval and short flash on-time would likely be the safest lighting configuration for night-flying birds.

Bats are known to feed on concentrations of insects at lights (Fenton, 1997). Thus, any source of lighting that attracts insects may also attract bats at a wind facility. While the mean numbers of insect passes were somewhat higher at lighted turbines than at unlighted turbines at the Mountaineer Wind Energy Center in West Virginia, aviation lighting did not appear to affect the incidence of foraging bats around turbines (Horn et al., in press). No studies have found differences in bat fatalities between turbines equipped with red, flashing FAA lights and those that were unlighted (Arnett et al., in press).

Under current Federal Aviation Administration (FAA) guidelines (FAA, 2007; <http://oeaaa.faa.gov>), anyone proposing construction of structures above a certain height must notify the Federal Aviation Administration 30 days prior to construction and in that notification should specify the type of lighting desired at the proposed structure. Plans for lighting should balance FAA requirements with protection of birds and bats. Use flashing lights with the minimum "on" period on turbines. Keep lighting at both operation and maintenance facilities and substations to the minimum required to meet safety and security needs. Use white lights with sensors and switches that keep the lights off when they are not required. These lights should be hooded and directed to minimize backscatter, reflection, skyward illumination, and illumination of areas outside of the facility or substation.

Minimize Power Line Impacts

To prevent avian collisions and electrocutions, place all connecting power lines associated with wind energy development 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 use bird deterrents.

Decommission Non-Operational Turbines

Remove wind turbines when they are no longer operational so they cannot 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 three feet (one meter) below ground level and removal of access roads, 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. Plans for decommissioning can also be addressed as an obligation of the property owner as part of the lease arrangement with the wind developer.

Compensation

Project developers and permitting agencies should ensure that appropriate measures are incorporated into the planning and construction of the project to avoid or minimize impacts as much as possible. If these measures are insufficient to avoid or minimize estimated impacts to birds and bats, compensation can be used to mitigate or offset such impacts, including cumulative impacts. Although impacts still occur, the ability to compensate for them can determine whether a project is delayed, approved in a timely manner, or not approved at all. Feasible compensatory mitigation is mandated by CEQA if it will serve to mitigate a project's effect on the environment to less than significant. Given that all wind energy projects impact bird and/or bat species to some degree, compensatory mitigation will likely be needed at most wind energy facilities to offset the impacts of wind energy development.

The CEQA lead agency makes the decision on exactly which compensation measures shall be required to mitigate for a project's impact. Compensation amount and metrics are site- and species-specific and must be formulated for each individual project. Compensation should have a biological basis for ensuring protection or enhancement of the species affected by the project. Development of effective compensation measures should involve the CEQA lead agency, project proponent, wildlife agencies, and the affected public stakeholders, through the CEQA process. Lead agencies should establish the general terms and funding commitments for compensation prior to issuing final project permits so project developers have some assurance of their mitigation costs and monitoring commitment for the life of the project. Triggers for additional compensatory mitigation beyond that required at project approval should be well defined and feasible to implement, so the permittee will have an understanding of any potential future mitigation requirements.

Compensation required as project mitigation must be monitored for success by the lead agency pursuant to a CEQA mitigation monitoring plan. When a permit is required from CDFG or USFWS, compensatory mitigation must satisfy those permit conditions to fully mitigate a project's effect on listed species.

The following potential compensation options are known to protect and enhance bird and bat populations at biologically appropriate locations when properly designed and implemented:

- Offsite conservation and protection of essential habitat
  - Nesting and breeding areas
  - Foraging habitat
  - Roosting or wintering areas
  - Migratory rest areas
  - Habitat corridors and linkages
- Offsite conservation and habitat restoration
  - Restored habitat function
  - Increased carrying capacity
- Offsite habitat enhancement
  - Predator control program(s)
  - Exotic/invasive species removal

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 purchased land or easements 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 be part of a well-defined and established conservation program, such as a mitigation bank. Mitigation banks need to be biologically suitable for the impacted species. 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>. Potential mechanisms to secure compensation 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, the permitting agency should establish a nexus between the level of impact and the amount of mitigation. Unlike habitat impacts, in which an acre of habitat loss can be compensated with an appropriate number of acres of habitat protected or restored, 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 nature of impacts to birds and bats from turbine collision, permitting agencies must consider compensation alternatives to a simple acreage ratio. 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. Consult the wildlife agencies and species experts 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 Mitigation and Adaptive Management

Operations impact mitigation and adaptive management generally occur only if the level of fatalities at a project site was unanticipated when the project was permitted, and therefore, measures included in the permit are inadequate to avoid, minimize, or compensate for bird or bat fatalities. Once a project is operating, it is difficult to modify turbine site layout, and operations impact avoidance, minimization, and mitigation options are limited. Developing contingencies and plans to mitigate high levels of unanticipated fatalities becomes even more important when choices for operational impact avoidance or minimization are so limited. To avoid open-ended conditions that are difficult for developers to include when planning for project costs and timing, establish minimization measures and compensatory mitigation that could be needed for unexpected impacts as well as the thresholds that will trigger these actions. Determine these measures and compensatory mitigation before permits are issued.

In extreme cases, the compensation specified in the permit may not be adequate for high levels of unanticipated impacts, and project operators may need to consider operational and facility changes. For example, if a Category 3 site is developed without resolving uncertainties about potential risk to birds and bats through pre-permitting and operations monitoring studies, adaptive management may be a necessary tool to reduce impacts to the level described in permit conditions. The adaptive management process recognizes the uncertainty in forecasting impacts to birds and bats and allows testing of options as experiments to achieve a goal and determine impact avoidance, minimization, and mitigation effectiveness. 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 if other minimization measures are ineffective in reducing fatalities.

Do not use adaptive management as a reason to defer impact analysis and mitigation commitments. Rather, establish the biologically appropriate goals and triggers in the permitting process. Mitigation measures should establish clear, objective, and verifiable biological goals, a requirement to adjust management and/or mitigation measures if those goals are not met, and a timeline for periodic reviews and adjustments.

Successful adaptive management requires a firm commitment by project owners to accountability and remedial action in response to new information that pre-determined bird and bat fatality thresholds are being exceeded. This commitment must be included in permit conditions during the permitting process so that a mechanism is available to implement mitigation recommendations after the project is permitted. Permit conditions should also include language providing reasonable access to project sites for monitoring of mitigation. A lead agency may need to seek technical experts to interpret operations monitoring data and develop management recommendations and may find it useful to establish a science advisory committee for this purpose.

CHAPTER 5: OPERATIONS MONITORING AND REPORTING

This chapter describes the standardized techniques 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 it to bird and bat use data and 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. At a minimum, the primary objectives for operations monitoring are to determine:

- Whether estimated fatality rates described in pre-permitting assessment were reasonably accurate
- Whether the avoidance, minimization, and mitigation measures implemented for the project were adequate or whether additional corrective action or compensatory mitigation is warranted
- Whether overall bird and bat fatality rates are low, moderate, or high relative to other projects

On a larger scale, monitoring informs the development of new wind energy facilities in California with project-specific fatality data that will improve pre-permitting estimates on other, future projects. Collected in a consistent manner, including consistency with pre-permitting protocols and attention to environmental variables, monitoring data can provide insight into the occurrence, magnitude, and reasons for bird and bat fatalities and will fine tune the development of avoidance, minimization, and mitigation measures for wind energy projects throughout the state.

Operations monitoring typically consists of ongoing bird and bat use surveys and counts of bird and bat carcasses in the vicinity of wind turbines. The number of carcasses counted during operations monitoring is likely to be an underestimate of the birds and bats actually killed by wind turbines for several reasons. 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 also may not be counted 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.

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

Duration of Operations Monitoring

The duration of operations monitoring should be sufficient to determine whether pre-permitting estimates of impacts to birds or bats were reasonably accurate and to determine whether turbines are causing unanticipated fatalities that require 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. Consult the CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders regarding study protocol and the duration of an operations monitoring program.

While most projects will need two years of operations monitoring to assess whether pre-permitting impact estimates were accurate and to evaluate the effectiveness of mitigation measures, Category 1 projects may need only one year of operations monitoring. Reduced monitoring during the second year might be appropriate for Category 1 projects if the first year provides scientifically defensible data documenting that fatality rates were as expected and similar to those from nearby projects. To justify reduced monitoring, the first year of data from use counts and from nearby projects should also indicate that annual variability in numbers of birds and bats is low for all seasons.

For Category 2 and 3 projects, two years of operations monitoring study are needed to determine whether pre-permitting estimates of fatalities are accurate, whether mitigation is working, and whether further operations monitoring is warranted. Category 2 projects may be able to reduce the level of study effort for year two if the results of year one monitoring indicate fatality rates equal to or lower than estimated during pre-permitting studies and if CDFG, USFWS, and experts agree such a reduction is warranted. Category 3 projects may need additional study effort in year two and possibly beyond if the first year of data shows fatalities higher than expected and/or to different species than anticipated.

For both Category 2 and 3 projects, the results of the first year of data should be critically assessed to determine which modifications, if any, are needed for the second year of study. For example, the second year of fatality monitoring may need to focus more effort on turbines or habitat types where impacts were higher than expected by shifting searches away from areas that showed few or no fatalities. Similarly, first year monitoring results might warrant a reallocation of study efforts to those seasons where more impacts were recorded.

The two years of operations monitoring need not necessarily be consecutive. After monitoring the turbines during the first year after operation, one option is to wait a few years to complete the second year of monitoring. This time lapse allows disturbed habitats in the vicinity of the turbine construction sites to recover, provides more time for birds to possibly habituate to the turbines, and may incorporate more temporal variation in bird use at the site.

When Long-Term Monitoring May Be Appropriate

Operations monitoring beyond two years will rarely be needed if impacts to birds and bats estimated during the pre-permitting studies have been adequately avoided, minimized, and mitigated. Upon completion of operations monitoring, CDFG, USFWS, and other scientists and stakeholders who may have been involved in developing the operations monitoring protocol should assess whether continued, long-term monitoring of fatalities is warranted. Long-term monitoring on a periodic basis (for example, every five years) for the life of the project should occur if operations monitoring data or other new information suggests that project operation is likely to result in high levels of fatalities to birds or bats that were unanticipated and unmitigated during permitting of the project. The purpose of such monitoring would be to gather information to develop impact avoidance, minimization, and mitigation measures and to verify whether these measures were effective in reducing fatalities. Factors to consider in assessing the potential for unanticipated impacts include changes in bird and bat use of a site due to changes in habitat conditions or shifts in migratory and movement patterns that are a result of climate change and that might affect collision risk. Such long-term monitoring could be coordinated with larger regional studies within the entire wind resource area. Access to project sites for purposes of long-term monitoring should be permitted unless precluded by safety or private property considerations.

Operations Monitoring for Repowered Sites

Operations monitoring for repowering projects will be similar to other wind energy projects and will be based on pre-permitting site screening and monitoring results. Additional fatality and use data that can augment the new data collection efforts may also be available from nearby existing wind facilities. Generally, standardized 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.

Determining Bird and Bat Abundance and Behavior During Operations

Data on bird and bat abundance and site use should accompany all fatality studies at wind energy project sites. Bird and bat use surveys characterize bird abundance, flight, and perching behavior and bat use in and around turbines, as well as topographic features of the site. This information provides a context for interpreting fatality data and feedback information for future pre-permitting impact estimates. Conduct standardized surveys, as described earlier in the "Pre-Permitting Assessment" chapter, to allow for comparisons of data before and after the project and with other projects.

For operations monitoring of bats, evaluate the pre-permitting data and consult with CDFG, USFWS, and other knowledgeable scientists and appropriate stakeholders to determine whether information about the ambient level of bat activity is a necessary adjunct to the bat fatality data. If bat use data is considered a necessary component of operations monitoring, collect data on environmental and weather variables concurrently with the bat activity data collection so that these variables can be correlated with daily carcass counts. The pre-permitting surveys should have indicated which seasons are of particular concern for potential impacts to bats and which times of the year may warrant more intensive bat and bird monitoring (for example, March through June and August through October when many bat species are migrating). The methods should be consistent with those used during pre-permitting studies, and the study design should be confirmed in consultation with CDFG, USFWS, and other scientists and stakeholders who were involved in developing the pre-permitting studies. Kunz (2004), Kunz et al. (in prep), and the California Bat Working Group (2006) provide a discussion of post-construction survey methods for bats.

Carcass Searches

Establishing Carcass Search Plots

Establish search plots at approximately 30 percent of the turbines. The number of search plots should reflect the desired precision in the fatality estimates. A sample larger or smaller than 30 percent may be needed for some projects. For example, projects with diverse habitats may require sampling more than 30 percent of the turbines, while projects with more than 50 turbines may need fewer than 30 percent of the turbines sampled. The turbines to be sampled can be selected at random, via stratification, or systematically as long as the lead agency, CDFG, and USFWS has determined that the selection process is scientifically defensible. The dimensions of carcass search plots will vary depending on turbine size and configuration and characteristics of the site. The search area should have a width equal to the maximum rotor tip height. For example if the rotor tip height were 400 feet (120 meters), the search area would extend out 200 feet (60 meters) from the turbines on each side. The search area may be a rectangle, square, or circle depending on turbine locations and arrangements. If the site is steep, extend the search area on the downhill side because carcasses could fall farther from the turbine. 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).

Surveyors can select a search area that does not encompass 100 percent of the carcasses, as indicated by pilot searches or incidental observations of carcasses outside the search area. However, surveyors must quantify that source of error, make corrections in the final calculation of fatalities, and disclose that information in the monitoring report. Surveyors should establish a search area that includes approximately 80 percent or more of the carcasses.

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. This document does not provide recommendations for methods to estimate crippling bias because such attempts in previous studies produced relatively little relevant data per unit time of effort (EPRI et al., 2003).

Conducting Searches

Carcass search and bird and bat use data provide an estimate of the number of bird and bat deaths attributable to collisions with wind turbines or meteorological towers. Locate carcasses by using trained and tested searchers who walk the search area in either linear or concentric circle transects around the turbine. This document recommends a standard transect 20 feet (6 meters wide), 10 feet (3 meters) on either side of a centerline (the searcher looking at three meters on either side), but with adjustment to the transect width for vegetation and topographic conditions on the site. The rate of searching will also vary depending on terrain and vegetation. Searching an area at one large turbine can take from one hour to several hours depending on the site conditions.

Collecting Carcass Data

Record and collect all carcasses located in the search areas (unless they are being used as part of a scavenging trial) and determine a cause of death, if possible. Questions of non-turbine caused death may require necropsy. 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. Searchers have also found carcasses intact with no apparent cause of death, so documentation regarding nearby structures is important. Consider any injured birds or bats encountered during the search as fatalities. Take injured birds or bats to a nearby rehabilitation center.

Record the carcass condition in one of the following categories (Anderson et al., 1999):

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

Data collected during each carcass search should include: a unique carcass identification number, site, date, observer, species, sex, age, and when possible, time, condition (intact, scavenged, or 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 and make of nearest turbine, and distance to plot center. Also record a description of the characteristics of the carcass indicating the cause of death or other pertinent information, and photograph the carcass. Record an "incidental find" (carcasses found by personnel at times other than the scheduled search) as noted above and remove it 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>.

Birds and bats collected during carcass counts can provide invaluable data for advancing knowledge about the geographic source and abundance of resident and migratory populations. Tissue samples can be used for analysis of genetic variation and population structure, for assessing population size using DNA markers, and for assessing the geographic origin of migrants based on stable isotope and genetic analysis (Simmons et al., 2006). Use of mitochondrial and nuclear DNA sequence data derived from bats and birds killed by wind turbines also offers the potential for identifying closely related or cryptic species. For bats, the American Museum of Natural History in New York serves as a repository for carcasses and tissues collected from dead bats recovered beneath wind turbines or from other sources (contact Dr. Nancy B. Simmons, e-mail: simmons@amnh.org).

Frequency of Carcass Searches

Carcass searches for birds and bats should occur approximately every two weeks, with searches more or less frequent if pilot scavenging trials indicate high or low levels of carcass removal. Small birds and bats may be scavenged more quickly than large birds (Morrison 2002), which may warrant searches more frequently than every two weeks at sites where pre-permitting studies indicate high potential for impacts to these smaller species and where scavenging rates are high. Establish the frequency of carcass searches at a wind energy project site after analyzing the results of pilot scavenging trials and in consultation with USFWS, CDFG, and other knowledgeable scientists and appropriate stakeholders. 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. If the search interval is more than seven days, researchers can relax this assumption by conducting searches over multiple days to better assess temporal variation in fatality rates. 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 of fatalities could be biased, especially if carcass removal rates are high. The study design for carcass searches can involve intensive searches at a subset of the turbines, with less frequent sampling at the remainder of the carcass search plots. This stratified sampling can help clarify the relationship between weather events and fatalities and allow researchers to fine tune the estimate of scavenging rates. For example, if the goal of the operations study is to determine the effect of weather on fatalities during the bat migratory period (March through June, August through October), daily carcass searches could be conducted during this period at one-third of the search plots and weekly searches at another third. After some trial carcass searches, the study design could involve a shift in the number of turbines searched. Establish such stratified sampling protocol only after careful review of pilot scavenger removal studies and in consultation with USFWS, CDFG, and scientists familiar with post-construction survey protocols.

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). Therefore, estimates of fatalities must incorporate corrections based on searcher efficiency and scavenging rates, as described below, and these estimates must be statistically independent of each other. Because season, topography, and vegetation influence searcher efficiency and scavenging, calculate these correction factors based on season and vegetation-specific data for every study. Correction factors 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 birds 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 inefficiencies of observers. Researchers therefore need to quantify and correct for these variations as much as possible.

Base corrections for searcher efficiency 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). Searchers may also easily overlook bats because of their small size and cryptic coloration (Keeley et al., 2001; Arnett and Tuttle, 2004). To correct for variation in searcher efficiency, conduct on-site trials to test each searcher using fresh carcasses of species likely to occur in the project area. Be aware that observer detection rates may change as carcasses decompose. Personnel conducting searches should not know when trials are being conducted because awareness of the trial makes searchers more vigilant and generally improves search results. Conduct trials at regular intervals throughout all four seasons to address changes in vegetation and weather. Geo-reference the planted carcasses by GPS and mark them in a fashion that is not detectable to the searcher. Spread the carcasses across a large area so that searchers are less likely to suspect or recognize that a trial is in process. If new searchers are added to the search team, conduct additional detection trials to ensure that detection rates incorporate searcher differences.

Trained search dogs can enhance the efficiency of carcass searches, particularly in dense vegetation (Arnett, 2006; 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). Conduct searcher efficiency trials for the dog-human handler team to evaluate biases and correct for them.

Carcass Removal Estimates

Use carcass removal estimates to determine how many carcasses searchers miss 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. Check planted carcasses at least every day for a minimum of the first three days and thereafter at intervals determined by results from pilot scavenger trials. Track the percentage of carcasses removed, and use that information to adjust fatality rates (Gauthreaux, 1995; Erickson, 2004) and to help determine the appropriate search interval.

Conduct Carcass Removal Trials

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. Spread trials 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). Also consider the effects of carcass size (Gauthreaux, 1995) and use different sizes of birds, ranging from large to small, in the trials. 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 might disappear more frequently and more quickly than larger birds (Orloff and Flannery, 1992; Gauthreaux, 1995).

Conduct carcass removal trials 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. Verify carcasses from the latter sources 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 should be avoided if possible because these surrogate carcasses may provide different cues that could affect their detection and appeal to scavengers. Old or long-frozen specimens (those frozen for more than six months) may also be less appealing to scavengers than freshly killed birds or bats. Avoid their use 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 maggotridden, severely decayed, or desiccated (Gauthreaux, 1995; Smallwood, 2006). Carcass removal rate—the average time a carcass remains in place—becomes biased when scavengers begin to ignore a degraded carcass. Also consider the number of carcasses used during scavenger trials. 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.

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 researchers must 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. Calculate corrected fatality rates 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, use the number of fatalities per MW of installed capacity per year as the metric. This avoids the problem of comparing turbines that have substantially different rotor-swept areas and capacities.

Reporting Monitoring Data

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 by lead agencies at various stages during project implementation or upon completion of the mitigation. Individual project permits typically specify which agencies should receive monitoring reports directly. In the context of CEQA, "monitoring" is generally an ongoing or periodic process of project oversight. CEQA 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.

Operations monitoring reports are crucial to improving the accuracy of future pre-permitting fatality estimates and understanding the effect of impact avoidance, minimization, and mitigation measures. Monitoring reports are most informative when they follow standard scientific report format and provide sufficient detail to allow agency and peer reviewers to evaluate the methods used, understand the basis for conclusions, and independently check conclusions. Clearly stating the assumptions, methods, study design, analysis, results, and conclusions in the monitoring report allows others to gain knowledge from each project. An essential report component is an appendix with the tabulated raw data from the carcass counts and bird use surveys. As with any type of biological survey, it is important to report observations of special-status species to the California Natural Diversity Database (CNDDB) <www.dfg.ca.gov/bdb/html/submitting_data_to_cnddb.html>.

Making pre-permitting and operations bird and bat data publicly available serves several important functions and would be a useful permit condition of all wind energy projects. Aside from facilitating maximum utility of results from bird and bat surveys, sharing the data may foster collaboration among individuals working on similar projects in various parts of the state. Operations monitoring reports and raw data have value as public documents because they facilitate the learning process for application on subsequent projects and can supplement baseline data for nearby new projects. Making raw data available to the public is useful in cumulative impact analyses and potentially provides an overview of trends. Additional study results from impact avoidance, minimization, and mitigation monitoring and adaptive management programs would similarly be useful to the public.

Where to Submit Bird and Bat Data

The Energy Commission and CDFG encourage data owners to share raw data by participating in CDFG's Biogeographic Information and Observation System (BIOS) program <www.bios.ca.gov>. Contributing data to a central online repository like BIOS will help others make data comparisons among wind energy-related biological datasets and ultimately help inform and improve management decisions. Another benefit of contributing to BIOS is that datasets can be viewed without specialized software and in conjunction with other data layers (for example, geographic features, other species, critical habitat) to accommodate larger planning efforts. Individual data owners may also limit data access to selected groups or individuals, but those submitting data should be careful not to include information that may be considered proprietary or confidential.

At this time, the recommended method of submitting data to BIOS is for data owners to send electronic data to the Energy Commission's Biology Unit Supervisor (contact information follows below). Energy Commission staff will then work closely with BIOS staff to upload the dataset to BIOS, which involves data review and possible formatting to fit the BIOS Data Viewer. The BIOS program's guidelines for contributors note the following necessary elements of data submittals: 1) electronic format, 2) geographic locations of biological observations including projected or geographic coordinate system and datum, 3) attributes defining observational data, and 4) metadata. If desired, monitoring reports (preferably in PDF format) can be stored along with raw data for particular projects on BIOS.

Please e-mail a complete dataset (smaller than 8 megabytes) with metadata to <biology@energy.state.ca.us>. Datasets larger than 8 megabytes may be e-mailed as a Zip file or mailed on a CD to the following address: California Energy Commission; ATTN: Biology Unit Supervisor; 1516 9th Street MS 40; Sacramento, CA 95814. Please identify the data as belonging to the “California Wind Energy Biological Database” and specify any viewing restrictions (see <http://bios.dfg.ca.gov/how2share.html> for details).

Once enough datasets have been submitted, the Energy Commission and CDFG will release a database structure in which interested parties can easily view wind-related biological observations through BIOS. A standard database and format for metadata will help streamline the uploading and updating of datasets to the California Wind Energy Biological Database on BIOS. The Energy Commission and CDFG are also considering a future project to develop a Web portal for receiving wind-related BIOS data submissions.

Self-Reporting of Incidental Findings

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, which are typically implemented in collaboration with USFWS. The Avian Powerline Interaction Committee (APLIC, 2006) also offers suggestions on developing avian fatality reporting programs by trained field personnel. While not part of a systematic data collection effort, incidental observation data from trained workers who record and report bird and bat carcasses discovered in the project area can supplement fatality data from the standard operations monitoring studies. If such incidental observations are to be included in the data analysis and monitoring reports, researchers should coordinate closely with field personnel collecting the data, establish criteria for which self-reported data are appropriate for inclusion, and fully describe the criteria and protocol for incidental observation data collection in the monitoring reports.

It is also helpful to submit incidental findings and observations to BIOS (common species) and CNDDB (special-status species) because other researchers and future nearby projects can benefit from a larger body of existing public data for a wind resource area. However, the absence of fatality records from self-reporting monitoring programs and databases like BIOS and CNDDB should not be used to demonstrate absence of fatalities.

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LIST OF ACRONYMS

APLIC	Avian Power Line Interaction Committee
BACI	before-after-/control-impact
BIOS	Biogeographic Information and Observation System
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 Database
CWHR	California Wildlife Habitat Relationships System
FAA	Federal Aviation Administration
FESA	Federal Endangered Species Act
ITP	Incidental Take Permit
MBTA	Migratory Bird Treaty Act
NAIP	National Agriculture Imagery Program
NEPA	National Environmental Policy Act
NWCC	National Wind Coordinating Committee
PIER	Public Interest Energy Research
SBC	small bird count
TADS	thermal animal detection systems
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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 Region (Region 1)
601 Locust Street, 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

North Central Region (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

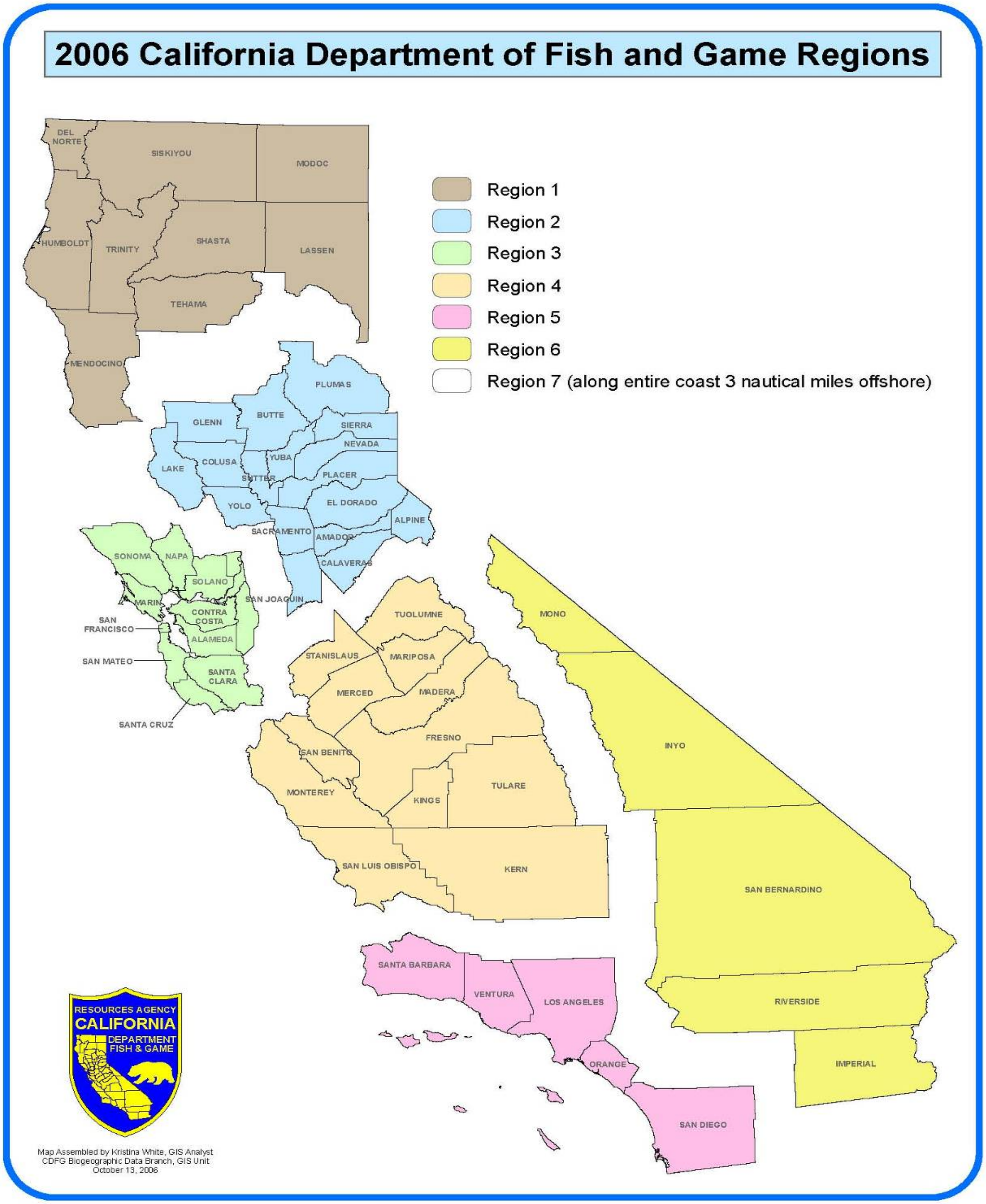
Bay Delta Region (Region 3)
7329 Silverado Trail, Napa, CA 94558
(707) 944-5517
http://www.dfg.ca.gov/regions/region3.html
Alameda, Contra Costa, Marin, Napa, Sacramento (south of railroad tracks), San Joaquin (west of Interstate 5), San Mateo, Santa Clara, Santa Cruz, San Francisco, Sonoma Solano, and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

Central Region (Region 4)
1234 E. Shaw Avenue, 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 (Region 5)
4949 Viewridge Avenue, 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

Inland Deserts Region (Region 6)
3602 Inland Empire Boulevard, Suite C-220, Ontario, CA 91764-4913
(909) 484-0167
http://www.dfg.ca.gov/regions/region6.html
Imperial, Inyo, Mono, Riverside, and San Bernardino Counties

Marine Region (Region 7)
Department of Fish and Game Headquarters, 1416 Ninth Street, Sacramento, CA 95814
(831) 649-2870
http://www.dfg.ca.gov/mrd/index.html
California coastline from border to border and three nautical miles out to sea


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
BUTTE
GLENN
SIERRA
NEVADA
YUBA
COLUSA
LAKE
SUTTER
PLACER
YOLO
EL DORADO
ALPINE
SACRAMENTO
AMADOR
CALAVERAS
SONOMA
NAPA
SOLANO
MARIN
SAN JOAQUIN
CONTRA COSTA
SAN FRANCISCO
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 Road
Arcata, CA 95521
(707) 822-7201
http://www.fws.gov/arcata/

Yreka (Arcata sub office)
1829 S. Oregon Street
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 Road
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 Boulevard
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/

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

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

APPENDIX C: GLOSSARY OF TERMS

Accuracy: The agreement between a measurement and the true or correct value.

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 provide 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.) Enacted in 1970, CEQA 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.

Category 1: A classification of a proposed wind energy project site that is characterized by the availability of data on wind-wildlife interactions from nearby, similar projects. Category 1 projects might include infill projects and those near existing, well-studied wind resource areas.

Category 2: A classification of a proposed wind energy site characterized by little existing information and no indicators of high wildlife impacts.

Category 3: A classification of a proposed wind energy site characterized by high or uncertain potential for wildlife impacts. For example, sites with known avian migration stop-over destinations, special-status species, high concentrations of wintering and/or breeding raptors, or sites near wind projects with high bird or bat fatalities might be classified as Category 3.

Category 4: A classification of a proposed wind energy site that is inappropriate for wind energy development, such as land protected by local, state, or federal government and sites for which existing data indicates unacceptable risk of bird or bat fatalities.

Ceilometer: 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 percent).

Contour hunting: A foraging method typical of some raptors, such as golden eagles, in which a bird will fly 3 to 10 feet (1 to 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.

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 function is an important component for estimating density of a population because it allows estimation of the overall probability of detecting an individual.

Displacement effects: Displacement refers to the indirect loss of habitat if birds or bats avoid a project site and its surrounding area due to disturbance. Displacement can also include barrier effects in which birds are deterred from using normal routes to feeding or roosting grounds.

Distance sampling: 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 thus helps the animal to orientate, navigate, and find food.

***Empidonax* flycatcher**: A genus of flycatchers that includes 11 species in North America. Birds in this group are known for looking remarkably alike and are often distinguishable only by their vocalizations, breeding habitat, nest structure, or by examination in the hand. California supports one species of Endangered *Empidonax*, the willow flycatcher (*Empidonax traillii*).

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.

Falconiformes: A classification of birds containing the diurnal birds of prey, including falcons, hawks, vultures, and eagles.

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. When rotors are feathered they are pitched parallel to the wind, essentially making them stationary.

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

Fossorial: Adapted for digging or burrowing.

Fully protected species: A statutory designation created by the California legislature for some species of birds, reptiles, and fish. By statute, permits are not allowed for the taking of fully protected species unless it is required for scientific research or recovery purposes.

Goura: One of several species of large, crested ground pigeons of the genus *Goura*, which inhabit New Guinea and adjacent islands.

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

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

Harp traps: Traps used to capture bats and consisting of one or more rectangular frames, strung with a series of vertical wires or monofilament lines usually spaced about 1 inch (2.5 centimeters) apart. When a bat hits the bank of wires, or lines, it falls into a bag beneath the trap where it can be retrieved and examined.

Impact gradient analysis: A sampling design used to detect the effects of an environmental disturbance when no reference areas are available. This design assumes that the impact is greatest closest to the disturbance, and the effects of the disturbance decline with distance from it.

Incidental finds: Carcasses found by personnel at times other than the scheduled carcass search.

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 10 inches (25 centimeters) 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 or more 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.

Macrositing: 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.

Metadata: The California Department of Fish and Game's Biogeographic Information and Observation System (BIOS) program defines metadata as information about data that describes its "who, what, where, when, why, and how." Metadata describes the purpose, intended uses, limitations, assumptions, data collection methods, and results, and ideally, it includes a detailed definition of each field within a dataset. BIOS considers metadata to include both the geographic information necessary to define the data in space and the scientific reporting information associated with data quality and use.

Micrositing: Small-scale site selection for wind turbines, typically involving placement of turbines; involves locating the placement of turbines, roads, power lines, and other facilities.

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

Migratory flyway: A broad geographical swath through which migratory birds travel seasonally between breeding grounds to wintering areas. California is within the Pacific Flyway, one of four major waterfowl flyways in North America.

Migratory route: Migration routes or corridors are the relatively predictable pathways that a migratory species travels between breeding and wintering grounds. Migratory routes are diverse and vary widely between species.

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

Parameter: A statistical term denoting 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.

Precision: The repeatability or reproducibility of a measurement, without respect to its correctness (accuracy).

Range: 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.

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

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

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.

Significant: According to CEQA Guidelines, “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, threatens to eliminate a plant or animal community, substantially reduces the number or restricts the range of an endangered, rare, or threatened species.” (CEQA Guidelines §15065[a][1]).

Small birds: Birds 10 inches (25 centimeters) 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.

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

- Listed on California Department of Fish and Game’s Special Animals List <www.dfg.ca.gov/whdab/pdfs/spanimals.pdf>
- Officially listed or proposed for listing under the California and/or Federal Endangered Species Acts
- State or federal candidate for possible listing
- Taxa that 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 California Department of Fish and Game to be a Species of Special Concern
- Taxa that are biologically rare, very restricted in distribution, declining throughout their range or that 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

Species richness: The number of species in a given area.

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.

Strigiformes: A classification of birds that includes owls.

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

Take: Defined by California Department of Fish and Game (Fish and Game Code §86) 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 that 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 D: SCIENTIFIC NAMES OF BIRDS AND MAMMALS MENTIONED IN TEXT

Common Name	Scientific Name
BIRDS	
American kestrel	*Falco sparverius*
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*
Cooper's hawk	*Accipiter cooperii*
Golden eagle	*Aquila chrysaetos*
Greater prairie chicken	*Tympanuchus cupido*
Horned lark	*Eremophila alpestris*
House sparrow	*Passer domesticus*
Marbled murrelet	*Brachyramphus marmoratus*
Northern goshawk	*Accipiter gentilis*
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*
Swainson's hawk	*Buteo swainsonii*
White-tailed kite	*Elanus leucurus*
Willow flycatcher	*Empidonax traillii*
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 E: 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 same 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)

Morrison 1998

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
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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

Orloff and Flannery 1992

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.

[illegible]: Second 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^o)
- 2 = moderate (5^o-30^o)
- 3 = flat (<5^o)
- 4 = unknown

Tp: Temperature at each sublocation in ^{o}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
- 1 = North
- 2 = North-East
- 3 = East
- 4 = South-East
- 5 = South
- 6 = South-West
- 7 = West
- 8 = North-West
- 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^o)
- 002 = perpendicular (46 - 90^o)
- 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 ______ sect # ____ 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

Anderson et al. 1996

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.

Anderson et al. 1996

[illegible] 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 neecec.

_ _ _ 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
Temp.																		
Wind																		
Cloud																		
Precip.																		
Fog																		
Moon																		

SITE#:	Time																		
Spp: ____ Size: ____ Bd#: ____	Cond.																		
	Comments:																		

SITE#:	Time																		
Spp: ____ Size: ____ Bd#: ____	Cond.																		
	Comments:																		

SITE#:	Time																		
Spp: ____ Size: ____ Bd#: ____	Cond.																		
	Comments:																		

SITE#:	Time																		
Spp: ____ Size: ____ Bd#: ____	Cond.																		
	Comments:																		

SITE#:	Time																		
Spp: ____ Size: ____ Bd#: ____	Cond.																		
	Comments:																		

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 ___

CEC 12/12/95

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:				Flag Loc:		Flag Color:
Map & Comments:						

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:				Flag Loc:		Flag Color:
Map & Comments:						

check 1 ☐ comp ☐ check 2 ☐

Anderson et al. 1996

OBSERVER BIAS STUDY
1996

DATE:_____ / _____

OSERVER:__________ (c) ____

NCom. Type:_____ (c) _____

SITE #:_____

ORDER: 1st 2nd 3rd

COMPANY:__________ (c) ______

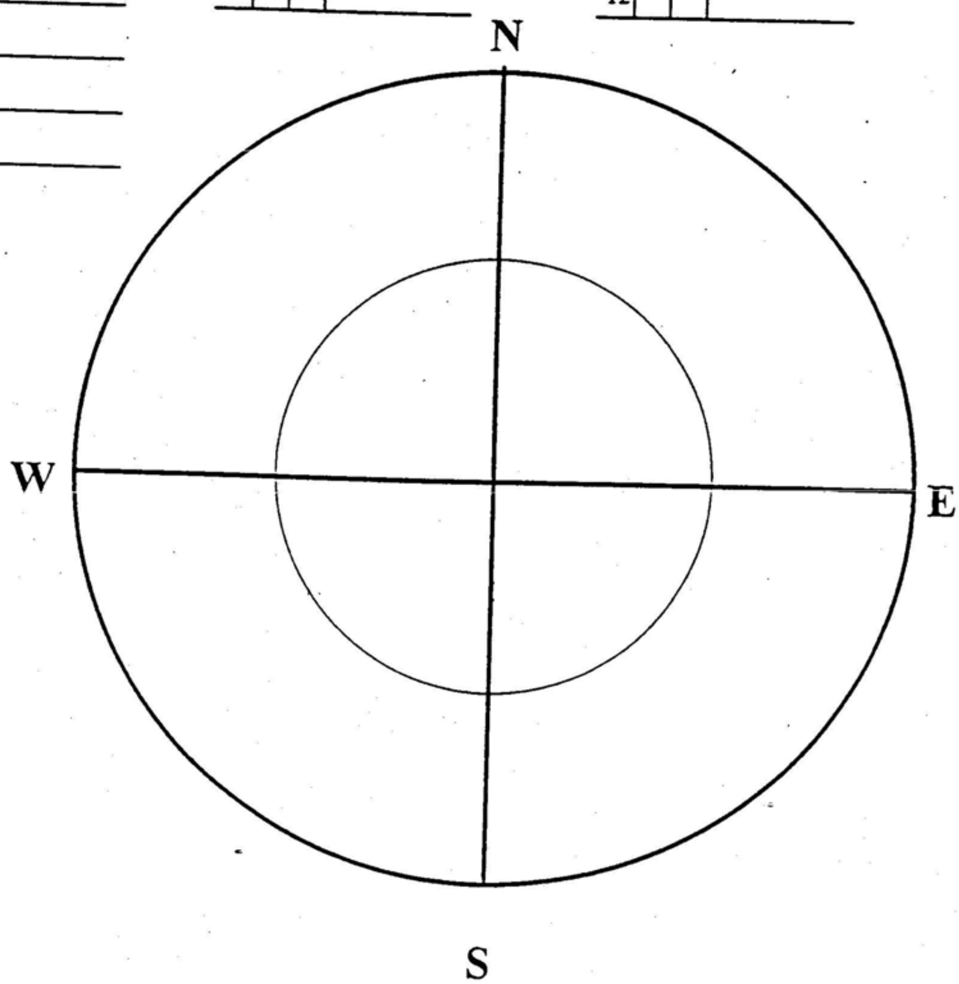
TIME: Start _______ End _______

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			



Anderson et al. 1996

APPENDIX F: 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

1. 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.
2. 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.
3. 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, pp.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 pages 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 is 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 G: ESTIMATING IMPACTS TO RAPTORS USING BIRD USE COUNT AND FATALITY DATA FROM EXISTING PROJECTS

This section provides examples and background information to evaluate a project's potential impacts to raptors. Raptors were used for these impact estimate examples because a large data set is available for use and fatality rates for this set of birds. Furthermore, raptors are a visible and valued wildlife resource in California, and raptor deaths from wind energy projects such as those at Altamont Pass Wind Resource Area in Alameda County, California, have received worldwide attention. Numerous studies have noted that raptors disproportionately collide with wind turbines (Orloff and Flannery, 1996; Anderson et al., 1995; Erickson et al., 2006). Consequently, raptors merit special attention at most proposed wind energy sites in California.

The data in Table 1 and Figures 1 and 2 were taken from studies at wind energy projects in California, Oregon, Washington, Wyoming, and Minnesota. These studies were selected as data sources because they used standardized methods similar to those recommended in the *Guidelines*. These wind energy projects are also useful for comparisons because the wind turbines at these sites (with the exception of Tehachapi and San Gorgonio) are the large, newer generation models (0.6 MW to 1.5 MW) similar to those that will be built on future projects. For several of these studies, raptor use had been estimated using 20-minute counts, so the data were adjusted in this table to provide a uniform metric of raptor use per 30-minute count.

Table 1. Raptor Use and Raptor Fatalities.

Study Site	Raptor Use/30-Minute Count	Raptor Fatalities/ MW Installed Capacity/Year	Source
High Winds, CA	5.250	0.68	Kerlinger et al., 2006
Diablo Winds, CA*	4.350	0.52	WEST, 2006
Combine Hills, OR	1.350	0.00	WEST, 2006
Tehachapi Pass, CA *	0.900	----	Anderson et al., 1996
Foote Creek Rim, WY	0.735	0.04	Young et al., 2003
Buffalo Ridge, MN	0.720	0.02	Johnson et al., 2000
Klondike, OR	0.705	0.00	WEST, 2003
Nine Canyon, WA	0.660	0.05	WEST, 2001
Stateline, WA/OR	0.615	0.09	Erickson et al., 2003, 2004
Vansycle, OR	0.450	0.00	Erickson et al., 2000
San Gorgonio, CA	0.150	0.03	Anderson et al., 2005

*A range of 0.40 to 0.64 raptor fatalities per MW per year was calculated for Diablo Winds—the mid-range value of 0.52 is used in this table. Fatality data for studies at Tehachapi, California were not included because carcass searches were too infrequent to be comparable to other studies.

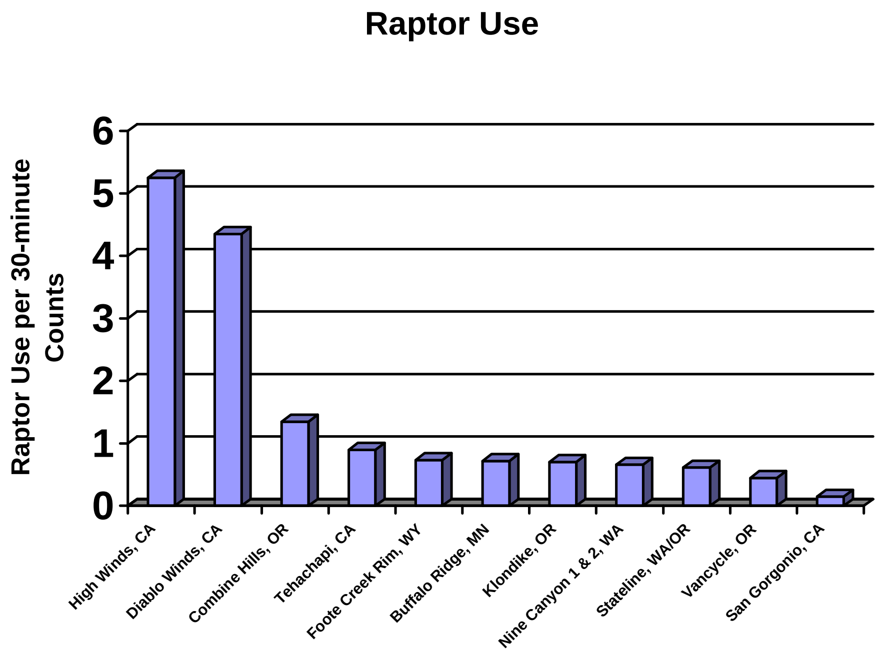


Figure 1. Raptor use per 30-minute count at wind resource areas in California, Oregon, Washington, Wyoming, and Minnesota.

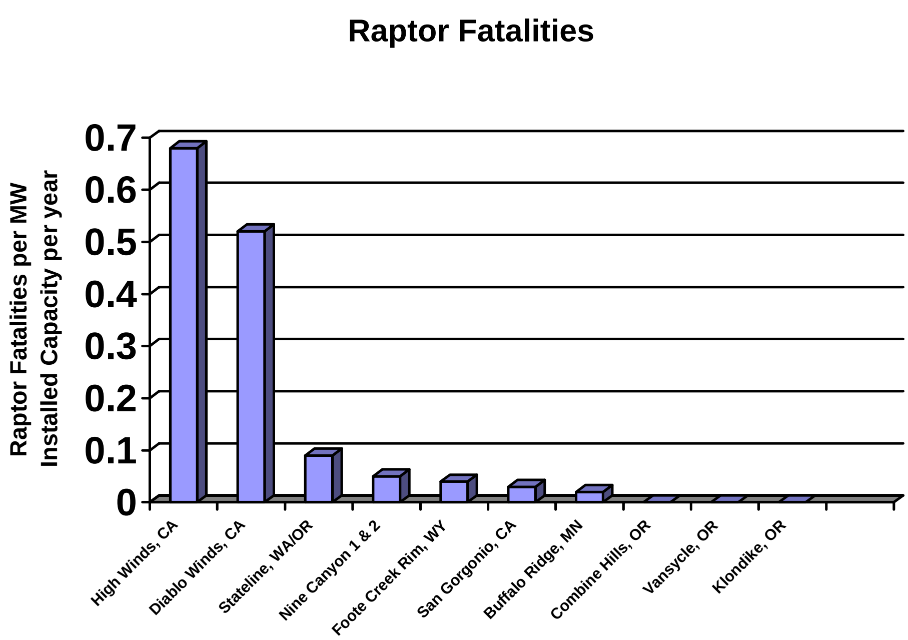


Figure 2. Raptor fatalities per MW installed capacity per year at wind resource areas in California, Oregon, Washington, Wyoming, and Minnesota.

Examples of Projects with Potential for High and Low Raptor Fatality Rates

Example 1: Pre-permitting bird use counts (BUCs) find an average of 0.15 raptors per 30-minute count at a proposed project site. Table 1 shows that the 0.15 raptors per 30-minute count is the same as found at San Gorgonio, California. Looking at Figures 1 and 2, raptor use and raptor fatality graphs, allows a visual comparison of where the 0.15 raptors per 30-minute count fit in the distribution of other projects that have been studied using standardized methods and metrics. The raptor use number of 0.15 is on the low end of the comparison graph, similar to San Gorgonio, which also is on the low side of the raptor fatalities graph. Therefore the proposed project might be expected to have a relatively low fatality rate for raptors.

Example 2: Pre-permitting BUCs find an average of 4.35 raptors per 30-minute count at a proposed project site. Table 1 shows that the 4.35 raptors per 30-minute count is the same as found at Diablo Winds, California (in Altamont Pass). Compare this BUC count in Table 1 with Figures 1 and 2. The raptor use number of 4.35 is on the high end of the comparison graph, similar to Diablo Winds, which also is on the high side of the raptor fatalities graph. Therefore the proposed project might be expected to have a relatively high fatality rate for raptors.

Figure 3, from Strickland et al. (2006), provides a regression analysis showing the association between standardized metrics for raptor use and fatality rates from projects with the newer turbines. This figure also illustrates the positive correlation of raptor use and raptor fatality rates at wind energy facilities.

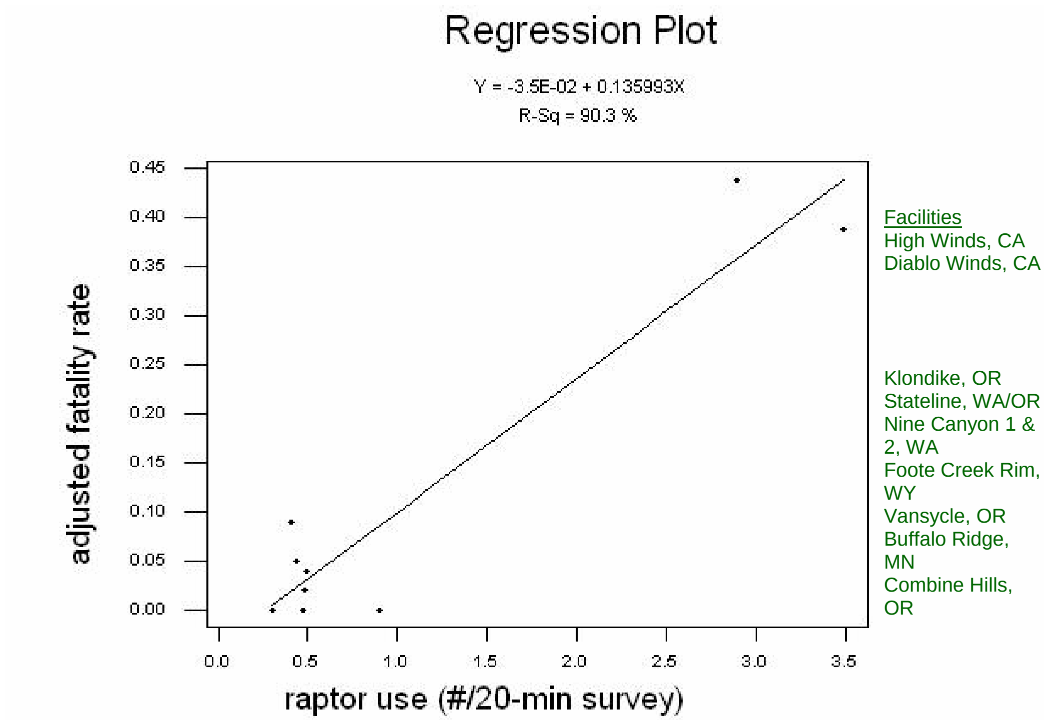


Figure 3. Comparison of raptor use and fatalities at new turbine sites that used comparable study methods (20-minute bird use counts) (Strickland, 2006).

Cautions

Exercise caution when using this simple assessment approach to extrapolate fatality rates and make impact assessments, and be careful in analyzing and presenting the data. Inappropriate grouping of data for species and bird groups can alter conclusions about potential impacts and mislead the reader. Be aware that grouping species into a bird group such as raptors can mask impacts to a particular species that may be of concern. For example, both Diablo Winds at Altamont Pass, California, and High Winds in Solano County, California have relatively high raptor use and fatalities; however, the mix of raptors is different. High Winds has more American kestrels and red-tailed hawks, while Diablo Winds has more golden eagles (Kerlinger et al., 2006; Erickson et al., 2006). These distinctions can be important for a project impact assessment that would be obscured if the analysis failed to separate use and fatality rates for each raptor species.

Grouping raptor use or fatality rates into overall bird use can also be misleading, as can use of national averages of bird use and bird fatalities when assessing impacts. Overall bird use can be low, but raptor use can be high on a project, as illustrated theoretically in Table 2 below. Consider the following hypothetical example while referring to Table 2: assume a hypothetical national average of 17 birds per 30-minute bird use count and 3.0 bird fatalities per MW of installed capacity per year. Suppose studies at a wind energy site showed an average of 11 birds per 30-minute bird use count and 2.0 bird fatalities per MW of installed capacity per year. This hypothetical site looks reasonably good compared to the national average with lower bird use and lower bird fatalities. However, a closer review of the results shows the national average includes 0.3 raptors per 30-minute count and 0.07 raptor fatalities per MW of installed capacity per year, but the theoretical project raptor use is 3.0 per 30-minute count and 0.75 fatalities per MW of installed capacity. The new project has 10 times the raptor use and 11 times the raptor fatalities of the national average, while having less overall bird use and less overall bird fatalities. In this example, if only the "all bird use" numbers were used, the assessment would reach an inappropriate conclusion.

Table 2. Illustration that Overall Bird Use Can Be Low on a Project with High Raptor Use.

	Bird Use	Bird Fatality	Raptor Use	Raptor Fatality
Theoretical national average	17.0	3.0	0.3	0.07
Theoretical project	11.0	2.0	3.0	0.75

To avoid the problems described above, analyze data for each bird group and special-status species separately, as appropriate for the site. In making the impact assessment, consider whether a local bird population has experienced declines and the effects of additional losses to such a population. Be aware that the use-fatality rate relationship depicted in Figure 3 has only been demonstrated for raptors. Bird use data for songbirds does not reflect the same clear correlation of bird use to bird fatalities as does raptor use data.

Figure 4 displays raptor use information for many wind energy project sites throughout the nation. This figure shows the range of raptor use at wind energy project sites in California and elsewhere in the country and is provided to allow convenient comparisons for new project data.

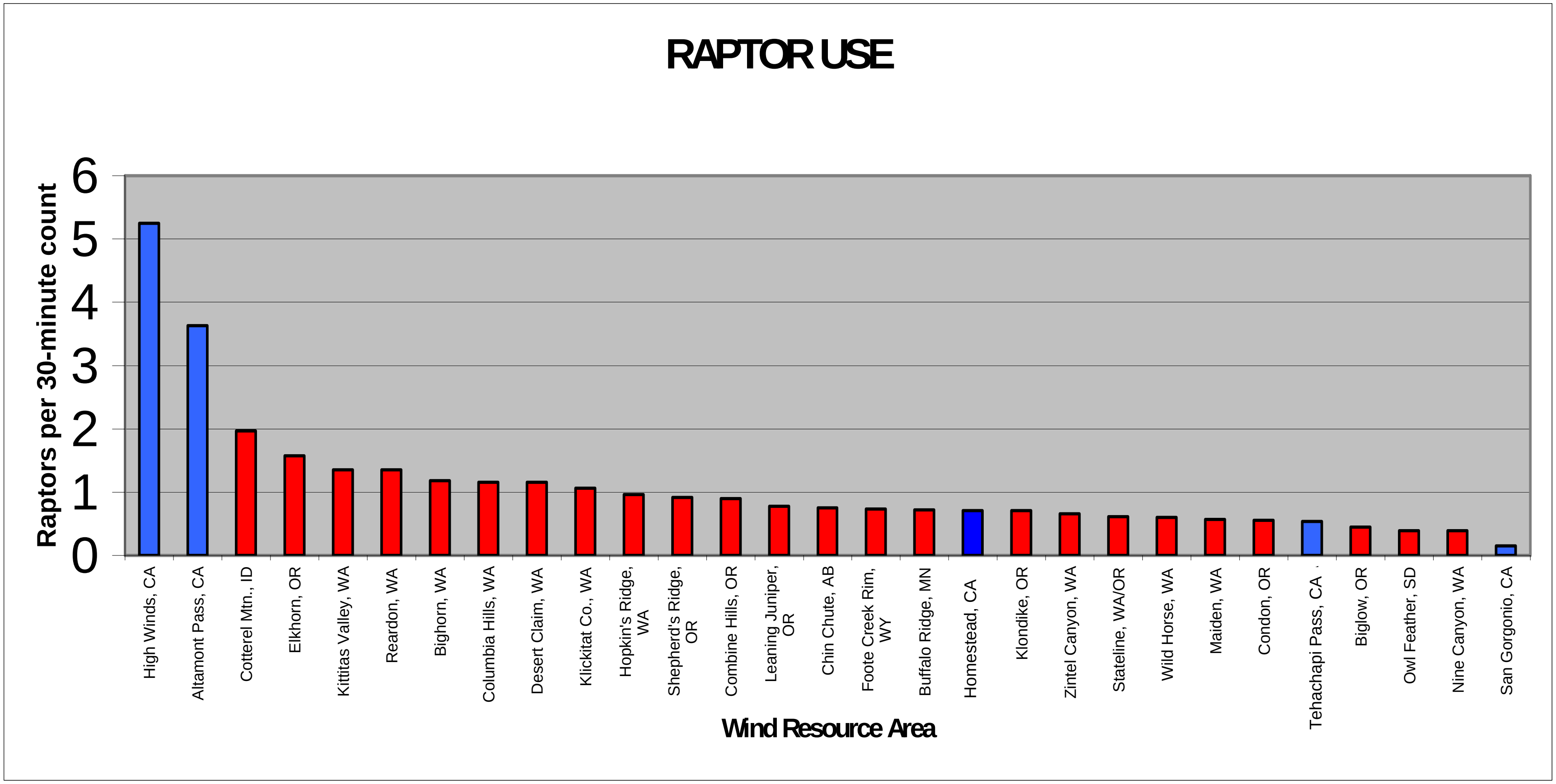


Figure 4. Raptor use estimates at several wind resource areas within and outside California. Blue columns depict data from studies at California wind resource areas.