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ASSESSMENT OF AVIAN MORTALITY FROM COLLISIONS AND ELECTROCUTIONS

STAFF REPORT

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EXECUTIVE SUMMARY

Safeguarding endangered and protected avian species is an increasingly important component of both California's development of electric generation and the siting and operation of power lines. Bird deaths from electrocution and collision with wind turbines and power lines are an ongoing environmental issue affecting wind energy development and the siting and operation of electrical transmission and distribution lines. Wind energy is a major part of the renewables portfolio standard (RPS), and wind developers rely on federal and state tax credits to help offset costs of new development. However, high wind areas are also prime habitat for certain protected bird species. Major wind developments in Altamont Pass, San Gorgonio, Tehachapi Pass, and Solano County have caused numerous bird deaths. To resolve issues with current wind resources and accommodate additional wind development and repowering, mitigation and/or avoidance is needed to reduce avian mortality.

When birds and bats collide with electrical power line infrastructure, their electrocution also can result in electrical outages, affect service reliability, and cause wildfires. Most bird species being killed are protected under state and federal laws and are thus of concern to the public at large, as well as environmental and wildlife law enforcement officials.

This staff paper issued in conjunction with the *2005 Environmental Performance Report* examines the ongoing issues of avian fatalities from electrocution and collision with energy structures. This paper includes current research results, information provided from the utilities, research conducted through the Public Interest Energy Research (PIER) program and a brief look at how some other states are addressing energy infrastructure-related avian fatalities. This paper is divided into two chapters: the first discusses avian fatalities in relation to wind energy resources and the second, avian fatalities in relation to electrical transmission and distribution lines.

There are several trends in California wind energy development and associated avian issues. Among them are research shifting from identifying the extent of the avian collision problem to resolving it, the discovery that bat fatalities may be an issue in at least one wind resource area, and how mitigation for projects is determined and applied. The rates of bird use and collision differs in other wind resource areas in California. California's Altamont Pass Wind Resource Area stands out as having a high bird fatality problem due to the combination of approximately 5,000 operating turbines and a high concentration of year-round raptors. Alameda County continues to implement a moratorium on developing additional wind development in the Altamont Pass until avian fatalities can be reduced. Solano County also has a high rate of collisions, while San Gorgonio and Tehachapi Pass have lower rates. More recently, studies at wind farms have identified bat fatalities as an issue. In Solano County, surveys for bats have been conducted confirming bat fatalities are an issue there. Elsewhere in California, bat fatality studies have not

been conducted and, therefore, the extent of the problem in these wind resource areas is uncertain.

Wind turbines should be sited in areas that reduce impacts to birds and other species as well as critical habitat. Mitigation measures should also be developed for all of the wind resource areas and applied to existing and new development to effectively lessen impacts on avian resources. Applying measures that reduce the chances of avian interactions with wind turbines and electrical infrastructure is the only way to reduce collisions. Voluntary guidelines for surveys and mitigation measures exist, but industry and local agencies do not implement them consistently between projects.

Avian fatalities due to collisions with and electrocutions from electrical power lines in California cannot be accurately quantified although they can be reduced using bird-safe designs. In some areas the utilities collect information on avian interactions with transmission lines and have adopted an Avian Protection Plan. The data collected are not normally publicly reported, except when federally listed species are reported to the U.S. Fish and Wildlife Service. However, one recent study in Arizona showed that 85 percent of avian interactions with electrical power lines go undetected by the utility (Dwyer 2004), although they still critically injure or kill the bird. Therefore, the information collected by the utilities maybe grossly underestimating the impacts to avian resources in California.

The PIER Environmental Area (PIER–EA) is collaborating on current research to help quantify the problem as well as resolve it through identification of mitigation measures and dissemination of information to stakeholders. There are other guidance documents available that utilities use to lower the potential for electrocutions and collisions with power lines. The guidelines are voluntary and the extent of their implementation differs throughout the state.

SUMMARY OF STAFF FINDINGS AND POLICY OPTIONS

Most Bird Species Killed by Interactions with Wind Turbines or Electrical Power Line Infrastructure are Protected by Federal and State Laws and Regulations. Nearly each bird killed results in a violation of one of these laws. Bird deaths also impact the species and can result in litigation.

The California Energy Commission (Energy Commission) Could Promote Development of New Wind Resources Only in Areas That Have Low Risks to Birds. As wind energy production expands the rotor swept area of turbine blades increases and more birds will be at risk of collision. To lower risks to birds, the developer should conduct protocol level bird use surveys prior to development. Expansion or repower projects should be required to incorporate mitigation measures and monitoring and to report the results so fatality rates and mitigation efficacy can be assessed. Using that information, they can then site turbines to avoid areas of high avian use. Additional wind development to meet the RPS goals is feasible while at the same time limiting the avian impacts.

To Determine Statewide Impacts on Bats, the Energy Commission Could Support Bat Use, Behavior and Carcass Surveys at All of the Wind Farms in California. The information could be used to determine statewide impacts to bats and design mitigation measures to reduce bat collisions with turbine blades.

The Energy Commission Could Support Statewide Guidelines Requiring the Wind Industry to Mitigate Its Impacts on Birds in the State. The wind siting and mitigation guidelines produced by the National Wind Coordinating Committee and the U.S. Fish and Wildlife Service to date are voluntary, and the level of implementation by industry and local agencies vary. Statewide guidelines for wind energy projects may be an appropriate way to gain consistency statewide when developing and mitigating projects. Statewide standards could also remove a significant environmental barrier to increasing wind energy in the state.

In the Altamont Pass Wind Resource Area, the Energy Commission Could Encourage Industry to Apply Mitigation Measures to Existing Projects, New Projects, and Repowering Projects to Reduce Bird Deaths. Over the last 20 years, researchers have documented the levels of bird use and mortality in the Altamont Pass. PIER-EA funded studies to develop a list of mitigation measures that could reduce bird kills (Smallwood and Thelander 2004, Smallwood and Neher 2004, Smallwood and Spiegel 2005). As the next step, industry needs to implement and monitor those mitigation measures Altamont-wide to determine their effectiveness. Two measures that would reduce bird kills by eliminating spinning turbine blades are seasonal shutdown in winter months or removal of wind turbines in the highest risk areas. This would reduce bird kills; it would also result in a loss of generation (Smallwood and Spiegel 2005). Ultimately, implementing mitigation could

allow industry to expand if Alameda County was able to lift its moratorium because of a reduction in bird kills.

In the Solano County Wind Resource Area the Energy Commission Could Encourage Industry to Lower Its Existing Impact on Bird and Bat Resources. Past research shows that bird use for several raptor species is higher in the Solano County Wind Resource Area than at the Altamont Pass. Recent post-construction carcass surveys for the High Winds Project indicate a high rate of bird mortality. High bat fatalities are a newly identified issue in Solano County; the extent of which is uncertain. There is insufficient information on bird and bat fatality rates in the entire Solano County Wind Resource Area. Research aimed at identifying the extent of the problem and developing mitigation measures for implementation would allow for continued use of the wind resources in Solano County while minimizing the potential for another wind resource area in California with high impacts.

The Energy Commission Could Support Further Research Using More Current Research Protocols in the Tehachapi Pass, San Gorgonio Pass, and Pacheco Pass to Confirm Low Avian and Bat Impacts in These Areas. Collisions with wind turbines have been studied less in these areas than at the Altamont Pass and Solano County wind resource areas. The studies that have been completed report lower bird use and fatality rates in these wind areas. Based on research results it may be appropriate for the Energy Commission to encourage repowering and expansion in these areas.

Electrocutions and Collisions with Electrical Power Line Infrastructure Can Be Adequately Measured Using More Intensive Survey Methodologies. For years, utilities, researchers, and the resource agencies have documented that electrical power line infrastructure has caused avian collisions and electrocutions, but there has been a lack of standardizing the collection and reporting of data. Several studies have tried to estimate the number of bird deaths from interactions with utility structures; however, without further research they cannot be accurately quantified. Recent research suggests that up to 85 percent of collisions and electrocutions may go undetected by the utilities (Dwyer 2004).

The Utilities Are Beginning to Develop Avian Protection Plans in Collaboration with the U.S. Fish and Wildlife Service and Are Actively Retrofitting Power Poles That Cause Electrocutions.

Statewide Guidelines for Electrical Power Poles May Be an Appropriate Way to Gain Consistency Statewide. Raptor friendly power lines are only constructed in certain places and voluntarily by some utilities. Statewide construction standards that include raptor-proofing distribution pole equipment and transmission line conductors would ensure the greatest reduction in electrocutions and collisions.

Electrical Transmission Line Guidance Documents for Collision and Electrocution Are Well Used by Many Stakeholder Groups. Guidance

documents include the Avian Power Line Interaction Committee documents (electrocution and collision). The guidance documents need periodic updating to incorporate new research that can provide better mitigation and a larger reduction in birds killed.

The Energy Commission Could Support Long-Term Monitoring Studies. These studies will be used to understand the long-term impacts of electrocutions and collisions, the scope of the impacts, and how the implementation of mitigation measures reduces bird kills. The PIER-EA program efforts to collaborate with industry, researchers, and other stakeholders to gather and share research information and continue to resolve impacts should continue to be supported.

CHAPTER 1: AVIAN FATALITIES FROM INTERACTIONS WITH WIND TURBINES

Introduction

Avian fatalities in association with wind turbines continue to be an issue impacting birds, wind repowering, and wind expansion. California was one of the first states to develop its wind resources and by 1995 produced 30 percent of the world's wind-generated electricity. However, wind development slowed considerably in the late 1990s primarily due to the end of federal tax credits and state incentives. In addition, researchers began to document bird fatalities from collisions with wind turbines, particularly at the Altamont Pass. One county, Alameda, instituted a moratorium on wind development in the Altamont Pass until bird collisions could be resolved (Alameda County 1998). Bird collisions became, and continue to be, the largest environmental barrier to wind expansion and repowering.

More recently, the California Legislature enacted Senate Bill (SB) 1078, which requires investor-owned utilities to increase their portfolios of renewable resources to 20 percent by 2017. In its *2003 Integrated Energy Policy Report (Energy Report),* the California Energy Commission (Energy Commission) recommended accelerating the timetable by seven years to 2010. Subsequently, the Energy Commission, the Public Utilities Commission (PUC), and the now-defunct Consumer Power and Conservation Financing Authority adopted the Energy Action Plan, which concurred with the *Energy Report's* recommendation to implement the Renewable Portfolio Standard (RPS) increase to 20 percent by the earlier date (California Power Authority 2003).

Wind turbines provide numerous benefits and are an important component in meeting the state's RPS goal. Wind turbines do not rely on fossil fuels and emit no air pollutants. The cost of the electricity they generate is competitive with the cost of electricity generated by fossil-fueled power plants. California has up to 1,000 megawatts (MW) of aging wind facilities that are candidates for repowering (California Energy Commission 2004). In addition, the Energy Commission is studying expansion of existing wind sites to include secondary wind areas (areas with lower wind speeds). Further, the American Wind Energy Association projects that an additional 254 MW will be proposed for construction in California in the next few years (American Wind Energy Association 2005).

In spite of its potential, new wind energy development and repowering is hampered by fatal avian interactions with wind turbines. Although there can be financial and transmission line barriers to wind development, the largest environmental barrier is avian mortality associated with wind turbines collisions (California Energy Commission 2004). Avian interactions with wind turbines can result in legal action from wildlife agencies or non-profit groups and can delay the permitting process. Studies show that avian collisions with wind turbines occur in all of the wind farms in

California, although the number of collisions differs between areas. Recent information indicates that wind turbines in California are also killing bats.

This section of the avian fatality paper describes a variety of factors that both help and hinder wind energy development, including environmental regulations; fragmented and poorly coordinated siting to reduce avian impacts; monitoring and mitigation; and regulatory enforcement. In exploring each of California's five wind resource areas individually, the paper summarizes the current state of scientific understanding of where and why avian fatalities occur; reports on current mitigation measures; introduces issues associated with new technology developments and the drive to repower existing wind energy facilities; and discusses the problems inherent with fragmented and uncoordinated regulation. The section concludes with a brief discussion of standardizing surveys, out-of-state wind resource development, and finally, a summary of staff findings and policy options.

Environmental Regulations Affecting Wind Energy Development

Certain federal and state environmental regulations require disclosure of project impacts on the environment. Compliance with the National Environmental Policy Act is required when a federal agency such as the U.S. Bureau of Land Management issues a right-of-way permit. California Environmental Quality Act compliance is required for all projects in California that require a state or local agency permit. Both require public disclosure of projects and a description of the environmental effects of their actions.

The federal Endangered Species Act protects threatened and endangered species and their habitat. The Act requires consultation with the U.S. Fish and Wildlife Service if a project may impact a listed species and a permit for the "take" (harm or harassment as defined in the law) of the species and its habitat. First passed in 1918, the Migratory Bird Treaty Act protects most migratory birds and their eggs. There is no provision to allow killing birds protected under the Act. In 1960, the Migratory Bird Treaty Act was amended to include new penalty provisions, which stipulate that violations of this Act constitute a misdemeanor. In 1998 the penalty provision was amended to allow the fine for convictions to be up to $100,000 for individuals, $200,000 for organizations. The Bald and Golden Eagle Protection Act also protects bald eagles and golden eagles, their nests and eggs and has no provision for "take."

California also has laws and regulations that protect biological resources in the state. The California Endangered Species Act protects animals that are state-listed as rare, threatened, or endangered species. Certain Fish and Game codes that make it unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, designate certain species as "species of special concern," and protect species classified as "fully protected," and migratory birds.

Permitting authority for wind energy projects in California resides with a local agency, usually the county where the development is located. In some cases the utility district completes its own California Environmental Quality Act documentation.

Wind Energy Siting and Survey Guidance Documents

Local agencies and industry inconsistently apply the recommendations in guidance documents that standardize turbine siting, surveys, implementation of mitigation measures, and monitoring to reduce avian impacts. Of the guidance documents written to help standardize turbine siting and surveys, the National Wind Coordinating Committee has published two. The Avian Subcommittee published a guidance document to help standardize the survey methodology for determining and monitoring potential impacts on birds at existing and proposed wind energy sites (Anderson 1999) and the Siting Subcommittee published a handbook on guidelines for permitting wind energy facilities (Therkelsen and Grant 1998).

The U.S. Fish and Wildlife Service has issued interim guidance documentation for siting wind turbines and reducing impacts to avian species (U.S. Fish and Wildlife Service 2003). Under the Migratory Bird Treaty Act, the U.S. Fish and Wildlife Service can take legal action if measures are not being implemented to reduce the impacts to all migratory birds; therefore, it established a protocol to conduct a site evaluation and wildlife use surveys for use in developing a site while reducing the avian risk and wildlife impacts. The U.S. Fish and Wildlife Service recommends a three year baseline survey and avoidance measures such as seasonal shut down when there are concentrations of bird use at the sites. Post-construction monitoring should also be completed with the level of monitoring depending on the sensitive species in the area. The guidelines also suggest that all of the preconstruction and post-construction work be developed in consultation with federal and other agency biologists. Although recommended, the guidelines are used on a case-by-case basis. Landowners in the Altamont Pass and the wind industry have taken issue with the implementation of the guidelines.

There are also Altamont Pass specific mitigation measures recommended in documents from the PIER-EA Altamont Pass Research (Smallwood and Thelander 2004; Smallwood and Neher 2004). These mitigation measures were formulated by studying bird behaviors and bird risk in the Altamont and correlating fatalities to a group of different variables. Researchers found that three years of carcass searches were needed before the sample of wind turbines sufficiently stabilized in mortality values. They also recorded time the birds spent close to the wind turbines and reviewed turbine designs and arrangements to correlate them to avian fatalities. Mortality rates also varied by season, with most of the fatalities occurring in the winter months when power production was at its lowest.

Trends in Wind Energy Development

Four trends characterize expansion of the wind energy industry: repowering existing sites, increasing turbine size, expanding into additional areas, and consolidation among smaller owners and operators. Repowering consists of removing older

smaller turbines and replacing them with larger more efficient turbines; resulting in fewer turbines but usually maintaining the same or increasing megawatt capacity. New wind farms also use the larger turbines. Because primary wind resource areas in the state are largely developed, most new development will occur as repowering with more efficient turbines or in secondary wind resource areas. Over time wind turbines in California are increasing in dimensions as well as megawatt capacity. Table 1 shows the trend of increasing turbine size in California between 1985 and 2003.

Most of the newer turbines in California are rated at least 1 MW capacity, with some projects under construction using 1.5 and 1.8 MW capacity turbines. As the turbines' capacity increases, so does their size. Turbines now can be 340 feet tall with the blade lengths 130 feet. As turbines get taller, the Federal Aviation Administration requires lighting in certain areas. The resulting effect of lights on avian and bat fatalities is not clearly understood. In studies of transmission towers, lights in inclement weather disoriented birds. Bats may be attracted to lighted areas if those areas have more prey available. How the new turbines and lights will impact avian and bat species or change fatality rates still needs to be determined.

Table 1: Number of Turbines by Size and Year in California

	Turbine Size (kW)						
Year	**1-49**	**50-99**	**100-199**	**200-499**	**500-699**	**700-999**	**1000-2000**
1985*	2,486	7,378	648	402			
2000	484	3,593	5,689	1,344	211	142	
2003	453	3,663	5,981	1,425	321	218	104

Source California Energy Commission Wind Reporting System Annual Reports
*1985 data is rated 1-50 kW, 51-100 kW, 101-199 kW and 200 kW and greater

Larger turbines also have an increased rotor swept area, a factor considered important in fatality rates. Rotor swept area is variable between models. Examples include a 100 Kilowatt Kenetech turbine with a 247 meter squared (m^2) rotor swept area, a 225 kW Vestas turbine with a 573 m^2 rotor swept area, and a 1 MW NEG-MICON turbine with a 756 m^2 rotor swept area. Even newer technology has resulted in constructing a 5 MW prototype turbine at almost 400 feet tall with 200-foot long rotor blades. Although this is the first turbine of this size, if technology continues to work without problems, such large turbines could be available for more widespread use (North American WindPower 2005). Rotor swept area is considered highly contributory to avian collisions. The larger the rotor swept area, the more space there is for birds to collide with blades. Bats and birds collide with wind turbine blades when they occupy the same air space.

Expansion of wind generation is also occurring on federal lands. The Bureau of Land Management (BLM) is issuing a Programmatic Environmental Impact Statement for wind development on its lands in the western United States. This programmatic document would allow for additional wind development in areas outside existing wind farms and could streamline the environmental review as long as adequate

surveys and additional environmental documentation are prepared as needed. Currently, there are more than 40 applications to build wind facilities on BLM lands in California.

When wind development began in California, there were many smaller owners. For example, in 1985 42 operators owned 10,914 turbines (California Energy Commission 1986). Since then, industry has consolidated and 18 operators own 11,941 turbines (Table 2). Many of these companies own multiple wind farms in multiple states. Industry is aware of the bird collision issues within the state and also knows how that compares to its facilities in other states.

Table 2: Wind Farm Owners in California in 2003

Project Operator Name	Net Capacity (MW)	Number of Turbines
AB Energy	6.98	31
Calwind Resources, Inc.	31.14	360
Coram	11.24	281
Enron	290.31	2,412
EnXco	52.85	403
EUI Management	25.45	167
FPLE Operating Services Inc.	552.64	1,490
Green Ridge	513.26	4,662
International Turbine Research	17.13	166
Northwind	12.09	186
Oak Creek	33.72	83
San Gorgonio Farms, Inc.	35.77	220
SeaWest Energy Group	202.84	968
Southern California Sunbelt	11.02	139
Westwind Association	16.96	179
Windland, Inc	5.18	30
Windland, Inc	6.98	33
Wintec	7.50	131
Total: 18 Companies	**1833.06**	**11941**

Source: California Energy Commission 2003 Wind Reporting Data

Wind development and expansion rates have also varied over the years depending on the state and federal tax credit programs. The federal government extended the tax credit program until December 31, 2005; recently, it has been renewed on an

annual basis. This leads to uncertainty from year-to-year as to whether the credit will be available for new projects. Repower projects do not qualify for the federal tax credit. Since industry relies heavily on the tax credit, when it is not available wind development slows down. Supporting renewal of the tax credits on a multi-year basis would help even out the rate of development.

There is increasing pressure to expand and repower wind energy in the state due to the RPS goals, the federal tax credits, and the efforts by the Bureau of Land Management. As the wind power industry expands, it can be expected to kill additional birds and continue to run into expansion barriers. To reduce its impact on bird species in the state, industry can construct projects following the best guidance documents and implementing appropriate mitigation measures.

Effects of Wind Energy on Avian and Bat Species

Avian interactions with wind turbines result in violations of federal and state laws, delay the permitting process, and can result in legal action from wildlife agencies or non-profit groups. There are five major wind resource areas in California (Figure 1): Altamont Pass, Solano County, Pacheco Pass, San Gorgonio Pass, and Tehachapi Pass. The wind resource areas vary in size and in the extent to which bird use has been studied and potential mitigation measures developed. Studies show that avian use differs between wind resource areas (Figure 2). Collisions with wind turbines occur in all of the wind resource areas in California; however, their rates also differ between resource areas (Figure 3). Recent information indicates that wind turbines in California also kill bats. Since the *2004 Integrated Environmental Policy Report Update,* industry progress has been slow in reducing avian fatalities by implementing mitigation measures at the Altamont Pass and in using background surveys to site turbines in low risk areas.

Once discovered, bird fatalities became an issue of concern to researchers, agencies, and the general public. Bird fatalities are in conflict with state and federal laws. Nearly all of the birds that are being killed are protected by the Migratory Bird Treaty Act, the Bald Eagle and Golden Eagle Protection Act, and a series of state Fish and Game codes. These birds include raptors and non-raptors. Avian fatalities can also be a barrier to wind development. Bird deaths result in impacts to the species, although the extent of the impact is not clearly understood.

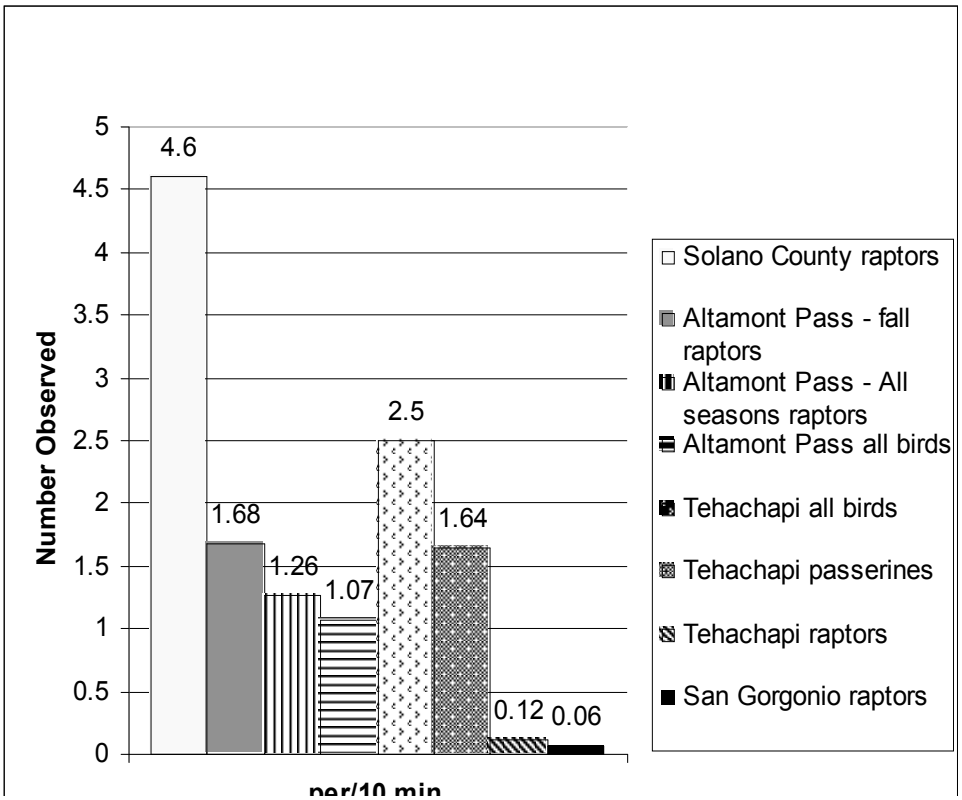
Many avian collision studies in California have been conducted in areas with older, smaller turbines. How increases in turbine size, height, and rotor swept area affect avian collision rates differs depending on bird behavior. The frequency with which birds and bats use the space occupied by the rotating blades increases the collision likelihood with rotating blades. In the Altamont Pass, researchers found bird use was highest in the same air space occupied by the smaller turbines and concluded that when repowering occurs, fatality rates may decrease (Smallwood and Thelander 2004), whereas, in Solano County the large turbines are killing birds at a high rate and surveyors are also observing bat carcasses at a rate previously not seen in

California. Therefore, it is critically important to understand bird behavior on a site-specific basis.

Figure 1: Primary Wind Resource Areas in California

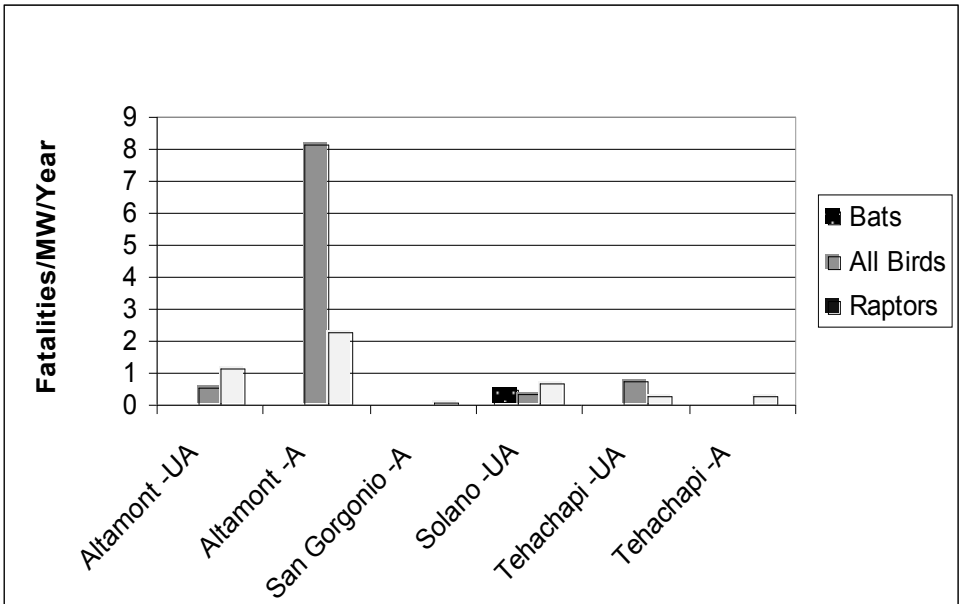
Erickson et al. (2001) attempted to compare estimated numbers of bird fatalities among sources of power generation and other human activities as a means of putting the number of wind turbine-caused fatalities in perspective. Erickson et al. compared estimated numbers of birds killed and not the levels of intensity or meaning to society of the various causes of fatalities. For example, millions of autos and trucks speed along our roadways every day; therefore, it should not be surprising that many birds are killed on roadways. Birds also face hazards from pesticides, buildings, and hunters at much greater frequencies than they do wind turbines, although as wind projects expand the number of birds killed will also increase. Whereas hunters take game birds and autos and buildings tend to kill migrating passerines, wind turbines kill disproportionately large numbers of golden eagles, red-tailed hawks, burrowing owls, and other raptors.

Figure 2: Bird Use per Ten Minute Scan



Sources: Orloff 1992, Smallwood and Thelander 2004, and Anderson 2004 and pers. comm. 2005

Figure 3: Avian and Bat Mortality Rates Unadjusted (UA) and Adjusted for Searcher Bias and Scavenger Rates (A)



Sources: Smallwood and Thelander 2004, Anderson 2004 and pers. comm. 2005, and calculated from High Winds data

The numbers of birds killed by other human actions are sufficiently large to conclude that any additional mortality caused by wind turbines qualifies as a considerable environmental impact. No activity should kill birds without mitigation simply because other human activities also kill birds. This is especially true when the birds killed are species protected by the Migratory Bird Treaty Act, which has no provision for killing birds. If means exist to avoid, minimize or reduce bird mortality, then those means should be implemented.

One serious constraint to repowering and expansion is the high bird fatality problem in the Altamont Pass Wind Resource Area (WRA) due to the combination of approximately 5,000 operating turbines and a high concentration of raptors year-round.

Bats: A Growing Concern

Bat collisions with wind turbines were not identified as an issue in early reports; however, surveys specifically for bats were not conducted. Surveyors may not have observed bat carcasses because of large time lags (up to 90 days) between survey dates, high scavenger rates or searcher bias rates. More recently, bat fatalities have become an issue at some wind farms including at the Solano County WRA where surveys for bats have been conducted. The extent of bat fatalities at other California wind resource areas has not been investigated and therefore is uncertain. Because of this, it is difficult to determine the extent of bat deaths in California based on prior studies. As awareness about the potential for bat collisions grows, researchers incorporate bats into their carcass surveys.

Bat deaths in large numbers were first recorded on Backbone Mountain, West Virginia in 2003. Researchers that were studying avian fatalities were surprised to find hundreds of dead bats and now estimate that between 1,500 and 4,000 bats died at the Mountaineer Wind Energy Center in 2004 (Blum 2005). In response to the number of bat deaths, the U.S. Government Accountability Office is also in the process of reviewing the impacts of wind development on avian and bat species and is looking at the legislative and legal requirements in several states across the country. The results of their review should be available this year (Roach personal communication. 2005).

There is not much information about why bats may be colliding with the turbines, although recent studies are giving additional clues. Several hypotheses exist: bats turn off echo location, they are migrating through the area, they are foraging but cannot feel the turbine blades, or they are attracted to the turbine blades to forage because of insects in the rotor swept area.

The Bat and Wind Energy Cooperative released its 2004 report on bat interactions with wind turbines. The study found a total of 765 dead bats at the two sites, but estimated the total number of bat fatalities at between 1,764 and 2,900 for the six-week period. The study found that most of the bats were killed on low-wind nights, when power production was minimal but the blades were turning near their maximum speed. Bat fatalities increased just before and after the passage of storm fronts, and bat activity was highest in the first two hours after sunset. The presence or absence of aircraft warning beacons on the wind turbines did not affect the results. The researchers recommended that future studies be conducted over the entire season of bat movement and activity, namely April through October, to further study these correlations and to help determine "high-risk" times that may be used to mitigate the impacts of wind turbines on bat populations. The Bat and Wind Energy Cooperative scientists recommended studying the effects of "feathering" wind turbines during low winds to cut their speeds, but no wind project owner has been willing to conduct such experiments. The Bat and Wind Energy Cooperative also plans to test the reliability of acoustic detectors at wind power sites and to evaluate the potential for using alerting or deterring devices at wind power sites. Until more is understood about bats and their behavior around the turbines, mitigation measures may not be successful.

The Bats and Wind Energy Cooperative was formed in 2003 by Bat Conservation International, the U.S. Fish and Wildlife Service, the American Wind Energy Association, and the National Renewable Energy Laboratory of the U.S. Department of Energy. The Bats and Wind Energy Cooperative is an alliance of state and federal agencies, private industry, academic institutions, and non-governmental organizations. These organizations are interested in cooperating to develop and coordinate research opportunities and identify solutions to prevent or minimize threats to bats. Experimental bat carcass surveys are being done to develop a

standard protocol that can be implemented in other wind resource areas (Arnett et. al. 2004).

Discussion of Wind Resource Areas

A number of factors contribute to the high number of fatalities in California (Sterner 2002). As an early leader in wind energy production, many of California's wind resource areas were built before there was an understanding of bird fatality risk, the high bird use in the Altamont Pass and Solano County, and where to place turbines to minimize interactions between birds and turbine blades.

The Altamont Pass has been the subject of multiple studies of avian use and fatalities (Orloff 1992a, 1992b and 1996, and Smallwood and Thelander 2004). New information on bird risk in the Tehachapi Pass has been published, and a comprehensive study of San Gorgonio Pass as well as a companion document comparing the bird risk at both areas is also being published (Anderson 2004 and in press). Mortality rates can be documented in several different ways including deaths/MW/year, deaths/turbine/year, deaths/rotor swept area/year and deaths/kilowatt hour (kWh). Different-sized turbines between projects makes the deaths/turbine/year metric difficult to compare between areas and therefore, Energy Commission-sponsored research recommends using deaths/MW/year (Smallwood and Thelander 2004). Standardized reporting of rates would make comparisons between studies easier.

Altamont Pass Wind Resource Area

The Altamont Pass has been well studied, and several conclusions can be made about the level of impacts and how they can be resolved. The Altamont Pass has a high level of bird use and consequently a high number of bird fatalities. As an understanding of bird risk and behavior has grown, mitigation measures have been developed that could potentially reduce collisions between 20-40 percent, depending on the species.

The Altamont Pass Wind Resource Area was developed approximately 20 years ago and included 5,175 turbines generating almost 671 million kWh (Energy Commission 1986). By 2003, the Altamont Pass generated approximately 820 million kWh of electricity from 4,955 turbines (Energy Commission 2005). The county has a moratorium on increasing wind-generating capacity until the issue of avian fatalities can be successfully addressed. The moratorium consists of a cap at the existing (~580 MW) capacity.

Early studies of the Altamont Pass include Orloff and Flannery (1992a and 1996), which investigated turbine characteristics and operation and analyzed whether some variables were more closely correlated to mortality. Variables studied included rotor diameter, rotor swept area, blade tip speed and pitch, perching behavior of raptor species, and the location and position of the turbine in the row. They concluded that blade pitch was significantly correlated to mortality and speculated that blades at certain angles would be more difficult for birds to see at turbine height. Perching

rates may have partially explained the high relative mortality of American kestrels and red-tailed hawks, but perching did not seem to explain the observed mortality for golden eagles or common ravens. Golden eagles rarely perched, but had high mortality rates, and common ravens often perched, but their relative mortality was low.

Orloff and Flannery observed 2.3 raptors per 10-minute interval at the Altamont Pass for the fall season and did not find that turbine locations affected raptor distribution or abundance over the study area (Orloff and Flannery 1992a). Using a conservative method of calculation, they estimated 39 golden eagles were killed each year of their study for the entire Altamont Pass Wind Resource Area. Golden eagles and red-tailed hawks each had a relative mortality that was higher than expected based on the number of birds observed. The variables they found significantly correlated to mortality were the end row turbines and proximity to canyons for tubular towers, and elevation and slope position for lattice towers (1992a).

Studies at the Altamont Pass continued with researchers observing avian mortality and bird risk behaviors (Orloff and Flannery 1996, Thelander, Smallwood and Rugge 2003, and Smallwood and Thelander 2004, Smallwood and Neher 2004). In one seven-year study funded by the Energy Commission PIER-EA, a total of 257 golden eagles were radio tagged in the coastal mountains adjacent to the Altamont pass. Of that number, 100 of the eagles died. Researchers found wind turbine blades killed at least 42 and12 were electrocuted outside the wind resource area, resulting in at least 54 percent of the deaths from electrical generation and transmission (Hunt 2002). With the death of this many golden eagles, the Altamont Pass is known as an ecological sink for the species, as more are killed than would normally be supported by habitat in the area.

The newest, most comprehensive study at the Altamont Pass expanded avian risk to include all avian species and expanded research to better understand factors associated with land management practices. Funded by the Energy Commission PIER-EA, the study focused on trying to better understand the causal factors associated with bird mortality (Smallwood and Thelander 2004). The study estimated that between 1,766 and 4,721 birds, including 881-1,300 raptors are killed annually at the Altamont Pass Wind Resource Area. Although many factors can co-contribute to bird collisions, several factors were associated with high collision risk including; land-use practices close to turbines, turbine location, and the degree of turbine clustering.

Researchers quantified bird use and behaviors and environmental and topographic conditions to develop predictive risk models and developed several potential mitigation measures to help reduce avian mortality. The researchers estimated that bird mortality might be reduced by up to 20-40 percent, depending on the species, if the mitigation measures act synergistically and are implemented Altamont-wide (Smallwood and Thelander 2004). The study also suggests that placing larger turbines with blade reaches at least 29 meters above ground may reduce collisions

by avoiding the air space birds tend to fly in most frequently. The mitigation measures developed for the Altamont Pass still need to be studied to determine their effectiveness and currently are not recommended on a statewide basis until more information on bird behavior and risk can be determined at the other wind areas.

To follow up the 2004 Energy Commission final report on bird mortality in the Altamont Pass Wind Resource Area, bird behavior data collected during 2002 and 2003 was geo-referenced and a spatial analysis performed (Smallwood and Neher 2004). Using bird behavior observations combined with wind directions recorded during the observation sessions, researchers analyzed what portion of the ridges red-tailed hawks, American kestrels, and golden eagles used and how their flights shifted with changing wind developments. They determined that locating new or existing wind turbines on the prevailing leeward side of the ridge should result in reduced encounters between those species and wind turbines. As a follow up, power output and wind turbine caused impacts between the wind turbine owner's preferred wind farm design, and a revised design based on bird behaviors are being studied. The goal is to achieve an economically viable wind farm design that also minimizes bird mortality. These results could increase the potential for additional wind development in the Altamont Pass, while reducing bird deaths.

The renewal of use permits for the wind farms in a portion of the Altamont Pass in Alameda County has also been constrained by a lawsuit filed by the Center for Biological Diversity. Industry is operating under temporary extensions for several of the existing permits. Because of the threat of litigation the county has been working with the litigants, industry, and agencies to implement mitigation measures developed by Smallwood and Thelander (2004) to reduce bird kills. Until avian fatalities are reduced, they are likely to continue to slow permit issuance in the Altamont Pass. Using the mitigation measures developed and setting a bird fatality reduction goal, industry has the flexibility to reduce avian impacts while operating at the Altamont Pass.

The turbine owners in the Altamont Pass have agreed to remove some of the high-risk turbines or shut down a portion of the turbines for part of the winter season when raptor collisions in the Altamont Pass are the highest (Erickson and Strickland 2005). Energy Commission staff has prepared two assessments using the proposed mitigation measures to determine which turbines are high risk and could be shut down to reduce bird kills while identifying the loss of generation and turbine type (Smallwood and Speigel 2005a and 2005b). These measures should be implemented soon and on a large scale and monitored so their effectiveness can be measured accurately.

An exception to the current permitting slowdown is the Buena Vista Wind Energy Project in Contra Costa County. The developer is using the PIER-EA findings (Smallwood and Thelander, Smallwood and Neher 2004) to help site wind turbines in a manner to reduce impacts. The repower project as proposed would remove 179

existing turbines and replace them with 38 new and larger 1 MW turbines. The applicant has proposed to cease the rodent control program, not establish rock piles, limit small mammal habitat at the tower foundations and roads, increase the ground clearance of the rotors, and not use guy wires to support meteorological towers. The turbines, where feasible, would not be sited on or immediately adjacent to the upwind side of a ridge crest where raptor use has been shown to be higher. In order to study the effects of the new turbines with the mitigation measures in place, a scientifically defensible monitoring program will be implemented for a minimum of three years. The project also plans to pay $500-1,000 per MW annually depending on the level of impact (based on post-construction monitoring) to an off-site habitat compensation/enhancement fund. One of the potential follow-up mitigation measures under the adaptive management plan includes seasonal shutdown (Buena Vista FEIR, 2005). The developer incorporated mitigation measures, and this project was permitted in a timely manner by the local agency. It will also be constructed in time to take advantage of the federal tax credit.

There is more information available for the Altamont Pass than other wind resource areas with significant research determining background bird use, bird use behavior, and mitigation measures to lower fatalities. Monitoring of the proposed mitigation measures needs to be completed to determine their effectiveness; one new project (Buena Vista) included mitigation measures in their repowering project. Monitoring the measures implemented at Buena Vista will be the first step to determining how well they work.

Pacheco Pass Wind Resource Area

The Pacheco Pass Wind Resource Area was developed in 1987-88. When constructed, it was private land but the entire ranch was donated to the state and is now located in Pacheco State Park. Currently the project has 166 turbines and in 2003 produced approximately 24 million kWh of electricity (Energy Commission 2005). One company owns all of the turbines, and no current avian mortality studies are being conducted. There are also no current plans for repowering the site, although there is interest in renewing the lease with California Department of Parks and Recreation. Since there is little information known about this site, the scope of the problem/impact cannot be determined, although according to the operator bird strikes are a rare occurrence (Penfold pers. comm. 2005). Because this property is owned by the state, there is opportunity for collaborative research with PIER-EA to study impacts and test mitigation measures.

San Gorgonio Pass Wind Resource Area

The San Gorgonio Pass Wind Resource Area, located in southeastern California, generated approximately 919 million kWh of electricity in 2003 with 2,746 turbines and is the second largest wind generating resource area in California. New development has recently occurred there with an increase of 27 MW of capacity in 2003 (Energy Commission 2005) and 40.26 new MW proposed (American Wind Energy Association 2005).

Few published long-term studies of bird use and risk assessment of the San Gorgonio Pass WRA are available, although several surveys were done for environmental impact reports on Bureau of Land Management land in the early 1980s prior to construction of the turbines. The most comprehensive fatality and use study to date is a multi-year study conducted by Anderson et al. in the late 1990s. Anderson will compare his research results from the Tehachapi Pass and San Gorgonio Pass Wind Resource Areas in an additional report. He did not attempt to make estimates of annual bird fatality estimates due to the high uncertainty of long search intervals and the unknown impact of scavenging rates. Once published, the study will make available comparison information between the two wind resource areas and suggest additional studies necessary to address the scope of the impact and propose measures to reduce it as warranted.

Solano County Wind Resource Area

Solano County Wind Resource Area, also known as the Montezuma Hills Wind Resource Area is located in Northern California southwest of Sacramento. In 2003, Solano County produced just less than 295 thousand kWh of electricity with 707 turbines. One hundred and sixty-two MW of new capacity was added in 2003 (California Energy Commission 2005). An additional 4.62 MW capacity are proposed (American Wind Energy Association 2005). Solano County is primarily dry farmed and is adjacent to the Suisun Marsh, which is an area protected for its wetland values supporting high concentrations of raptors and water related birds (San Francisco Bay Conservation and Development Commission, 1976).

Early surveys in Solano County conducted for proposed projects and to determine bird use found that bird use for several raptor species was higher there than at the Altamont Pass. Early preconstruction surveys in Solano County were completed for proposed projects with the focus on raptors and waterfowl (Howell and DiDonato 1988a,b; Howell et al. 1988; Jones and Stokes Assoc., Inc. 1987, Howell et al. 1991). The most comprehensive study in Solano County of wind turbine effects on avian activity, habitat use, and mortality was conducted in 1989-1991 (Orloff and Flannery 1992a). Based on surveys of raptor use, relative raptor abundance in Solano County was higher than in the Altamont Pass for red-tailed hawks, American kestrels, and turkey vultures and lower for golden eagles. They also found higher nesting density in Solano County and suggested that habitat quality in general for raptors may be higher in Solano County. During fall, Solano County had higher relative raptor use at 4.6 per 10-minute scan compared to 2.3 per 10 minute-scan at the Altamont Pass WRA (Orloff and Flannery 1992a). Raptor use in the Solano County Wind Resource Area is high; therefore, a high bird fatality rate can be expected as the area is developed without additional mitigation.

Numbers of bird and bat deaths from interactions with recently constructed projects using large turbines indicate high fatality rates and a California “fully protected species” initiative has been killed in Solano County. High Winds is required to complete post-construction carcass surveys twice a month and is reporting incidents of raptor and bat deaths to the U.S. Fish and Wildlife Service and the California

Department of Fish and Game. The project has 90 wind turbines rated at 1.8 MW capacity for 162 MW total capacity. From August 2003 to December 2004 the turbines have resulted in 114 bat, 104 avian non-raptor, and 95 raptor deaths. Unadjusted for scavenger rate, or searcher bias rate, that calculates to 0.6356 bat deaths/MW/year, 0.9240 bird deaths/MW/year and 0.4272 raptor deaths/MW/year. Two of the raptor deaths are white-tailed kites, which are California fully protected. The number of bat carcasses observed is higher than in other wind resource areas in California. The frequent search periods may contribute to finding the bats before they are scavenged. It is not possible to accurately extrapolate how many bats and birds a year may be dying in the entire wind resource area; a study of the entire wind resource area is needed to determine that.

A recently permitted project, Shiloh I Wind Plant Project, will be incorporating some of the mitigation measures that are being established for the Altamont Pass. Also as part of the project they are completing post-construction monitoring and will be purchasing a conservation easement for 120 acres, the equivalent acres to the rotor swept area of the project (Solano County 2005). Monitoring is important to determine the level of impact, and the effectiveness of the mitigation measures. Since the mitigation measures being implemented in Solano County were designed for the circumstances at the Altamont Pass, the effectiveness should be monitored closely.

In conclusion, a wind resource area-wide post-construction survey for all projects in Solano County would lead to a better understanding of the mortality rates, but the results for the High Winds project suggest high numbers of birds and bats are dying. Based on the early Orloff studies, raptor use of the area was known to be high, and in fact turbines are killing a high number of birds and bats. This also confirms the importance of preconstruction and post-construction monitoring to determine the level of impact. If bird and bat kills continue to be a problem, staff believes Solano County should implement a multi-year fatality study in the entire wind resource area to determine the extent of the issue and suitable mitigation measures. Mitigation could include a seasonal shut down and removal of the highest risk turbines as needed to reduce the impact. Ultimately, careful siting of wind turbines using bird use data is necessary.

Tehachapi Wind Resource Area

Tehachapi Pass Wind Resource Area encompasses approximately 80 square miles, with elevations ranging from 3,100-5,800 feet and is located in south-central California in the Tehachapi Mountains. Tehachapi Pass produced approximately 1.6 billion kWh of electricity from 3,591 turbines in 2003 (Energy Commission 2005). Orloff observed no dead birds over a two-week survey (1992b). Bird use was also lower than that found at the Altamont Pass or Solano County. The relative abundance was 0.6 raptors per 10-minute scan, compared to the relative abundance of 1.79 raptors per scan in Orloff's Altamont Pass spring surveys.

In the most comprehensive bird use study of Tehachapi Pass, use was highest for passerines, followed by corvids, other birds, and raptors for every season in the

study area surveyed (Anderson et. al. 2004). Raptors appear to be more susceptible to collision with turbines than other birds in the Tehachapi Pass; fatality rates and the risk index were higher than for other bird groups (Anderson et. al. 2004). Raptor use at Tehachapi Pass was the clearest factor related to raptor mortality and areas where baseline raptor use was higher also had higher collision rates. Anderson et al (2004) found raptor fatalities for the wind resources area were 0.047 per turbine per year, with an estimate of 0.25 raptor fatalities per MW per year unadjusted and 0.3 per MW per year adjusted for searcher efficiency bias. Because of the large search intervals the effect of scavenger rates on the above fatality estimates was unclear. Although perching rates were higher on lattice type turbines, most perching occurred on turbines that were not operating. Tower type is not likely to be related to collision risk at sites where perch sites are abundant. Ravens and turkey vultures had low fatality and relatively high use, suggesting they are not very susceptible to collisions. Red-tailed hawks, great horned owls, and American kestrels appeared to show the highest risk of collisions. Raptors appeared to be more susceptible to collision with turbines because they flew within the same height as the rotor swept area of turbine blades. Where raptor use was higher there were also higher fatality rates. Anderson et al. discussed other ideas, but did not draw other conclusions due to confounding variables in the study.

On April 19, 2005, the Los Angeles Department of Water and Power Board approved a new project for the Tehachapi Pass Wind Resource Area. The project consists of 80 1.5 MW turbines for 120 MW of capacity. It will complete post-construction monitoring for a year and, based on survey results, will make operational changes to turbines that kill significantly more birds than other turbines in the wind farm. Surveys will be completed and operational changes will be made in consultation with the California Department of Fish and Game and the U.S. Fish and Wildlife Service.

Out-of-State Wind Resources Development

Several states have passed renewable portfolio standards, and wind energy is one of the energy sources that states are relying upon to meet renewable energy goals. New York State just passed a renewable portfolio standard with the policy of supplying 25 percent of New York's retail electricity requirements from renewable resources by 2013 (see Table 3).

Table 3: States that Have a Renewable Portfolio Standard

State	Goal
Arizona	1.1% by 2007
California	20% by 2017
Colorado	10% by 2015
Connecticut	6% by 2009
Hawaii	20% by 2020
Illinois	15% by 2020
Iowa	2% by 2000
Maine	30% by 2000
Maryland	7.5% by 2019
Massachusetts	4% by 2009
Minnesota	19% by 2015
Nevada	15% by 2015
New Jersey	6.5% by 2008
New Mexico	10% by 2011
New York	24% by 2013
Pennsylvania	18% by 2020
Rhode Island	16% by 2019
Texas	2,880 MW by 2009
Wisconsin	2.2% by 2011

Source: North American Wind Power March 2005

In response to the increase in wind development, Washington State has developed guidelines for baseline and monitoring studies, minimizing impacts, operation monitoring and habitat mitigation. The guidelines are voluntary, but attempt to standardize the preconstruction, permitting and post-construction requirements for wind energy development in the state. There are also guidelines for habitat compensation, with established ratios depending upon the habitat disturbed. Mitigation measures to reduce avian fatalities are included, such as avoiding high bird concentration areas and developing already disturbed areas. The permit issued by the local agency should also clearly state all possible monitoring and mitigation measures (Washington Department of Fish and Wildlife 2003).

The first offshore wind energy project in federal waters has been proposed in Nantucket Sound, Massachusetts. The project was proposed by Cape Wind

Associates in 2001 and will have 130 turbines up to 454 MW. A draft Environmental Impact Statement has been released for review and the U.S. Army Corps of Engineers is the permitting agency (U.S. Army Corps of Engineers 2004). This project will help achieve the Massachusetts Renewable Portfolio Standard (Commonwealth of Massachusetts 1997). Since this is the first offshore wind project to be proposed in the United States it is unclear what the impacts may be to water birds. It will be difficult to conduct post-construction monitoring for mortality rates since carcasses would not be found.

Staff Findings and Suggested Policy Options: Wind Energy

Federal and State Laws and Regulations Protect Birds Killed By Interacting With Wind Turbines. Virtually every bird killed results in a violation of one of these laws. Bird deaths also impact the species and can result in litigation.

The Energy Commission Could Promote Development of New Wind Resources Only in Areas That Have Low Risks to Birds. As wind energy production expands, the rotor swept area of turbine blades increases and more birds will be at risk for collision. To lower risks to birds developers should conduct protocol-level bird use surveys prior to development. Expansion or repower projects should be required to incorporate mitigation measures and monitoring, and to report results so fatality rates and mitigation efficacy can be assessed. Using that information, they can then site turbines to avoid areas of high avian use. Additional wind development to meet the RPS goals is feasible while at the same time limiting avian impacts.

To Determine Statewide Impacts on Bats, The Energy Commission Could Support Bat Use, Behavior and Carcass Surveys at All of the Wind Farms in California. The information could be used to determine statewide impacts to bats and design mitigation measures to reduce bat collisions with turbine blades.

The Energy Commission Could Support Statewide Guidelines Requiring The Wind Industry to Mitigate Their Impacts on Birds in the State. The wind siting and mitigation guidelines produced by the National Wind Coordinating Committee and the U.S. Fish and Wildlife Service to date are voluntary and the level of implementation by industry and local agencies varies. Statewide guidelines for wind energy projects may be an appropriate way to gain consistency statewide when developing and mitigating projects. Statewide standards could also remove a significant environmental barrier to increasing wind energy in the state.

In the Altamont Pass Wind Resource Area The Energy Commission Could Encourage Industry to Apply Mitigation Measures to Existing Projects, New Projects and Repowering Projects to Reduce Bird Deaths. Over the last 20 years, researchers have documented the levels of bird use and mortality in the Altamont Pass. PIER-EA funded studies to develop a list of mitigation measures that could reduce bird kills (Smallwood and Thelander 2004, Smallwood and Neher 2004, Smallwood and Spiegel 2005). As the next step, industry needs to implement and monitor those mitigation measures Altamont-wide to determine their

effectiveness. Two measures that would reduce bird kills by eliminating spinning turbine blades are seasonal shutdown (winter months) or removal of wind turbines in the highest risk areas. This would reduce bird kills; it would also result in a loss of generation (Smallwood and Spiegel 2005). Ultimately, implementing mitigation could allow the industry to expand if Alameda County was able to lift its moratorium because of a reduction in bird kills.

In the Solano County Wind Resource Area The Energy Commission Could Encourage Industry to Lower Its Existing Impact on Bird and Bat Resources. Past research shows that bird use is higher in the Solano County Wind Resource Area than at the Altamont Pass for several raptor species. Recent post-construction carcass surveys for the High Winds Project indicate a high rate of bird mortality. High bat fatalities are a newly-identified issue in Solano County, the extent of which is uncertain. There is insufficient information on bird and bat fatality rates in the entire Solano County Wind Resource Area. Research aimed at identifying the extent of the problem and developing mitigation measures for implementation would allow for continued use of the wind resources in Solano County while minimizing the potential for another wind resource area in California with higher impacts.

The Energy Commission Could Support Further Research Using More Current Research Protocols in the Tehachapi Pass, San Gorgonio Pass, And Pacheco Pass to Confirm Low Avian and Bat Impacts in These Areas. Collisions with wind turbines have been studied less in these areas than at the Altamont Pass and Solano County wind resource areas. The studies that have been completed report lower bird use and fatality rates in these wind areas. Based on research results it may be appropriate for the Energy Commission to encourage repowering and expansion in these areas.

CHAPTER 2: AVIAN INTERACTIONS WITH POWER LINES

Introduction

Avian fatalities from collision with and electrocution from power lines were first identified in the late 1800s. Birds with long wingspans, such as raptors, are the most susceptible to electrocution. Collisions are most frequently documented with high voltage (greater than 69 kV) transmission lines; however, recent evidence suggests that collision with lower voltage distribution lines is a problem (Hunting 2002). Electrocutions usually occur at distribution line power poles where spacing is small enough between lines and hardware for raptors to complete the electrical circuit.

Avian collisions and electrocutions can cause costly power outages, fires, and kill many protected birds. The number of avian interactions with electrical power lines cannot be adequately assessed based on current information due to a lack of systemized reporting, indications that many interactions are undetected by the utilities, and the lack of statewide surveys. The utilities do use established guidelines to 'raptor-safe' poles in high raptor use areas, and are developing Avian Protection Plans at the request of the U.S. Fish and Wildlife Service. Electrical power line design guidelines do not include raptor-safe design standards, besides what the utilities voluntarily construct as part of their Avian Protection Plans.

The Avian Power Line Interaction Committee members are electric utilities and utility organizations, in and out of California, and federal agencies involved in bird and power line interaction issues. They are active in producing guidelines and sharing information about reducing avian collisions voluntarily. In addition, PIER-EA is collaborating with the utilities and other agencies to assess the level of avian interactions in the state, develop mitigation measures, and provide the most recent information available to stakeholders for implementation. More research on the extent of avian collisions, including affected species, locations and habitat, and the effectiveness and longevity of retrofit hardware, is needed to quantify and reduce the extent of avian collisions significantly.

Environmental Regulations Affecting Electrical Power Line Development And Retrofitting

Power line construction is required to abide by the same federal and state laws and regulations outlined above in the wind energy development section. The same state and federal laws also protect avian species that collide with power lines or are electrocuted.

Permitting authority for distribution lines in California resides with the local agency or the utility district in the location of the project. The California Public Utilities Commission permits transmission lines for investor-owned utilities.

Avian Interaction Guidance Documents for Power Line Construction

Since the early 1970s, utilities, resource agencies and researchers have collaborated to identify the extent of the electrocution and collision issue and prepare guidance documents on raptor safe designs for utilities to voluntarily implement. Over time guidance documents have been released and updated (Rural Electrification Administration, 1972; Raptor Research Foundation,1975; APLIC, 1981; APLIC, 1994). The APLIC has been the leading source for information and guidelines on electrocution (APLIC 1996) and collision (APLIC 1994) guidance documents.

The Avian Power Line Interaction Committee's most recent electrocution prevention guidelines, *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996* (1996), are the most widely-used guidelines and are used as the standard for the Rural Utilities Service (Rankin pers. comm. 2005) as well as by utilities in California (Pearson pers. comm. 2005, Scott pers comm. 2005 and Best pers. comm. 2005). The guidelines review literature and propose spacing and construction guidelines to reduce avian-caused electrical outages and avian fatalities through cooperative measures among electric utilities, industry, and federal and state agencies. PIER-EA is currently funding a project with the Avian Power Line Interaction Committee to update the electrocution guidelines.

The Avian Power Line Interaction Committee and U.S. Fish and Wildlife Service also recently (April 2005) released guidelines on developing an Avian Protection Plan. It is a joint document cooperatively prepared and is intended to help utilities develop Avian Protection Plans to fit their needs while furthering the conservation of avian species and improving reliability and customer service. The goal of the plan is to greatly reduce avian mortality as well as the risk of enforcement by the U.S. Fish and Wildlife Service under the Migratory Bird Treaty Act (APLIC 2005). Although bird fatalities are in violation of the Golden and Bald Eagle Protection Act and the Migratory Bird Treaty Act there are no programs to retrofit all poles as this is an expensive undertaking. Instead, lowering the number of avian fatalities by retrofitting high-risk poles, constructing new poles as raptor safe, and reporting federally protected species is usually part of an Avian Protection Plan.

Current Knowledge of Avian Interactions with Power Lines

Avian collisions and electrocutions from interactions with power lines result in avian deaths, reliability problems from outages and retrofits of the power poles. California's rich avifauna is a public resource used and enjoyed by millions of residents. The clear need for electrical power transmission and distribution should be balanced with stewardship of a valuable natural resource. Fatal impacts from collisions with power lines and utility structures have been documented for nearly 350 species (Manville 1999). In some cases, the level of fatalities attributable to these collisions has been substantial and has contributed to declines in local and regional populations (Avian Power Line Interaction Committee 1994).

Nationwide, avian fatality estimates range from tens of thousands to over 1.5 million annually, illustrating the lack of a standardized and repeatable methodology (Erickson 2002). Utilities may be reluctant to report fatalities because of the legal repercussions, and there are currently no legal requirements for them to do so. The U.S. Fish and Wildlife Service charged the Moon Lake Utility District with violations of the Migratory Bird Treaty Act and settled a case with Pacific Gas and Electric Company, which developed an Avian Protection Plan and now reports to the U.S. Fish and Wildlife Service. Undoubtedly, avian collisions will increase with heightened demand for new lines from new generation systems and land developments. Therefore, it is increasingly important that this problem be addressed.

A recent study in urban Tucson, Arizona, monitored power poles within 500 meters of Harris hawk nests (Dwyer 2004). The research documented a rate of 1.3 electrocutions per nest prior to installation of raptor safe hardware. After the poles were retrofitted the electrocution rate dropped to 0.3 electrocutions per nest. Of the electrocutions that occurred on retrofitted poles, none were due to equipment failure; rather, it was because poles were overlooked or only partially retrofitted. Dwyer found that if even a single dangerous configuration remains within the natal territory, one of the resident raptors at the nest was likely to encounter it and be electrocuted. He also found that only about 15 percent of the electrocutions and collisions resulted in an outage that notified the utility; that would suggest that up to 85 percent of collisions and electrocutions go undetected (Foltz pers. comm. 2005). In this study retrofitting poles reduced avian deaths substantially. If up to 85 percent of collisions and electrocutions are undetected, then the number of avian deaths is greater than anecdotal evidence would suggest.

Collisions

Most collisions with power lines occur during flights within a daily use area. Waterfowl and other water birds such as egrets and cranes appear to be more susceptible to collision in wetland areas, while raptors and passerines appear to be more susceptible in upland habitats. (Avian Power Line Interaction Committee 1994). Collisions with power lines can also occur in large numbers when birds are migrating in groups at night or in low visibility conditions such as fog. Body size and maneuverability, the age of the bird, as well as the height that birds fly, are considered important factors in the risk of collisions (Crowder and Rhodes 1999). Southern California Edison and San Diego Gas and Electric report few incidences of collisions, and assume it is because there is minimal habitat within their respective territories which results in collision risk (Alsobrook pers. comm. 2005 and Freeman pers. comm. 2005). However, because collisions with distribution and transmission lines often do not result in an outage, many collisions are undetected and unreported.

Once bird collisions with transmission lines were observed and recorded, research shifted to studying the causes of collisions and how they could be mitigated successfully. Line placement and configuration, and the use of bird flight diverters can lower collisions. Bird flight diverters work on the premise that they make a line

more visible to birds flying through the area. Very few studies on different bird flight diverters and their ability to reduce collisions have been completed, but most found bird flight diverters reduced collision rates (Crowder and Rhodes, 1999). Few research studies have been aimed at testing their effectiveness in low light conditions.

Bird flight diverters have not been tested in California in low visibility conditions when birds are using the flooded agricultural fields as wintering habitat. This is the time of year that has the lowest visibility due to fog, and also the largest number of birds that migrate into the Central Valley. PIER-EA is funding a study to evaluate the effectiveness and durability of visual diversion devices in low visibility fog conditions, common during winter months, throughout the Central Valley of California. The results of this evaluation will be used to develop a management plan aimed at reducing sandhill crane power line strikes on Staten Island, a wintering ground for tens of thousands of migratory waterfowl in addition to the sandhill crane. This investigation is being accomplished in cooperation with The Nature Conservancy and Cosumnes River Preserve (Yee pers.com. 2005).

PIER-EA is partially funding a study to determine whether various line marking products could be used on energized wires (at different voltages) without creating significant corona discharge. A variety of flight diverter devices were tested at simulated 115-kV, 230-kV, and 345kV phase-to-phase line voltages to measure the corona produced by each device. The bird flight diverters had different results at different voltages, but several did have acceptable levels of corona.

Electrocutions

Electrocutions usually occur at distribution line power poles. Electrocution does not usually happen on transmission line towers since line spacing is far enough apart that large birds cannot complete the electrical circuit. Raptors use power poles for a vantage point, to hunt from, and as nest sites, especially in areas where power poles are the tallest item in the landscape. Because of their size, raptors are more likely than other bird species to be electrocuted through phase-to-phase and phase-to-ground contacts while perching on poles. There is also some thought that juvenile raptors are killed more frequently due to their clumsy flight and landing abilities. Small birds can also be electrocuted when they interact with the hardware on the poles such as bushings and transformers (Best pers. comm. 2005 and Pearson pers. comm. 2005). Although the cause of avian/power line electrocutions have been identified and the problem still persists, raptors have presented a special challenge to researchers in this field. Since raptors are more likely to be electrocuted than small birds, most of the focus remains on reducing raptor electrocution rates.

In the summer of 1998 the U.S. government charged Moon Lake Electric Association, which services parts of Colorado and Utah, with 13 misdemeanor violations of the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. This was the first time an electric utility was criminally prosecuted under the Acts. The company pleaded guilty to six charges and in 1999 Moon Lake Electric

Association was fined $100,000, served three years probation and was ordered to retrofit its utility lines to prevent electrocutions in the future (Department of Justice 1999). PIER-EA is funding a study to look at the effectiveness of mitigation measures used at Moon Lake.

One of the recommended measures in the Avian Power Line Interaction Committee guidelines (1996) is to install perch guards on distribution line poles to discourage raptors from perching. Information from at least one study in Colorado suggests that placing perch guards on poles shifts the raptors to using unsafe portions of the pole (Harness 1999). The study found that using perch guards to limit raptors perching in the most unsafe sections of the poles in tandem with having safe sections of a pole available for perching reduces the likelihood of electrocution.

Ongoing research of the effectiveness of mitigation measures, such as perch guards, is important to continue to reduce avian deaths. Once developed, measures should be applied and monitored so they can be used the most effectively. When a measure is determined to work it should be incorporated into new guidelines and standardized. Furthermore, updating the guidelines results in utilities using the best available mitigation measures. The Energy Commission has also participated in collecting avian collision and electrocution research and information and helping to make it available in bibliographic form (Hebert and Reese 1995). PIER-EA is updating this effort with research released after 1995 (Spiegel pers. comm 2005).

Outside of California, there is also an effort to reduce electrocutions. There are about 35 cooperatives in the Rural Utility Service that presently have Avian Protection Plans in place. Many others do mitigation on a project-by-project basis and others are concentrating on equipment/transformer poles. Many of the utilities keep track of bird kills but most do not report to the Rural Utility Service so they have limited data. The implementation of mitigation measures depends on the state, with more being done west of the Mississippi (Rankin 2005).

PIER-EA funded development of an educational raptor mortality field guide that allows field researchers and utility personnel to identify bird species. They also developed an interactive Web site that features an up-to-date encyclopedia of available products for mitigating bird electrocution. The web site presents typical California distribution overhead power line configurations and associated avian fatalities with those configurations, and identifies retrofitting solutions that have been recognized as effective. PIER-EA is also co-funding a project with Southern California Edison and Pacific Gas and Electric to determine the highest-risk poles to help guide future retrofitting efforts.

Utility Avian Protection Programs

Some of the utilities were contacted to gain an understanding of the types of programs in the state. To understand the issue from a statewide perspective, information should be collected from all of the utilities. Some of the larger utilities are adopting Avian Protection Programs in response to the U.S. Fish and Wildlife

Service and the threat of legal action. As part of their programs, the utilities retrofit power poles and are required to report collisions and electrocutions of certain species. Utilities are keeping better internal records of avian interactions with power lines. However, that information was not available to the public or for this report outside of Pacific Gas and Electric's report on avian incidents for 2004. In lieu of research results that provide information on the number of avian interactions, avian deaths or reductions in avian deaths from the successful implementation of mitigation measures, a description of several of the Avian Protection Plans is provided below.

Southern California Edison

Southern California Edison has approximately 1.5 million distribution poles in its system, and 60,000 miles of above-ground distribution lines. As part of its Avian Protection Program, Southern California Edison retrofits any distribution pole where an electrocution is reported. All new or rebuilt poles in designated Raptor Concentration Areas are required to be raptor safe. If maintenance is completed on a pole then it, too, is upgraded to be raptor safe. Presently, Southern California Edison does not record the number of power poles it retrofits annually within its 50,000 square mile service area; however, it is estimated that many thousands of poles have been installed or retrofitted to be raptor safe (Pearson pers. comm. 2005).

Southern California Edison determines which poles are retrofitted through an internal reporting system whereby field crews are required to report all fatalities to Southern California Edison's environmental staff. They also retrofit poles based on outages that occur from wildlife interactions. Outages can be caused not just by raptors, but also by species such as blackbirds and starlings, large water birds, and some species that typically occur mainly in urban areas (e.g., peacocks, squirrels, opossums, rats and cats). Southern California Edison is required by its permit to notify the U.S. Fish and Wildlife Service of any eagles and endangered species that are found dead near its facilities.

Examples of different methods used by SCE for raptor-safe retrofits/upgrades include: elevated perches, insulating jumper loops, placing inverted "v's" to discourage perching, changing the location of the conductors and using raptor hoods. If electrocutions continue at a retrofitted pole then the spacing of the cross arms is increased, but this is the most difficult and costly upgrade to make (Pearson pers. comm. 2005) and is applied mainly when other measures do not work.

The locations of dead birds found by field personnel are all recorded in the RIMS (Raptor Information Management System) Database that Southern California Edison uses to record the location and species of raptors electrocuted. These data can be displayed electronically on a USGS Quadrangle map and can, at the same time, display other electrocutions reported in the vicinity. Southern California Edison facilities have, on rare occasions, electrocuted golden eagles, bald eagles, and one brown pelican; however, it is rare when these special-status or endangered species

are involved in electrocutions. The most commonly electrocuted species are non-raptors (e.g., pigeons, blackbirds, starlings, etc.). The most commonly electrocuted raptor species in the Southern California Edison service territory are great horned owls and red-tailed hawks (Pearson pers. comm. 2005).

Southern California Edison could not provide data on the frequency of electrocutions/collisions and the number of power poles that are retrofitted. Further analysis is needed to accurately assess how retrofitting poles may affect the number and distribution of bird fatalities. Southern California Edison recently participated with Pacific Gas and Electric on a jointly-funded PIER-EA research project to assess the most problematic distribution poles to help prioritize retrofitting to bird safe designs. The information that Southern California Edison continues to collect as part of its Raptor Protection Program monitoring effort will help determine the effectiveness of raptor-proofing design measures.

Pacific Gas and Electric

In Pacific Gas and Electric's service area, there are approximately 5 million power poles and the company spends about $5 million a year on its Avian Protection Plan. In cooperation with the U.S. Fish and Wildlife Service, Pacific Gas and Electric developed an aggressive Avian Protection Program. To accomplish the program's goals, a Utility Operating Standard was developed for migratory birds. Key elements of the program include: reporting bird interactions, a proactive retrofit program, a comprehensive pole rating system, and "bird safe" requirements for all new construction located within raptor concentration zones.

Reports are submitted to the U.S. Fish and Wildlife Service on both a monthly and quarterly basis. Pacific Gas and Electric proactively retrofits a minimum of 2,000 distribution poles annually. For incidents involving raptors, the incident pole and adjacent poles are retrofited with bird "safe devices" or by re-framing. Raptor Concentration Zones have been identified for the entire Pacific Gas and Electric service territory. All new or re-construction in the Raptor Concentration Zone is built to "bird safe" standards.

Pacific Gas and Electric provided extensive information on the number of bird interactions for this report (Table 4). About 18% of the total number of incidents are attributed to collisions. Also, PG&E documented 1005 bird-caused outages on its electric distribution system in 2004 (Best pers. comm. 2005).

Table 4: The Number of Reported Avian Incidents with Distribution Line Poles Within PG&E's Service Area from January 2004 – December 2004.

Raptors	Waterfowl	Perching	Other	Total	# of incident poles that require protection	# of adjacent poles that require protection
379	126	751	39	1295	612	1614

Source: Best, pers. comm. 2005

Similar to Southern California Edison's retrofit plans, the primary fix for existing poles is to cover the bushings, insulate the jumpers, and install perch deterrents in conformance with Avian Power Line Interaction Committee guidelines. As new information and new products become available their long-term effectiveness needs to be researched. In addition, Pacific Gas and Electric is participating in a bird flight diverter study partially funded by PIER-EA.

Pacific Gas and Electric also collaborated with Southern California Edison on a jointly funded PIER-EA research project to assess the most problematic distribution poles to help prioritize retrofitting to bird safe designs.

San Diego Gas and Electric

San Diego Gas and Electric has approximately 400,000 distribution and transmission line poles in its service area (Freeman pers. comm. 2005). They are also a member of APLIC and meet regularly with other utilities such as Pacific Gas and Electric and Southern California Edison to discuss avian and wildlife related issues. San Diego Gas and Electric has a voluntary Avian Protection Program that began approximately 5 years ago. The intent of the program is to reduce to the greatest possible extent the threat of electrocutions to avian species. When San Diego Gas and Electric initiated the program, critical areas were identified within the service areas based on habitat and raptor use. However, when these areas did not match with outage records the critical areas were redesigned and prioritized into 28 areas. Specific plans were written to address retrofitting power poles and new poles are being constructed using raptor safe guidelines.

San Diego Gas and Electric has just completed a new electronic internal reporting form for linemen to use to track wildlife interactions. The environmental staff collects the forms and the information is entered into a database. There are also annual training programs for the maintenance crews and the construction standards used by the districts also include raptor safe requirements (Freeman pers. comm. 2005).

San Diego Gas and Electric also has a Habitat Conservation Plan (federal) and Natural Communities Conservation Plan (state) and a 50 year permit that covers their maintenance activities. There are some provisions in the Habitat Conservation Plan that provide for raptor safety, but the Avian Protection Plan is more detailed.

Sacramento Municipal Utility District

The Sacramento Municipal Utility District has approximately 9,800 miles of distribution lines, with a portion of those underground, and 500 miles of transmission lines. At this time the Sacramento Municipal Utility District does not implement an Avian Protection Plan within its service area. Electrocutions that cause outages are identified, and if there is a location that has an ongoing problem with electrocutions that pole is retrofitted to be raptor safe. In urban areas new power lines under 69 kV are usually installed underground. In rural areas or in areas where new lines are being added to existing poles, lines are installed above ground. Almost all of the Sacramento Municipal Utility District avian-related outages are on overhead distribution lines, but no totals are available at this time (Scott pers. comm. 2005).

Costs to the Economy

Collisions and electrocutions not only cause impacts to birds but can also result in wildfires, power outages, and reliability of service. A PIER-EA sponsored report, "The Cost of Wildlife-caused Power Outages to California's Economy" (E3 2005), concluded that the total cost of wildlife-caused outages for the state ranges from $32 million to $317 million depending upon which customers are principally affected (residential versus industrial, for example). Most of the cost of outages is due to lost productivity and not the cost of fire-fighting. Because the estimate range is large, the accuracy could be improved with better information about which customers are affected, where these outages occur along the system, and consistent high-value service data for all electric customers. Additionally, the value of lost wildlife was not considered because this information is not available.

Records of the number of avian interactions that cause outages and fires are not always kept by the utilities so that information is more difficult to analyze. The California Department of Forestry doesn't track whether fires on its land are caused by avian interactions, although they do recognize that wildlife interactions can be the cause of fires. Unless the utilities make a voluntary effort or are required to start tracking and reporting this information, specific costs cannot be quantified in greater detail than what was reported in the PIER report referenced above.

Staff Findings and Suggested Policy Options: Power Lines

Electrocutions and Collisions with Electrical Power Line Infrastructure Can Be Adequately Measured Using More Intensive Survey Methodologies. For years utilities, researchers, and the resource agencies have documented that electrical power line infrastructure has caused avian collisions and electrocutions. However, there has been a lack of standardization for collecting and reporting data. Several studies have tried to estimate the number of bird deaths from interactions with utility structures; however, without further research, they cannot be accurately quantified. Recent research suggests that up to 85 percent of collisions and electrocutions may go undetected by the utilities (Dwyer 2004).

The Utilities Are Beginning to Develop Avian Protection Plans in collaboration with the U.S. Fish and Wildlife Service and are actively retrofitting power poles that cause electrocutions.

Statewide Guidelines For Electrical Power Poles May Be an Appropriate Way to Gain Consistency Statewide. Raptor friendly power lines are constructed voluntarily in certain places by some utilities. Statewide construction standards that include raptor-proofing distribution pole equipment and transmission line conductors would ensure the greatest reduction in electrocutions and collisions.

Electrical Transmission Line Guidance Documents for collision and electrocution are well used by many stakeholder groups. Those guidance documents include the Avian Power Line Interaction Committee documents (electrocution and collision). The guidance documents need to be updated periodically to incorporate new research that can better provide mitigation and a larger reduction in birds killed.

The Energy Commission Could Support Long-Term Monitoring Studies to understand the long-term impacts of electrocutions and collisions, the scope of the impacts and how the implementation of mitigation measures reduces bird kills. The PIER-EA program efforts to collaborate with industry, researchers, and other stakeholders to gather and share research information and continue to resolve impacts should continue to be supported.

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