WHAT CAN WE LEARN FROM DEVELOPED WIND RESOURCE AREAS?

I. Altamont Wind Resource Area

This session was the first of two intended to examine what existing science tells us about wind turbine impacts at existing wind project sites. This session focused on Altamont Pass Wind Resource Area (WRA), one of the older wind projects in the US. The presenter addressed the following questions: How is avian habitat affected at Altamont WRA, and do birds avoid turbine sites? Are birds being attracted to turbine strings? What factors contribute to direct impacts on birds by wind turbines at Altamont? How do use, behavior, avoidance and other factors affect risk to avian species, and particularly impacts those species listed as threatened, endangered, or of conservation concern, and other state listed species?

Bird Fatalities in the Altamont Pass Wind Resource Area: A Case Study, Part I

by
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The Altamont Pass WRA (APWRA) is located due east of San Francisco on the eastern side of the coastal foothills where they open into California's Central Valley. Wind energy generation began in the APWRA in the mid-1970s. By 1980, a California Energy Commission (CEC) biologist had identified a "bird kill problem" in the APWRA. Attention to the problem grew in the 1980s and by 1990 several studies were initiated. In 1990, more than 4,000 turbines had already been built at the site. A number of studies focused on bird impacts have been conducted at the APWRA since the early 1990s, and researchers continue to try and determine ways to mitigate bird impacts today. In 1998, the National Renewable Energy Laboratory (NREL) funded BioResource Consultants (BRC) for research focusing on bird behaviors and mortality at the APWRA. In 2001, the CEC provided further funding to BioResource Consultants in order to continue and expand its research. Some of the findings of BRC's research will be the focus here.[12]

The goal of BRC's research was to study the relationships between bird behaviors (such as flight, perching, and foraging), and bird fatalities. Part of the aim was to quantify bird fatalities to better understand the scope of the fatality problem, and to develop a large sample size representative of most of the APWRA. The ultimate objective of the research is to develop a quantitative model for the wind industry to use as a tool to help reduce bird

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[12] This presentation was based on a report prepared by BioResource Consultants for the California Energy Commission (Smallwood and Thelander 2004). Posted (8/10/04) on the Web at: http://www.energy.ca.gov/pier/final_project_reports/500-04-052.html.

fatalities at wind project sites.

There are about 18 different types of turbines in use at APWRA, of which several designs are entirely obsolete and no longer built. Both lattice and pole tower-mounted turbines can be found. In addition, many of the turbines are built in close proximity, arranged as ‘strings’ and are not very tall. These factors make it difficult for birds to pass through unharmed. Although research at APWRA has been conducted on a variety of turbine types that are no longer being built, information about bird behavior and interaction with turbines at the site may still be instructive. For example, bird behavior with respect to turbines in the APWRA tends to vary according to turbine activity. More turbines operate at the APWRA during the summer as winds increase during the summer. Research has shown that raptors seem to be able to perceive the difference between operating and non-operating turbines.

A set of 1,526 turbines arranged in 182 strings was sampled from March 1998 to September 2002 (Phase I). A second set of 2,538 turbines in 308 strings was sampled from November 2002 to May 2003 (Phase II). A total of 1958 30-minute bird behavioral observation sessions were conducted during Phase I, and another 241 behavioral observation sessions conducted during Phase II. During the second phase, only raptor observations were recorded.

BRC’s research between 1998 and 2002 yielded a variety of data regarding numbers of fatalities at APWRA, perching habits and other behavior of various bird species (including raptors), and bird attraction to turbine strings (rows of turbines). It was observed, for example, that more species tend to perch on lattice turbine towers, and for longer periods of time, when the turbines are not operating. It was also shown that some bird species such as Golden eagles, Red-tailed hawks, Northern harriers, Prairie falcons, American kestrels, and Burrowing owls spend far more time flying close to turbines (within 50 m) than would be expected by chance.

Fatality searches were conducted around each of the sampled turbines at least seven times each year. The total number of turbine-related fatalities for both study periods was 1,162, representing about 40 bird species and one bat species. Based on the findings from both study periods, annual fatality estimates for ten species of raptors as well as for all birds combined were projected for the entire APWRA. (This includes the 4,074 turbines surveyed over Phases I and II as well as the 1,326 turbines left unsurveyed.) The low-end of the projected fatality estimates has been adjusted to account for searcher detection bias, while the high-end estimate has been adjusted to account for both searcher detection bias and scavenging rates. For all raptors, the estimated annual number of fatalities in the Altamont Pass WRA ranges from 881.4 to 1300.3 birds. For all birds, the estimate ranges from 1766.5 to 4721.3 birds killed.

The research conducted by BRC yielded a series of key observations that shed light on bird-wind turbine interactions. For most bird species, there is no significant relationship between fatalities and observations of flights within 50 m of turbines. Fatality associations are usually species-specific, so solutions for one species might not serve as solutions for others. BRC research suggests that some birds, ravens for example, only rarely collide with turbines, while for other species of birds it seems to be a major problem. Thus, simply observing numbers of birds during a pre-construction survey will not necessarily predict fatalities because behavior potentially matters as much as sheer numbers. Risk/danger to birds increases with taller towers, larger rotor diameters, and slow to intermediate tip speeds. Also, tips with lower blade reaches are most deadly to Golden Eagles. The availability of perching spots on turbine towers appears less important than previously believed.

A number of findings specifically illuminated aspects of raptor interaction with wind turbines. Turbines on steeper slopes and in canyons are generally more dangerous to raptors, but ridge crests and peaks within canyons are also dangerous. In much of the APWRA, the presence of rock piles near turbines is associated with greater raptor mortality as raptor prey species (especially rodents) tend to occupy these rock piles. Although a rodent control program did manage to reduce ground squirrel numbers overall, it also increased the degree of clustering around turbines of remaining pocket gophers and desert cottontail rabbits. Thus, the program generally failed to reduce raptor mortality. Wind walls (clusters of turbines of varied heights) appear to be relatively safer for raptors, as research showed that raptors are killed disproportionately by turbines that are relatively less crowded by other turbines. Finally, raptor mortality differs by season, with summer and winter having the highest mortality.

The experience of wind project development at Altamont Pass continues to provide some important lessons for the future of wind power in general. It appears that fewer, taller, and larger-output capacity turbines offer lower risk than do many, smaller, lower-output turbines. Repowering may be the best alternative to solving the bird kill problem in the APWRA. Behavioral observations and activity level studies should precede turbine installation. The data produced by such research can guide turbine siting to avoid or minimize impacts. At APWRA specifically, it seems that a number of fatalities at the site are unavoidable with its current design. Mitigation measures aimed at the operation and maintenance of the existing turbines in the APWRA could potentially reduce bird mortality to some degree, but it appears that they will not prevent them.

References

Smallwood, Shawn, and Carl Thelander. “Developing Methods to Reduce Bird Mortality in the Altamont Pass Wind Resource Area.” Prepared by BioResource Consultants for the California Energy Commission Public Interest Energy Research (PIER) Program, Report #500-04-052. August 2004.

Discussion, Questions and Answers

Where do the raptors that frequent the APWRA come from?

Response: There have been no detailed movements studies conducted, but it appears that birds tend to move north and south through the WRA when there is a large fall/winter movement of raptors throughout central California, and especially on the margins of the Central Valley. Many red-tail hawks are in the area throughout the year, while eagles migrate through mostly during the fall and winter.

What is the status of Burrowing owls at Altamont Pass (and what of the lawsuit focused on that species)?

Response: Burrowing owls continue to breed in active and abandoned ground squirrel colonies, fledging their young just about the time when the summer winds pick up in the WRA. This results in high mortality for fledgling owls. The majority of owl fatalities have been clustered around 30-40 out of 5,400 turbines in the APWRA, and we are proposing some additional research to try to determine why. Several management options are going to be experimented with in the future that focus on the problem of burrowing owl kills.

Although overall impacts of wind turbines on birds are generally low, there are species such as the Burrowing Owl that are greatly impacted. Shouldn't we be concerned about such species suffering significant cumulative effects over time?

Response: Yes, it may be that the burrowing owl flight behaviors in close proximity to turbines makes them especially susceptible to being killed. Many turbine sites are in grassland/grazing areas that support ground squirrels and, therefore, also burrowing owls. The cumulative effects of killing burrowing owls in the few remaining nesting colonies in the state need to be better understood in terms of their biological significance.

Could we make comparisons between the impacts of wind power development on birds and other wildlife and the impacts of other types of energy projects such as hydropower?

Response: Yes, to some degree. For example, bird (wildlife) losses per MW of energy produced for each energy source can be compared, regardless of the type of facility used to generate the power. But some difficult assumptions about the direct versus indirect impacts must be made, which often confounds such comparisons. But it is a good idea to fully understand the relative risks of developing different energy sources. Resource economists more than field biologists usually have fun with models that compare such things.

In conclusion, it was noted again that research showed that the most frequently observed species in the APWRA were not the most frequently killed species. Pre-construction studies are valuable, but the value of pre-construction studies does not preclude post-construction monitoring because of behavioral differences among bird species.

II. Direct Impacts to Birds at New Generation Wind Plants Outside of California

This was the second of two sessions examining the existing scientific findings on wind turbine impacts at existing project sites: mortality, avoidance, direct habitat impacts from terrestrial wind projects, species and numbers killed per turbine rates/per MW generated, impacts to listed threatened and endangered species, to USFWS Birds of Conservation Concern, and to state listed species. This session focused on newer wind project sites outside of the state of California. The presenter addressed the following questions: What factors contribute to direct impacts on birds by wind turbines? How do use, behavior, avoidance and other factors affect risk to avian species? Are there sufficient data for wind turbines and avian impacts for projects in the Eastern US, especially on ridge tops? In addition, this presentation looked at regional factors that may affect impacts such as habitat use, behavior, and other differences. The state of data about direct wind impacts in different regions was also considered.

Bird Fatality and Risk at New Generation Wind Projects

by
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Researchers have been conducting bird fatality monitoring at a number of "new generation" US wind projects for several years. New generation wind projects consist of much larger turbines and more turbines than earlier sites, taking advantage of technological advancements made since the 1980s and generating greater quantities of energy. New generation wind plants where standardized fatality monitoring data has been generated include: Vansycle, Oregon; Nine Canyon, Washington; Stateline in Oregon and Washington State; Klondike, Oregon; Foote Creek Rim, Wyoming; Buffalo Ridge, Minnesota; and Mountaineer, West Virigina.

Bird fatality statistics have been reported from several new generation sites.

The Vansycle, Oregon site consists of 38 660-kW turbines, with 47-m rotor diameters and a maximum height of 74 m. The composition of bird fatalities identified during a one-year study at Vansycle showed a total of 10 fatalities representing 7 species. These results came out to an average of 0.6 fatalities per turbine per year (f/t/y) (Erickson et al. 2000).

The Nine Canyon, Washington site consists of 37 1.3-MW turbines, with 62-m rotor diameters and a maximum height of 92 m. Fifteen turbines at the site are lit by red strobe lights. A one-year study at Nine Canyon identified 36 bird fatalities representing 14 species. Seventeen of the fatalities were horned larks, while half of the bird activity observed at the site was horned larks. Approximately 25% of the Nine Canyon fatalities were night migrants (Erickson, Gritski, and Kronner 2003a).

The Stateline wind project consists of 454 660-kW turbines, with rotor diameters of 47 m and a maximum height of 74 m. One hundred-forty turbines are lit with red strobe lights at night. Fatality monitoring, raptor nest monitoring, Burrowing Owl surveys, and a grassland bird displacement study were all conducted at Stateline. The report detailing this work has not been published as of June 2004.

The Klondike, Oregon site consists of 16 1.5-MW turbines, with 65-m rotor diameters and a maximum height of about 100 m. Six turbines at the site are lit by red strobe lights at night. A one-year study at the Klondike site identified 8 bird fatalities representing 7 species (Johnson, Erickson, and White 2003).

At Foote Creek Rim, Wyoming, there are 133 600- and 750-kW turbines with rotor diameters between 42 m and 44 m, and a maximum height of about 74 m. The turbines at the Foote Creek Rim site, which is on Bureau of Land Management land, are not lit. Initially, there was a lot of concern about the potential for Golden Eagle fatalities. The site is a fairly flat tabletop mesa, but with a western rim edge, which was focus of raptor use study (Eagles and Buteos observed in 1999). The developer agreed to place turbines a minimum of 50 m back from the rim edge, which may have resulted in lower fatality rates than expected. A three-and a-half-year study at the site found 122 bird fatalities representing 37 species. Approximately 90% of the fatalities were passerines and 50% may have been night migrants. There were no documented "large" fatality events at Foote Creek Rim, however. On average, the Foote Creek Rim study showed a bird fatality rate of 1.5 per turbine per year (Young et al. 2003).

The Buffalo Ridge, Minnesota site is comprised of 73 300-kW turbines with 33-m rotor diameters and a maximum height of 52.5 m. A four-year study at this site yielded 55 fatalities representing 31 species, with 71% being migrants and just 2% raptors (Johnson et al. 2002). On the Phase I site, no turbines are lit; on the Phase II site, 6 peripheral turbines are lit (2.2 f/t/y); on the Phase III site, every other turbine is lit. Fatality rates ranged from 1 fatality per turbine per year (f/t/y) for Phase I to 4.45 f/t/y for Phase III. (The Phase III f/t/y was heavily influenced by one incident involving 14 birds at two adjacent turbines one night.)

The wind project at Mountaineer, West Virginia has 44 1.5-MW turbines. An approximately seven-month study identified 69 bird fatalities representing 24 species, with 71% being night migrants and 5% raptors or vultures (Kerns and Kerlinger 2004). Other studies include sites at Searsburg, Vermont (Kerlinger 1997), Somerset County, Pennsylvania (Kerlinger 2000), and Algona, Iowa (Demastes and Trainer 2000), each of which reported no fatalities over study periods of 5-9 months. (See slide presentation for further details.)

By integrating the data of these various studies, researchers have been able to reach some general conclusions about wind turbine-bird interactions at new generation wind power projects. For example, at new generation projects in the West, horned larks suffer by far the most fatalities due to collisions with turbines, and have typically been the most abundant species observed during avian use surveys. It also has been shown that bird fatalities tend to occur primarily between April and October, with low numbers in the winter months. Based on computer models (Tucker 1996a and 1996b, Podolsky 2003), comparisons of turbines of various sizes suggest that larger turbines with larger rotor diameters and fewer revolutions per minute may cause fewer bird fatalities for equivalent rotor swept areas. Empirical studies of these hypotheses are lacking.

Based on monitoring data, researchers have been able to develop a bird-turbine collision risk index. The formula is bird fatalities/relative abundance (relative abundance is the population size of a species in a particular region). This measure provides some information on the "significance" of fatalities suffered by specific species.

Fatality monitoring at new generation wind project sites is helping broaden knowledge about the dynamics of turbine-bird interaction. Most recent studies continue to add to the knowledge base regarding direct and indirect impacts of wind power development to birds and bats. Fatality data provide useful and direct measures of impact that assist in making predictions, especially for proposed projects. It has been found that a large percentage of fatalities at new generation wind plants are passerines, and that avian fatalities peak during migration season.

Comparisons of avian fatality rates to avian use provide some measure of collision risk, and may be useful for identifying individual species or groups of species more or less susceptible to collision. In some cases, the most common fatalities are the most abundant, suggesting in some cases fatality rates are proportional to use. Other species may be considered more or less susceptible because the fatality rates are not in proportion to their abundance. Through these types of risk indices, common ravens and turkey vultures appear to be less susceptible to collision than other large bird species.

Spring migrant fatality rates compared to estimated nighttime radar target passage rates appear very low based on the results of three studies, two in the Pacific Northwest and one in the Midwest. Much caution should be employed in making large generalizationss from these results, due to the many assumptions underlying the calculation of target rates from these and other radar studies.

Finally, theoretical and empirical-based models of comparative risk among turbine structure types may provide useful insight into relative risk to birds between various designs and in comparison to communication towers. For example, the likelihood of a bird getting hit by the rotor blade of a single 1.5 MW, 65-m diameter rotor is smaller than the likelihood of a bird getting hit by a rotor blade when passing through 15 18-m turbines with the same total rotor swept area as the single larger turbine. To facilitate such comparisons, we have started presenting data on a per-rotor swept area basis or MW nameplate capacity rather than a per turbine basis.

On average for all birds, new generation projects outside California have recorded three fatalities per megawatt per year. (California data were excluded because we have yet to see all-bird data corrected for scavenging and detection rates.) For raptors (excluding older turbines in California), the average is 0.04 fatalities per MW/year. For the Stateline (Oregon/Washington) project, fatalities were estimated at 0.01% / target passage rate.

It is also instructive to compare collision risk for different structure types (e.g., guyed meteorological or cell towers and wind turbines). Based on computer models, for a bird with a one-foot wingspan, the likelihood of collision with a 105 m high communications tower having 1.25 total miles of guy wires is three times as great as the likelihood of colliding with a 65-m rotor diameter, 92-m maximum height wind turbine. Basic assumptions in the model include equal avoidance of or attraction to the guyed structure and the wind turbine. Empirical data from a wind energy project in Wyoming corroborated the higher per structure collision risk for a guyed structure compared to a wind turbine for songbirds. These results likely vary, depending on the birds considered (e.g., raptors versus songbirds).

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Discussion, Questions and Answers

How is it that Foote Creek turbines are unlit? Noting that some of the turbine towers at the Foote Creek Rim site in Wyoming are over 74 m tall, one participant asked how it was that the Federal Aviation Administration (FAA) had exempted the Foote Creek Rim turbines from lighting requirements.

Response. The FAA can ask for any tower of any kind anywhere to be lit, regardless of height. However, compliance with such requests are voluntary; the FAA has no authority to make a developer do it. (Local permitting agencies may, however, require compliance with FAA requests as a condition of permitting.) It may be that the FAA did not request lighting at the Foote Creek Rim wind farm because of its remote location.

Which measure would be more useful, fatalities per MW capacity, rather than by MW hours or kW hours? It was noted that correlating operating time with fatalities would be useful, but that this type of data is difficult to collect. It was also noted that it is difficult to determine what level of impact is "significant," particularly at the pre-construction stage. For the most part, it has been determined that individual projects will not have biologically significant impacts on bird populations. For example, the apparently high numbers of Horned Lark fatalities at Nine Canyon become less disturbing when one examines the abundance of horned Larks in that region. However, cumulative impacts are a different (and more difficult) question.