

## **AVOIDING, MINIMIZING, AND MITIGATING AVIAN AND BAT IMPACTS**

This session addressed a variety of questions related to avoiding, minimizing, and mitigating the avian and bat impacts of wind power development, including:

- What has been learned from operating turbines and mitigating impacts where they are unavoidable, such as at Altamont Pass WRA?
- Should there be mitigation measures such as habitat creation or land conservation in places where impacts occur?

Other impact minimization and mitigation approaches discussed included: location and siting evaluations; options for construction and operation of wind facilities; turbine lighting; and the physical alignment/orientation of facilities.

### ***Bird Fatalities in the Altamont Pass Wind Resource Area: A Case Study, Part II***

by  
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The Altamont Pass Wind Resource Area (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 with the WRA's wind energy development. By 1990, more than 4,000 turbines had already been built at the site, and several studies had been initiated. 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. BRC's findings were presented in the fifth session of the Wind Energy and Birds/Bats Workshop (page 27 of these proceedings). This chapter focuses on the implications of those findings for reducing bird fatalities at Altamont Pass WRA. Some key questions include: Are bird fatalities unavoidable at APWRA? Can mitigation strategies alone sufficiently reduce bird mortality at APWRA, and if so which ones? What next steps are to be taken?

The goal of BRC's research was to study the relationships between bird behaviors (e.g.,

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<sup>31</sup> 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](http://www.energy.ca.gov/pier/final_project_reports/500-04-052.html).

flight, perching, and foraging) and bird fatalities. Part of the aim was to quantify bird fatalities in order 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 fatalities at wind project sites. This model is to be based on relationships identified between bird kills and numerous variables including: landscape features, topography, land use practices, raptor prey species numbers and distribution, turbine types and infrastructure configurations, or any other factors that appear associated with bird fatalities.

A major step toward reducing bird fatalities at any wind energy facility is to identify and understand the causal factors of fatalities. This task is somewhat difficult because collisions with wind turbines are rarely observed directly, and therefore inferences must be drawn from patterns discernable from carcasses found near turbines. BRC's research resulted in sample sizes large enough to reveal relatively robust patterns. Those patterns have resulted in a predictive model based on the causal factors underlying the observed fatalities. The question is what do the number of bird fatalities and their distribution indicate about the underlying causes of mortality, and are there any solutions?

There are a few environmental factors (i.e., bird attractants) within APWRA that are potentially underlying causes of bird mortality at the site. It has been found that cattle grazing within the WRA spend a disproportionate amount of their time under the wind turbines. Large concentrations of grasshoppers feed on the cow dung that accumulates near the turbines. These grasshoppers are a major food source for American kestrels and burrowing owls during much of the year (chiefly in the late summer and fall). BRC biologists found the stomachs of some freshly killed red-tailed hawks at WRA filled with grasshoppers as well.

Another environmental dynamic at the APWRA is that construction and maintenance practices around turbines have resulted in a disproportionate number of burrowing mammals present near turbines. Wind energy facilities create many artificial lateral and vertical edges in the landscape – most notably at the base of turbine towers and along access roads and other structures – and these edges tend to be preferred habitat for gophers and other burrowing mammals such as ground squirrels. Gophers and other burrowing mammals are a prey species for raptors. Rock piles created during construction, intended to provide habitat for San Joaquin kit foxes, instead have attracted desert cottontail rabbits, which are a preferred prey species for golden eagles and other large raptors. Raptors are attracted to areas near turbines by these prey species, increasing the raptors' risk of mortality. The lesson to be drawn from these observations is that it may not necessarily be the wind facility or turbine type itself that attracts birds (thereby increasing their mortality), but rather what is happening on the ground in the surrounding ecosystem/landscape. In some instances, it may be possible for the operation and maintenance of the immediate area around turbines to be modified so that it reduces raptor activity near turbines in general.

BRC conducted surveys at selected turbine strings throughout the large (140 sq km) APWRA and developed species-specific fatality data for a large number of APWRA

turbines. Predictions were made as to which turbines pose the greatest risk to certain species (golden eagle, burrowing owl, red-tailed hawk, American kestrel) based on landscape/ topography, and bird behavior. BRC then recorded and mapped where fatalities actually occurred in the APWRA in order to test their predictions and work toward mitigation measures for high-risk turbines.

“High risk” turbine locations within the APWRA display a confluence of risk factors. Accountable Mortality was measured by “teasing out” the percentage of the fatalities attributable to 11 individual factors (of 30-40 considered) which showed statistical significance. Mapping turbine strings where Golden Eagle fatalities occurred, it became apparent that there are a relatively smaller number of turbine strings responsible for most of the eagle deaths. The same exercise can be done for other species (e.g., Burrowing owls). This helps researchers to focus on higher risk strings, then look at other contributing factors. The model predicts where fatalities are most likely to occur, and accurately predicts what turn out to be the (smaller number of) places where the most fatalities are occurring. This kind of information can be used to focus repowering changes where they are most likely to make a positive difference for multiple species.

Several variables were examined to determine the magnitude of increase in a species’ mortality due to that variable (i.e. when the feature was present, how much did mortality risk increase). The variables considered included height of lowest blade reach, whether in the wind wall, position in turbine string, location in wind farm, wind turbine congestion, physical relief, whether in canyon, slope grade, edge index, rodent control, and cattle pats at turbines.

There are a number of conclusions to draw from BRC’s research regarding bird fatalities and the potential for mitigation at Altamont Pass WRA.

- Danger to birds generally increased with taller towers, larger rotor diameters, and slow-to-intermediate tip speeds.
- Turbines with lower blade reaches were most deadly to Golden eagles.
- Perch availability on towers appears to be a less significant factor in mortality risk than previously believed.
- Turbines on steeper slopes and in canyons were generally more dangerous to raptors, but ridge crests and peaks within canyons were also dangerous.
- The presence of rock piles within turbine laydown areas is associated with greater raptor mortality in certain areas of the APWRA.
- Wind walls (rows of turbines in relatively close proximity) appeared to be relatively safer for raptors than previously assumed. Raptors were killed disproportionately by turbines that were less crowded by other turbines.
- Although the APWRA rodent control program reduced rodent numbers overall, it also increased the degree of clustering around turbines of remaining pocket gophers and desert cottontails and therefore generally failed to reduce raptor mortality.

- Raptor mortality differs by season, with summer and winter having the highest mortality.

It is important to note that fatality associations are usually species-specific, so solutions for one species may not serve as solutions for others. In fact, what benefits one species may increase risk for another. BRC's research suggests that species-specific behavioral observations and activity level studies should precede turbine installation, as these data can guide turbine siting to avoid or minimize avian impacts.

Based on this research, BRC has distilled a series of recommended corrective measures and/or operating practices for Altamont Pass WRA. These recommendations relate to managing use of the area by small mammals which attract birds of prey, and otherwise managing the landscape to avoid attracting birds to turbines.

Discontinue the rodent control program in favor of promoting small mammals away from wind turbines; reduce lateral and vertical edges near wind turbines to discourage small mammals from burrowing near the wind turbines.

- Experiment with range management techniques such as allowing vegetation to grow tall near turbines so that small mammals are less visible to raptors near turbine, and subsequently Burrowing owls may reside farther from turbines.
- Prevent cattle from congregating around wind turbines to reduce the accumulation of cow patties and the accumulation of grasshoppers which serve as a food source for a number of bird species.
- Where they are a problem, move rock piles away from turbines or get rid of them in order to decrease the presence of raptor prey species in the vicinity.

Another set of recommendations for avian impact mitigation are related to the location and configuration of turbines.

- Relocate or decommission turbines located in canyons.
- Isolated turbines should be relocated as part of windwall configurations or as part of clustered groups of wind turbines.
- Remove (or lay down) derelict and non-operating turbines.
- BRC recommends testing the Hodos painting scheme<sup>32</sup> in the field and applying it selectively if it is found to be a useful tool. Turbines at the "edge" of the APWRA and at the end of turbine strings could be modified to divert bird flights (possibly using the Hodos painting scheme if it is proven effective).
- Benign physical structures could be erected to divert birds away from the ends of turbine strings, or the WRA could potentially experiment with strategically placed raptor perches.
- All power poles could be retrofitted to be raptor-safe, following Avian Power Line

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<sup>32</sup> William Hodos et al. 2001

Interaction Committee (APLIC) compliance standards.

- Replace the Wildlife Response and Reporting System (WRRS) monitoring program for bird fatalities with one that is more scientifically rigorous and is performed independently.

Since it is likely that on-site mitigation cannot entirely solve the bird kill problem, APWRA's turbine operators should investigate engaging in off-site mitigation measures to compensate for impacts that cannot be avoided on-site. Generally, it is unlikely that all impacts at APWRA can be avoided, but implementing the recommendations outlined here could reduce fatalities as much as 50%, according to BRC's research results.

BRC has outlined a number of steps to be taken for the future of the APWRA based on the research outlined in this presentation.

1. Prioritize and select what appear to be the best fatality reduction techniques for field testing and monitoring. Specific techniques recommended for testing include:
  - placing benign structures (perhaps of several types and settings) at the ends of turbine strings where fatality rates historically have been high;
  - modifying grassland management practices to reduce prey populations or their visibility/vulnerability to raptor predation;
  - manipulating prey population distributions and abundances to increase prey populations further away from turbines;
  - painting turbine blades to increase the visibility of turning rotors (as suggested by William Hodos, et al.).
2. Design controlled experiments to test their effectiveness using the Before-After Control (reference)-Impact (BACI) approach.
3. Decide which bird species to focus mitigation and/or experiments on.
4. Based on the results of these experiments, report on the effectiveness of various techniques and consider widespread application on a case-by-case basis.
5. Design and conduct controlled experiments to determine the effects of the repowering program on bird mortality.

Overall, it appears that repowering the APWRA with larger, taller turbines with greater output capacities will be most effective at reducing bird kills. In designing a monitoring program to compare any changes in bird mortality (especially for raptors) associated with the repowering program at sites with historical fatality data, BRC recommends using the number of fatalities *per MW* per unit of time rather than simply the number of fatalities per turbine per year.<sup>33</sup> The proposed metric, which is described at length in an upcoming BRC

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<sup>33</sup> Repowering typically results in the replacement of smaller older-model turbines with larger, more productive models, hence the need for an output-based metric rather than simply a per-turbine metric.  
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paper and report to the CEC,<sup>34</sup> will require gathering output data from turbine operators.

## References

Hodos, William, A. Potocki, T. Storm, and M. Gaffney. "Reduction of Motion Smear to Reduce Avian Collisions with Wind Turbines." In Proceedings of the National Avian-Wind Power Planning Meeting IV, 2001.

Thelander, Carl, and Shawn Smallwood, Ph.D. "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.

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<sup>34</sup> The CEC report can be downloaded from the Web at:  
[http://www.energy.ca.gov/pier/final\\_project\\_reports/500-04-052.html](http://www.energy.ca.gov/pier/final_project_reports/500-04-052.html).

## ***Prevention and Mitigation of Avian Impacts at Wind Power Facilities***

by

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Various strategies been employed at wind power facilities around the United States in order to prevent or mitigate the impact of wind turbines on birds.

- In the Midwest and West, it is wise to avoid true grasslands, prairie and some grazing land. These habitats can be lekking (breeding/courtship) areas for species like Lesser and Greater Prairie-Chickens and Sage Grouse, which are declining precipitously. It is best to avoid such areas altogether, as well as avoiding areas designated by professionals as necessary for recovery programs of these species and including buffer areas. Siting turbines on tilled agricultural land would minimize impacts to nesting grassland birds and reduce the displacement of certain key species (prairie songbirds, shorebirds, grouse) while reducing the potential for collision fatalities (e.g., of Upland sandpipers and Horned larks) at wind power projects.
- In Eastern forests, prevention measures should include developing forest management plans in conjunction with wind facility siting to minimize turbine footprint/forest clearing and encourage regrowth of forest (up to a height of about 20-30 feet above ground level) right up to the base of the turbine towers. In forested areas, roads should be kept narrow and regrowth should be encouraged along roadsides. A point to consider is that wind energy development may preclude housing development, which would have greater impact on habitat and wildlife.

There are several other measures that may be taken to prevent avian impacts of wind facilities in any locale. One key prevention measure is avoiding or minimizing lights on turbines, especially steady burning or bright lights such as sodium vapor lights or spotlights. Guy wires contribute significantly to risk and should be avoided entirely on meteorology towers. Towers as high as 700 feet can be built without guy wires, although this is expensive. For 300-400 ft. towers, non-guyed construction is not prohibitively expensive. As a general rule, perch sites should be eliminated from wind facilities. Collection lines should be installed underground and substations insulated per Avian Power Line Interaction Committee (APLIC) standards to avoid collisions, electrocution, and perching. It is possible that building fewer, larger turbines may help prevent bird fatalities as well, but this is not yet fully understood.

Eastern and Midwestern hayfields are prime sites for wind power facilities and also prime nesting areas for grassland birds. Hay mowing kills thousands of bobolinks, savanna sparrows and other species every year and is a preventable source of fatality. Delaying hay

mowing at these sites can reduce fatalities dramatically.<sup>35</sup>

Currently, on-shore turbine towers and their rotors reach up to about 380 feet above ground level. One lingering question is whether there is a threshold height for wind turbines above which night migrating birds will be impacted in much larger numbers. Most migrants fly between 300 and 2,000 feet above ground level, so it is likely that above 400 feet, turbines would impact more night migrants than they do currently. The question of whether there is a meaningful height threshold (with regard to avian impacts) and where that threshold might be set is a question for future consideration.

### ***Discussion, Questions and Answers***

*It has been suggested that clearing vegetation around turbine bases creates habitat for prey animals and makes them more visible, thus attracting raptors. However, uncleared vegetation would make monitoring wind facilities for bird and bat impacts more difficult. What is the recommendation?*

*Response:* In the first one to two years after clearing there usually is not much re-growth of vegetation, especially in mountainous areas, which allows monitoring studies to be conducted. Dogs can also be trained to do searches in thick brush if need be.

*Comment:* The bulk of a wind facility's footprint is from roads. Thus, it may be preferable for wind projects to try design/use roads more efficiently and in turn reduce the footprint of turbine sites.

*Comment/Question:* There is a lack of data from Texas and Iowa where there is a lot of wind power development. Have any researchers been assessing bird and bat impacts at those sites?

*Response [from workshop participant other than the presenter]:* One small study has been done in Iowa, which will be available soon.<sup>36</sup> In Texas, mortality studies are not required and therefore have not been done.

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<sup>35</sup> A workshop participant noted that the Natural Resource Conservation Service has arranged payments to farmers to delay mowing until after nestlings fledge, thereby increasing productivity of birds at these sites and offsetting additional fatalities.

<sup>36</sup> This is a reference to a three-season study conducted at three modern turbines near Algona, Iowa. No bird fatalities were found at this site. (Demastes, J. W. and J. M. Trainer. 2000. Avian risk, fatality, and disturbance at the IDWGP Wind Farm, Algona, Iowa. Final report submitted by University of Northern Iowa, Cedar Falls, IA. 21pp.)