# Avian Interactions with Wind Power Structures

**1005384**

# Avian Interactions with Wind Power Structures

1005384

Technical Update, March 2003

EPRI Project Manager

R. Carlton

EPRI • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

## DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES



ORGANIZATION(S) THAT PREPARED THIS DOCUMENT

**EPRI**

**This is an EPRI Technical Update report. A Technical Update report is intended as an informal report of continuing research, a meeting, or a topical study. It is not a final EPRI technical report.**

## ORDERING INFORMATION

Requests for copies of this report should be directed to EPRI Orders and Conferences, 1355 Willow Way, Suite 278, Concord, CA 94520. Toll-free number: 800.313.3774, press 2, or internally x5379; voice: 925.609.9169; fax: 925.609.1310.

# CITATIONS

This document was prepared by

EPRI
3412 Hillview Avenue
Palo Alto, CA  94304

Principal Investigator
R. Carlton

This document describes research sponsored by EPRI.

The publication is a corporate document that should be cited in the literature in the following manner:

*EPRI Workshop on Avian Interaction with Wind Power Structures,* EPRI, Palo Alto, CA:  2003. 1005384.

**Welcome and Agenda Review**

Rick Carlton, EPRI, welcomed participants to the workshop. Facilitator Abby Arnold, RESOLVE, reviewed the agenda and workshop objectives:

- provide an overview of wind development to date
- provide a context for avian/wind interactions in electricity generation
- provide a historical overview of avian/wind power interactions and lessons learned
- describe what we know about avian/wind power interaction and what are we still investigating, including behavioral aspects and physiological (vision, flight, limitations) aspects
- describe the importance of proper siting and what methodology to use for predicting and quantifying avian interactions at particular sites
- **discuss questions still being researched or questions that need to be researched**

**Keynote Address**

To begin his keynote presentation, Robert Thresher, National Renewable Energy Laboratory (NREL), noted the documented and projected rise in U.S. energy consumption, global population, and atmospheric concentrations of carbon dioxide, methane, and nitrous oxide. He also noted the worldwide growth in wind energy capacity, with increased growth projected for the next four years. He outlined the evolution of commercial U.S. wind technology and noted that the cost of energy from wind has decreased substantially over past decades due to increased turbine size, research and development advances, and manufacturing improvements. A Department of Energy goal is to develop turbines capable of producing energy at a cost of three cents per kilowatt hour in class 4 (thirteen mile per hour) wind sites by 2010. Achieving the goal would increase the area available for wind development by a factor of twenty or more. Closing the gap to achieve lower costs at lower wind speeds poses technology challenges and will require new understanding, new designs, and new tools.

Dr. Thresher explained that NREL is closing out research on avian interactions with wind power facilities. Data suggest that the area with the most significant avian wind-turbine interaction problem in the U.S. is the Altamont Pass Wind Resource Area (WRA) in California. Dr. Thresher commented that a combination of variables at the Altamont are unique, and there is no reason that avian issues should be a concern for future wind plant development as any potential problems should be identified and addressed before micrositing occurs. He noted that two documents prepared by the National Wind Coordinating Committee (NWCC) (*Permitting Wind Energy Facilities: A Handbook* and *Studying Wind Energy/Bird Interactions: A Guidance Document*) provide guidance for siting and development of new wind facilities.

Dr. Thresher commented that wind power continues to face challenges unrelated to avian issues, such as transmission issues and the technological challenge of balancing load and demand.

**What Have We Learned about Avian Wind Interaction? What Is the Nature of the Problem?**

Ed DeMeo, NWCC and Renewable Energy Consulting Services, Inc., served as moderator for the session and introduced each of the speakers.

*Empirical Background and Historical Perspective*

Dick Anderson, California Energy Commission, outlined the empirical background and historical perspective on bird collisions and other negative impacts of wind turbines and provided an overview of the work of the National Wind Coordinating Committee (NWCC). He explained that the large number of raptor fatalities at the Altamont Pass WRA, one of the first large wind power developments in the U.S., created national concern about the impacts of wind power and indicated the need to learn more.

The NWCC was created in response to the realization that while wind power was generally considered a clean technology there were issues to address. The NWCC exists to provide a forum for identifying issues and impacts and promoting coordination and to catalyze actions to reduce barriers to wind power development. The Avian Subcommittee of the NWCC provides a forum for multi-stakeholder teamwork to identify key issues, define a research agenda to resolve issues, ensure compatible research, avoid duplication and inadequate science, and build consensus on research.

Mr. Anderson commented that much has been learned since the subcommittee formed. He summarized that avian-wind power interactions remain a serious consideration in new wind farm siting, but problem sites can be avoided with adequate consideration of site-specific issues early in the process. The subcommittee has identified areas needing further research, giving high priority to determining the importance of bird kills to the population and developing nocturnal survey methods and metrics (for birds and bats). Mr. Anderson closed by summarizing research findings from several wind resource areas and outlining what has been learned thus far:

- wind turbines kill birds and bats
- bird impacts can be significant or insignificant
- raptors are a high-risk bird group
- bird use, mortality, and risk vary between and within wind resource areas
- avian impacts is a site-specific issue
- birds are killed during day and night
- there are no conclusive data as to whether a) large or small turbines reduce risk or b) tube or lattice towers reduce risk
- there is nothing known for sure that significantly reduces avian fatalities
- avoidance of areas with high bird use is only proven to avoid high levels of avian fatalities

*Comparing Wind to Other Development*

Wally Erickson, WEST, Inc., presented a summary of research findings and estimates of various sources of avian mortality and compared those to research findings from several newer wind power sites. Examples of estimates of annual avian fatalities for the U.S. include the following:

- 100 million to 100 billion due to collisions with buildings and windows
- 4 million to 50 million due to communication towers
- 130 million to 174 million due to high tension lines
- 60 million to 80 million due to vehicles
- 70 million due to pesticides
- 100 million due to cats

Based on research at wind plants across the U.S., bird fatalities from wind turbines are estimated at 10,000 to 40,000 per year. These estimates assume about 15,000 commercial turbines, including about 11,000 in California. Excluding California, bird fatalities from turbines are estimated at 4,000 to 8,000 annually.

Mr. Erickson's other points included the following:

- substantial empirical data have been collected for predicting direct impacts to birds from wind projects
- raptor mortality has been absent or low at all new generation wind projects, possibly due to proper siting, characteristics of new turbines, turbine spacing, or project size
- overall bird mortality from wind turbines at current development level is a very minor component of overall human-caused mortality
- siting and impacts to threatened and endangered species or groups of concern (e.g., raptors) are still important to consider

*Discussion*

Comments made by Dr. DeMeo, Mr. Anderson, and Mr. Erickson in response to questions included the following:

- Lighting issues on new higher turbine towers are being studied, but the data are still preliminary.
- A study at the Buffalo Ridge site in Minnesota indicated that displacement impacts to grassland birds were small scale and close to the turbines.
- Correlation of fatalities and weather events has been considered but is difficult to determine because carcass surveys are not done daily. So far, there have been no large fatality events to correlate to weather events at the sites studied.
- Diligence during siting is key. It is important to know the particular species in the area.
- Early in its formation the NWCC looked to Europe to see what had been learned about avian issues there. Studies had been done that showed mortality, but concern about bird mortality seemed to be less than in the U.S.
- Specific guidelines have not been developed for where to place turbines. Placement decisions are generally made based on site-specific data and experience with the species found at the site.

Comments from other meeting participants included the following:

- Relocation of turbines may not have to be many miles away. For example, at Foote Creek Rim, Wyoming, it was found that raptor use was concentrated within 100 meters of the rim edge, so the wind turbines were sited back from the edge accordingly.
- A question to consider is whether we have learned enough about bird use and topography to be able to establish protocols for the placement of turbines.

At the close of the discussion, Dr. DeMeo summarized some of the key points he had drawn from the presentations and discussion. He noted that a lot of attention has been given to Altamont Pass and commented that one reason for this is that Altamont serves as the only laboratory because mortality at other sites is low. He said it is good news that the industry is learning how to avoid problems at the outset through siting.

*Why Is It Important to Pay Attention to Avian-Wind Interaction?*

Al Manville, U.S. Fish and Wildlife Service (FWS), spoke about the FWS role in and approach to addressing avian-wind power interactions. He said the FWS aims to do whatever it can to reduce bird mortality, looking at additive impacts as well as cumulative. The FWS is the trust agency responsible by law for the conservation and management of the 836 species of migratory birds in the U.S. Dr. Manville explained that the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Act are strict liability statutes, where proof of intent to violate any provision of the Acts is not required. The killing of any bird is not technically allowed under law unless permitted, and the FWS does not issue "incidental or accidental take" permits. The FWS can and does use these statutes for compliance.

Dr. Manville commented that there are things that can be done to reduce the avian impacts of wind power. He said that as wind power is the fastest growing energy source, questions and issues remain to be addressed, particularly in regard to technology changes (e.g., low-speed turbines, tower design), application of turbines to new sites, offshore development, use of the precautionary approach, and lighting. He commented that he is working to involve the Federal Aviation Administration (FAA) in an effort to develop consistent guidance for lighting for a range of structures, including wind turbines and communication towers. [Since this Workshop, a meeting with representatives of the FAA, Federal Communications Commission, and President's Council on Environmental Quality was held on November 7, 2002, to begin addressing lighting issues.]

Dr. Manville explained that the FWS prefers to partner with parties up front rather than use regulatory action. In November the FWS will release for comment its draft interim voluntary guidance for wind turbines. Mr. Manville invited workshop participants to attend the conference at which the FWS will preview the draft guidance in Reno, NV, November 13-14, 2002. He noted that the FWS would provide other opportunities for comment as well. The document will provide guidance on the site evaluation process, siting considerations, turbine design and operation, mortality monitoring, aviation warning lighting, and future research needs. The FWS intends to use investigative and prosecutorial discretion if a project follows the voluntary guidance.

Dr. Manville explained that the FWS prefers to partner with parties up front rather than use regulatory action. He indicated that he hoped his agency would be able to release its draft interim voluntary guidance for review and comment by interested stakeholders at a workshop in Reno, NV, on November 14. [Following the workshop Dr. Manville notified workshop participants that, unfortunately, the FWS director had yet to approve the draft for release, so it would not be available to the public at the Reno workshop. It is hoped to be ready for release in early 2003. FWS staff hope to brief members of the NWCC Avian Subcommittee once the draft guidance is released for the public.]

Dr. Manville reported that the FWS recently signed a memorandum of understanding (MOU) with Xcel Energy in Denver, CO. He encouraged participants interested in working with the FWS to consider developing a MOU.

*Discussion*

A participant commented on the difficulties posed by conflicting lighting requirements. He reported his experience with one project for which the FAA required red, constant lights but the FWS regional office said to use white strobe lights. The project went ahead with white strobe lights, and then local citizens formed a group to protest the sleep disturbance the lights caused. Dr. Manville acknowledged the difficulty of balancing multiple concerns and demands and said that that is the reason he is trying to work together with the FAA. He said that the FWS draft voluntary guidance likely will recommend minimum intensity white strobe lighting of the minimum flash duration per minute currently allowed by the FAA.

Another participant commented that his company is in the process of developing an MOU with the FWS. The company and its attorneys feel comfortable with the agreement. The participant noted that working with the FWS has gone well and the MOU appears to be a good approach.

**Why Is Up Front Diligence on Site Selection and Evaluation So Important?**

Tom Gray, American Wind Energy Association, served as moderator for the session and introduced each of the speakers.

*Overview of* Studying Wind Energy/Bird Interactions: A Guidance Document

Mr. Anderson presented an overview of the guidance document, which was published in December 1999 by the NWCC and Avian Subcommittee. The purpose of the document was to serve as a reference for site suitability evaluation and for impact prediction for both individual projects and wind energy technology. The document sets forth standard methods, metrics, and definitions and promotes studies producing comparable data and data useful in reducing risk. The document includes sections on site evaluation biology, basic experiment design and level 1 studies, advanced experiment design and level 2 studies, and risk reduction studies. Examples of metrics (standards of measurement) defined in the document include bird utilization rate, bird mortality, attributable risk, rotor swept hour risk, scavenging factor, and searcher detection rate. Methods (systematic procedures) described in the document include bird utilization count, dead bird search, scavenging study, and searcher detection efficiency study.

Mr. Anderson shared the following summary comments:

- good study design and analysis principles should always be followed, regardless of the type of study
- a clear understanding of the question is essential
- studies should be designed to address the time period and species of interest and to accommodate potentially confounding variables
- budget, time available for study, project magnitude, and regulatory requirements will typically determine the scope of study
- assessment of impacts and risk will typically involve a combination of observational, manipulative, and model-based studies
- analysis will require a weight-of-evidence approach, combining statistical and biological significance

*Application of Methods at Buffalo Ridge Project*

Mr. Erickson outlined how the methods and metrics described in *Studying Wind Energy/Bird Interactions: A Guidance Document* have been and are being applied at the Buffalo Ridge Wind Plant in Minnesota. He explained that the plant was developed in three phases completed between 1994 and 1999. A mixture of study designs were used on the phases, but only post-operation data are available on the first phase turbines.

Mr. Erickson described what was done for each step in the study implementation process, including identification of the need for a study, preparation of protocols, implementation of the studies, and analysis and documentation. He commented that the technical advisory committee (TAC) formed early in the process was an important tool, with representatives from the power company, the state department of natural resources, FWS, and Audubon Society.

Mr. Erickson outlined the study design and sampling plan and shared some of the data collected. He then summarized some of the conclusions drawn from the studies:

- radar data collected on Buffalo Ridge by the University of Minnesota indicate 3.5 million migrants per year pass through the wind development area
- although flight height data from diurnal surveys indicate that the larger Turbine B may pose less risk to some groups of birds than the smaller Turbine A, mortality data indicate that mortality rates per turbine are higher for Turbine B
- higher mortality at larger turbines could be due to larger rotor swept area or increase in height making nocturnal migrants more susceptible to collision
- avian mortality may be reduced if turbines are sited away from woodlands and wetlands
- reduced use (displacement) by some groups of birds occurs primarily in close proximity to turbines
- nocturnal migrating passerines constitute approximately 50% of wind-plant-related avian mortality on Buffalo Ridge; mortality of resident breeding birds appears very low, involves primarily common species, and would not likely have population consequences
- raptor mortality was very low

In closing Mr. Erickson noted that in 2000 the TAC voted to discontinue most bird studies but to conduct a more focused bat study.

*Application of Methods for Small Project Risk Assessments*

Paul Kerlinger, Curry and Kerlinger, LLC, explained that the Phase I Avian Risk Assessment was developed partially in response to the need for a way to evaluate smaller projects. The Phase I Assessment is the first step in evaluating risk to birds. It is used to determine fatal flaws and the potential for risk, determine whether further studies are necessary, identify information gaps regarding birds in the project area, and recommend specific studies if necessary. The assessment includes a site visit to assess habitat and topography, literature and database searches, and interviews with agency biologists, conservation organizations, and avian experts to both gather and share information. Dr. Kerlinger commented that Phase I Assessments are ecological in approach, examining potential risk to populations of common and listed species and considering the MBTA only tangentially. The assessment report includes information for the client to use to determine whether to move forward, abort, or conduct more research, as well as recommendations for avian safety. The report also can be used in permitting, if required, and provides predictions that can be tested through post-construction monitoring. Dr. Kerlinger commented that his experience with several small projects is that the predictions from the assessment are borne out during operation. He shared his conclusions that Phase I Assessments

- are efficient and effective means of determining potential for risk to birds
- work for small and large projects
- are cost effective as they happen early in the project so that issues may be addressed
- are the best way to identify what studies, if any, may be needed
- are perhaps the best (first) method for assessing risk

*Discussion*

Comments made by Mr. Anderson, Mr. Erickson, and Dr. Kerlinger in response to questions included the following:

- The carcass surveys do not find all of the birds that are killed, but studies are done to estimate scavenging and adjust the data accordingly. Scavenging rates should be estimated and used in designing the studies.
- One role for a TAC is to make recommendations to the permitting agency.
- Mitigation triggers can be tied to the results of post-construction monitoring, though they can be difficult to predetermine given the range of possible results (i.e., overall mortality versus mortality of specific species).
- The Buffalo Ridge TAC decided that bird fatality rates were well understood based on the 5-year study and the rates were apparently not considered biologically significant based on the species composition of the birds killed and the lack of raptor fatalities.
- High use area and low use area cannot yet be generically defined because of the need to consider certain specific species.

Another meeting participant commented that results from risk modeling for sites in Tazmania indicated that fatalities increased with the height of the turbines. He noted, however, that because

the higher, larger turbines produce more energy, fatalities per unit of energy decrease with higher turbines.

**Non-Avian Impacts of Wind Projects**

Dr. Carlton served as moderator for the session and introduced each of the speakers.

*Overview of* Permitting Wind Energy Facilities: A Handbook

Mr. Gray presented an overview of the handbook, which was initially published by the NWCC in 1998 and revised and updated in 2002. The handbook provides an overview of the permitting process, guidelines for the process, information on specific permitting issues, and case study and language examples. Categories of issues included in the handbook are birds and biological, visual, land use, noise, erosion and water quality, cultural and paleontological, health and safety, public services, solid and hazardous wastes, and air quality and climate. Mr. Gray summarized the impacts and advantages of wind power plants for each of these categories. He noted that while wind power is largely environmentally benign, there are potential biological impacts, especially during construction. In regard to land use he noted that wind power facilities have been found to be compatible with other typical uses (e.g., farming, ranching), but they may not be compatible with suburban development in some areas.

*How Are Non-Avian Impacts Addressed?*

Mike Azeka, SeaWest Consulting, shared information on how visual impacts and non-avian wildlife impacts are addressed for wind power projects in the predevelopment stage, during construction, and during operation. He explained that one process for assessing visual impacts is the visual resource management (VRM) methodology developed by the Bureau of Land Management (BLM). If federal agencies are not involved, states and counties may do reviews, which often use visual simulations to assess impacts. Mr. Azeka commented that the quality of computer simulations has improved and the price has decreased. Considerations to minimize visual impacts include placement relative to ridges, topographic features, and slopes; grid versus random placement; height, turbine size, and rotation speed and direction; color, finish, reflectivity, and logos; uniformity of appearance; and overhead versus underground lines. Mr. Azeka commented that the need to install turbines where they are most efficient is the predominant placement consideration, but generally there is room for adjustment based on visual and other considerations.

Before discussing wildlife impacts Mr. Azeka commented that wind power facilities have been found to be compatible with cattle and sheep grazing and can provide ranchers a welcomed second source of income.

Mr. Azeka commented that non-avian wildlife impacts are varied. Experience has shown that the impacts are greatest during the construction phase, so scheduling construction around high use times is important. Other measures to address impacts during construction include clearance surveys, avoidance of threatened and endangered plants, active monitoring, notification and reporting to relevant agencies, and flexibility to address issues as they emerge. Impacts during

the operation phase are generally minimal, but training for employees can help to minimize any potential impacts that are identified.

In response to a question Mr. Azeka shared an example of off-site mitigation. A facility in Palm Springs, CA, was located in blow-sand habitat and there was concern about possible impacts to certain plants and lizards. For mitigation the company paid fees to cover the acquisition of similar habitat nearby and its perpetual maintenance by a land trust.

*What Is Known and Not Known about Impacts on Bats?*

Greg Johnson, WEST, Inc., presented information and outlined remaining questions regarding bat mortality caused by wind power facilities. He noted that bat collision mortality is not unique to wind plants and offered estimates of mortality from other sources. He commented that bat mortality has been observed at wind plants across the U.S. and in Australia, and often exceeds avian collision mortality. A breakdown of over 600 fatalities indicates that most bat mortality at wind plants involves solitary, tree-roosting bats, with hoary bats being the most prevalent fatality. The timing of the highest mortality during late summer indicates that migratory bats are involved. This theory is supported by surveys at sites near relatively large resident bat populations, which have found no mortality of resident species.

Mr. Johnson then outlined the many questions that remain unanswered about bats and their mortality at wind power facilities. Examples include

- why is mortality during spring migration a fraction of that in the fall?
- are the bat species involved more susceptible than others or is the fatality composition proportional to the abundance of bats during migration?
- why are bats unable to detect turbines?
- do turbines attract bats?
- what are the population effects of collision mortality?

Mr. Johnson shared research findings and theories related to these questions but explained that no definitive answer has yet been found for any of them. Following the presentation, other workshop participants offered ideas of factors and considerations for further research.

*Discussion*

Comments made by Mr. Gray, Mr. Azeka, Mr. Johnson, and Mr. Erickson in response to questions included the following:

- There is a good level of confidence that a sample period of two weeks for carcass surveys gives an accurate picture of mortality when adjusted based on scavenging studies and detection effectiveness studies. The method is documented to be unbiased for overall mortality, though it may not be effective for determining mortality of an individual species. Communication tower surveys are more frequent but involve only one tower. For wind facilities, less frequent surveys including multiple turbines provide a better picture related to the topography of the site.
- It is difficult to add motion to visual simulations of wind facilities, so few people, if any, have used motion simulations as a rigorous tool.

**What Direction Is Research on Avian – Wind Interaction Taking?**

Mr. Anderson served as moderator for the session and introduced each of the speakers.

*Overview of Current Research*

Dr. Thresher explained that five major research areas emerged from the first National Avian-Wind Power Planning Meeting, held in July 1994:

- assess mortality attributable to wind turbines at existing sites (including control data from "no turbine" sites)
- predict mortality at planned wind power sites, based in part on previous bullet
- predict population consequences
- identify ways to reduce bird kills at wind plants
- set values for off-site mitigation

In the eight years since the meeting, NREL has made progress on or accomplished most of the objectives, though values have not been set for off-site mitigation.

Dr. Thresher noted that the NWCC permitting handbook and methods and metrics guidance document will remain keystones as research moves forward. He listed other research publications and meeting proceedings available through the NREL website and highlighted some of the findings from studies at the Altamont Pass WRA and studies on visual enhancements. He commented that there is no reason why avian-wind interactions cannot be avoided if guidelines are followed and migratory paths and large local populations are avoided.

In closing, Dr. Thresher shared some thoughts on future research:

- Altamont Pass provides field test opportunities to reduce avian risk due to wind turbines, including population field studies, turbine size effects, visual treatments, and terrain and prey base effects
- the development of even larger turbines associated with offshore wind farms presents a different situation where we may be able to learn from European experience

*Avian Interactions with Wind Energy Facilities in Offshore Environments*

Steve Ugoretz, environmental analysis and review specialist, observed that offshore wind energy development is proceeding rapidly in Europe and soon will begin in North America, noting that most offshore wind farms currently operating in Europe are at a smaller scale than those currently being proposed in the U.S. However, larger wind installations are planned for the next few years. He commented that considerations for avian interactions with offshore developments include collisions, exclusion, and habitat changes. Avian studies are being done at the European offshore sites, and Mr. Ugoretz suggested that one priority to consider is translating the papers into English. He reported that Germany and the United Kingdom have fairly detailed study requirements for offshore wind facilities, covering birds and all marine flora and fauna. European studies show that mortality is occurring, though at a relatively small scale. Mr. Ugoretz noted, however, that the sites also are relatively small, and additional research on larger sites will be needed to find out if this trend continues.

Dr. Kerlinger added that study design needs to be site specific. He also commented that lighting issues will need to be addressed early. He explained that the FAA is allowing lower intensity lights than for terrestrial facilities, but the effects of the lower intensity lights on birds is not yet known.

*Developing an Ecology Power Scorecard*

Dr. Kerlinger described a project that has begun to develop a tool for comparing ecological impacts of various modes of electric power generation. He noted that the project is in the early stages and collaborators are welcome. The Ecology Power Scorecard (EPS) is an extension of the Power Scorecard, which was created by the Pace University Energy Project in collaboration with other organizations. The EPS will rate each of various power generation modes for their impacts on each of various taxa, such as mammals, invertebrates, vascular plants, and lichens. Lifecycle impacts (e.g., resource extraction, waste disposal) will be included, not just the impacts of the power plant facility. Dr. Kerlinger noted that the reason for developing an EPS originates in the avian-wind issue and the question of its ecological significance. The intent is that the EPS will provide an analysis of alternatives for consumers, regulators, biologists, environmentalists, industry, and legislators.

Dr. Kerlinger outlined the proposed process for creating the EPS and shared examples of the kind of impacts that will be considered. The products of the project will be 1) a fact sheet in the form of a matrix of generation modes and impacts, 2) a technical report with details on the ratings, and 3) a popular version of the technical report for magazines, websites, and other media. Dr. Kerlinger commented that the end goal of the project is to help people understand the consequences of turning on the lights.

*Discussion*

Comments made by Dr. Thresher, Mr. Ugoretz, Dr. Kerlinger, and Mr. Johnson in response to questions included the following:

- No projects have been constructed in sage grouse habitat yet, so no studies have been done. Projects are now being proposed in Washington state.
- The EPS will include conservation. Also, by educating people about the impacts of their choices, the hope is that conservation will increase.
- Ecological significance has to be determined species by species.
- Logistical problems remain for carcass surveys at offshore sites. One study in the United Kingdom used a shoreline search.
- The FWS and U.S. Army Corps of Engineers have proposed guidelines for offshore wind development in the eastern U.S.

Comments from other workshop participants included the following:

- The first line of mitigation should be onsite; offsite mitigation should not be the first choice.
- Studies at Altamont Pass are being used to determine which turbines have the greatest mortality impact. During repowering of the facility, new turbines will be concentrated in areas of lower avian risk.

- Diesel is a major fuel for electricity generation in Alaska and other parts of the world. Including it in the EPS may be useful, particularly for the World Bank and other international organizations.
- Consider tailoring the EPS by region.
- Conservation may help, but there will still be load growth in the U.S. Other plants are not expected to be closed because wind power generation increases.
- Several larger power companies are beginning to invest in wind. The Utility Wind Interest Group (UWIG) includes about sixty utilities, about half of which already use some wind power generation.
- The NWCC should address offshore development through a subcommittee or other avenue.
- The Pacific Seabird Group and the Colonial Waterbird Group are two organizations involved in offshore issues.
- While it is necessary to try to define ecological significance, it is very difficult to compare among projects. The responsibility is to review each project and mitigate its impacts.

**What Have We Learned? What Do We Think?**

Workshop participants commented on what they had learned from the presentations and discussions and what key messages they would take away with them.

*General Comments and Take-Home Messages*
- Do we hold other entities (e.g., highways, powerlines) to the same standard to which we want to hold wind energy? Relative importance needs to be considered.
- The workshop did not provide enough specific information (e.g., what to do when impacts are found). The message that wind is environmentally friendly was too prominent; a more critical approach is needed to acknowledge and address the issues.
- There should be more international cooperation and information sharing on these issues.
- The BLM has done an assessment of wind energy potential including considerations of land availability, site accessibility, and transmission lines. The results will soon be available through the BLM and NREL websites.
- BLM is considering preparing a regional environmental impact statement for wind energy in the western states, partially in response to Secretary Norton's request to reduce barriers to renewable power generation on public lands.
- The willingness of the FWS to enter into memoranda of understanding is a significant development. It is a great step toward increasing research to reduce avian impacts. It often has been difficult to get companies to collect data as they feared the data might be used against them in legal proceedings.
- Upfront diligence is key; it is difficult to start a project if there is a risk of having to relocate the turbines.
- European experience with offshore development suggests there will be issues to address as offshore development begins in the U.S.

*Research and Information Needs*
- Methods and metrics are needed for offshore studies and nocturnal studies.

- Site specificity is key. There should be continued investment in understanding site specifics. Guidelines should be updated as conservation science continues to mature and wind technology changes.
- More research should examine the effects of weather on avian-wind interactions.
- Regional data and information are needed rather than national.
- A meeting on the state of the science in regard to lighting issues would be helpful.
- A document compiling what has been done for mitigation would be useful.
- More research is needed on bats and why some species are particularly susceptible to collision fatalities.
- Research should be considered on changes that can be made to existing turbines to decrease impacts. Towers could be used for data collection as components are changed.
- More research is needed on eastern areas.
- Definitions need to be developed for "suitable" and "unsuitable" sites.
- If the environmental community could define and identify unsuitable sites, these priority areas could be avoided for development.
- Identifying areas as unsuitable for development may raise property rights issues. The NWCC has chosen the right approach by developing guidelines.
- Given the limited research budget of small companies and projects, it would be helpful to have information that shows where resources are and narrows down the risks that need to be considered.

**Closing Comments**

Rick Carlton thanked the workshop organizers and presenters, who volunteered their time. He commented that he and the organizers wrestled with defining the scope of the workshop and noted that it may be time for another conference to review the current research and state of the science.

Dr. Carlton thanked all of the workshop participants for attending and contributing to the discussions. He invited anyone to contact him with additional comments or suggestions.

This Technical Update is an abbreviated version of the complete proceedings, which will be posted during April 2003, for download from websites of EPRI www.epri.com and NWCC www.nationalwind.org.

## About EPRI

EPRI creates science and technology solutions for the global energy and energy services industry. U.S. electric utilities established the Electric Power Research Institute in 1973 as a nonprofit research consortium for the benefit of utility members, their customers, and society. Now known simply as EPRI, the company provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries. EPRI's multidisciplinary team of scientists and engineers draws on a worldwide network of technical and business expertise to help solve today's toughest energy and environmental problems.

EPRI. Electrify the World



1005384

*Printed on recycled paper in the United States of America*

EPRI • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com