Proceedings

of the

Wind Energy and Birds/Bats Workshop:
Understanding and Resolving Bird and Bat Impacts

Washington, DC
May 18-19, 2004

Co-Sponsored by

The American Wind Energy Association

and

The American Bird Conservancy

Meeting Facilitated by

RESOLVE, Inc.

Washington, DC

September 2004

Abstract

Most conservation groups support the development of wind energy in the US as an alternative to fossil and nuclear-fueled power plants to meet growing demand for electrical energy. However, concerns have surfaced over the potential threat to birds, bats, and other wildlife from the construction and operation of wind turbine facilities. Co-sponsored by the American Bird Conservancy (ABC) and the American Wind Energy Association (AWEA), the ***Wind Energy and Birds/Bats Workshop*** was convened to examine current research on the impacts of wind energy development on avian and bat species and to discuss the most effective ways to mitigate such impacts.

On 18-19 May 2004, 82 representatives from government, non-government organizations, private business, and academia met to

- Review the status of the wind industry and current project development practices, including pre-development risk assessment and post-construction monitoring;
- Learn what is known about direct, indirect (habitat), and cumulative impacts on birds and bats from existing wind projects; about relevant aspects of bat and bird migration ecology; about offshore wind development experience in Europe; and about preventing, minimizing, and mitigating avian and bat impacts;
- Review wind development guidelines developed by the USFWS and the Washington State Department of Fish and Wildlife; and to
- Identify topics needing further research and to discuss what can be done to ensure that research is both credible and accessible.

These Workshop Proceedings include detailed summaries of the presentations made and the discussions that followed.

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Gerald Winegrad, *American Bird Conservancy*

Tom Gray, *American Wind Energy Association*

Steering Committee Members:

Taber Allison, *Massachusetts Audubon Society*

Matthew Banks, *World Wildlife Fund*

David Blockstein, *National Council for Science and the Environment*

Ed DeMeo, *Renewable Energy Consulting Services, Inc.*

Sam Enfield, *Atlantic Renewable Energy Corporation*

Caroline Kennedy and **Aimee Delach**, *Defenders of Wildlife*

Steve Sheffield, *George Mason University*

Steve Steinhour, *SeaWest Windpower*

Dale Strickland and **Wally Erickson**, *Western EcoSystems Technology*

Carl Thelander, *BioResource Consultants*

Facilitation team: Abby Arnold, Rachel Permut, Brad Spangler, Detra Stoddard, *RESOLVE, Inc.*

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Preface

In 2003, representatives of the wind industry, environmental community, and biological research community agreed that it would be useful to convene a meeting to:

- thoroughly examine the most current and best data on wind energy impacts to birds and bats; and

- examine the measures that are and could be employed to minimize or prevent such impacts.

The meeting, the Wind Energy and Birds/Bats Workshop, was held in Washington, DC in May 2004. These Workshop proceedings provide an overview of the current state of the wind industry (technology, siting considerations, and environmental assessment standards), research methods and results of bird and bat impacts, and wind energy regulation.

The organizers of the Wind Energy and Birds/Bats Workshop hope this publication will be useful to the academic community, managers, and the public involved in wind development projects throughout the US and internationally. Additionally, the organizers thank *all* the presenters and participants for their assistance in making the workshop a success.

Glossary of Acronyms

ABC	American Bird Conservancy
APLIC	Avian Power Line Interaction Committee
APWRA	Altamont Pass Wind Resource Area
AWEA	American Wind Energy Association
BPA	Bonneville Power Administration
BRC	BioResource Consultants
CEC	California Energy Commission
DoW	Defenders of Wildlife
EFSC	Energy Facility Siting Council
EFSEC	Energy Facility Site Evaluation Council
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FAA	Federal Aviation Administration
GIS	Geographic Information Systems
kW	Kilowatt
LIPA	Long Island Power Authority
MAS	Massachusetts Audubon Society
MW	Megawatt
NCSE	National Council for Science and Environment
NIMBY	"Not In My Backyard"
NREL	National Renewable Energy Laboratory
NEPA	National Environmental Protection Act
NEXRAD	Next Generation Radar
NYSERDA	New York State Energy Research and Development Authority
ODFW	Oregon Department of Fish and Wildlife
NWCC	National Wind Coordinating Committee
RPS	Renewable Portfolio Standard
SEPA	State Environmental Protection Act
TAC	Technical Advisory Committee
TNC	The Nature Conservancy
USFWS	United States Fish and Wildlife Service
WA	State of Washington
WADFW	Washington State Department of Fish and Wildlife
WRA	Wind Resource Area
WWF	World Wildlife Fund

INTRODUCTION

Wind energy is able to generate electricity without many of the environmental impacts (air and water pollution, mercury emissions, and greenhouse gas emissions) associated with other energy sources. This can significantly benefit birds, bats, and many other plant and animal species. However, the direct and indirect local impacts of wind plants on birds and bats continue to be an issue. The populations of many bird and bat species are experiencing long-term declines, due to the effects not only of energy use, but of many other human activities.

Aside from its benefits, which are mainly indirect, global and regional in scope, wind energy production may affect birds and bats in several ways:

1. Birds and bats may be killed or injured by colliding with rotors, towers guy wires, or related structures.
2. Birds and bats may avoid wind energy developments and surrounding habitat.
3. Habitat may be directly impacted by the footprint of the turbines, roads, power lines, and auxiliary buildings.

The Wind Energy and Birds/Bats Workshop was convened to bring together representatives from government, non-government organizations, private business, and academia to examine current research on the impacts of wind energy development on avian and bat species and to discuss the most effective ways to mitigate such impacts. Workshop participants represented a wide range of interests concerned with wind energy, its development and its impacts on avian and bat species. Collectively, they share a desire to foster the development of wind power facilities while minimizing the impacts of wind energy facilities on bird and bat populations.

Meeting Organizers, Facilitator and Proceedings

The workshop was co-sponsored by the American Bird Conservancy (ABC) and the American Wind Energy Association (AWEA). The Steering Committee responsible for organizing the workshop consisted of the following representatives: Gerald Winegrad, ABC; Tom Gray, AWEA; Matthew Banks, World Wildlife Fund (WWF); Taber Allison, Massachusetts Audubon Society; David Blockstein, National Council for Science and the Environment; Ed DeMeo, Renewable Energy Consulting Services, Inc.; Sam Enfield, Atlantic Renewable Energy Corporation; Caroline Kennedy and Aimee Delach, Defenders of Wildlife; Steve Sheffield, George Mason University; Steve Steinhour, SeaWest Windpower; Dale Strickland and Wally Erickson, Western EcoSystems Technology; and Carl Thelander, BioResource Consultants.

The workshop was co-chaired by Tom Gray of AWEA and Gerald Winegrad of ABC. The Steering Committee and workshop were facilitated by Abby Arnold of RESOLVE Inc. RESOLVE specializes in environmental conflict resolution. Ms. Arnold was assisted by Rachel Permut and Bradford Spangler also of RESOLVE. Susan Savitt Schwartz was contracted by RESOLVE to assist in documenting the Proceedings.

The Proceedings were compiled by Bradford Spangler and edited by Susan Savitt Schwartz, based on the presentations and discussion at the meeting. Draft Proceedings were reviewed by the organizers, presenters, and participants, and were finalized taking their comments into account.

Workshop Participants

The following is a list of the people who took part in the Wind Energy and Birds/Bats Workshop and their organizational affiliations. Participants were invited based on their representation of the wind industry, federal and state regulatory agencies, or environmental conservation and renewable energy non-government organizations. Speakers were selected by the Steering Committee. An * indicates a Steering Committee Member, and ^ indicates a workshop presenter.

Participant	**Affiliation**
Aird, Brenda	US Office of Land and Minerals Management
Almy, Jessica	Humane Society of the United States
Anderson, Dick	California Energy Commission
Arnold, Abby	RESOLVE, Inc.
Banks, Matthew*	World Wildlife Fund
Blockstein, David*	National Council for Science and the Environment
Boone, Dan	Coalition for Responsible Wind Power
Boydston, Kathy	Texas Parks and Wildlife Department
Bridges, John	Western Power Administration
Burke, Kristin	Massachusetts Technology Collaborative
Carter, Nina	Audubon Washington
Clark, Ed	PPM Energy
Cole, Alison	Shell Wind
Cooper, Brian^	ABR, Inc. Environmental Research and Services
Cuccuini, Margaret	New Jersey Department of Environmental Protection
Curry, Dick^	Curry & Kerlinger
Delach, Aimee*	Defenders of Wildlife
Deyette, Jeff	Union of Concerned Scientists
Enfield, Sam*^	Atlantic Renewable Energy Corporation
Erickson, Wally*^	Western EcoSystems Technology
Fahey, Colleen	National Wildlife Federation
Fischer, David	American Bird Conservancy
Fry, Michael	Stratus Consulting
Gaarde, Jette^	Elsam Engineering
Georges, Anne	National Audubon Society
Golden, Dave	New Jersey Division of Fish and Wildlife
Gray, Tom*^	American Wind Energy Association
Hatch, Jeremy	University of Massachusetts-Boston
Hester, Joy	Houston Audubon Society
Hopwood, Bill	Hopwood Inc.
Hueckel, Greg^	Washington State Department of Fish and Wildlife
Jodziewicz, Laurie	American Wind Energy Association
Johnson, Betsy	Maryland Sierra Club
Johnson, Greg^	Western Ecosystems Technology

Johnston, Scott	US Fish and Wildlife Service
Jones, Jody	Maine Audubon Society
Kearns, Matt	Tetra Tech FW
Kennedy, Caroline*	Defenders of Wildlife
Kerlinger, Paul^	Curry & Kerlinger
Kerns, Jessica	Appalachian Laboratory, UMCES
Kronner, Karen	Northwest Wildlife Consultants
Kunz, Tom^	Boston University
Lindsay, Jim	FPL Energy
Linehan, Andy^	CH2M Hill
Mabey, Sarah^	North Carolina State University
Manville, Al^	US Fish and Wildlife Service
Marsh, Mary	Maryland Conservation Council
Mehlman, Dave	The Nature Conservancy
Miller, Lucile	Valley Conservation Council
Mosher, Jim	North American Grouse Partnership
Niven, David	National Audubon Society
Panella, Elizabeth	Natural Resources Defense Council
Parsons, Katharine	Manomet Center for Conservation Sciences
Paul, Ellen	Ornithological Council
Perkins, Simon	Massachusetts Audubon Society
Permut, Rachel	RESOLVE, Inc.
Piper, Richard	FPL Energy
Rackstraw, Kevin	Clipper Wind
Ram, Bonnie^	Energetics
Romme, Russ	BHE Environmental
Roy, Robert	Woodlot Alternatives
Savard, Jean-Pierre	Canadian Wildlife Service, Environment Canada
Schwartz, Susan Savitt	Consultant to RESOLVE, Inc.
Sheffield, Steve*	George Mason University
Sherwell, John	Maryland Department of Natural Resources
Sinclair, Mark	Conservation Law Foundation
Sokoloski, Adam	Izaak Walton League Midwest Office
Spangler, Bradford	RESOLVE, Inc.
Stiles, Eric	New Jersey Audubon Society
Stoddard, Detra	RESOLVE, Inc.
Strickland, Dale*^	Western EcoSystems Technology
Thelander, Carl*^	BioResource Consultants
Thresher, Bob	National Wind Technology Center
Totten, Michael	Conservation International
Ugoretz, Steve	Wisconsin Department of Natural Resources
Wasserman, Carol	EES Group
Wilkins, Neal	Synergics Energy Services
Willis, Robert^	US Fish and Wildlife Service
Winegrad, Gerald*^	American Bird Conservancy
Yonker, Terry	Maine Services Diversified

Appendix B provides a full list of speakers and participants and their contact information.

Introductory Comments by Organizers

Gerald Winegrad, American Bird Conservancy. Gerald Winegrad of the American Bird Conservancy (ABC) welcomed participants to the Wind Energy and Birds/Bats Workshop. He explained that ABC deals with a range of threats to birds and that interested parties had come to the organization for its view on wind-turbine interactions. Mr. Winegrad noted that the workshop aimed to answer two key questions:

1. What is the research on bird and bat impacts of wind energy?
2. What can be done to mitigate those impacts?

Tom Gray, American Wind Energy Association. Tom Gray offered a welcome to participants on behalf of AWEA. He explained that AWEA is the main association for the wind energy industry and that essentially all companies interested in wind energy are members of the association. Mr. Gray noted that the wind industry and AWEA have been involved in wind-bird interaction issues since the early 1990s, when the National Wind Coordinating Committee was founded, in part in response to concerns about avian mortality in Altamont Pass. The NWCC played a major role in bringing experts together to standardize ways of studying and monitoring wind-bird interactions, and later in reviewing research results.

Objectives of the Meeting

The purpose of the Wind Energy and Birds/Bats Workshop was to thoroughly examine the best data on wind energy impacts on birds and bats and the measures that are and could be employed to minimize or prevent such impacts. The workshop was designed to facilitate discussion of:

- Wind power development status and potential, including strategies and techniques employed to date to mitigate impacts on birds;
- Factors considered to select, construct, and maintain a site;
- Wind industry avian risk assessment methodologies;
- Wind industry direct avian impact analyses, both methodologies and results;
- Lessons learned about risk to birds from wind power;
- Lessons learned about risk to bats from wind power;
- Implications for birds from offshore wind development;
- Wind impacts on bats and other wildlife;
- Habitat fragmentation and species displacement resulting from wind power project development;
- Measures that can be taken to prevent/minimize impacts to birds and bats; and
- Guidelines and regulations for the siting, construction and operation of wind energy

facilities.

During this two-day workshop, participants reviewed the best available science on the issue of wind/avian/bat interaction. Participants examined avian and bat impacts of existing wind turbines around the US as well as studies conducted on new and proposed turbine sites in the US and on turbines operating off-shore in Europe. Discussions focused on common methodologies used by the wind power industry to assess risk to birds and bats prior to site development, and to document actual impacts to birds and bats subsequent to project construction. Observed causes of risk to birds and bats from wind turbines and tools that have been or could be used to minimize or avoid impacts were also examined.

The workshop was designed to facilitate information exchange. In addition to the discussions that followed each presentation, two sessions were devoted to brainstorming existing research gaps/needs and ways for the group to move forward toward the goal of understanding wind energy's impacts on birds and bats and mitigating/minimizing them as development continues. (See Appendix A for a list of Research Topics proposed by workshop participants.) Although the group brainstormed research and action ideas collectively, a consensus process was not employed to develop the lists of research topics, nor were the lists prioritized.

Process Guidelines

The Facilitator reviewed the draft agenda circulated before the workshop (Appendix C). There were no suggestions for changes. The first day of the workshop consisted primarily of prepared presentations, followed by question and answer sessions. The second day included additional presentations as well as group discussion aimed at identifying future goals. Questions generally were fielded by participants after all presenters for a particular session had completed their formal presentations. These Proceedings will present summaries of group discussions for sessions at the end each section.

The following ground rules for the workshop were proposed by the Facilitator and accepted by the group:

- All parties participate and will be acknowledged by the facilitator.
- Comments may not take the form of a personal attack.
- Participants should feel free to express their own opinions while respecting other points of view.
- No party will characterize any comment made in the meeting by any other party in public statements, in discussions with the press, or in other venues outside of this meeting
- A meeting summary and proceedings will be prepared by the Facilitator. The meeting summary will document each presentation and will summarize discussions. The proceedings will be reviewed by the Steering Committee and presenters and, once finalized, will be made available to the public.

WIND INDUSTRY PROJECT DEVELOPMENT

This session consisted of two presentations intended to provide a general overview of wind energy project development, from the industry's perspective. Tom Gray of AWEA offered an overview of the state of the wind energy industry as of 2004. Sam Enfield of Atlantic Renewable Energy Corporation outlined the key factors that wind facility developers must consider when choosing a site to build turbines and associated structures.

State of the Wind Energy Industry in 2004

by

Tom Gray, AWEA[1]

The modern wind industry began in 1981 with the first wind turbines installed in California and Denmark. Because US wind development was driven initially by investment tax credits based on installation rather than on performance, early wind energy developments were not always productive, and there were some serious problems with equipment reliability.

Improved Performance, Lower Costs. When the investment tax credits expired in 1986, the only path to profitability was to improve the performance of wind energy technology. Since the late 1980s wind energy technology has improved greatly, significantly improving reliability. Turbine size and rated capacity also have increased significantly. A typical commercial turbine installed in the year 2000, for example, has a 71-meter rotor diameter and a rated capacity of 1,650 kW, as compared with a typical 1980 turbine, which had a 10-meter rotor diameter and a rated capacity of 25 kW. Moreover, the larger modern turbine produces 120 times the energy of the smaller 1980 turbine, but costs only 20 times as much to build and install.

In addition to the development of larger, more reliable turbines, other technological advances include specialized blade design, power electronics, and more efficient designs derived from computer modeling. The combination of these improvements and economies of scale have driven costs down from $0.38/kWh in 1980 to a projected $0.025-$0.035/kWh in 2007,[2] making wind energy more competitive. Fixed "balance of plant" costs mean that larger wind farms are more profitable than smaller ones. Likewise, relatively small increases in wind speed significantly lower the cost of wind power, so that a site with a better wind resource will be more profitable/competitive than a comparable sized wind energy development at a site with lower wind speeds.

Addressing Avian Impacts. Serious problems arose at some older wind farm sites with respect to avian impacts. At Altamont Pass (California), the largest of the early 1980s wind farm developments, a variety of factors (including lattice towers which provided horizontal cross-bars for perching, rapid blade movement, and the close proximity of turbines)

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[1] American Wind Energy Association, P.O. Box 1008, 175 Kerwin Hill, Rd., Norwich, VT 05055
[2] These represent levelized costs at excellent wind sites in nominal dollars, not including tax credit.

resulted in unanticipated negative avian impacts. The wind energy industry has worked to understand the causes of those impacts and to mitigate them in subsequent developments. Lessons learned from Altamont Pass have led to a number of improvements in site assessment and design. The use of much larger turbines that are spread farther apart in all directions; tubular towers with few or no perching opportunities; larger, slower-turning rotors; greater spacing between turbines; and site evaluations that include an assessment of avian risk have all become standard practice.

Wind Energy Poised to Become a Significant Renewable Resource. Currently, wind energy developments provide approximately 0.4% of electricity production in the United States. At the end of 2003, there were 6,374 megawatts (MW) installed, generating approximately 17 billion kilowatt hours per year (kWh/year). This total is equivalent to the usage of more than 1.6 million homes. (As a rule of thumb, 1 MW of power is enough to supply 200-300 homes.) Even though it now meets less than one half of 1% of overall US electricity demand, current wind energy output is equivalent to 8 million tons of coal, 25 million barrels of oil, or 150 billion cubic feet of natural gas. If the 17 billion kWh/year wind-generated power currently being produced in the US were generated using today's average US utility mix, it would result in emissions of: 36,000 tons of NOx (smog); 60,000 tons of SOx (acid rain); 11 million tons of CO_2 (carbon dioxide, a greenhouse gas); mercury and other heavy metals.

The wind industry includes a few large players (FPL Energy, GE Wind, and PPM Energy), but unlike the oil – or even the photovoltaics – industry, about two-thirds of the wind industry is comprised of small businesses (fewer than 10 employees). Wind development plans for the near future are in process in states around the US including California, Iowa, Massachusetts, Montana, New York, Oregon, Texas, Washington State, and West Virginia. Overall, estimates indicate that there may be as much as 2,000 to 3,000 additional MW of wind power developed through 2006, and potentially 9,000 to 19,000 additional MW through 2010. It is anticipated that the bulk of this wind energy development will be concentrated west of the Mississippi, in the Northern Plains, Southwest, and West. Given these statistics, wind energy is ready to become a significant alternative power source in the US, with the potential to generate up to 6% of the United States' electricity by 2020.

Expectations for the Near Future. Although wind turbine technology and strategies for mitigating avian impacts continue to improve, it is unlikely that the current configuration of wind projects will change significantly. The size of onshore wind turbines will likely be constrained to a size of 1.8 MW to 2.0 MW, in the near term. Most turbines will likely be lighted in some form. New transmission lines will not be essential for reaching the aforementioned 2010 production forecast.

Key Factors for Consideration in Wind Plant Siting

by
Sam Enfield, Atlantic Renewable Energy Corporation[3]

The development of a wind energy facility site is an extremely complex endeavor – much like setting up a business to run for 20-30 years. Many US landowners have shown interest in developing wind power on their property. However, landowner interest does not always coincide with the resource and other characteristics that make a good site. As developers seek out suitable sites to build turbines, there are several key factors they must consider: 1) the wind resource; 2) land ownership patterns; 3) access to transmission systems; 4) access to the site itself; 5) the degree of construction difficulty; and 6) environmental issues associated with the site.

Wind resource. The industry has benefited from the development of mapping tools that integrate topology and meteorology to identify areas that are most likely to be windy. Generally speaking, Western sites are characterized by large landforms that channel wind (i.e. Columbia River Gorge). In the East, developers usually must look for smaller ridges where the wind resource is plentiful. Elevation makes a large difference in the capacity factor of a development.

$$\textbf{Capacity Factor} = \frac{\text{amount of power generated over time}}{\text{amount of power over time with constant maximum generation}}$$

In fact, the capacity factor jumps dramatically as elevation increases even by relatively small amounts. For example, a capacity factor of 17% may jump up to 28% with another 250 feet, and up to 35% with an additional 200 feet of elevation.

Ownership and land use patterns. Parcel size is another factor that makes a potential wind facility site suitable for development. Larger parcels are better, as there are fewer owners with whom the developer must negotiate. Large parcels often offer easier access to the site as well. An area with low population density also is preferable. Many land uses are compatible with wind energy development; for example, once turbines are built and operational, farm and grazing land is minimally disrupted by their presence.

Access to transmission lines. Transmission line access is critical to the siting of wind energy facilities. It is much preferred for a site to be within a few miles of transmission lines, and interconnection to the grid must be physically possible as well as economically feasible. Interconnection rules and costs, particularly for an intermittent resource, can be considerable. Part of the problem is that transmission station managers are not used to dealing with an intermittent resource. They are required to accommodate the interconnection if they have the capacity, but obtaining reasonable terms and conditions for the interconnection requires educating station managers about wind power projects' capabilities.

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[3] 22170 Dickerson School Rd. Dickerson, MD 20842-8926

Accessibility. A site must be physically accessible in order to build. Getting large-scale equipment to remote sites can be extremely challenging and may not be possible under some circumstances. The size of roads can and does limit the size of turbines that can be used. Development often damages roads and areas along roads, but developers routinely restore both after construction is completed.

Environmental impacts. Finally, developers must consider the impacts of the wind development site on the human and natural environment. Although turbines are much quieter than they once were, noise is still an issue that must be considered. Aesthetic impacts are highly subjective, but some viewscapes are more sensitive or important to people than others. Any wind project also must comply with wetlands regulations.

Discussion, Questions and Answers

Risks taken by wind project developers. A participant noted that money invested by developers in pre-development studies to examine potential bird and bat impacts at a site under consideration for development is entirely "at-risk." If a developer pays for a $50K study, there is no guarantee the developer will make that money back. Developers are criticized by the environmental community for hesitating to fund such studies, but the bottom line is that when developers fund studies they want to do it wisely.

How does the wind industry's research and development spending compare with that of the oil industry?

Response: (Nobody in the room was sure how oil companies spread their development budgets, but as presenter Tom Gray reminded participants, wind developers—unlike oil companies—tend to be small businesses.)

Comment: In addition to costing money, biological studies take time, which increases the risk incurred by the developer. The longer it takes to build a facility, the longer the period until there is return on the investment. This effectively increases the cost of money, which could make some projects infeasible.

Would putting a set time frame on research (e.g., three years) make carrying out research more manageable?

Responses: 1) Smaller companies would not be able to wait as long as three years for a return on their investment. 2) How much better would the information from a three-year study be compared to a one-year study? Given the investment risk, developers have to ask researchers how critical a difference the extra time spent studying a potential site is likely to make in terms of the decision whether to proceed with development.

What do regulatory agencies require? It was noted that there is a lack of transparency among regulatory agencies as to what applications developers are required to apply for, what studies they must conduct, and how agencies will respond to the results of studies on possible new sites. Given that land use planning is a major issue in every community, the developers must learn how each community operates.

What is AWEA doing to educate its membership about what regulatory agencies are going to require, so that companies are taking consistent approaches to conducting avian impact studies?

Response: AWEA has two siting workshops scheduled for the fall of this year. Otherwise, AWEA's education efforts have been informal. A listserve was set up about six months ago as an effort to inform AWEA members about developments in avian studies. AWEA also recently hired someone to work full-time on siting and development issues.

Dealing with the utilities. *Do developers establish contractual relationships with utility companies during the planning process, and do power grid managers allow wind power facilities in?*

Response: Utilities have to allow wind power in, but only if their system can accommodate it based on their system studies. The receptiveness of grid operators tends to increase as they become familiar with wind systems and how they manage output. Utilities and grid operators do not guarantee any prices, however, and negotiation is ongoing as the project develops.

Conclusions. The Facilitator concluded this session by raising some key questions for participants to consider as the next session kicked off. How can risk to wildlife be reduced? What is the presumption of risk to wildlife going into development? Are agencies and developers using the right tools and asking the right questions to assess that risk?

PRE-DEVELOPMENT PROJECT RISK ASSESSMENT

This session included presentations on the practices and methodologies used in the wind energy industry for assessing risk to birds and bats at candidate project sites. Presenters offered examples of pre-development siting evaluation requirements set by certain states.

Practices and Methodologies and Initial Screening Tools [4]

by
Richard Curry, *Curry & Kerlinger, LLC*[5]

The wind industry is working to develop standardized siting practices, however at this point in time there is only a roughly uniform approach.

Fatal Flaw Analysis. Generally, when wind facility developers identify a strong potential wind site, the first step is to conduct a “fatal flaw analysis.” This initial step involves doing a quick environmental assessment to determine if there are any obvious flaws about the site that would preclude proceeding with a wind resource assessment or permit application. A “fatal flaw” analysis may consist of a basic desktop review of maps, existing literature, or other readily available information about the area and its proximity to known highly sensitive habitat or protected areas. It is wise to start the “fatal flaw” analysis as soon as a potential site is identified, because it takes up to a year to assess the wind resource, and it is advantageous to get the initial environmental assessments completed in that time frame.

Phase One Risk Assessment. If a site presents no obvious “fatal flaws,” the next step is a Phase One Risk Assessment. At this stage, the objectives are to: 1) establish a project- and locale-specific information base, 2) determine the general scope and design of additional information to be gathered, and 3) estimate the general level of risk to the developer – including the possibility that the site will have to be abandoned. Phase One activities include visiting the site to gather information about terrain and land use, habitat, observed species, prey potential, how the proposed project would fit on the site, as well as habitat and land use information about the surrounding area. Developers will supplement this information with a literature search (including databases compiled by Federal and state agencies and non-governmental organizations), and by consulting with government agency biologists, environmental groups, or local bird enthusiasts who may possess unrecorded knowledge about bird activity. Requests by consultants working for the developer for information about the proposed project area from other stakeholders should be taken seriously and responded to in a timely manner.

Pre-Development Studies. The next stage of pre-project assessment involves a more substantial investment of resources. The objectives include: 1) developing a baseline of

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[4] Mr. Curry chose to present a very brief summation of his prepared presentation at the workshop. This summary includes additional details from Mr. Curry’s slide presentation, which is also available as a supplement to these Proceedings.

[5] 1734 Susquehannock Drive, P.O. Box 66, McLean, VA 22101

information about avian and bat use of the site, including use by rare or endangered species or species of special concern; 2) identification of potential avian (or bat) risk factors present at the site; 3) consideration of site topography and turbine layout options for mitigating that risk; and, 4) formulating recommendations for post-construction monitoring and evaluation. A variety of activities are employed to achieve these objectives, including abundance and use surveys (point counts), diurnal migration and nesting surveys, surveys focused on rare, threatened, endangered, or "special concern" species; and, radar and other types of studies to learn about night-time avian and bat activity within the site.

At this stage, all stakeholders need to address the following questions:

- How should this project's impacts be compared with the impact of alternative means of supplying energy?
- What are the site-specific concerns being raised, and are these concerns supported by available and applicable data?
- If there is an absence of applicable information regarding a potential risk, what applicable information *can* be gathered, and how good an indicator is that information as a predictor of the risk in question?
- What methodologies should be used?
- What tools can be used to estimate cumulative impacts?
- What criteria will be used to determine levels of risk and their significance?
- How do these criteria compare with those used to assess the impact of other kinds of projects?

State of the Industry in the Pacific Northwest

by

Andy Linehan, *CH2MHILL*[6]

This presentation focused on the regulatory framework and evolution of permitting processes in the Pacific Northwest, with an emphasis on Oregon and Washington. Topics covered included site risk assessment and tools and processes used to assess the potential biological impact of wind energy projects. Other states can learn about pre-development assessment of environmental risk from the rigorous siting processes required of wind energy plants in the US Pacific Northwest (PNW), because that region has among the most rigorous and well-developed frameworks for environmental analysis to support permitting, and the techniques and processes used in the PNW may provide a sense of the direction that the industry is heading.

The Federal regulatory framework for wind power in the PNW is largely determined by Bonneville Power Administration (BPA), which acquired the Condon and Foote Creek Rim wind projects and issued a request for proposals (RFP) for 1,000 MW of wind power

[6] 825 NE Multnomah, Suite 1300 Portland, OR 97232

in 2000. BPA transmits power from Stateline, Klondike, Vansycle, and other wind projects in the region, and therefore it is the key Federal agency with a National Environmental Policy Act (NEPA) role.

The other regulatory frameworks of interest are the state siting councils that oversee energy facility siting in Washington and Oregon. In Washington State, wind projects may opt into the Energy Facility Site Evaluation Council (EFSEC) process. Washington's State Environmental Protection Act (SEPA) requires a comprehensive analysis (checklist or Environmental Impact Study) of all wind projects. For biological studies, the Washington Department of Fish and Wildlife Windpower Guidelines provide standardized guidance. In Oregon, projects larger than 105 MW must apply for permits through the Oregon Energy Facility Siting Council (EFSC) process. The EFSC process requires compliance with a series of prescriptive siting standards, including Habitat Mitigation Standards. At this point, only the Stateline Wind Project (Phases 1-3), which is one of the largest in the US, has been through EFSC. Smaller projects use local land use processes (i.e., Conditional Use Permit), which are relatively robust under Oregon land use law.

EFSEC and EFSC were developed in response to Washington Power Supply System (WPSS)-era nuclear power plants and coal-fired gas projects in the 500-1,500 MW range, and have been applied to gas-fired combustion turbines, also typically in the 1,000 MW range. Permitting study requirements were developed with projects five to ten times larger than the typical wind project in mind. Thus, on a per-megawatt basis, the EFSEC/EFSC processes are expensive and time-consuming as applied to wind power projects, and agencies and developers have been struggling with the appropriate ways to "scale down" the required studies for wind projects.

The state Fish and Wildlife offices in Washington and Oregon are both very active. Both states have regional and central office biologists responsible for reviewing county and state-level permit processes. The Washington Department of Fish and Wildlife (WDFW) is an agency of "special expertise" under the SEPA, so its review carries weight. In Oregon, ODFW plays a more informal role in County-level energy permitting, although it is routinely involved in the process at this level. ODFW is mandated to participate in EFSC-level permitting. These institutional frameworks for reviewing data are critical for ensuring the value of biological study data in Oregon and Washington.

In Montana, the Montana Environmental Policy Act (MEPA) applies to state agency decisions. Idaho has no state-level NEPA-type process and therefore wind projects are permitted primarily through local land use decisions. However, both states have high proportions of federally owned lands, meaning wind projects often require NEPA review.

Environmental risk assessment is a standard element of site risk assessment in the Pacific Northwest. Early PNW wind project environmental assessment procedures were strongly influenced by the experience of wind power development in Altamont Pass, California. The number of bird fatalities at Altamont generated great concern; however, as results from studies at other western wind facilities became known and showed much less severe impacts, these concerns over avian impacts of wind turbines relaxed somewhat. Overall, bat impacts have received relatively little attention. There has been increasing focus on the impact of habitat loss and fragmentation.

Today's standard wind industry practice for environmental risk assessment in PNW involves seven key elements: 1) Information Review; 2) Habitat Mapping; 3) Raptor Nest Surveys; 4) General Avian Use Surveys; 5) Surveys for Threatened, Endangered, and Sensitive species; 6) Rare Plants Surveys; and 7) Wetlands/Jurisdictional Waters Surveys.[7] The results of these assessments may lead developers to modify the layout of the planned wind development, or even to discontinue the project if the environmental risk is too high. The author is aware of several cases where the developer has abandoned a project because it appeared that environmental impacts would be too high.

Information Review. Information review aims at understanding sensitive habitats and species on a site, formulating study protocols, and beginning to identify mitigation needs and options. Review involves a search of the regulatory databases (i.e. Oregon Natural Heritage Program, Washington Priority Habitats and Species, and USFWS). Developers contact local biologists and/or local environmental groups to gather local knowledge about bird and bat activity. Data are also collected from nearby or similar wind projects.

Habitat Mapping. The goal of habitat mapping is to evaluate the range and condition of habitats on a site, to steer facilities toward low value habitat (such as wheat fields), and to help focus later wildlife surveys. Techniques for habitat mapping vary by state and habitat type, but typically involve a combination of photo interpretation and field work.

Raptor Nest Surveys. Surveys—typically conducted from an aerial view—are used to identify raptor nests that might be affected by construction activities or operation of the wind project. An aerial survey would cover the area within one mile of all ground-disturbing activities, or within two miles if there is a likelihood of sensitive species. For forested areas, other techniques are employed.

Avian Use Surveys. Use surveys characterize avian use of an area well enough to determine if there is significant potential for high bird mortality. Once the level of use is known, a risk index can be developed, based on avian use and bird mortality at established wind projects with similar avian use profiles. The surveys typically involve establishing a grid of 800-meter sampling points spaced one to three miles apart, surrounding the project. Weekly observations are conducted at each point for twenty to thirty minutes. An incidental (driving) survey is also conducted.

BPA funded a project called "Meta-Analysis," which evaluated the extent to which one or more seasons could predict annual avian use. A generally good correlation was found between spring and the rest of the year.[8] WDFW guidelines call for "at least one season" and "additional seasonal data (e.g. fall or winter)" if: 1) "Avian use is estimated to be high relative to other projects"; 2) "Very little existing data regarding seasonal use of area"; or 3) "The project is especially large." Typically, avian use studies of less than one year have been accompanied by a commitment to a year of post-construction mortality monitoring.

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[7] Rare plants and wetlands surveys are outside the focus of these Proceedings, and are not detailed here.
[8] Erickson, W., et al. 2002.

Avian use studies may also involve night radar monitoring in order to characterize nocturnal bird use of a site, particularly during migratory periods. Nocturnal use is characterized in terms of passage rates of “targets” (which may be bats, birds, or clouds of insects) and flight height/turbine height exposure. Sampling is carried out using mobile marine radar in horizontal and vertical mode to detect radar targets and to determine number, direction, and height. The challenges presented by night radar monitoring revolve around distinguishing among bird, bat, and insect targets, and identifying different bird species. However, improvements in radar technology are making it somewhat easier to distinguish insects from birds. Thermal imaging and bird call identification are also being employed.

The Stateline Wind Project on the border between Washington and Oregon offers an example of a case where night radar monitoring might be useful. The Blue Mountain Audubon Society expressed concern about migratory bird corridors running through the proposed northwest portion of the project. FPL Energy agreed to make the construction of 72 turbines contingent on the results of night radar monitoring. ABR Inc. conducted a total of three seasons of monitoring at two locations, one of which had actual mortality data available. Actual mortality data from the Vansycle site were used in conjunction with radar data to evaluate potential mortality at the proposed site. Data from Fall 2000 and Spring 2001 were adequate to demonstrate low potential for impact from the 72 proposed turbines. Blue Mountain Audubon Society, which was represented on the project’s Technical Advisory Committee, not only approved the construction of additional turbines at Stateline, but has gone on to play an important educational role with other Audubon Societies in the state of Washington.

The methodologies used for threatened, endangered, and sensitive species surveys vary substantially by species in the PNW. Some of the key species of concern in the region are Bald and Golden eagles, Sage grouse, Prairie chickens, Spotted owls, and the Washington ground squirrel.

Standard wind industry practice for pre-development environmental risk assessment in PNW has evolved in tandem with post-construction monitoring. In general, with the exception of Altamont, post-construction monitoring at Western wind energy sites has confirmed low impact on birds. The focus of assessment continues to evolve away from avian mortality to an emphasis on habitat impacts.

References

Erickson, Wally/WEST, Inc. et al., 2002. *Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting, and Mortality Information from Proposed and Existing Wind Developments*. Prepared for the Bonneville Power Administration.

Discussion, Questions and Answers

Where do study requirements—and study findings—fit into the permitting process? One participant requested clarification, noting that, in the Eastern US, the term "pre-permitting" is used (rather than "pre-project," pre-development," or "pre-construction") to mean that impact studies must be done before a permit can be obtained for the wind project, although often there is no framework for evaluating the study results.

Responses: In the PNW, there are regulations that say environmental assessments should be carried out as part of project development, and usually before a permit will be issued. However (another participant noted), there is at least one case of a project in Oregon that was issued county permits prior to conducting a full year of avian impact studies.

Would it be possible, after construction, to require wind project managers to modify their operations as new information about bird impacts is made available? The participant raising this question asked whether, for example, if researchers identified new information about migration patterns once a project was operating, whether it might be possible to shut down turbines with higher mortality rates for certain periods of time when migrating birds are at risk.

Responses: 1) Wind power developers are likely to resist the idea due to the large amount of capital invested in the turbines. 2) There is an example of a wind project in Spain, near the Straits of Gibraltar, at which radar studies revealed bird "migration pulses" — times when many birds passed through the area of the wind farm. Based on this information, the operators were able to shut down operations for a specific period of time to avoid significant mortality risk. In addition, one or two turbines were removed.

Are there permitting conditions or thresholds regarding size and scale of projects?

Responses: 1) Project size is a valid consideration, but in at least some locations (e.g., the state of New Jersey), small projects are subject to the same regulations as large ones. 2) Under NEPA, projects for which it is proven that significant impacts will not result are able to go through a less stringent permitting process—that is, the determination of significance is independent of the size of the project.

How do you "prove" that "significant impacts" will not result? In other words, what is a "significant impact" and what is the threshold of acceptability for impacts? There are a wide variety of standards across locations and jurisdictions when it comes to standards for measuring bird and bat impacts and what is an acceptable level in terms of issuing permits to developers. This variability raises many questions. For example, how many years should an impact study be? How many bird fatalities amount to a significant impact? Is there a fixed threshold for permitting?

Responses:

1) One organization’s policy for dealing with these issues in the state of Washington is that the state should be completely mapped to indicate potential wind project areas, mitigation areas, etc.

2) If the standard approaches for diurnal and nesting surveys are used consistently throughout regions and the US, there are sub-regional conclusions that can be developed.

3) Wisconsin undertook a collaborative statewide monitoring effort that brought state and federal agencies together with local groups. The group examined formal bird viewing areas as well as local viewing spots and drew red lines around sensitive bird areas. It was noted that it is helpful if the methods necessary to carry out surveys could be performed by volunteers.

Other discussion of mapping efforts:

There are similar statewide mapping processes taking place in other parts of the US as well. One participant described a statewide process that is taking place in Virginia, using GIS technology to map bird activity and habitat. In Maryland, researchers are in the process of developing a layered GIS-analysis of bird activity that is intended to be a model for this type of work. There are also plans to incorporate conditions for limited turbine shutdowns into the policy recommendations developed out of the Maryland effort. However, there is no strict standard or threshold for determining how significant mortality must be to recommend turbine shutdowns. In New Jersey, critical wildlife areas have been mapped in relation to development, but state agencies are still trying to get funding to specifically map bird activity and habitat. California has also done work along these lines. Public and private funding will be necessary in order for mapping to proceed efficiently and effectively and for comprehensive databases on par with those for fish for example, to be compiled.

Caveats about mapping and assessing risk based on avian use:

1) While GIS is good for mapping large areas, wind development permitting often comes down to very site-specific issues, requiring intense surveying/data-gathering that cannot be afforded for very large (e.g., state-wide) efforts. Moreover, there are significant data gaps in GIS information because there is no data on nocturnal mortality for much of the US and about half of fatalities occur at night.

2) Avian “use” does not necessarily connote risk, even among bird species on a single site. Behavioral aspects must be considered as well. Data from Altamont Pass underscores this point.

3) The wind industry is definitely interested in how GIS information can help in the siting process to minimize impacts on birds and bats—for example, by providing pre-

construction baseline information. On the other hand, waiting to complete statewide mapping efforts before pursuing wind energy development would mean considerable delay in the construction of new wind projects, and the construction instead of more polluting conventional generation.

MONITORING WIND TURBINE PROJECT SITES FOR AVIAN IMPACTS

This session focused on existing wind projects are monitored for their impacts on birds and bats. How many existing energy projects are or have been monitored for avian and bat impacts? Are there case examples of requirements for such monitoring? What are the options for designing and implementing scientifically sound monitoring programs for avian mortality – how is monitoring conducted? Are results made public? What are the metrics being employed to measure impacts?

Bird and Bat Fatality Monitoring Methods

by
Wally Erickson, *West, Inc.*[9]

Protocol development and review. Protocols for bird and bat fatality monitoring depend to some degree on the requirements of the permitting agency. One approach (used at the Vansycle site and now at most new projects) employs a Technical Advisory Committee (TAC) to help develop and review monitoring protocols, gather and process peer review reports, and make recommendations to permitting authorities on further studies and possible project/site changes necessary to mitigate impacts. Consultants on the development of such protocols may include organizations, agencies, and private interests such as Audubon Society, USFWS, state wildlife agencies, developers, researchers, and landowners. Bird and bat fatality monitoring protocols usually are part of an adaptive management approach, ensuring room for flexibility as new data/information is made available.

Methodology. Standardized carcass searches are the primary method employed to determine the level of bird and bat mortality at project sites. Both rectangular and circular plots have been used, with rectangular plots being easier to manage. Plot size depends on turbine size, the distribution of fatalities, habitat at the site, and the cost of the study versus the data researchers anticipate gathering. Search plots may need to be extended on the down-wind side, where more carcasses tend to be located. (Slides show rectangular search plots mapped for the Nine-Canyon wind project, along with the distribution of distances from bird and bat fatalities to the nearest turbine. At this site, bird fatalities tended to be within 120 m of the nearest turbine, while bat fatalities tended to be within 50 m of the nearest turbine. Turbines were 92 m tall to the blade tips, with rotors 62 m in diameter.)

Depending on plot size and terrain, time spent searching around each turbine can range from ten minutes to two hours, at a walking pace of 30-60 m/minute. Some studies only sample portions of plots, usually mowed areas. Search frequency varies from daily to every five weeks. Uncertainty in fatality estimates increases as the ratio of interval between searches to mean removal time increases. Longer search intervals also limit the ability to

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understand potential associations between fatalities and weather. One way to compensate is to intensively search a small sample area, and search the remaining sample area less intensively. This can help clarify the relationship between weather events and fatalities and allow researchers to adjust the scavenging rate.

Carcass search studies categorize finds as *intact*, *scavenged*, or as a *feather spot*. “Intact” indicates that the carcass is completely intact, not badly decomposed, and showing little or no sign of having been fed upon by a predator or scavenger. “Scavenged” denotes an entire carcass which is to some degree dismembered and shows signs of having been fed upon by a predator or scavenger. A “feather spot” consists of ten or more feathers, or two primary feathers at one location, indicating predation or scavenging. Most recent studies include feather spots as project-related fatalities. This means that fatality rates may be artificially high as some may have resulted from natural predation or other non-project related cause. For example, at Buffalo Ridge, Minnesota, estimates of fatality rates at plots without turbines were one-third of the estimate at turbines.

Adjusting for scavenging rates. Fatalities attributed to wind turbines must also be adjusted upward to account for carcasses that are removed by scavengers during the intervals between scheduled searches. This is done by conducting carcass removal trials. A variety of carcasses – including rock dove, house sparrow, starling, upland gamebird, waterfowl, and raptor carcasses are placed in a field to see what environmental effects they experience, primarily whether they disappear or are fed upon. Carcasses (which are frozen but have been thawed for 8-24 hours before use) are placed randomly in the vicinity of turbines which are part of a regular search regime, near turbines not routinely searched, and within plots away from turbines. The percentage of carcasses removed by scavengers or by other means is usually tracked daily for the first few days, and less frequently for the remainder of the trials. Removal rates are used to adjust observed fatality rates upwards, and should also be used to determine the search interval.

Adjusting for observer detection bias. Observer detection trials are employed to adjust observed fatality rates for searcher bias. The result of this method is an estimate of the average probability a wind turbine fatality that is available is found during a search. The trial carcasses are placed randomly in search plots. Searchers are not informed when and where trials are taking place, though they may become aware of the trial if they find a marked carcass.

The solutions employed for adjusting fatality rates for the standardized carcass search may contribute their own biases. For example, some casualties or injured birds may land or move outside of the search plot. Ignoring this potential source of bias could lead to underestimating the fatality rate. Other issues brought up by others include the fact that removal trial carcasses located away from turbine strings may be scavenged at a different rate than carcasses near string, which could also bias the findings. Scavengers may be attracted to the scent of humans who put carcasses in the field, which would artificially increase scavenging rates. Lastly, small bird trials may not be representative of bats.

Simulations show that formulas for calculating fatality estimates are unbiased or close to unbiased, and that potential biases that exist in the sampling procedures of carcass searches and carcass removal trials mostly lead to an overestimate of bird fatalities. The most effective answer to these problems may be more intensive sampling at some turbines, which is an approach currently taken at a couple of sites.

The methods described in this presentation were published in a peer-reviewed article about research at Buffalo Ridge, Minnesota (Johnson et al. 2002). There is a forthcoming article describing these methods as they were used at the Stateline project in the Pacific Northwest. Some of the earlier fatality studies were conducted over periods as long as four years, however, protocols have changed and this is less common now.

Reference

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Discussion, Questions and Answers

Has the hypothesis that small passerines basically disintegrate when they fly into turbine blades (the so-called "poofing principle") ever been tested?

Responses: 1) Most fatalities that are found tend to be intact. 2) Researchers could examine airline trials that test the impacts of windshields on birds.

What is done with birds found alive, but injured?

Response: If a bird is rehabilitated and released then it is not included in fatality data. If it dies or is euthanized, it is included.

Please distinguish between carcass search and carcass removal trial methodologies.

Fatality searches and carcass removal trials are conducted separately, with detection and scavenging data kept separate. "Availability" estimates resulting from carcass removal trials (i.e. scavenging adjustment) are integrated into the final calculation of fatality detection results. At Tehachapi Pass, carcass removal trials were conducted at sunup and then at sundown. It was found that most carcasses were scavenged during the day because ravens locate carcasses by sight. In addition, large carcasses were taken before smaller ones. Carcass removal trials tend to overestimate scavenging rates, which in turn leads to an overestimate of overall fatality rates from wind turbines.

Other points noted by participants:
A participant suggested that if only about 1-3 birds are killed per turbine per year, this does not seem like a major food source that would attract scavengers or predators.
There appears to be more annual variation in fatalities for bats than for birds. There is seasonal variation for both.

WHY AVIAN IMPACTS ARE A CONCERN IN WIND ENERGY DEVELOPMENT

This lunchtime session provided a more detailed overview of the environmental community's perspective on wind power's impacts on birds. The presentation described how wind projects impact birds, detailing the species distribution of collisions at various sites around the US and discussing problems such as avoidance, habitat disturbance, and cumulative effects on populations.

Wind Turbines and Birds

by
Gerald Winegrad, *American Bird Conservancy*[10]

While still a small component of overall energy output in the US (0.3%), wind energy is the fastest growing energy source in the country. In 1981, the capacity of US wind energy installations was only 10 MW. By 2000, capacity had reached 2,554 MW. In 2004, 16,000 utility-scale wind turbines are operating in 30 states with a capacity of approximately 6,370 MW. The wind industry's goal is to supply 6% of America's electrical energy by 2020. Fourteen states have already adopted Renewable Portfolio Standards requiring utilities to use a specified portion of renewable energy in their electrical supply. Federal legislation is pending, which would require 10% of energy nationwide to come from renewable sources by 2020. Currently, California requires that 20% of electrical use come from renewable sources by 2017, and New York has set the bar at 25% by 2012.

Wind energy production may affect birds in three ways: First and the most widely noted, are fatalities resulting from collisions with rotors, towers, power lines, or with other related structures. Electrocution on power lines is also possible. Second, birds may avoid wind turbines and the habitat surrounding them. Third, are the direct impacts on bird habitat from the footprint of turbines, roads, power lines, and auxiliary buildings.

While annual per-turbine mortality rates average 2.19 birds or 1.825 outside of California (and the highest recorded per turbine mortality of 7.5 at Buffalo Mountain, Tennessee), there are a number of environmental concerns. One of the key concerns is mortality or other effects on ESA-listed species or Birds of Conservation Concern. There are worries about local or regional population impacts on species such as Golden eagles, other raptors, grassland breeders, and Horned Larks. Cumulative impacts on species at national and regional scales as well around individual projects, especially large ones, are of concern. One concern regarding research to date is that most of the wind projects that have been monitored for bird impacts are in the West. In the eastern US, locating wind turbines along ridge tops and potentially off-shore are both of concern. Finally, growth in the number of wind turbines and their increasing height, have the potential for more avian impacts.

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Avoidance and direct habitat impacts are also of concern to wildlife conservationists. For example, Prairie Grouse species are affected by habitat fragmentation and have been observed avoiding breeding leks near wind projects. Researchers also have noted direct habitat loss from wind facilities.

A wide variety of bird species have been killed at wind turbine sites. Fatality searches at various wind projects have yielded fatalities of a number of USFWS Birds of Conservation Concern, including particular species of owls, hawks, and other raptors, sparrows, wrens, warblers, and others. At communication towers (*not* wind turbines) Over 90% of all bird species killed are neo-tropical migrants, with 230 species documented as being killed at such towers. Sixty-four of those neo-tropical migrant species are on the USFWS Birds of Management Concern List, meaning that without strong management measures, in the future they may be listed under the Endangered Species Act. In addition, some endangered bird species have been killed.

Findings from studies done on the impact of communication towers on birds offer some lessons on the potential cumulative effects of wind turbines on bird populations. For example, a 29-year study at a single TV tower in Tallahassee, Florida yielded 44,007 birds (representing 186 species) killed. Many of the birds identified in this study were USFWS Birds of Conservation Concern. Another example comes from Eau Claire, Wisconsin where a 38-year study at a single 1,000-foot TV tower documented 121,560 birds killed (representing 123 species), primarily long-distance migrants. Significant numbers such as these led the Director of USFWS to issue a letter to the Chairman of the FCC in 1999, recommending that the FCC prepare a programmatic EIS under NEPA to delineate the extent of bird mortality due to communication towers and to develop mitigation measures. The USFWS Director referenced data that suggest the annual death toll of migratory birds due to communication towers could be from 4 to 40 million. Although communication tower impacts and wind turbine impacts are separate issues, the extent of cumulative impacts at communication towers may be taken as instructive.

There are certain measures that can be taken to prevent/minimize avian and other wildlife impacts at each wind energy project. A thorough review for potential avian mortality and disturbance of critical habitat should be conducted before construction of any new wind energy project. Bird impacts due to habitat fragmentation and any other habitat impacts related to construction and/or operation of a wind facility should be thoroughly evaluated and measures should be taken to prevent/minimize mortality and non-lethal impacts. Projects should be sited on areas with disturbed habitat wherever possible. Sites with major bird attractants (such as Altamont Pass, California) should be avoided. Attention should be paid to impacts on specific species, not just general numbers of kills. The use of guy wires should be avoided. Transmission lines should be placed underground to minimize project footprint. Lighting should be minimized, with only a limited number of towers being lit using only white or red strobes at no more than 24 pulses per minute. Sites should be monitored using scientifically rigorous methods, and data should be published.

Currently, there are a few existing examples of guidelines that make similar recommendations to those listed above:

1) USFWS Interim Guidelines to Avoid and Minimize Wildlife Impacts From Wind Turbines (July 2003);
2) Washington State Department of Fish and Wildlife Wind Power Guidelines (August 2003); and
3) Siting guidelines developed in the State of Kansas.

Ultimately, all energy choices have implications for birds. In 2001, conventional electricity generating power plants produced 36% of the carbon dioxide, 68% of the sulfur dioxide, 38% of the nitrogen dioxide, and 23% of the toxic heavy metals in the US. The US is expected to increase its carbon dioxide emissions by 43.5% between 2001 and 2025. Over 52% of the nation's electricity is produced from coal burning power plants. Mining for fossil fuels like coal can devastate bird habitat – witness the 387,000 acres of Appalachian mature deciduous forests destroyed by mountaintop removal and valley fill operations in West Virginia, Tennessee, Kentucky, and Virginia. This operation is likely to have a massive and permanent impact on the entire suite of Partners in Flight mature forest birds, the most notable of which is the Cerulean Warbler, a species proposed for listing under the ESA. The loss of these Appalachian forests will result in a loss of as many as 191,722 of the global population of about 560,000 Cerulean Warblers. In addition, 1,200 miles of streams have been filled with mining waste. Another 380,000 acres of mountain top removal is projected in the next decade along with 1,000 miles of streams being filled.

Current wind energy generating capacity in the US could prevent the burning of 8.4 million tons of coal at the current utility fuel mix. For each Megawatt of wind energy produced, 2,000 tons of carbon dioxide greenhouse gases are avoided, 10 tons of sulfur dioxide, and 6 tons of nitrogen dioxide. In addition, newer turbines are larger and can produce twenty times more electricity than turbines from the early 1980s.

Thus, if the proper measures are taken to prevent/minimize avian impacts, particularly to ESA-listed and other species of concern, wind energy can be a win-win development for birds and clean, renewable energy for the future.

Discussion, Questions and Answers

Are there any examples of projects in the Eastern US where the pre-construction criteria discussed in the presentation were adequately met?

Response: I am not familiar with the pre-construction reviews conducted at either the Buffalo Ridge, Tennessee or Mountaineer, West Virginia wind projects or other operating wind projects in the Eastern U.S. Relatively low impacts on birds have been found at Buffalo Ridge and Mountaineer. However, the record number of bats (47.53 per turbine) killed at the Mountaineer site is of concern and indicates that wind energy's impact on bats also needs to be considered, and should be treated as a separate issue. Bat mortality ranges have been low at other facilities, down to as low as 0.7 bats per turbine per year at the Vansycle, Oregon wind project site. This needs to be and is being addressed.

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
Carl Thelander, *BioResource Consultants*[11]

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.

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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
Wally Erickson, *West, Inc.*

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.

NON-FATALITY AND HABITAT IMPACTS ON BIRDS FROM WIND ENERGY DEVELOPMENT

This session focused on discussion of non-collision impacts of wind energy projects on birds, primarily impacts to habitat. The presentation included information about the impacts of habitat fragmentation, disturbance, and site avoidance from wind turbines, as well as from roads, transmission facilities, and other related construction at wind project sites. Whether birds habituate to the presence of turbines and the influence of regional factors were also addressed.

Overview of Non-Collision Related Impacts from Wind Projects

by
Dale Strickland, *West, Inc.*

There are a variety of direct and indirect, long-term and short-term non-collision impacts that wind projects may have on birds. Direct loss of habitat results from the construction of turbine pads, roads, and substations. Indirect loss of habitat may occur from birds' behavioral responses to development, such as avoiding wind plant facilities and areas surrounding them. Long-term habitat impacts result from the construction of relatively permanent structures that remove habitat for the life of a project and from birds avoiding habitat disturbed by a wind plant and not habituating (i.e., becoming accustomed) to wind plant features. Short-term habitat impacts occur while habitat disturbed temporarily during construction of the wind plant is being restored and/or while birds habituate to the disturbance.

Direct Habitat Disturbances. Some estimates as to the extent of direct habitat disturbances from wind project development were drawn from the Foote Creek Rim site in Wyoming and several projects in the Pacific Northwest (e.g., State Line in Washington and Oregon). Temporary impacts from the construction of roads, turbine pads, and substations were 0.4 to 2.6 acres per turbine or 0.6 to 1.7 acres per MW. Long-term impacts from permanent facilities were 0.7 to 1 acres per turbine, or 0.4 to 0.7 acres per MW. The overall magnitude of impacts and the potential for successful reclamation of sites depends on the ecological context and characteristics of the site, the type of turbines being built, and the design of the reclamation plan. For example, a prairie area dominated by tall grass with good moisture has a better chance for reclamation than a cold desert area dominated by sagebrush. Flat sites require less topographic restructuring than rougher terrain, and arranging turbines in compact strings requires less road-building than widely dispersed turbines.

Displacement Impacts. Displacement of birds is a potential indirect impact. In Europe wind plant-related displacement effects are considered to have a greater impact on birds than collision mortality. European studies suggest that most displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 m to as far as 800 m away from turbines. In a Denmark study, eiders were found to avoid desirable feeding areas within 100 m of turbines but no population impacts were detected.

Studies at Buffalo Ridge, Minnesota indicated small-scale displacement of less than 100 meters (Leddy 1999; Johnson et al. 2000). Use by grassland species was significantly lower in plots containing turbines than in plots without turbines. On a broader scale, there was a slight reduction in use of the Buffalo Ridge Wind Resource Area by some species during spring and fall, but no reduction in use during the breeding season. At Stateline (Oregon/Washington), bird use appears to be significantly less within 50 m of turbines. In Wisconsin, there appeared to be no significant displacement of birds from the general area of a wind plant as compared to a reference area (Howe, Evans, and Wolf 2002). Several other Western and Midwestern sites show small-scale impacts. Small scale impacts have been reported in ongoing studies including at the Ponnequin site in Colorado, a site in North Dakota, a site in Montana, and a site at the National Wind Technology Center in Golden Colorado. Habituation may be occurring at the Ponnequin site (Paul Kerlinger, pers. comm.).

In a study of a similar development involving natural gas impact on sagebrush steppe habitat, sagebrush obligates showed a 39%-60% reduction in use within 100 m of roads carrying 10-700 vehicles per day. Sage sparrows showed significant reduction in use along a gas pipeline with no traffic. The horned lark, by contrast, showed a slight increase in use within 100 m of gravel road. Changes can be attributed to traffic, noise, vegetation change and an increase in "edge" habitat (with related predation) (Ingelfinger and Anderson, in preparation).

US Fish and Wildlife Service guidelines suggest a 5-mile impact to Prairie grouse leks (breeding grounds) from wind development. While we could find no data suggesting an impact radius in the published literature on wind development, studies of the impacts of other human disturbances (e.g., construction of houses and roads, oil and natural gas development) on Prairie chickens and Sage grouse indicate that birds do avoid disturbed areas. Prairie chickens seldom nested or raised broods within one mile of an operating coal-fired power plant in Kansas, and seldom nested within a half mile of inhabited homes, well-traveled roads, a compressor station, or within 200 yards of highways or other habitat edge (Robel 2002). For sage grouse, leks within 3 km of development of a gas well showed lower nest initiation rates, with birds traveling twice as far to nest, although nesting success was the same in disturbed and undisturbed areas (Lyon 2000). Sage grouse use was found to increase with distance (up to 600 m) from powerlines (Braun, unpub. data). Greater Sage Grouse and Sagebrush Steppe Ecosystem Management Guidelines[13] suggest avoiding surface occupancy within 1 km of seasonal habitat (e.g., lek, nesting habitat, winter habitat) of sage grouse.

There have been a few specific studies of displacement effects at wind sites. For example, a population of Mountain plovers inhabiting the wind plant site at Foote Creek, Wyoming declined from a mean of 50 during the two years prior to wind plant construction, to a

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[13] A set of guidelines prepared by the Bureau of Land Management, US Fish and Wildlife Service, US Forest Service, Oregon Department of Fish and Wildlife and Oregon Department of State Lands, August 21, 2000.

mean of 28 in the five years during and after construction. Mountain plover use on a reference area declined from 30 to 9 over the same period of time. The decline in both areas appeared to coincide with a regional decline in Mountain plover abundance (Knopf, pers. comm.).

The only published report of avoidance of wind plants by raptors came out of a study conducted at Buffalo Ridge, Minnesota (Usgaard et al. 1997). This study estimated a nest density on a 261 square-kilometer of land surrounding the wind plant of 5.94/100 square km. Based on that density, researchers predicted that there would be approximately 2 nests found on the 32 square-km wind plant facility site with similar habitat. However, no nests were found on the wind plant site. In contrast, a study of raptors' responses to wind development show a similar number of raptor nests before and after wind plant construction at Montezuma Hills, California (Howell and Noone 1992). At Foote Creek Rim, Wyoming eight Red-tailed hawks, one Great horned owl, and one Golden eagle successfully nested within one mile of the wind plant. A successful Swainson's hawk nest was found within 0.8 km of an Oregon wind plant (Johnson et al. 2003). Finally, there is also anecdotal evidence that raptor use of Altamont Pass WRA may have increased with the installation of wind plant turbines (Orloff and Flannery 1992; AWEA 1995).

Several conclusions can be drawn regarding non-collision impacts of wind projects on birds. First, reduced use or displacement of some birds probably occurs primarily in close proximity to turbines, with the actual distance depending on the species and probably ranging from < 100m to 3 km. There may be a relatively minor reduction in use of WRAs by song birds, primarily during spring and fall, which would not be expected to have population consequences on a regional scale. Direct impacts on habitat have been based on predictions and not empirical measurements. Overall, there is still much uncertainty about the extent of indirect impacts of wind plants, particularly on Prairie grouse. Remaining concerns include habitat fragmentation by roads and the impact of turbines on behavior.

Further research is necessary on a few aspects of non-collision impacts of wind plant facilities on birds. First, more work should be done on the relationship between small-scale and large-scale impacts of wind development. Predictions of direct impact should be evaluated by quantification of actual habitat impacts and correlated with project features and site characteristics. Indirect impacts should be quantified, particularly on Prairie grouse. There should be consideration of the linkage between non-fatality impacts to population dynamics and biological significance. Finally, sites should be monitored to track the progressive (cumulative) spatial impact of wind sites on animal behavior over time using resource selection statistics (Manly et al. 2002).

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Discussion, Questions and Answers

Species discussed in the presentation were all western species; is there information on waterfowl or other species in the eastern US?

Response: It was noted that data from offshore sites in Europe do indicate some impact on water birds such as sea ducks. As for the eastern US, there has been little research done on non-collision impacts of wind development in the region. One may assume, however, that if the habitat used by an obligate species is removed, use by that species will decline.

OFFSHORE WIND

This session addressed the current state of offshore wind energy development. The first presentation summarized selected environmental studies conducted to date at operating offshore wind turbine projects in Denmark and lessons from other offshore wind developments in Europe. Wildlife impacts studies from the Danish sites focused on birds, fish, and mammals. The second presentation provided an update on current permit applications for offshore wind developments in the US, as well as lessons that may be drawn from the European experience.

Monitoring Program and Results: Horns Rev and Nysted

by
Jette Gaarde, *Elsam Engineering*[14]

Denmark started to site offshore wind farms in the 1980s, and is now one of the leading countries in offshore wind installations in Europe. Of 3 GW total electricity consumption, 422 MW (15.9% of consumption) is wind-generated, with another 400 MW planned.

The Danish process to approve construction of offshore wind farms involves several steps, including rigorous pre-construction environmental impact assessment (EIA) and post-construction monitoring. The Danish EIA process involves collection of baseline data, including a description of the proposed site area and evaluation of the possible effects of the wind farm on the environment. (A screening year and year-and-a-half baseline period are used together to provide baseline data for impact assessment purposes.) Post-construction environmental monitoring takes place for two to three years after construction, with annual reports due to the government.

This presentation outlines the Danish siting/EIA process, in the context of the development of Denmark's Horns Rev and Nysted offshore wind projects, developed by Elsam Engineering. In 1998, the Danish government issued a ministerial order for the construction of five wind farms. Sites had to be no more than 12-15 m deep. Protected areas and military exclusion zones were avoided. Three of the five sites originally identified were later dropped, leaving Horns Rev and Nysted. Elsam Engineering's formal application was reviewed, and in 1999, an in-principle approval was issued. The in-principle approval set the preliminary engineering and pre-construction environmental assessment into motion. In 2001, final approval of the projects was obtained after public hearings and government acceptance of Elsam's EIA reports and project proposals.

The Horns Rev site is located 14 km off the western coast of Denmark and consists of 80 2-MW turbines built on a seabed of sand, in water 6.5-13.5 m deep. A monopile foundation design was employed at this site. The Nysted project is located 10 km off the coast and consists of 72 2.3-MW turbines built on a seabed of sand over heavy clay, in

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[14] Kraftvaerksvej 53, DK-7000 Fredericia

water 6.5-9.5 m deep. A gravitation foundation design was employed at the Nysted site.

Developers gathered baseline information over a period of about a year at each site, and monitored the sites for a variety of potential impacts, including: disturbance effect and risk of collision for birds; impact on mammals (e.g., seals and porpoises); impacts on fish; and impacts on bottom-dwelling flora and fauna. Geomorphology and noise/vibration effects were also monitored. Impact surveys were conducted on the introduction of hardbed habitat (artificial reef effect) and on the farm's visual and socioeconomic significance. Methodologies employed include underwater surveys of hard bottom and fish communities around turbine foundations, aerial surveys of birds and seals, radar studies to count migrating birds, infrared (IR) camera monitoring of birds, and remote video registration of seals.

Seals are of particular concern with respect to Danish offshore wind development as they are protected under an EU habitat directive and the Jutland Wadden Sea, which surrounds Denmark, has a population of 3,500 seals. Ten seals were marked and tracked in order to examine temporary and permanent impacts on the species from the construction phase of the project. Preliminary conclusions indicated that seals travel farther than presumed. There were large seasonal and individual variations. Some of the marked seals moved to German territory.

Porpoises are another mammal of potential concern in waters off Denmark. Previous surveys indicated that the Horns Rev area is one of high density for porpoises, and so an evaluation of the entire area's importance for porpoises was conducted. It was found that porpoise activity decreased in and outside of the wind farm area during the ramming process that is part of the installation phase of the project, but returned to normal levels three to four hours after ramming. Throughout the construction phase, there was a general effect on the behavior of the animal up to 10-15 km from the wind farm. During construction, a pinging device was used to disperse the mammals from the immediate area and thereby mitigate noise impacts. It is not certain how effective these measures are because of the lack of data on potential noise impacts. Studies are still being conducted to determine the possible effects of noise on marine species, particularly porpoises.

The impact of offshore wind power developments on bird species is also of potential concern. The Horns Rev wind farm area is of international importance for the Red- and Black-throated diver, Eider, Common scoter, Common tern, and Sandwich tern. The area also holds large numbers Guillemot, Gulls, and Gannet. Bird impact studies at the Horns Rev wind development examined disturbance impacts on wintering and resting bird species and collision risk for migrating and local species. Research at the site focused on the wind farm area itself, a transect outlining the wind farm 2 km out, and another transect at 4 km out from the actual site boundary.

Disturbance impacts were assessed by estimating the area's importance to birds, and gathering detailed baseline information. Disturbance observations (counts from planes) are made during months where weather permits. By integrating these data an estimate of the potential impacts on wintering and resting birds was made. One species examined was the Common scoter, which may have been displaced by the construction of the turbines.

However, further research is necessary to determine whether their movement might have been a function of natural variation in the feeding ground, or related directly to the wind farm construction. At Horns Rev, bird disturbance studies concluded that Divers and Razorbills seem to move away from the wind farm area during construction (without statistical significance), while Herring Gulls are attracted to the wind farm area (with statistical significance).

Collision investigations also are conducted about once a month, using radar observations (from a transformer station in the NE corner of the array) and visual observation (to detect type of bird). Collision risk studies at Horns Rev involved collecting baseline data for evaluating collision risk and quantifying the risk of collision frequency. The basic categories of bird activity investigated were occurrence (species, number, day/night, where, when); avoidance/attraction; flying height, speed, and direction; size of flock; activity (foraging, transit); and weather. Based on visual and radar observations, it was found that for the most part birds passing through the Horns Rev area were flying north to south. Birds have been observed flying around the wind farm area and some have been seen flying between the turbines. Plans have been made to start vertical radar studies to determine if/how many fly over the site. There were no direct observations of collisions/ fatalities at Horns Rev. However, it is important to remember that because it is an offshore site, it is difficult to identify fatalities by collecting carcasses.

In addition to wind development's impacts on wildlife, the socioeconomic, visual, and noise impacts are also considered by Danish developers. The sociological aspect seeks to determine and explain the preferences of the public. The economic aspect attempts to evaluate the economic consequences of offshore wind turbines in relation to individual preferences. The visual impact of Horns Rev after construction is comparable, if not less than expected, to pre-construction computer-generated visualizations of the view from the coast.

What Has the US Wind Industry Learned from the European Example?

by
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Offshore wind power development is currently under consideration in the United States, with research being conducted by the National Renewable Energy Laboratory (NREL).

NREL is mapping the offshore wind resource along the northeast coastline, investigating the permit process, regulatory requirements, and potential ecological impacts, and evaluating technology pathways for an offshore wind industry in the US. As with onshore wind projects, there are many potential ecological concerns to consider in siting and construction, including potential impacts on: sea mammals, fisheries and avian species; hydrography, coastline, and artificial reefs. Viewshed, socioeconomics, and noise/vibration impacts need to be taken into account, as well as the potential for disturbing radar/radio

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communications, navigation and air traffic, and marine archaeology. Logistics and maintenance issues also need to be taken into account, in relation to increased traffic and the potential impact from subsea cables and transmission lines.

Fortunately, developers and regulators in the US have the benefit of drawing on the European offshore experience to date as the US enters into this phase of offshore wind energy development. European offshore wind farms have been in operation since the early 1990s, and there are a variety of lessons to be learned from the approach of European developers and governments to the development of offshore wind facilities.

- Heavily subsidized demonstration projects (essentially public-private partnerships) were very important and provided useful learning. For example, the Danish government has allocated over a million US dollars annually into environmental monitoring of offshore wind projects.
- Preliminary conclusions across European sites are lacking, although a European Community effort comparing findings from 180 sites is underway.
- Good baseline studies are critical for monitoring purposes. The most scientifically rigorous results are obtained with Before-After-Control-Impact (BACI) methodologies. Study designs and results must be peer reviewed.
- Establishing "zones for development" may help developers avoid sensitive ecological areas. For example, the United Kingdom outlines areas suitable for wind development before developers could make proposals. In addition, the European Union designates protected areas and countries must adhere to the designations as they develop wind energy facilities.
- Viewsheds are a controversial aspect of offshore wind development.
- Finally, the European experience demonstrates the effectiveness of a national energy policy comprising both political will and financial incentives (i.e. lawsuits are not typical). The Kyoto agreement has been a key factor motivating offshore wind policy in Europe.

There have been several offshore wind permit applications proposed in different US Army Corps of Engineers (USACE) district offices. However, only one application (in the New England District) is complete and underway. The table below gives an overview of the applications submitted in the US.

Offshore Wind Permit Applications (US)

Applicant	**Project Location**	**Application Filed**	**Status**
Cape Wind	Nantucket Sound	November 2001	Draft EIS expected this year
Bald Eagle Power	Long Island Sound	May 2002	The applicant is revising the application
Greenlight	Lake Erie	May 2003	Project on hold
Winergy	Plum Island, NY	June 2003	Incomplete Application
Winergy	Smith Island, VA	July 2003	Application administratively withdrawn
Winergy	Asbury Park, NJ	NA	No meeting scheduled
Winergy	4 sites in New Jersey	NA	Pre-application meeting Nov 2002
Winergy	Indian River, Delaware	NA	Pre-application meeting Feb 2003
FPL Energy	Long Island Sound	TBD	Awarded the end of May 2004

NREL has been closely tracking two key offshore wind power developments in the US – Cape Wind in Nantucket Sound, MA, and the FPL Energy site off of Long Island, NY. The Cape Wind project would be the first offshore project in the US and would consist of 130 turbines operating at a total capacity of 468 MW. The area covered by the site is about 20 square miles, with turbines located on Horseshoe Shoal, a shallow area in the middle of Nantucket Sound. The draft Environmental Impact Statement (EIS) is expected to be available to the public in 2004. A meteorological tower is collecting wind, wave, and temperature information at the proposed site. Two lawsuits have been filed in relation to the Cape Wind project, dealing with jurisdictional and regulatory authorities of the US Army Corps of Engineers. To learn more about the Cape Wind project go to the USACE website: http://www.nae.usace.army.mil.

In 2002-2003, the Long Island Power Authority (LIPA) and New York State Energy Research and Development Authority (NYSERDA) partnered to identify the best possible site for an offshore wind farm in Long Island Sound. The site identified is a few miles off the coast of Jones Beach. The site would produce as much as 150 MW of power and LIPA, a municipal utility, has guaranteed to enter a purchase power agreement and to build the substation cable. This project is still in the conceptual stage and is early in the public involvement process, but has strong state political support. In May, LIPA selected Florida Power & Light as the developer. To learn more about this offshore wind project, go to www.lioffshorewindenergy.org on the web.

Regulation of offshore wind development in the US presents a rather complex situation because there is no experience and there are multiple jurisdictions for ocean activities. State boundaries extend three nautical miles off the coast (with the exception of Texas, whose state boundary extends ten miles into the Gulf of Mexico), and the Federal boundary extends to 12 nautical miles. There are many federal agencies and regulations that could potentially come into play when siting and permitting a wind farm. The US Army Corp of Engineers takes the lead in coordinating its section 10 permit and the concurrent National Environmental Protection Act (NEPA) process. One of the primary objectives of the permitting process is public involvement.

In addition to what may be learned from European coordination of environmental studies, US wind developers and regulatory agencies may draw on their own experience with US wind energy development to date. NREL and NWCC workshops with regulators and stakeholders tend to highlight the uncertainties around offshore wind development in areas such as: ecological effects and risk levels; best available data and standards of measurement; environmental benefits; and the issue of multiple government agencies with potential jurisdiction over a project. Market-driven development also requires due diligence from regulators as many applications may be filed, but only some developers actually have the resources and know-how to follow through with project development.

There have been several other lessons learned in recent years about the process of wind development in the US. People with limited knowledge of the technology and/or the marine environment may create an unnecessary fear of offshore wind developments. Therefore it is important to educate the public early and encourage informed debate. Lack of a national energy policy leaves individual agencies to set their own policies, but sustainable development requires interagency coordination. At this point in the US, states are taking the lead on wind power development with Renewables Procurement Standards (RPSs). It is unclear which agency will have jurisdiction (and what decision-making process will be used) regarding offshore energy development on the outer continental shelf. The proposed national energy bill may shift jurisdictional control to the Minerals Management Service, though the US Army Corp of Engineers would still be involved.

In terms of environmental concerns in the US, the history of avian and bat issues as well as public reaction to viewshed impacts are instructive. The “green” image of wind power has been tarnished by incidents of bird fatalities at Altamont Pass in California, though this is a unique development with thousands of turbines. There are also questions about the cumulative effects of wind projects on bird populations and habitat. It is evident that research protocols and peer review of impact studies at wind farms is necessary, and that baseline studies are critical. The collaboration of industry, government, and NGOs to fund wind-bird/bat research has proven effective. Finally, the NIMBY (“not in my backyard”) aspect of public perception/opinion may become more prominent as the numbers of wind projects grow.

Future DOE/NREL activities to promote appropriate development of offshore wind resources in the US include:

- Coordination of workshops in 2004 (a proposed technical tutorial for New York regulators; international deep water research and development workshop, validation of resource maps)

- Technical support for state agencies with offshore wind activities
- Review and analysis of the Cape Wind Draft Environmental Impact Statement
- Technical support for the International Energy Agency proposed offshore annex
- Continued analysis and lessons learned from European environmental studies from installed offshore wind sites.

[A tight schedule precluded time for group discussion of this presentation session.]

BAT ECOLOGY RELATED TO WIND DEVELOPMENT AND LESSONS LEARNED ABOUT IMPACTS ON BATS FROM WIND DEVELOPMENT

This session shifted the focus of the workshop to the issue of wind energy development's impacts specifically on bats. The presentations discussed lessons that have been learned regarding direct and indirect impacts on bats, and strategies planned to address such issues. Presenters addressed what the existing science demonstrates about land-based wind turbine impacts on bats, including: mortality, avoidance, direct habitat impacts, species and numbers killed, per turbine rates/per MW generated, and impacts on threatened and endangered species. They discussed whether there is sufficient data for wind turbines and bat impacts for projects in the eastern US, especially on ridge tops. Finally, the subject of offshore impacts on bats was briefly addressed, including what lessons have been learned in Europe and how these can be applied in the US.

A Review of Bat Impacts at Wind Farms in the US

by
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Bat collision mortality at wind farms is a definite concern with respect to the ongoing development of wind energy facilities. It is important to note, however, that bat collision is not unique to wind farms. Bats also are known to collide with lighthouses, communication towers, tall buildings, powerlines, and fences. Nevertheless, bat collision mortality at wind plants is a widespread phenomenon, with bat mortality at wind plants often exceeding avian collision mortality. (Between mid-July and mid-September, the number of bat fatalities found at Buffalo Ridge, Minnesota averaged on the order of 175 bats compared with about 10 avian fatalities during the same period.)

Of forty-six species of bats in North America, eleven species have been identified among fatalities at wind plants, although no federally endangered or threatened bats have been found at a US wind farm. Typically, bat mortality involves solitary, tree-roosting bat species such as the silver-haired, hoary and eastern red bats. Hoary bats account for nearly half of all bat fatalities at wind plants. Other species impacted by collisions with wind turbines include the northern long-eared bat, western red bat, Brazilian free-tailed bat, long-eared myotis, and the Seminole bat.

The overall average bat fatality rate for US wind projects is 3.4 fatalities per turbine per year, or 4.6 per MW per year. The highest rates of bat mortality at wind plants have been found in the Eastern US, with one particularly large fatality event occurring at Mountaineer, West Virginia. In all other regions of the US, bat fatality rates are relatively low (see table, below). Generally, bat mortality occurs primarily in the late summer and early fall. Existing data include a summary of 1,628 fatalities, with about 90% occurring from mid-July to the end of September and over 50% of those occurring in August. It has been found that the late summer increase is *not* due to increases in the number of inexperienced juvenile bats. For example, at the Buffalo Ridge site in Minnesota 68% of the fatalities found were adults. At Stateline, Oregon/Washington, 64% of all bat carcasses found were adults.

Bat Fatality Estimates for the US, by Region

Region	# Studies	# MW	Fatalities/ Turbine/year	fatalities/ MW/year	~ Annual Fatalities
Northwest	4	397	1.2	1.7	675
Rocky Mountains	2	68	1.2	1.9	129
Upper Midwest	4	254	1.7	2.7	686
East	2	68	46.3	32	2,176
Overall	12	787	3.4	4.6	3,620

The seasonal timing of high bat fatality rates at wind plants does suggest that migrating bats are involved. For instance, hoary bats, eastern red bats, and silver-haired bats all migrate from mid-July through October. Migratory concentrations of hoary bats have been observed throughout North America in the month of August. In addition, the autumn dispersal of eastern pipistrelle, big brown and little brown bats occurs from the last week of July to mid-October. One possible reason that bat mortality at wind sites is much lower in the spring, as opposed to the fall, is that bats may follow different migration routes in each season and generally have different migration behavior (i.e., leisurely in spring vs. hurried in the fall). For example, in Florida it was observed that the fall migration of hoary bats occurred in waves, but the spring migration was more scattered and less organized.

Other evidence regarding bat mortality at wind energy facilities suggests that fatalities do not involve resident or foraging populations, which by default again points to migrating populations as the key group at risk. With respect to resident populations, research has shown that at Buffalo Ridge, Minnesota, Foote Creek Rim, Wyoming, Wisconsin, and the National Wind Technology Center in Colorado, relatively large populations of bats were documented breeding in close proximity to wind plants when no or few fatalities were documented. Moreover, only 51 of the 1,628 (3.1%) documented bat fatalities across the US have occurred during June and early July when most bats are residing at summer breeding areas.

Studies of bat activity also suggest that fatalities at US wind facilities do not involve foraging bats. For example, a bat activity study conducted in Minnesota found 2 passes per night at turbines compared to 48 passes per night in more suitable habitats such as woodlands and wetlands. Also, no “feeding buzzes” typically made by foraging bats were documented at turbines in Minnesota or Wyoming; however, bats foraging at the top of the turbine hub or higher would not have been detected. Generally, the turbines in the West and Midwest with the highest bat mortality are situated in crop fields, pastures, or short-grass prairies – all of which are habitats not typically used by foraging bats. One study from Sweden did, however, find that bats were foraging near turbines.

Given their finely-tuned echolocation capabilities, it is somewhat of a mystery as to why bats cannot detect wind turbines. For example, bats can navigate through constructed clutter zones made of staggered vertical strands of fine wire, spaced 1 m apart. It has also been demonstrated that captive bats can avoid colliding with moving objects more successfully than stationary ones, presumably because their foraging habits program them to detect moving objects.

So the question remains, why do bats collide with turbines? Several researchers believe that migrating bats may navigate without the use of echolocation. For example, a study conducted in Wyoming suggests that migrating hoary bats do not echolocate (Gruver 2002). Of 20 echolocation calls recorded at turbines and attributed by species, only one was a hoary bat even though this species comprised 88% of the fatalities. (Again, however, migrating hoary bats flying at or above the turbine hub height would not have been detected by the instruments being used in this study.) A study from Minnesota offers contradictory evidence that migrating bats possibly do echolocate, as echolocation activity was found to peak in late July and August, around the beginning of the migration period (Johnson et al. 2003). Generally, evidence suggests that bats depend on vision rather than echolocation for long-distance orientation. Thus, if bats are flying through wind farms by sight only, then causes of bat mortality could be similar to causes of nocturnal avian collision mortality at wind plants.

Another key question regarding bat mortality at wind plants is whether turbines attract bats. Several studies have shown high foraging activity by bats around artificial lights. Lights on turbines may attract moths and other nocturnal insects, thus increasing the probability of bat collisions since bats feed on insects at night. However, several data sets have been examined to date and there has been no correlation between turbine lighting and bat activity or mortality at turbines. For example, at Buffalo Ridge, Minnesota there are 138 turbines and every other one is lit. There have been 171 fatalities found at the site, of which 52% were found at lit turbines and 48% at unlit turbines. Findings at another Minnesota site as well as at Foote Creek Rim, Wyoming, Klondike, Oregon, and Stateline, Oregon/Washington sites similarly seem to indicate that bats are not attracted specifically to lit turbines.

Other possible reasons why bats could be attracted to wind turbines include roosting behavior and noise effects. An older study (Dalquest 1943) reported that migrating hoary bats look for the nearest available tree when daylight approaches, so it may be possible that bats mistake turbines for trees. There have been questions raised regarding whether turbines emit ultrasonic noises that attract bats or “jam” their echolocation frequencies. Bat echolocation devices placed at turbines have not detected any ultrasonic noises, but it should be noted that the detectors used are not capable of picking up ultrasonic noises from the nacelle or higher portions of the turbine. Other bat activity studies from Iowa (Koford 2004) and Sweden (Ahlen 2003) also found that bats were not attracted to turbines. An interesting aspect of this problem is that if bats were simply colliding with a random obstacle (that happened to be a wind turbine), higher mortality would be expected at meteorological towers supported by guy wires. However, searches conducted at six Foote Creek Rim meteorological towers did not bear this out. (None of the 128 bat carcasses, found at Foote Creek Rim, were found near the met towers. Searches conducted at Buffalo

Mountain, Tennessee (Nicholson 2003) and Buffalo Ridge, Minnesota (Johnson et al.2003) also found no dead bats at met towers.

Given the uncertainty that exists regarding wind turbine-bat interaction, there are a number of research questions still to be addressed with respect to the issue. Some of the key research questions to be answered at this point include:

- Are the bat species involved more susceptible than others or is the fatality composition proportional to the abundance of migrating bats?
- At what altitude do migrating bats fly?
- To what extent do migrating bats echolocate?
- Do bats follow linear features such as ridgelines while migrating?
- How can bat migration corridors be identified pre-construction?
- What factors may be related to collisions – weather, fronts, turbine operation?
- What affect does collision mortality have on populations?
- Is there any way to repel bats from wind turbines?
- What can be done to mitigate bat mortality at wind energy facilities?

To address any of these questions thoroughly will require methods and tools (night vision devices, infrared cameras, radar) for documenting bat behavior and collisions — and for helping formulate solutions.

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Wind Power: Bats and Wind Turbines

by
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PART I: WHAT IS CURRENTLY KNOWN

There are some things we know regarding the interaction between bats and wind turbines, and also a variety of things that are unknown (Johnson et al. 2003; Ahlen 2003). Wind energy is the fastest growing sector of the power industry, with over half of the states in the US possessing developed on-shore wind resource areas and wind power prevalent throughout Europe (Elliott, Schwartz and Scott 2004). Europe has also pioneered offshore wind developments (Pasqualetti, Righter and Gip 2004), with the US currently exploring offshore options.

It is known that bats are being killed by wind turbines and that about 90% of the fatalities are migratory species, with most bat fatalities occurring in late summer and fall (Pasqualetti, Righter and Gip 2004). It is also known that wind turbine sites are concentrated along expected migratory corridors, such as along ridge tops and in open plains (on-shore) and along coastal regions (offshore). Turbines are tall and mostly white, with pronounced blade tip and wake vortices (Petersen and Madsen 2004; Morrison and Sinclair 2004). Rotating turbine blades create motion smear and turbulence (Pasqualetti 2004; Petersen 2004), while rotors and turbine blades produce audible (and possibly ultrasonic) sounds (Morrison and Sinclair 2004).

At present, the short- and long-term quantitative environmental effects of existing turbines have not been adequately assessed (although there are more data on birds than bats) (Ahlen 2003; Morrison 2004). It can be further argued that re-powering of existing turbine sites with larger and more efficient turbines poses an unknown risk on bats (and birds) at sites that have shown little adverse impact to date. There are several outstanding questions regarding the characteristics of wind turbines that should be addressed. Some of the key questions are noted as follows:

- Do wind turbines attract bats? If so, how and when?
- Do wind turbines attract flying insects? If so, how and when?

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- Can wind turbines be locked or shut down during bat migration?
- If wind turbines attract bats, can they be modified to reduce impact?
- Can wind turbines be structurally modified to mitigate impacts on bats?

There are also a number of outstanding questions with respect to bats and their behavior that also need be answered, including:

- What are the migratory corridors of bats?
- What sensory cues do insectivorous bats use at night, especially migratory species?
- What time of night or day are bats being killed by wind turbines?
- Do bats collide with turbine blades or with the tower poles?
- How many bats are actually killed by wind turbines?
- What is the feeding behavior of bats in the vicinity of turbines?
- What are the ages of bats killed by wind turbines?
- Is mortality linked to age, sex, or reproductive condition?

I have listed nine hypotheses for testing in an attempt to determine how and why insectivorous bats are being killed by wind turbines: sensory failure, roost attraction, acoustic attraction, insect concentration, food resources, reduced maneuverability, decompression, and light attraction.

- The ***sensory failure hypothesis*** postulates that migrating and feeding bats fail to visually or acoustically detect wind turbines (Ahlen 2003). The smooth cylindrical turbine masts may not be detected by during night migration and it is possible that motion smear associated with rotating turbines (Morrison and Sinclair 2004) also makes it difficult for bats to see turbine blades, if vision is used by bats flying at relatively high altitudes

- The ***roost attraction hypothesis*** asks whether bats are attracted to wind turbines during migration because they are perceived as roost trees (Ahlen 2003). If bats approach a wind turbine tower, as if was a roost place, fatalities may result. This hypothesis is provisionally supported by observations that the greatest number of bats killed at the Mountaineer site in West Virginia was located relatively near the towers (J. Kearn, pers. comm.).

- The ***acoustic attraction hypothesis*** states that blades from some wind turbines emit low frequency sounds that attract bats (Ahlen 2003). If bats are attracted to the sound, and encounter turbine rotors, fatalities may occur.

- The ***insect concentration hypothesis*** employs the following logic. Many flying insects rise in altitude with warm daily air masses; insects become concentrated along high points in the landscape, known as "hill-topping" at night; migrating and foraging bats may use corridors with high insect concentrations and therefore collide with turbines on ridge tops where insects often concentrate (Ahlen 2003).

- The ***insect entrapment hypothesis*** postulates that flying insects are attracted to the white turbine masts at night and then get trapped in the wake of the downstream vortex. Bats are in turn attracted to the concentrations of insects in the wake and collide with the turbine in the process of trying to feed on the insects. This hypothesis may be most relevant to locally feeding, non-migratory species, rather than migratory species.

- The ***linear corridor hypothesis*** states that many bats follow linear corridors while foraging and during migration, and thus they tend to concentrate in areas where forests have been cut down to create right-of-ways for wind turbine construction and maintenance.

- The ***reduced maneuverability hypothesis*** states that the body mass and wind loading of migrating and prehibernating bats increase during the summer and autumn (Kunz, Wrazen, and Burnett 1998), thus reducing their ability to maneuver in the air and making them less able to avoid wind turbines.

- The ***decompression hypothesis*** states that flying bats are killed by rapid decompression as they encounter the turbulence associated with rotating wind turbines.

- The ***light attraction hypothesis*** states that flying bats are attracted to the flashing lights placed on wind turbines to warn low flying aircraft. Recent evidence suggest that there is no difference in fatality rates at lighted and unlighted wind turbines (Johnson et al. 2003), although additional evaluation is needed using different colors, positions, and flash frequencies.

In addition to testing the above hypotheses, monitoring programs should be conducted both pre- and post-construction, with a focus on identifying species, estimating population trends and demographic variables, and on identifying habitat and environmental variables (Morrison and Sinclair 2004). There are several types of studies that should be thoroughly executed to fully assess the impacts of wind turbines on bats. The siting of turbines and their design characteristics need to be examined. Assessment of insect activity should be carried out and test (wind turbine) and control (no wind turbine) sites. Comprehensive bat fatality assessments need to be conducted at all sites with the use of cutting novel methods (e.g., bat sniffing dogs) and standardized sampling and survey methods (daily and seasonal surveys). Key environmental variables (e.g., moon phase, moon light intensity, cloud cover, air temperature, wind speed and wind direction) should be collected at the altitudes above the ground where flying bats are expected to encounter wind turbines. In turn, these data should be used to develop models of bat fatalities at wind turbine sites.

Monitoring methods should minimally include: ground surveys, acoustic (ultrasound) recordings, spotlighting, night vision imaging, infrared thermal imaging, and radar imaging. Pre-construction assessments should focus on acoustic and radar monitoring, infrared thermal imaging, and insect sampling. Use of mist nets set at ground level is highly questionable for assessing the presence of migrating and feeding bats in the vicinity of wind turbines. In addition to the above mentioned detection devices, post-construction assessments should incorporate fatality searches and scavenger/decomposition assessment. Proposed protocol criteria and data required for assessing and modeling bat fatalities are outlined below.

Proposed (Post-Construction) Protocols for Assessing Bat Fatalities at On-Shore Sites

Minimum Search Area	Span of wind turbine rotor
Frequency of Search	Daily at 1/3 of the sites Weekly at 1/3 of sites None at 1/3 of sites
Time of Search	Daytime
Consistent Search Effort	One hour per wind turbine
Search Path	Circular
Search Period	March-November
Human Observers	x 2
Use of Trained Dog “Sniffers”	To test human searcher efficiency

Data Needed for Assessing and Modeling Bat Fatalities at Wind Turbines

Date	Day, month, year
Environmental Conditions	e.g., temperature, precipitation, light, etc.
Relationship of bat position from turbine	Bearing and distance
Species Identification	e.g., forearm length of bats
Further specification	Sex, age (juvenile v. adult, based on fused epiphyses)
Reproductive condition	e.g., pregnant, lactating, post-lactation, non-reproductive
Physical condition	e.g., broken bones, abrasions, decomposition, damage from scavengers

When assessing bat fatalities, results should be corrected for searcher bias, scavenging/removal bias, crippling/injury bias, and habitat bias.

PART II: IDEAS FURTHER RESEARCH

In February 2004, Bat Conservation International (BCI), US Fish & Wildlife Service) (USFWS), American Wind Energy Association (AWEA), and National Renewable Energy Laboratory (NREL) sponsored a two-day workshop in Juno Beach, Florida. Hosted by FPL Energy, the Bats and Wind Power Generation Technical Workshop grew out of concern about bats at the Mountaineer, West Virginia site. The workshop brought together bat ecologists and ornithologists, Federal and state government agencies, and people from the wind industry to share information about how wind power affects bats and to identify ideas for better understanding and resolving bat-related issues in wind energy development. In particular, we wanted to learn what had occurred at Mountaineer, what were the significant knowledge gaps, and what are the most helpful tools, technologies, and information-gathering techniques to better understand bat-turbine interactions and quantify the magnitude of problem. We wanted to figure out what actions to take – both immediate next steps to address problems, near-term priorities. For top ten priorities, we came up with a table with "soundbite" descriptions of what needs to be done, tasks, performers, schedule, costs, and immediate next steps. We tried to develop a seasonal understanding of what needed to be done.

A peer-reviewed paper that raises a variety of wind power-related issues such as bat issues, technology and research protocols is being developed. It is hoped this paper will provide information to researchers, Federal and state agencies, and people in the wind industry – most of whom are expected to contribute to this paper. (It is quite rare to have input from this wide of a range of stakeholders in a peer-reviewed paper.)[17]

There are a variety of points to consider for future work/research on bat monitoring protocols. The importance of temporal and spatial considerations in fatality assessment is of high importance. While night vision devices, including infrared reflectance imaging, requires some light source (for bright moon light or an infrared light source), infrared thermal imaging (which detects heat) can be used independent of ambient light (Frank et al. 2003). This technology can be used to successfully to monitor and census flying bats (Ahlen 2003; Frank et al. 2003). Infrared thermal imaging has the advantage of making it possible to distinguish between birds and bats (Kunz, pers. obs.). Visible spotlighting may be the most cost effective way to do make visual spot checks for activity of bats and insects in the vicinity of wind turbines. Spotlighting should be relatively brief (<30 seconds) to avoid attract insects (and bats) in the beam of light.

Monitoring studies should employ ultrasonic detectors to record sounds produced bats (typically in the range 20 to 100 kHz. However, most ultrasonic detectors have a relatively short range of detection (<30 m) (Pettersson 2004), thus they should be positioned high enough above the ground to detect bats that are likely to encounter turbine towers and rotors. Most small, frequency modulating (FM), echolocating bats have a fairly short range of effectiveness for detecting objects while in flight (typically < 5 m) (Fenton 2004; Pettersson 2004). Marine surveillance radars may be effective at detecting flying targets, but they cannot distinguish birds from bats. Using infrared thermal imaging in conjunction with marine surveillance radar may prove useful in distinguishing bats from birds in radar images. Sticky traps may prove useful for assessing insect activity in the vicinity of wind turbines (Pettersson 2004).

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Discussion, Questions and Answers

Comment: FPL Energy first met to discuss bat-wind turbine interactions in December 2003; the Juno Beach workshop was held in February, and now (in May) is gearing up to do a study of fall bat migration at Mountaineer. The $300,000 effort (including funding a full-time bat-wind turbine interactions staff position and bringing technology up to Mountaineer to do study). In terms of birds, it's been very difficult to actually observe the interaction, but hoping to be able to accomplish that at Mountaineer with respect to bats.

Does the wind industry periodically clean turbine blades, in which case they could be examined for insect remains, which may help inform the insect concentration hypothesis?
Response: Turbines are designed to prevent the collection of dust and insects as much as possible. Rotor blades in the West require more regular cleaning because there is less rainfall.

Has the airspeed of bats relative to the wind speed in the rotor vortex been examined? The participant also asked whether insect updraft along ridgelines had been investigated, noting that some of those types of wind currents reverse at night.

Response: Existing evidence suggests that insects are drawn up during the day and concentrate on ridges at night.

Comment: There have been inconsistent statements made about the range of bats' echolocation abilities.

Response: Bat echolocation has been detected as far out as 30 m, but most insectivorous bats that produce frequency modulated (FM) calls typically can only detect small insects within the range of 2-5 m. There is no empirical evidence that bat echolocation has been recorded at distances of 100 m or more.

Comment: Research protocols between birds and bats may need to be coordinated.
Response: This may be difficult. Bird carcasses are easier to spot than bat carcasses. When a bat dies, it folds up, so that the carcass looks like a small brown blob about the size of man's thumb.

WHAT DO WE KNOW ABOUT CUMULATIVE OR POPULATION IMPACTS?

This session was structured as a panel discussion concerning the potential cumulative impacts of wind turbines on bird and bat populations over time. Panel members gave brief presentations that touched upon what is currently known, what laws apply, and the usefulness of population modeling. Topics addressed included which sources of modeling should be included in cumulative impacts, comparison of impacts from different modes of energy generation, as well as what research is still needed regarding cumulative impacts of wind energy development on bird and bat populations.

Paul Kerlinger, Curry & Kerlinger, LLC[18]

With respect to permitting on private land, almost all states with state-level permitting processes make permitting conditional on looking at potential significant biological impacts (local, regional or global), especially for declining, threatened, or endangered species. Permit applications often ask about cumulative impacts. By definition, any project will have cumulative impacts. But how do you deal with that? Do you add potential impacts from a given (wind) project to all the impacts from cell towers, traffic, hunting, etc?

The Migratory Bird Treaty Act stipulates that, if you kill any migratory birds, you are at risk of prosecution, even if you have reason to believe that the risk is small.

Population modeling is complex and challenging. If a species population is declining, how many fatalities will it take to push that population over the edge (so to speak)? How many fatalities for a given species or population before you affect a percentage of the population that is biologically significant? Although we lack many of the reproductive and survivorship parameters needed to run such models and it is hard to put confidence intervals on the results, population modeling issues are not insurmountable.

Al Manville, U.S. Fish and Wildlife Service

We know now that, with the exception of Altamont Pass, wind impacts on avian populations appear to be low, based on projects assessed and data publicly released from the West, Midwest, and one project in the East. Wind energy is growing exponentially in the US, which raises concerns – as does the fact that 223 bird species (>26% of the 836 species USFWS is currently tasked by law to manage) are in trouble, and that we don't know the status of about one-third of the birds that we're managing.

We know that probably all birds succumb to human-induced threats. While USFWS can deal substantially with some of these threats – e.g., turbines, communication towers, and power lines – there is not much USFWS is able to do about other threats (such as pesticide

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poisoning and global climate change). Raptors are a greater collision concern in the West while songbirds and bats are more of a concern east of the Rocky Mountains. We know that grassland songbirds and prairie grouse – especially those lek-breeding species – are very sensitive to structures, disturbance, and habitat fragmentation. All prairie grouse are declining and some are in very serious shape. The current edition of *The Wildlife Society Bulletin* provides a detailed discussion of the fate of prairie grouse. We need to look very closely at the heights songbirds migrate particularly in the East, certainly in New York at the Flat Rock Project, based on preliminary findings by Cooper and Mabee (2000). We need to know much more about bird and bat use and migration along and over Appalachian ridge-tops. We know very little about bats, except that their populations are declining and Federally endangered species like the Indiana and Virginia big-eared bats, among others, are in serious trouble.

Regarding the question about what laws currently apply, we must look on both public and private lands. On public lands, Sections 7 and 9 of the Endangered Species Act (ESA) apply, as well as the National Environmental Policy Act (NEPA), the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), and Section 404 of the Clean Water Act (CWA; dealing with wetlands) all apply.

On private lands, Sections 9 and 10 of ESA apply, as do MBTA, BGEPA, and Section 404 CWA. Most of these acts address the issues of "takings" and may require permits.

With regard to population modeling, Richard Podolsky's Avian Rate of Collision modeling efforts are of interest and may be helpful in predicting risk from turbine collisions. Granger Hunt's Golden Eagle modeling at Altamont Pass regarding "floater" birds provides some very interesting insights, but raises questions about stability of the Golden Eagle population in the area. Overall, modeling anthropocentric causes of mortality is interesting but not particularly useful since there still are too many unknowns. Models, as such, may therefore not be that reliable.

Regarding the question of sources of mortality to include in cumulative impacts, there are several. Density-independent mortality such as natural catastrophes needs to be factored in. Density-dependent mortality by factors such as stress, starvation, predation, disease, and parasitism must also be included. These two types constitute natural mortality. Human-caused impacts are significant but hard to quantify. For example, anywhere from an estimated 300 million to more than 1 billion birds die per year in the US from structural impacts. Of these, anywhere from 98 to 980 million birds are estimated to strike windows and die each year in the US. Unfortunately, statistics such as these are not particularly useful because the ranges are so large. There is a major bias that must be considered. We are unable to factor behavioral impacts – issues like disturbance, disruption, and avoidance – into models. This is a major shortcoming. We need to work to quantify and factor in these variables if we can. The USFWS will do everything we can to reverse populations trends from human impacts, whether those impacts appear to be large or small, on public or private lands.

Which "straw" will eventually break the camel's back? Which "straws" can we deal with to reverse population trends? Hopefully, wind energy development is not the last straw, but anywhere we can reverse mortality trends (or keep them low) that will help.

As for comparing impacts from different modes of energy generation – again, there are many unknowns. How do we quantify specific avian and bat impacts from global climate change? Acid precipitation? Mercury contamination? We can estimate bird mortality at oil pits and this issue is being resolved. How can we estimate habitat destruction from open-pit and mountaintop-mining? How can we estimate impacts from burning of fossil fuels?

On the issue of "beyond birds and bats," several thoughts come to mind. We next must address offshore wind issues. Habitat fragmentation is a critically important issue. Habituation is another issue requiring serious consideration. We need to look at the impacts of wind on insects, especially bees and butterflies. We need to address the issue of "good" versus "bad" places to site wind plants. Lastly, we need to seriously consider using an ecosystem approach to the analysis of impacts.

What is needed? More data are needed on bats, including migration routes, behavior, movement, breeding and wintering range, attraction, sonar use, and their population status. USFWS would like the opportunity to review, critique, and comment on consultants' monitoring protocols. We need an accepted definition of "cumulative impacts." Data need to be peer-reviewed and published in credible scientifically journals. The ideal scenario would include peer-reviewed or peer-refereed data published in credible ornithological and mammalian journals.

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Bill Kendall, US Geological Service[19]

How do we look at biological significance for other species? Ultimately, "biological significance" is in the eye of the beholder. We can consider levels of significance from the individual to family group to local population to breeding/wintering population. Usually, when we talk about "biological significance," we are talking about the latter two levels.

The basic equation for population modeling is:

$$N_{t+1} = N_t + \text{births} + \text{immigrants} - \text{deaths} - \text{emigrants}$$

Habitat disruption can affect mortality as well as reproduction rates. The significance of individual fatalities varies. "Value" factors for an animal include: sex, age, time of year,

[19] This presentation was a short version of a talk given by Bill Kendall and Doug Johnson in Fall, 2003

whether the population in question is at "carrying capacity" (in which case fatalities are not critical) or near "minimum viable population size" (in which case small numbers of individual fatalities may be critical for the population).

Whether population impacts are significant depends on what the management objectives are: To avoid extinction? To maintain a local population? It is important to define the "population" of interest. For example, in the case of the population study of Golden eagle in the Altamont Pass, the focus is limited to Golden eagles in the Altamont.

We cannot look at the impact of wind on birds without looking at it in context of other anthropogenic impacts. And given multiple factors in bird population impacts, which factor do you try to control?

Discussion, Questions and Answers

Comment/Question: If there's no uniform definition of what's biologically significant – USFWS has 78 different Ecological Service Field Offices – we can't come up with a uniform vision and a roadmap. Ideally, the wind industry and its proponents would like to look at "build-out" scenarios (achieving the wind energy's potential capacity) and coming up with standards and a vision and a roadmap, as opposed to various agencies operating in a reactive mode.

Response: FWS guidance is a work-in-progress, whereas the Bald and Golden Eagle Protection and Migratory Bird Treaty Acts are well-established "strict liability" laws. What we're trying to do, for example, with the electric utility industry is come up with a guidance document for industry – an avian protection plan – to use with respect to avian mortality. Message to the industry is "work with us, provide feedback on our guidance."

Comment: We have been trying to deal with cumulative impacts for waste management in New York state, and the state doesn't deal with cumulative impacts very well.

Response (Paul Kerlinger): Each state's process is different. You have to look at how they've dealt with similar issues in the past.

Follow-up on earlier discussion of biological significance: What about trying to set thresholds for birds? The threshold would depend on each bird's status ("watch list," "sensitive," etc.) – depending on species, a take of x% may be sustainable or it may not. From this you could extrapolate mortality for wind build-out and see what kind of impact you might expect to see.

Facilitator: But would such a framework or modeling tool be used just for wind development, or for all kinds of development?

Comment: Ornithologists are looking at conservation plans, coming up with goals for different bird populations for individual states for planning purposes.

Comment: It is interesting that a panel on biological significance still comes back to individual project impacts. It's important not to give up on big picture effort, to put project-based impacts in perspective.

Response (Al Manville): As I just mentioned, we're working with the electric power line industry to develop voluntary guidance; we're trying to work with the communication tower industry – doing this industry-wide, not just on a project-by-project basis.

Developers are just dealing with the margins; no one is looking at all the cumulative impact, just focusing on the marginal impact, no matter how small.

Comment: Salmon recovery in the PNW is a good example of trying to grapple with cumulative effects and biological significance. Look at what Daniel[20] is doing for a model.

Comment: If you want to try to establish a policy framework that optimizes energy choices from an environmental perspective, the direction has to come from higher up – e.g., from the state public utility infrastructure as well as at federal level. The trade-offs have to be made transparent.

Response: New sources always get regulated more than old sources. Coal and agriculture have and have had a tremendous impact. Bird deaths have driven the pesticide regulatory acts, resulting in a very strong infrastructure for this. It's impressive that the wind industry is here doing this, because nobody is going to change the Mining Act of 1872, but it's a fact of life that wind is being developed under much more stringent conditions.

Comment/Question: If we can't model because we don't have enough data inputs, we're left with the "tyranny of small decisions." But if we can determine what the national average is for bird and bat fatalities per turbine or per MW, why even consider building projects that are likely to exceed that average?

Response: There are national averages, but there are also regional averages.

Response: We know where to build projects that kill fewer v. more birds. (We have less information on bats.)

Response: The point is that we can bring down the mortality levels.

Comment: "Birds per turbine" is the wrong denominator. Birds (or whatever environmental impact) per unit of energy production is how we should be discussing this, because then the question then becomes how do you reduce environmental impact of energy production – and then you can compare impacts across energy resources.

NWCC has been wrestling with this. "Number of homes served" as a denominator makes it clearest to consumers. Mountaineer project kills one bird per every 105 (or so) homes

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[20] Daniel Niven, Senior Scientist, Bird Conservation, National Audubon Society USGS Patuxent Wildlife Research Center, Laurel, MD. E-Mail: dniven@audubon.org

served. This helps put things in perspective.

Comment: Keep in mind that highly productive organisms like prairie dogs can withstand a lot of fatalities. In such cases, if I want to think about biological significance, I think in terms of habitat rather than fatalities. If we can maintain adequate habitat for resilient species, we don't have to worry about losses in a particular location.

Response (Al Manville): This is a good point; probably the greatest threat to all species is loss of habitat. An example would be the loss of over-wintering habitat for neotropical migratory songbirds in Latin America.

Response: We have to be more concerned about long-lived, less productive species.

Comment: Dale [Strickland]'s slide emphasizing European concern with habitat is important. Habitat is the real issue, especially for prairie grasslands and lekking areas.

OBSERVATIONS, INSIGHTS, QUESTIONS FROM DAY 1

Day Two of the Wind Energy and Birds/Bats Workshop began with a group discussion of what participants had learned and new questions raised by Day One's activities. Participants also were given an opportunity to raise issues they would like to discuss later in the day.

FAA Lighting Requests v. Lighting Requirements

Comment/Question: A participant posed a question about turbine lighting at the Foote Creek Rim, Wyoming wind farm, pointing out that it was stated that none of the turbines were lit, even ones over 74 m tall. Towers that tall are normally lit due to Federal Aviation Administration (FAA) demands.

Response: The FAA can ask for any tower anywhere to be lit, but the FAA does not have the authority to make a developer do it. Ultimately, lighting towers is a voluntary action. As for Foote Creek Rim, it may have been cleared by FAA without lights because of its remote location.

Larger Public Policy Picture

Comment: There should be some time allotted for discussion of the larger public policy picture around wind energy and bird/bat interaction. Potential funding of federal and/or state laws/programs, for example: technical "fixes" can alleviate some problems, but there is also a need to talk about policy initiatives and public-private funding of initiatives such as that carried out in Denmark.

Who Should Fund Impact Studies?

Comment: There seems to be an inherent conflict of interest if wind energy developers hire the people that do the impact studies, because there is a fine line between doing a rigorous study and pleasing those that hired you. For example, one hypothesis regarding the cause of the large bird kill event at Mountaineer, West Virginia is that sodium vapor lights attracted birds on a foggy night. Although this is just a hypothesis, it is being treated as truth by many. Witness the fact that some participants at this meeting have said that bird fatalities are not a problem along Appalachian ridges. It is not clear [to commenting participant] that that is necessarily the case, yet there are no studies scheduled at Mountaineer in 2004.

Response: Research protocols are necessary to avoid conflicts of interest and to develop rigor and legitimacy for wind-bird/bat research.

Comment/Response: If USFWS is setting protocols and developers have to pay for the research, then it may be very difficult to contain costs and it could drastically slow the progress of wind development. For example, radar studies cost about $100,000 per year. If three years of radar studies were required, this high cost put take some of the smaller developers out of the game, making it so only the largest companies could afford to develop wind energy.

Response: Studies in new areas should be rigorous three-year studies. However, developers should not have to pay for studies at all; rather, studies should be publicly financed since the energy source would be for the public good.

Comment [several participants]: Publicly-funded pre-construction studies would be a good idea, but only if the government could work within developers' timeframes, which is unlikely. Moreover, developers would not want to work with researchers that may jeopardize their integrity and all research would have to be peer-reviewed. Either way, there always tends to be an underlying tension of credibility in public-private partnerships.

Facilitator: There is some discord in the room regarding how some previous projects were carried out and that they did not go as hoped. However, there may be ways to learn from an honest appraisal of what could be done differently.

Consistency, Transparency, Communication, and Trust

Comment: Three key things people working on the wind energy and birds/bats issue need to focus on are **consistency** and **transparency**, and **communication** to support the first two. This would require all parties being very clear about what they consider consistency.

Comment: Add **trust** to that list. Parties need to work together at the local level, not just at national meetings. Local advisory committees can be formed to look at the science together, as was done (for example) to develop wind project siting guidelines in Washington State.

Comment: In Massachusetts there is a collaborative effort to design the study for the Hoosic wind project: what would Fish & Wildlife like to see, what would environmentalists like to see. The collaborative is being paid for out of a trust fund – it would be too expensive to do this for every project – but we are hoping that doing it this once will inform future project studies.

Comment: We spend a lot of time looking for all the information that's out there. Even when people put their studies up on their websites, it would be great if there were a clearinghouse for all the information that's available. A single point of contact would be useful. Right now it's all subgroups. NWCC's website has a lot of it, and these big meetings are useful, but there is a need for something ongoing and comprehensive.

Comment: Also, it would be nice to have a permanent independent review body. Everything needs to be made public, and everything needs to be peer-reviewed. There should be public funding for this. Developers need to pay for some of it, but we all benefit.

Comment: Regarding the need for trust: the National Academy of Sciences has two mottos: "trust but verify;" and "in God we trust, all others must bring data." The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) is a model. The registrant pays for studies, but raw data is reviewed by EPA before anything goes forward. The Minerals Management Service offers another model; offshore oil research and development is paid for out of a royalties fund. Wind permitting is largely local, but some issues are not local – bird migration is a good example – and require national policy. Granted, the wind industry doesn't have the money to pay royalties that the oil industry has, but the concept is valid.

Comment: The US Fish & Wildlife Service no longer has a research "arm", it's now under US Geological Survey. Not clear how the Service is going to accomplish anything with budget cuts. NGOs need to put pressure on Congress to make something happen (e.g., in the Appalachian ridge). US FWS does not regulate windfarms in any way shape or form. We have no legal authority – we can only make recommendations. We can advise people what the laws are (e.g., MBTA), but we are not a regulatory agency.

Comment: All the issues that just came up relate to the **need for public policy**. It is not clear right now what it is we want. Perhaps the NWCC Wildlife Work Group can take this a step further?

Facilitator: Keep in mind that the NWCC cannot advocate, only come up with ideas.

AVIAN MIGRATION AND IMPLICATIONS FOR WIND POWER DEVELOPMENT IN THE EASTERN UNITED STATES

This session was arranged to convey what is known about avian migration, particularly in the eastern US. The first presentation frames the issue of migratory bird interactions with wind energy facilities from an ecological perspective: when, where, and why are migrant bird species vulnerable to wind turbine collision? The second presentation reported on radar studies conducted at wind sites in the eastern US, including Mount Storm, Clipper Wind, and others.

Migration Ecology: Issues of Scale and Behavior

by
Sarah E. S. Mabey, *North Carolina State University*[21]

This presentation aims to provide a picture of bird migration as ecologists see it, taking into account:

- the scale on which migration takes place – and its import for ecology and policy;
- constraints – how weather, geomorphology, landscape, resources, and habitat factors influence the choices that lead to migration patterns;
- what it means to be a migratory bird in a changing world; and,
- consequences of changing world to migratory bird populations.

Migratory birds lead extremely challenging lives when they are in transit, facing new foraging circumstances, predators, and competition on a daily basis. The process of migration is spatially and temporally dynamic, thus the pattern and timing of migration can be highly unpredictable. In effect, predictability is scale-dependent. The broader the spatial and temporal scale (i.e., greater area and longer time-frame), the more predictable migration movements appear. As we scale down to a particular local on a given day or hour, it becomes much more difficult to predict whether migrants will or will not be present. The dynamic nature of bird migration makes it difficult to describe migratory patterns of songbirds in detail, particularly of specific species. Another problem is that much of what is known about certain species is geographically biased because data are only available for the places where researchers work. In fact, the Wilson's Warbler is arguably *the only* neo-tropical migratory songbird for which scientists actually know something about the actual migration routes of sub-populations.

There is a hierarchy of factors that determine the migratory patterns of birds, influencing where and when birds stop, where and when species concentrations occur, species

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composition, and the distribution of age and sex classes. The hierarchy is arranged according to the degree of control birds have over the factors that influence their migration choices. At the top of the hierarchy is the factor over which birds have the least influence, *weather*. Birds cannot control the weather, but they can and do respond to it. They also cannot control the second factor in the hierarchy, *geomorphology* (landmasses). As birds respond to weather (fronts), moving north in the spring and south in the fall, their choices of where to stop are constrained by geomorphology. Once they make an initial decision about where and when to stop, migrants enter the "landscape level" where their choices are constrained only by the availability (or lack of availability) of habitat and resources within the local landscape.

The stopover site chosen by a migrant is directly related to the hierarchy of constraints that determine the individual bird's range of choices. Based on this understanding of stopover ecology, a number of colleagues and I developed a series of functional definitions for different kinds of stopover sites used by migratory birds (Duncan et al. 2002). A "fire escape" is a stopover site near an ecological barrier such as the Great Lakes or Gulf of Mexico where birds are highly concentrated. The use of such sites is related to bad weather and occurs infrequently under "emergency" conditions. A "convenience store" is a site within a patchy, ecologically unsuitable habitat matrix that is used if nothing better is available within a particular landscape. The "full-service hotel" designation refers to extensive, suitable habitat with diverse resources such as the Great Smoky Mountains. Unfortunately, full-service hotels are becoming increasingly more difficult for birds to locate as habitat is continually being lost to or fragmented by development, reducing birds' choices. Migrants must stop to rest and regain the fat stores that fuel their migratory flights. Habitat suitability impacts birds' migratory behavior as it directly affects the amount of energy and time required to refuel during stopovers. Thus, all of these types of migratory stopover habitats should be considered when making policy and conservation planning decisions.

At present, we do not have a clear understanding of how plastic or static many bird migration behaviors might be. There exist empirical data to support both possibilities. For example, a number of important questions remain open. Are diet shifts opportunistic (plastic) or are they essential for fat deposition (static)? Does orientation of bird flight depend on their physical condition (plastic) or is it genetically determined (static)? Are migrants socially tolerant, sticking together in flocks, or are they territorial and defensive of their resources? It also is not known whether there is rapid evolution of migratory routes or if species can consistently track the changing climate. Recent work has shown that some birds fatten only under certain magnetic field conditions (i.e., at particular latitudes) that exist where the birds prepare to cross an ecological barrier. This means that these birds may not adjust to deteriorating resources at that location by fattening opportunistically when they encounter better resources elsewhere.

We have looked at migration from the perspective of the individual songbird migrant, but what does this all mean for populations? Population models help us understand how resilient species are to a changing world. As we have seen earlier, models for migratory species must begin to include migration events. There are both direct and indirect consequences of avian migration events. Direct consequences include injuries/fatalities caused by accidents as well as predation (including hunting). Indirect consequences of migration include intra- and inter-species-specific competition and seasonal resource declines. Weather, inexperience and orientation errors can lead to both types of consequences. Some factors that lead to mortality during migration affect populations at a general level. Stochastic (random) events such as hurricanes affect birds of all ages and sexes, but other events may affect young birds more than old birds. For example, young of the year tend to congregate in coastal areas during their first migration and are, therefore, more likely to be seriously affected by coastal development as it presents obstacles during migration. Given that, overall, young birds are more valuable to a population because of their reproductive potential, coastal mortality events could potentially have a significant impact on a bird population.

The key challenge to protecting migrating birds from fatality at wind turbines is that they are a moving target – as individuals and as populations. The intercontinental scale of birds' movement requires scale-appropriate conservation planning. Moreover, because migration is spatially and temporally dynamic, it presents a challenge to traditional conservation paradigms. The demographic consequences of the changing world and its impacts on migratory songbirds will be knowable over time. Until then, protecting migratory birds requires a conservative approach applied at an intercontinental scale.

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Radar Studies of Nocturnal Migration at Wind Sites in the Eastern US

by

Brian Cooper, *ABR, Inc.*[22]

Nocturnal radar studies of bird migration are important because most birds (including warblers, tanagers, vireos, orioles, kinglets, thrushes, gnatcatchers, many sparrows, cuckoos, flycatchers, thrashers, and owls) migrate at night and approximately half of all bird mortality at wind turbines involves nocturnal migrants.

There are several types of radar tools available to researchers. NEXRAD (Next Generation Radar) is used by the National Weather Service to measure both precipitation and wind. A Doppler radar system currently deployed at about 150 locations around the US, NEXRAD can also be used to detect birds. This technology provides excellent data for many aspects of migration, but has some limitations for studies of individual wind energy sites: resolution is low (1 km x 1 km); eliminating insect noise data is difficult; there is a lack of low-altitude coverage for many areas (below 500 m); and there is a lack of precise altitude data – making it impossible to calculate passage rates in the zone of exposure to turbines.

[22] P.O. Box 249, Forest Grove, OR 97116

Researchers also use marine radar technology, which gives higher resolution and is mobile. These radars can be operated in horizontal surveillance mode to determine traffic rates and general movements/behavior, or operated in vertical mode to obtain flight altitude information. Marine radar studies on avian migration have been carried out at several locations across the US. Work carried out during Fall 2003 at the proposed (as yet undeveloped) Mt. Storm, West Virginia wind energy site (just east of the Mountaineer wind site along the Allegheny Front) offers a good example of the potential findings of avian migration radar studies in the Eastern US.

Mobile (vehicle-mounted) radar labs were set up at five locations within the proposed Mt. Storm wind development. The surveillance radar beam provided coverage over a 1.5-km radius and the vertical radar provided coverage up to ~1.5 km high. Flight altitudes are of interest, because birds flying well over turbine height are not at risk from wind farms. The radar "target" represents one bird. It is possible to distinguish between some species groups such as songbirds and waterfowl, or to distinguish small birds from insects, by their flight speed.

Passage rates varied widely from night to night, as well among sites within a night, but were found to be fairly stable over the course of any given night. Fall observations from the five sampling sites at the Mt. Storm site yielded mean fall nocturnal passage rates of 54-241 targets/km/hour. This is comparable to mean fall nocturnal passage rates (130-242 targets/km/hour) found at three sites in New York State (Cooper and Ritchie 1995); and higher than the fall rates (83-108 targets/km/hour) observed in Minnesota (Day and Byrne 1989 and 1990); or at two western wind sites (27-40 targets/km/hour at a site in South Dakota, and 19-26 targets/km/hour at sites in Oregon [Cooper and Mabee 2004]).

During fall 2003, 16% of targets (birds) were flying at or below turbine height (125 m above ground level) at the central Mt. Storm site. Most targets (birds) passed at an altitude between about 250 m to 750 m agl, with a mean of about 410 m above ground level. Based on temporary checks at the 3-km-range, it was estimated that about 6% of passing birds flew between 1500-3000 m agl. There was substantial among-night variation in flight altitudes but little among-site variation in flight altitudes at the Mt. Storm sites. Altitudes tended to peak in the middle of the night and taper off toward morning. Flight directions recorded at Mt. Storm indicate that birds do not concentrate along the Allegheny Front, but rather that they tend to fly across the ridge.

Using radar data to assess mortality risk for birds at wind developments involves determining passage rates at or below turbine height (i.e. combining passage rate and altitude data). In other words, researchers calculate the number of targets per hour at or below turbine height. This is multiplied by the following factors: the number of migrants per radar "target" (here assumed to be one); the length of the migration season (number of nights); the total number of hours per night; and the width (km of migratory front) of the wind resource area or total rotor swept area of the turbines. For example, applying this formula (using WRA width instead of total rotor swept area) to the Mt. Storm observations yields the following equation:

36 targets/km/h at or below turbine height * 1 migrant/target * 45 nights * 10 hours/night * 10 km migratory front[23]

= 162,000 migrants[24] passing over the Mt. Storm WRA at or below turbine height during the Fall 2003 migration study period.

There are some conclusions that may be drawn and recommendations to make regarding radar studies of avian migration and the potential risk posed to birds by wind developments. It is important point to keep in mind that migrants determined to be at risk *will not* all be killed. In fact, it will most likely be a small proportion that is impacted because many birds will detect and avoid the turbines. To improve wind-bird radar studies, researchers could collect concurrent radar and mortality data to elucidate the relationship between numbers of migrants in the zone of exposure and mortality. Behavioral studies would help to determine the proportion of migrants that detect and avoid wind turbines. Finally, it would help to develop common or comparable metrics to facilitate comparisons among radar studies.

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[23] Note that while each radar has a 1.5 km band of detection, this formula extrapolates from radar data to calculate an estimated number of migrants passing over the entire (10 km wide) wind resource area (WRA).

[24] Note that radar data does not distinguish between birds and bats. The only way to distinguish them would be to conduct concurrent surveys using night vision or spotlighting.

Discussion, Questions and Answers

How do migrating birds use winds? Do they use them to their advantage or simply react to them?

Response (S. Mabey): Most birds will leave a site on a strong tailwind, and tend not to leave in a headwind, but they also will leave at times when there is no wind at all. However, crossing a water body like the Gulf of Mexico may take ten hours, and the winds may change during the crossing. Birds do shift altitudes to take advantage of more favorable winds.

In response to a general question about how the wind industry can make use of the expertise of migration ecologists to help site wind energy developments, participants were referred to the Society for Conservation Biology and The Ornithological Council are good organizations to contact: http://conbio.net/; http://www.nmnh.si.edu/BIRDNET/index.html

Do researchers correct for wind direction and speed when looking at the concentration of migrants near the Allegheny Front?

Response (B. Cooper): Wind direction and speed were corrected for in the study, in order to calculate actual air speed of radar targets and thus distinguish birds from insects.

Has there been research conducted on birds' nocturnal flight orientation relative to ridgelines at any other sites?

Response: There are actually a few such studies under way around the US: near Chatauqua, New York; on a ridge in Idaho; and in western Oregon.[25] Data from the New York and Idaho sites should be available soon. There also is a published paper by Williams et al. (2001, Auk 118:389-403) that describes nocturnal bird movements through a major pass in the northern Appalachians.

Comment: Developers have the option of putting stipulations into their contracts to release study results to (or via) NREL.

Comment/Question: In the West, results of night radar studies seem generally to be in line with information derived from conventional diurnal observations, at least in terms of predicting avian mortality by major birds groups. What analysis has been done to correlate these two types of data, given the high cost of night radar?

Response: At the Mt. Storm site, WEST Inc. compared there daytime visual data with our radar data and found that there was no significant correlation between the two data types. In Europe, some early studies actually found an inverse relationship between the numbers of birds on the ground and radar migration rates from the previous nights. On the other

[25] The Chautauqua data are available on the website http://www.chautauquawind.ene.com/avian.htm The other studies are still confidential and have not yet been released.

hand, there is study by Williams et al. (2001, Auk 118:389-403) in the northern Appalachians that found some positive correlations between daytime and nighttime bird movements. There also probably is positive correlation on the Gulf Coast, where big migration nights often are followed by large numbers of migrants on the ground during the day.

Has post-construction fatality monitoring has been conducted at Mt. Storm to identify a kill ratio against the 162,000 migrants observed passing through the WRA?

Response: Post-construction fatality monitoring has not yet been done at the Mt. Storm site, which does not yet have any turbines in place. Based on Mt. Storm radar radar data from the Fall 2003 and Fall 2003 mortality data from the nearby Mountaineer wind site (i.e., 2.4 birds per turbine per fall season), however, WEST, Inc. calculated that approximately 0.16% of the fall migrants flying at or below turbine height over the WRA at Mountaineer were killed.

How do birds detect and avoid wind turbines, under what conditions do they not detect and avoid them, and is it possible for manufacturers to incorporate audio cues to make turbines more detectable?

Response: Birds detect and avoid turbines primarily visually, thus poor visibility is probably one factor that makes detection more difficult for them. It has been noted that on moonless nights in Europe resident wintering seaducks made wider swings (than on nights with moonlight) around one wind farm surveyed, although clearly this strategy does not benefit migrating birds that are unfamiliar with the terrain and turbine locations. The presenter did not know anything about the potential for using audio cues.

What do multi-year pre-construction studies tell state regulators about whether a wind facility will have unacceptable impacts on avian species in order for them to make a permitting decision?

Response: Multi-year studies have shown variation in migration rates from year to year (Mabee and Cooper 2004), but clearly more information is needed to assess the degree of annual variation in rates and flight altitudes that one might expect in general. Regulators have to make decisions based on the best available information to assess nocturnal risk to birds and obviously more years of data would give them more information to make those decisions, but sometimes multi-year studies are cost-prohibitive or time-prohibitive.

Can bird and bat species be distinguished via analysis of wing beat frequencies when using night radar?

Response: Although there are tracking radars that could do this for some species, the surveillance radar equipment [Brian Cooper] has worked with cannot. However, a combination of radar and visual techniques can be used to help determine the proportion of bats vs. birds in surveillance radar data.

What are the sample sizes for night radar studies?

Response: The fall studies I summarized today generally were conducted over 45 nights per season, with 6-9 hours of each night monitored. During spring, we typically sample 30-45 nights per season.

Could the variability observed from night to night possibly be attributed to the fact that radar "targets" included both birds and bats? If so, then what level of confidence can be assigned to this data, given uncertain identity of the targets?

Response: Both birds and bats are included in "targets," with birds being the majority later in the fall season (after early September). Some of the variation in the data could be due to this fact, but it could also be due to a number of other variables. To sort out these variables, it will be necessary to do more visual monitoring to assess the proportion of birds and bats, while concurrently examining the effects of factors such as weather and time of year.

When will the Clipper study be available?[26]

Response: Results of the radar study of the Clipper Criterion wind site, located along Backbone Ridge north of the Mountaineer site, was originally scheduled to be released to both Clipper Windpower and the public after the facility was operational.

Response [Kevin Rackstraw, Clipper Wind]: These reports are done but have not been released. Clipper followed the lead of the other developer working in Maryland [NedWind] in agreeing to additional studies (although theirs were far less extensive), but stipulating that they would not be made available until after the project was operating. The reason [for this stipulation was] that we didn't believe the [studies] would be appropriate for use in micro-siting turbines. We have long since agreed to release the information (dating back to at least the beginning of this year) but the individual interveners in our permit process, with whom we must have an agreement on the issue for legal reasons related to our settlement agreement with them, have not agreed to allow the data to be released. Their reason appears to be a concern that the data from the NedWind site contradicts their assertions about the site and about bird behavior around the site.

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[26] This question refers to a two-season study (Fall 2003 and Spring 2004) using on-site marine radar and acoustic sampling. The Clipper Criterion wind site is located in Maryland, along Backbone Ridge north of the Mountaineer site in West Virginia.

WHAT HAVE STUDIES OF COMMUNICATIONS TOWERS SUGGESTED REGARDING THE IMPACT OF GUY WIRES AND LIGHTS ON BIRDS AND BATS?

This presentation outlines lessons that have been learned from research on communications (*not* cell) towers, about the impacts of guy wires and lights on birds and bats as well as other issues.

Wind Turbines and Avian Risk: Lessons from Communications Towers[27]

by

Paul Kerlinger, *Curry & Kerlinger, LLC*[28]

There are three key variables associated with risk to migrating birds at communication towers: height; guy wires; and lighting. First, the height of a tower in relation to the height of migration is important. Secondly, it is the guy wires that support these tall structures that are the primary source/cause of collisions. Third is lighting, which may attract birds when there is fog, low clouds, and/or light rain. Some of these lights are requested by the FAA[29] for air traffic safety purposes, while others are non-FAA lights such as sodium vapor lights and spotlights.

Large-scale avian fatality events occur at communication towers taller than 500 feet, with FAA lights and guy wires. Single and small-scale bird fatality events have occurred at towers less than 500 feet with guy wires and FAA lights.[30] (The presence of sodium vapor and other bright lights seem to be the confounding variable causing fatalities at shorter communication towers.) Large-scale avian fatality events have not occurred at wind turbines, which are mostly less than 300 feet tall, with the newest ones being 300-380 feet. Virtually all collisions at communication towers are with guy wires. To date there have been no studies published that document birds being killed by unguyed meteorological or communication towers. Wind turbines are mostly unguyed, although meteorological towers associated with wind facilities often are guyed. Because of the collision risk associated with guy wires, it is recommended that wind developers build unguyed meteorological towers.

FAA lighting on communication towers has been identified as a key issue in terms of bird impacts. FAA obstruction lights on towers can attract nocturnally migrating birds. In addition, bright lights such as ceilometers, spotlights, sodium vapor lamps, light houses,

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[27] Note that this presentation discusses impacts from communication towers, not cell towers.
[28] P.O Box 453, Cape May Point, NJ 08212
[29] During an earlier session, it was explained that the FAA has no authority to require lighting, but only to request it. Local permitting authorities may, however, require FAA-requested lights as a condition of permitting.
[30] A new study comparing 475 and 1,000 ft. comm. towers is looking at lighting, guy wires, and height as factors in avian mortality risk (Gehring 2004). Statements about communication towers less than 500 feet in height are based on the author's review of original communication tower studies in literature.

and streetlights can also attract nocturnally migrating birds. The question is whether FAA obstruction lights on wind turbines attract night migrating birds in the way that communication towers lights do. There is evidence that suggests that different types of lighting schemes may differentially attract birds. Flashing lights appear to be less of an attractant than steady-burning lights at night. Whereas the FAA usually requests three flashing red lights and 4-6 steady-burning red sidelights on communication towers 351-700 feet tall, and 5-7 flashing red lights and 9-12 steady-burning lights on communications towers 1,000-1,400 feet tall, wind turbines of any size over 199 feet require only two (side-by-side) red flashing lights, and no steady-burning lights. By contrast, it seems that tall communication towers with steady-burning red lights and guy wires essentially act like large bird nets in the sky.

A “large” fatality event occurred at the Mountaineer, WV wind energy site in late May 2003 when a carcass search study was being conducted (Kerns and Kerlinger 2004). The Mountaineer site has 44 wind turbines along a high ridge; 12 turbines are lit with FAA red strobe lights, and 32 turbines are not lit at all. There is also one guyed and one unguyed meteorological tower. On May 23, 2003, there were about 30 fatalities found at turbines #22, 23, 24 and the nearby substation. The substation at turbine #23 had sodium vapor lamps on it. During the same day, fog in the area caused a 100-car accident on Route 68, demonstrating the severity of the weather. Other turbines at the wind site were not involved, despite having FAA (flashing) lights. Also, almost all the dead birds were found at turbine #23 (the closest to the substation) and at the substation. The lights at the substation were turned off on May 25, 2003, and there were no other major fatality events during the study period. This event suggests that bright sodium-vapor lamps were the cause of the large fatality event at Mountaineer, WV, and that the red flashing lights on the other turbines did not attract birds, despite thick fog.

Similar events have been documented at some communications towers, water towers, and ski lifts. Night migrant carcasses found in searches of unlit and lit turbines at other wind energy sites around the country are presented in the table below.

Night Migrant Carcass Search Findings

Location	Turbines (lit)	Height	Study period	Migrants found	Reference
Foote Creek Rim, WY	69 (0)	239 ft	1 year	~59	Johnson et al., 2001
Searsburg, VT	11 (0)	192 ft	5 mos. (1 summer; 1 autumn)	no avian fatalities found	Kerlinger, 2002
Vansycle, OR	38 (11 lit)	243 ft.	1 year	~5	Erickson et al., 2000
Stateline, OR/WA	394-399 (111)	243 ft.	18 months.	~28	Erickson et al., 2003
Ponnequin, CO	44 (Phase I: 29 incand., ½ w/red blinkers; Phase II: 15 end-of-row turbines with red strobes)	259 ft.	5 years	< 5	Kerlinger et al., unpublished
Wisconsin (2 sites)	31 (3/4 with red strobes)	292 feet	3 migration seasons	~5	Howe, Evans et al., 2002
Buffalo Ridge, MN	353 (76 "solid red")	max 249 ft.	4 yrs' study (3 phases)	~ 40 (600-700 killed per year); Event: 14 birds found in one night at 2 turbines – one lit, one unlit.	Johnson 2000
Buffalo Mountain, TN	3 (3 w/white flashing strobes)	290 feet	3 years (completed to date)	~ 8 per turbine per year	Nicholson 2004 (unpub. pers. comm.)
Green Mountain, PA	8 (4 w/red flashing incandesc.)	295 feet	1 year	No fatalities found	Kerlinger 2001 (unpub.)
Madison, NY	7 (7 w/red strobes)	328 feet	1 year	3	Kerlinger 2002 (unpub.)
Toronto, Ontario	1 (1 w/red strobe)	308 feet (lakefront)	1 year	No migrants	James and Coady, 2003
Pickering, Ontario	1 (1 w/red strobe)	384 feet (near lake and wetland)	1 year	2	James 2002

Overall, there have not been any large-scale bird fatality events at wind turbines like those documented at some communications towers. It seems that red flashing FAA lights on wind turbines do not attract birds migrating at night in the way that steady-burning lights do. In addition, turbines are shorter than communications towers that cause large-scale bird mortality. It is not clear whether rotating turbine rotors function as analogues of guy wires in terms of bird mortality.

Reference

Gehring, J. 2004. Pilot study for Michigan Public Safety Communication System towers. Presentation to U. S. Fish and Wildlife Service Communication Tower Working Group, February 11, 2004.

Kerns, J., and P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Prepared for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee.

Discussion, Questions and Answers

How is a "large-scale" fatality event defined?

Response: At Mountaineer, "large-scale" refers to an event involving more than seven birds.

How do fatality rates relate to weather conditions (i.e., cloud ceiling, flight altitudes)?

Response [from workshop participant other than the presenter]: It appears that as flight altitudes go down, fatality rates go up. Ceiling height (weather/clouds) does affect flight altitudes. It is relatively easy to predict major migration nights in the east based on weather conditions and prevailing winds.

Response [P. Kerlinger]: It is not necessarily the case that a lower cloud ceiling means lower flight altitudes; for example, radar has sometimes shown that birds fly at higher altitudes in response to fog.

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
Carl Thelander,[31] *BioResource Consultants*

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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[31] 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.

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 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[32] 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

[32] 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.[33] The proposed metric, which is described at length in an upcoming BRC

[33] 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.

paper and report to the CEC,[34] will require gathering output data from turbine operators.

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[34] The CEC report can be downloaded from the Web at: http://www.energy.ca.gov/pier/final_project_reports/500-04-052.html.

Prevention and Mitigation of Avian Impacts at Wind Power Facilities

by
Paul Kerlinger, *Curry & Kerlinger, LLC*

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.[35]

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.[36] In Texas, mortality studies are not required and therefore have not been done.

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[35] 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.

[36] 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.)

DEVELOPMENT AND APPLICATION OF GUIDELINES FOR SITING, CONSTRUCTING, OPERATING AND MONITORING WIND TURBINES

This session provided a comparison of wind project guidelines developed by the U.S. Fish and Wildlife Service (May 2003) and the Washington State Department of Fish and Wildlife (August 2003). Is there a need or desire for uniform national or state criteria? Can other states learn from Washington State's example, or from the USFWS voluntary guidelines? Should there be uniform requirements/guidelines/check-lists for the siting, operation, monitoring, and mitigation to prevent or minimize avian, bat, and other wildlife impacts?

Development and Application of USFWS Guidance for Site Evaluation, Siting, Construction, Operation and Monitoring of Wind Turbines

by

Albert M. Manville, II, Ph.D., *U.S. Fish and Wildlife Service*[37]

Although wind turbines are not new to the United States (over 1,000 windmills were reported on Cape Cod, Massachusetts, in the late 1800s), the development of large scale "wind farms" or wind plants and their impacts on birds and bats is a relatively recent phenomenon. Compared to the decades of documented impacts of power lines and communication towers on birds and bats, wind farm impacts are certainly recent.

The US Fish and Wildlife Service (USFWS or "the Service") took notice of avian-wind turbine collisions in the late 1980s and early 1990s as a result of events at Altamont Pass Wind Resource Area, California (APWRA). It was estimated that several hundred raptors were being killed each year at APWRA due to turbine blade collisions, guy wire strikes, and electrocutions. While mortality has been somewhat reduced at APWRA, the problem has yet to be resolved at that site. In addition to direct collision threats, concerns began to be raised in the late 1990s about wind plants disturbing and fragmenting habitats and disrupting birds. Breeding grassland songbirds and prairie grouse, particularly lek-breeding prairie grouse (*e.g.*, Greater and Lesser Prairie Chickens and Sage Grouse), all appear to be adversely affected. Studies on habitat impacts are ongoing. More peer-reviewed published research is needed to determine the extent and implications of impacts.

USFWS' involvement in wind power and issues related to its development began with the Service's Office of Law Enforcement in the late 1980s as a result of events at Altamont Pass. In addition to 1980s investigations, USFWS partnered with the wind industry in 1995 when it joined the Avian Subcommittee (now called the Wildlife Work Group) of the National Wind Coordinating Committee (NWCC). In 1997, Al Manville was designated the USFWS representative to NWCC. In 2002, the Service recognized the need for voluntary guidance to assess, rank, site, place, monitor and conduct research pre-and post-

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[37] 4401 N. Fairfax Dr., Mail Stop MBSP-4107, Arlington, VA 22203

construction at wind power developments. Mr. Manville was tasked to chair the Service's Turbine Siting Working Group – represented by all seven Service Regions and the Washington office – including representatives from Ecological Services, Permits, Law Enforcement, Habitat Conservation, and Migratory Birds. The creation and release of USFWS wind power guidance was fast-tracked as part of the President's National Energy Policy addressing renewable energy, and the Interior Secretary's 2001 Renewable Energy on Public Lands Initiative.

In July 2002, the USFWS Turbine Siting Working Group held a three-day meeting with fifteen Service representatives. The meeting resulted in the creation of draft interim voluntary guidance for wind power development. The guidance was critically reviewed by all Service Regions, later by the Washington Directorate, and finally by the Department of the Interior. The interim voluntary guidance for land-based wind turbines was completed and approved in July 2003, when it was announced in the Federal Register. The complete guidelines can be found at: http://www.fws.gov/r9dhcbfa/windenergy.htm.

There are a variety of reasons why USFWS's guidance on wind development are voluntary rather than regulatory. Given the opportunity, the Service prefers partnerships over a regulatory approach when working with industry. This is how the Service has worked with the electric utility industry since the 1970s (in a partnership formalized in 1989 through the Avian Power Line Interaction Committee [APLIC]) and with the communication tower industry since 1999 (through the Communication Tower Working Group); the same model likely will be used with the commercial and recreational fishing industries in the near future. With respect to the electric utility industry, USFWS helped develop voluntary guidance with APLIC through "suggested practices" for strike and electrocution avoidance (published in 1994 and 1996 respectively). The Service, with feedback from industry and academics, developed voluntary guidance for siting and placement of communication towers in 2000.

The voluntary guidelines[38] are based on the best available science, and will be updated in July 2005 based on comments received from the public and when new information becomes available (with the exception of National Wildlife Refuge policies regarding grassland easements in Region 6, found in Appendix 6 of the USFWS guidance document, pp. 39-44). Comments received on the guidelines will become part of the Service's administrative record. Two public meetings/briefings have been held on the guidelines to date, and the Service anticipates holding others. Much of the guidance is based on studies conducted by, information collected from, and recommendations presented by the NWCC, including input from the American Wind Energy Association (AWEA).[39] General recommendations regarding siting, design, and operations are intended to *suggest* (based on the best available science) the sorts of analyses that should be performed. These are recommendations, *not binding, bright-line rules*.

While the USFWS guidelines are voluntary, there are applicable Federal statutes and

[38] The terms "guidelines," "guidance," and "guidance document" hereafter are used interchangeably.
[39] See Partial List of Literature Reviewed, below.

regulations which the wind industry must obey. These include the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), and the Bald and Golden Eagle Protection Act (BGEPA), and the regulations applicable to these statutes. With respect to the ESA on public lands or where Federal funding or Federal permits are involved, USFWS strongly recommends that the applicable Federal agency or the turbine company/contractor – if designated as a non-Federal representative – consult with USFWS through Section 7. On private lands, particularly in the East, USFWS suggests contacting the local Ecological Services Office for guidance regarding Sections 9 and 10 of ESA. To avoid problems, it is best to contact the nearest Ecological Services Office at the outset.

The MBTA is a strict liability statute, meaning that *proof of intent* to violate any provision *is not required* to establish that a party is in violation of the law. The killing of any bird is not allowed under the law unless permitted, and the USFWS does *not* issue "incidental" or "accidental take" permits under MBTA. However, on page 2 of the Director's memo to the Regional Directors, signed May 13, 2003, the guidance does state:

> "While the Act has no provision for allowing unauthorized take, it must be recognized that some birds may be killed at structures such as wind turbines even if all reasonable measures to avoid it are implemented."[40]

Because of these stipulations, USFWS encourages a pro-active, partnership approach in order to avoid potential problems. BGEPA, like MBTA, is a strict liability statute protecting Bald and Golden Eagles. It is important to contact the nearest Ecological Services Field Office for issues regarding either act.

Migratory birds are a trust responsibility of USFWS. The Service is currently responsible for the conservation and management of 836 species of migratory birds. In 1995, USFWS listed 124 "nongame species of management concern" representing birds whose populations were declining, some precipitously. This list represents an "early warning" system. The next step for species of management concern could be listing as candidates under the ESA, which USFWS would rather avoid. As of 2003, the Service raised the number from 124 to 131 species in the publication, *Birds of Conservation Concern 2002*. This is not good news. In addition, there are 77 endangered and 15 threatened birds listed on the ESA, and these numbers continue to increase. This means that at least a total of 223 of the 836 species of migratory birds in the U.S. are in trouble, while the status of fully one-third of the other species is not known. As a trust agency tasked to protect and manage migratory birds, USFWS must do everything it can to reverse these population trends (the vast majority of which are human-caused), whether impacts appear to be large or small, on public or on private lands. The issue involves cumulative impacts as well, including those from wind farms, communication towers, buildings, automobiles, power lines, and other sources of mortality related to human activity.

Generally speaking, estimated nationwide avian mortality due to wind turbines appears to low with the exception of Altamont Pass. USFWS wants to ensure that impacts stay low.

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[40] USFWS Director's memo to Regional Directors introducing the Service's voluntary land-based wind turbine guidance, May 13, 2003, 2 pp.

Because the wind industry is still in its infancy, the Service hopes to prevent any new problems from developing as the industry and the nation gear up for exponential turbine growth. The bottom line: USFWS encourages the wind industry to work with the Service to help prevent avian and bat impacts, especially as electricity demand (and wind energy development) increases in the US. To make this happen, the industry's review process needs to be transparent, especially concerning the protocols being used to assess wind sites for bird and bat impacts (e.g., Phase I and II risk assessments, and pre- and post-construction monitoring protocols). USFWS and other agencies would like the opportunity to review them as well. This is one reason why USFWS recommended that a professional Federal and/or State biologist be involved in the pre-development review process. USFWS strongly encourages wind energy developers and trade associations to work directly with Robert Willis (of the Division of Habitat Conservation, Arlington, VA, office); Rob Hazelwood (of the Helena, MT, Field Office), Al Manville, and all 78 Ecological Services Field Offices from the outset of the project development process. By working together at the local level to properly site and design wind turbines, we have the potential to reduce loss of migratory bird trust resources and habitats, listed bats, and other listed species by replacing more disruptive forms of energy development with wind energy.

USFWS encourages the wind industry to follow the guidelines USFWS has developed and to conduct scientific research to provide additional information on migratory birds, prairie grouse, grassland songbirds, bats and other species. Specifically, USFWS asks contractors/developers to do the following:

- rank and evaluate each site;
- assess and monitor wildlife impacts;
- perform pre- and post-construction monitoring and mortality studies;
- use USFWS site development recommendations;
- use turbine design and operational recommendations; and
- address research needs.

In a memo to Regional Directors dated April 26, 2004, the USFWS Director noted that these actions

> "should be accomplished through flexible application of our voluntary guidelines based on local conditions, local knowledge, locally applicable scientific data, and technical feasibility (e.g. sufficient wind, lease space, transmission grid access).
>
> Where we recommend collecting 3 years of data prior to construction, this recommendation is *not* intended to be a *strict requirement* in all areas, especially if less time can be expected to yield sufficient data. However, where risk is considered sufficiently high due to variable weather, changing flight paths, and variable migration timing, then 3 years of data may be appropriate."

In other words, three years of pre-construction data is a recommendation, not a requirement.

There are some relatively new and very promising technologies that can be used individually or in tandem to monitor for birds and bats. These technologies include: a) thermal imaging equipment; b) fixed vertical beam radar; c) BIRDRAD (high resolution marine radar); d) WSR-88D (Doppler weather radar); e) acoustic monitoring; f) GIS; and g) GPS. Taken as a whole, these technologies are helping to better assess bird and bat presence, animal behaviors, altitudes of migration, patterns of movement, speed and direction of movement. USFWS reminds researchers that it is important to "ground the truth" by corroborating the findings of any one tool with data from other sources or tools. Despite the number and rigor of avian/bat studies that are conducted, from a wildlife and habitat perspective there are still fundamentally "good" and "bad" places to locate wind turbines. It is USFWS's fear that as the industry grows, more "bad" sites will be considered as "good" ones get developed. The site evaluation guidance developed by USFWS is designed to help make that "good"/"bad" determination and avoid potential problems.

USFWS hopes to achieve a range of goals with the development of the guidance document and the Service's overall involvement with wind the wind industry. The primary goal is to partner with the wind industry and consider developing voluntary avian protection plans (APPs) as is currently being done with the electric utility industry. The Service aims to keep bird and bat mortality low as the industry grows exponentially. It hopes to resolve issues at Altamont Pass and avoid similar scenarios in other locations. USFWS hopes to learn more about and answer questions about bat mortality at wind farms,[41] and to look much more closely at avian and bat migration in the Eastern US, particularly along the Appalachian Mountain ridge-tops. More radar and thermal imagery work are needed, and more replication is suggested. For example, one study found "roughly half the night [bird] migrants flew at altitudes below 125 m, putting them at risk of colliding with 112-m high wind turbines…" at proposed sites in New York (Cooper and Mabee 1999).

Overall, USFWS seeks more cooperation and collaboration from the wind industry from the beginning of development planning processes. The Service would like to see greater transparency incorporated into the industry's review process, especially with respect to research protocols used to assess wind sites for birds and bats during Phase I assessments. If the wind industry is to portray itself as "green," developers need to contact USFWS at the outset, not just as a second thought after a site has been selected, landowner agreement has been reached and a power agreement signed.

Several next steps are planned to develop and promote the guidance. The Service plans to:

- conduct more public workshops;

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[41] The retrieval of 475 bats at Backbone Mountain, WV (fatalities estimated at 1,900-2,375 for the year 2003) is of concern. The level of mortality at Backbone Mountain has been reassessed by Dr. Merlin Tuttle of Bat Conservation International, indicating that the total number of fatalities could approach 4,000 (Tuttle 2004).

- implement a series of multi-stakeholder workshops (such as the Region 5 [Northeastern US] workshop which took place in September 2003 on Virginia's Eastern Shore) on use of USFWS guidance;
- encourage more dialogue between the wind industry and USFWS Field Offices;
- ask industry to encourage a 5+ year reauthorization of tax credit legislation;
- encourage the industry to continue funding bird and bat research (the industry has spent an impressive $6+ million on research since 1994) and to get their results published in peer-reviewed journals.

The current guidance will be updated in July 2005. USFWS hopes to participate in more meetings like the Wind Energy and Birds/Bats Workshop, and encourages industry members not already involved to engage in the process.

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Plus numerous other sources referenced in Literature Cited Section of Guidance.

Discussion, Questions and Answers, USFWS Guidelines

Noted: Proceedings from a National Wind Coordinating Committee (NWCC) meeting held to help guide development of the USFWS guidelines will be available on the NWCC website in the near future (www.nationalwind.org). AWEA also has commented on the USFWS guidance and these comments are available for review at www.awea.org.

Noted: APLIC is developing research methods and protocols for bat monitoring around power lines. The group is working on developing sensors/markers to put on power lines to deter birds and bats.

Does the USFWS website present recommendations to developers of coal-fired power plants?

Response: USFWS tried to get involved with the mountaintop mining issue in the past and was ignored. Different energy development pursuits are regulated in disparate ways… i.e., wind power development is being constrained because of bird and bat impacts while mountaintop mining, while clearly destructive of bird and other wildlife habitat, continues.

Noted: People in the wind industry are beginning to understand that USFWS recognizes some of the industry's concerns regarding regulation. Industry people hope to continue working with USFWS.

Could the presenter say something about the Cuban Bill?

Response: This bill was an extension of tax credit authorization for all energy sectors except wind to five years rather than two.

How has USFWS prepared its field offices to respond to the inquiries of the wind industry regarding the guidance?

Response: Regional Directors report to the USFWS Director, and all Regional Ecological Services field officers commented on the guidelines before they were published. Part of the guideline development process may be considered an opportunity to educate everyone involved – USFWS, environmentalists, and industry people. USFWS is striving for coordination. All field offices have been provided with the guidelines and were instructed to apply them and get feedback from the wind industry. Additional guidance was sent to field offices based on feedback and questions the Service was receiving. Basically, USFWS is doing its best to develop consistency throughout in the advice it provides with respect to the guidance, but it is a work in progress. The Service Director is encouraging field office people to familiarize themselves with the wind industry, and the Service plans to hold more workshops in the future.

Given that the guidance has been out for nearly a year as of May 2004, what has the response been to the suggestion of looking at and ranking multiple potential sites?

Response: USFWS has not received much feedback on that point to date. Most comments from the West have been positive, but it is too early to tell for the East. One developer did complain about the recommendation to conduct three years of pre-construction wildlife studies; however, this developer and the state involved have been working on getting the project in question moving for six years.

How did USFWS come up with its nationwide mortality estimate?

Response: USFWS does not use an estimate, but rather a range – and even if it is off by a couple orders of magnitude, mortality is still significantly less at wind turbines today than it is at communication towers.

Comment: More outreach by public utility companies may help direct developers to USFWS sooner than in the past.

Response: Yes, this is a good idea.

Wind Power in Washington State

by
Greg Hueckel, *Washington State Department of Fish and Wildlife*[42]

The Washington State Department of Fish and Wildlife (WDFW, or the Department), in consultation with representatives from the wind power industry and environmental groups has developed Wind Power Guidelines that achieve ways to reconcile support for renewable wind power projects with the need to protect wildlife and the State's habitat. These Wind Power Guidelines include innovative provisions that not only protect our native habitats, but also greatly improve habitat value with mitigation expenditures. There is currently little operational experience with wind projects in Washington State, and these Wind Power Guidelines are designed to add important studies and operational knowledge to our understanding of how to site, design, and operate wind projects to avoid and minimize impacts.

These Wind Power Guidelines, which will be used by the Department to shape its comments on wind power projects through the State Environmental Policy Act process, are divided into the following three sections:

1. *Baseline Monitoring Studies for Wind Projects:* calls for pre-project assessments of wind power sites with the goal of avoiding and minimizing bird and bat mortality from turbine strikes; operational monitoring; and a Technical Advisory Committee (TAC) to evaluate impacts and determine if additional measures are needed to address unexpected impacts.
2. *Wind Project Habitat Mitigation (conventional):* steers wind projects toward cropland and developed areas and away from undeveloped native habitat; provides ratios for replacement habitat as mitigation for temporary and permanent wind project impacts; adheres to the principle of no loss of habitat functions and values.
3. *Wind Project Alternative Habitat Mitigation Pilot Program:* creates an innovative option for wind developers (as an alternative to #2) to streamline the mitigation process and ensure that mitigation dollars are spent on acquiring, restoring, and managing strategically important habitat in central and eastern Washington State, where most wind projects are sited. The Alternative Mitigation Program is designed to use public funds for acquisition of the highest value habitat with annual payments from wind developers for stewardship of these lands, greatly increasing the value of mitigation expenditures over those of conventional on-site mitigation.

These Guidelines will be re-evaluated after five years and adaptively altered as needed. They provide wind project applicants with clarity and streamlined processes, require mitigation to not reduce our native wildlife and their habitats, and provide an option to partner with WDFW to protect and improve some of Washington State’s most important native habitats.

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[42] 600 Capitol Way N., Olympia, WA 98501-1091

References

A complete copy to Washington State's Wind Power Guidelines can be obtained over the internet at: http://wdfw.wa.gov/hab/engineer/windpower/intex.htm

Or by writing to the Washington State Department of Fish and Wildlife at:

Habitat Program
Washington Department of Fish and Wildlife
600 Capitol Way N.
Olympia, WA 98502-1091

Discussion, Questions and Answers

How does WDFW determine the footprint that the $55/acre fee is applied to?

Response: It is applied to the actual footprint including roads and tower pads and the buffer around them.

Comment: In New Jersey, neither developers nor environmentalists have dealt with state-level guidance yet. Could any other workshop participants comment on the process of developing the Washington State guidelines?

Response (representative of Washington State Audubon): Our organization was given a copy of the guidelines to review, but I wish we had been more integrally involved in developing the alternative mitigation guidelines. We did not entirely agree with the guidelines regarding monitoring, and wondered whether research protocols had been peer-reviewed. We would have liked to have seen a minimum of two years (rather than one season) avian use assessments even for "low-risk" areas. In particular, we did not like the fact that if operation monitoring is "unfinanceable" (i.e., cost prohibitive), then it is not required. Basically, Audubon would have liked to have been party to negotiations and the guideline development process, rather than just being given a chance to review something developed by the wind industry and WDFW.

Response (WDFW): An Audubon representative was included on the review team.

What is meant by the term "unfinanceable"? If taking an operating turbine out of operation is not an option, what do you do if you start seeing high fatality levels post-construction?

Response: The industry has said that taking turbines out of operation after they're built is not a viable mitigation option because of the risk of such a possibility would make it impossible (or prohibitively expensive) to get financing for a project. The solution arrived at in Washington State was to list (at the pre-permit stage) options for operational changes that may be implemented to deal with mortality should it appear during post-construction monitoring.

Comment: There seems to have been much thought put into the Washington guidelines;

they should be used as a template for other states.

Has Washington State thought about statewide monitoring/review?

Response: The State is paying for eco-regional studies, but lack of staff is a real constraint. However, WDFW does have a staff biologist who helps developers put together the information they need for the permitting process.

Comment: The issue of conducting three years of pre-construction studies keeps coming up, and the idea of a three-year standard goes way back before USFWS guidelines. It is considered important for studying critical high-use habitat areas. However, as has been noted here today, when you have good data another three years worth is not necessary, and where you don't have high risk you don't need three years of studies.

In Maine it is entirely up to the developer to decide who gets involved in the site assessment process and whether to conduct pre-construction studies. Which is closer to the current norm, Maine or Washington State?

Response: Washington is definitely a leader for this type of regulation, and thus ahead of the norm.

Might the lack of mitigation demands for disturbed lands motivate developers to disturb an area and then come back later and identify the site for wind development without mitigation requirements?

Response: There is enough trust between parties in Washington State that this is not viewed as a problem.

Has the allowance of less than one full year of pre-project monitoring as outlined in the guidelines been an issue for concern?

Response: Pre-permit assessment in most current cases in Washington State has involved a review of existing information and contacting WDFW, with at least one year of pre-construction studies and, in some cases where there is a critical season, two years of data for that season.

DISCUSSION OF RESEARCH NEEDS

The Facilitator asked participants for their overall reaction to the research that has been presented during this workshop. Questions addressed by workshop participants included the following:

- How do you develop trust and confidence in the research?
- What are some of the specific gaps in our understanding of wind energy's impact on birds and bats?
- How do we prioritize and proceed with closing the data/research gaps? How do we "connect the dots" and bring various research and mapping efforts together?
- Given gaps in the data, what are the critical questions we need to answer to make project decisions now? How do we track/influence the policies that will shape wind energy development?

How do you develop trust and confidence in the research?

The first part of the discussion centered on the credibility and accessibility of research being done. Participants considered what guidance is available for protocol development and whether protocols and study results should be peer-reviewed. A peer review requirement raises several issues, including questions of confidentiality for proprietary information, what it takes to get research published, and the importance of timely reporting of research results – including findings of "no significant impact." Participants concluded that the issue is not whether research is peer reviewed, but whether it is a) credible, and b) accessible. (It was noted, however, that the peer review process does provide both credibility and accessibility in a way that no other process does.)

Guidance available for developing research protocols.

While industry has funded most of the research to date, one participant noted that some of the results we have been looking at come from publicly-funded research (e.g., NREL, CEC), and that the industry-funded research follows largely the same protocols. Another participant cited the NWCC's stakeholder-developed "Methods and Metrics" document (*Studying Wind Energy-Bird Interactions: a Guidance Document*) which was intended to facilitate the comparison of results from different studies. This guidance document is now three years old, and it would be useful to get feedback so that it could be updated.

Questions and comments related to NWCC's Guidance Document:

1) Are the protocols described in the guidance document applicable to all terrestrial sites?

Response: Yes, but not to offshore sites. (See Jette Gaarde's presentation on offshore development in Denmark.)

2) Guidance document could be revised to address offshore research methodologies as well

as new imaging technologies – but the basic research principles apply no matter where you're doing the research.

3) Are people using this document as intended? Are they drawing the correct inferences?

Response: The document just provides a toolbox; agencies have to draw the inferences.

Issue of peer review and the confidentiality and timeliness of research.

One participant noted that Phase I assessment protocols could be reviewed by an independent body (without publication), which also could review the inferences drawn from the results of Phase I studies. Another agreed that it would be helpful to get protocols as well as actual studies peer reviewed. A third pointed out that "we have to be clear about what is meant by peer review. Many documents that are peer-reviewed still wind up in gray literature; we're talking about peer-reviewed literature."

Confidentiality

With respect to confidentiality, one participant recommended considering the FIFRA process – EPA is dealing with proprietary information. The nature of the chemical is not even revealed to reviewers, yet a technical review committee process can review the science without breaching confidentiality. Other participants said it was best to proceed with caution when engaging the Federal or state governments in the review of proprietary information.

The research may be valid, but is it publishable?

The question was raised whether the kind of work being presented here would qualify to get into peer-reviewed scientific journals, or whether "we have to look for a different venue for "applied" science studies." *Response:* There are many high quality journals (e.g., Ecological Applications) that publish applied research.

Reports that are useful to industry may not meet article standards, noted one research consultant. "Those of us who publish long reports have an obligation to summarize the information in a series of publishable reports, and go the publication/peer review route." Another consultant observed that it takes a long time to get a research article published. "When we do a monitoring study, we try to get the information out there as soon as possible. [Researchers] may need to do three to four sites before [they] can get the information into a scientific journal."

A participant with experience both as a research consultant and as an associate journal editor acknowledged that "an awful lot of what we do is not publishable… But we do have to start publishing in refereed journals." However, as a consultant, he and his staff can't afford to make publication (as opposed to billable work) their focus. "We're not in the academic arena, so it is problematic."

How do we reconcile the need for review with the need for timely decision-

making?

When it comes to wind energy project developments, timely decision-making is important, sometimes a statutory requirement. One participant emphasized the importance of having access to reports *as they come out*. ("We need to avoid 'paralysis by analysis.'")

Suggestions:

1) Some research would add to the scientific knowledge base without necessarily having to be tied to a particular project's development. Night radar monitoring, for example, would be useful to help us learn more about the ratio of flyover rates to mortality data.

2) A common post-construction monitoring practice is to have a Technical Review Committee. Is that an appropriate level of review?

3) A variation on this suggestion was described as "pseudo" peer review by stakeholder committees when permitting requirements create time pressure.

4) It might be useful for this group to establish its own publishing forum.

Other participants followed up on this last idea. One made the point that, while the peer review process takes time, a group of people such as those represented at this Workshop could "certify" research findings and make them accessible. It was suggested that the NWCC could be a central repository for research, providing access to the information, with a review process being conducted in parallel. Such a forum also would enable researchers to publish findings of "no significant impact," which might be of legitimate interest to the industry, agencies, and environmental groups, but not to scientific journal editors. (One consultant noted that an article which reported an absence of fatalities at Vansycle Ridge was rejected as not having a sample size large enough.)

One participant noted that the two main issues are credibility and accessibility – both of which are necessary. "We need to think creatively as a community about how to provide credibility for a body of work, an agreed-upon process for conferring credibility." Because accessibility is sometimes at odds with getting stuff published in peer-reviewed literature, this participant suggested various other outlets, including Web-related activities, access to technical reports with associated databases (e.g., via NREL), etc. A "technical working group" of half-a-dozen qualified individuals (perhaps set up by a group such as was gathered for this workshop) could perform the function of a peer review committee. It was suggested that the committee could even publish the review comments, allowing the work itself to be presented as it is.

Another participant summed up this discussion by noting that "peer review is just a tool to make sure you have good science. Good science, not peer review, is what we really care about."

What are some of the specific gaps in our understanding of wind energy's impact on birds and bats?

This question yielded a wide range of responses.

How do birds detect turbines? There is a presumption is that it's visual, but do they use sound? Under what conditions do birds not detect turbines? Are there things that can be done to make sounds that would help birds avoid turbines?

When during the night do fatalities occur? Do they occur early, when birds are leaving habitat, during mid-stream, or when birds are putting down? Need to know more about the impact of weather and how birds interact with lights and objects.

Responses: 1) We need to collect concurrent information on weather, and passage rates in zone of exposure and mortality. That will help us to predict weather impact. 2) Diurnal use should also be collected concurrently.

Are bigger turbines necessarily better for birds and bats? What about lighting? Look at Podolsky's Avian Risk of Collision (ARC) model determining risk of birds flying through different rotor swept areas. We can expect to get more definitive answers about red strobe lights from Paul Kerlinger's Michigan study and from other studies; this will be very valuable.

Studies of grouse are needed. Two participants underscored this point, citing the need to look at prairie grouse in particular, look at the impact of human activity on grasslands, other grouse habitat impact.

We need to know more about cumulative effects of wind farm development.

1) Can we start to model what would happen to bird and bat populations if we were to start building out wind energy potential?

2) We should look at wind energy's cumulative effects in the larger context – i.e., the impact on wildlife of all power generation technologies.

Information about migration patterns means looking at the bigger picture.

Some research requires a more proactive statewide approach, as opposed to project-specific studies. For example, it would be useful to the wind industry and consultants, as well as to wildlife and permitting agencies, to learn more about avian-wind interactions in the context of migratory behavior (e.g., use of stopover habitat). Such information would help agencies know what additional sitework needs to be done for a given project. People are already working on this (e.g., the US Geological Survey's science support program), we need to help pull this together. The National Fish & Wildlife Foundation's state wildlife program grant is another example (see www.nfwf.org).

We need more controlled experiments.

Example of an experiment to test the effect of lighting on bird impacts, where a controlled experiment was actually built in to a project.

Offshore and coastal wind development should be studied.

We need to learn about the impact of offshore wind energy facility construction and operation on whales, how artificial reefs would affect marine wildlife, etc.
So little is known about the coast (e.g., coastal Texas). It would be good to see some research on coastal sites.

Other Areas of Research on Which to Focus:

- We need more data from the Eastern US, especially about birds' use of ridges, passes, gaps.
- Bats – Don't forget the Bat Conservation International (BCI) research needs that have been identified.
- Crippling events and other "hidden" impacts – In the case of pesticides, for every bird that's killed, at least one is sub-fatally impacted. We don't seem to be measuring this for wind impacts, because it's hidden. (Also, what about the impact of electro-magnetic fields on birds?)
- We don't know that much about HOW birds and bats are being killed. Are they running into towers? Running into blades? Guy wires?

How do we prioritize and proceed with closing the data/research gaps?

How do we "connect the dots" and bring various research and mapping efforts together?

Noting that "this is an ongoing process," one participant suggested that, rather than have workshop participants vote on research priorities, it might be better to set up an ongoing committee that tracks research priorities.

Referring again to the issue of who funds the research, a participant argued for working to get Federal and state governments to partner with industry to help close some of these research gaps.

Who connects the dots?

Another participant suggested that we might be able to "get smarter sooner" by looking at existing sources of data and how they might be tied together. With respect to the Appalachian ridges, for example, there are NEXRAD stations with data concurrent with radar studies that we've done already; if we can figure out how to "tie the data together," maybe we can learn what we need to know without doing another year of radar studies." This idea was greeted with enthusiasm, although one researcher noted that the NEXRAD technology has severe limitations for detecting birds, particularly in mountainous areas; it is more useful along coastal areas.

The Workshop Facilitator noted that people are starting use GIS to map bird migration and wind resource information in some parts of the country. "The question is, who connects the dots?"

One approach has been to map "areas of concern" – geographic areas where development either should not take place, or would require careful pre-development study to assess risk.

Yet focusing on "areas of concern" tends to be a somewhat piecemeal approach, and some environmentalists would argue for a more proactive approach.

Audubon has introduced the "important bird areas" (IBA) concept at the state, national, and continental levels. Forty-six states have IBA work ongoing, and some 5800 IBAs have so far been identified in this country. The National Audubon Society will be able to put together a national picture in a few years, which will help developers plan and also bring stakeholders together on the ground. (In a similar vein, the state of Pennsylvania has started implementing IMAs – Important Mammal Areas – and other states are thinking of establishing them as well.)

There are a number of people using NEXRAD to create regional maps as well as bird migration traffic maps for the entire US (maps showing density and direction of movement). There is a proposal in to the National Oceanic and Atmospheric Administration (NOAA) to develop a spatial model that looks at all the risk factors to migratory birds.

A participant representing The Nature Conservancy reported that the Conservancy has invested a lot in "biodiversity areas" but that "we don't have a good handle on bird and bat 'fly-ways' or movement corridors. It isn't the wind industry's job to do this, but we need to close that gap."

The group concluded that it is the NGOs that are taking the lead in coming up with the information—e.g., population numbers from IBA programs, the Natural Heritage Program (now NatureServe), the Nature Conservancy's biodiversity programs. These are the dots that need to be connected, and a lot of that information is starting to come together.

What are the Critical Questions We Need to Answer?

Given gaps in the data, what are the critical questions we need to answer to make project decisions now? How do we track/influence the policies that will shape wind energy development?

Noting that "we'll probably never have all the information we need," a participant asked, "How do we react to wind development decisions that need to be made, given that there are and will always be gaps? What is an acceptable risk? Is it the same for all species? What are the questions we need answered to make project decisions?"

Another participant reminded the group that, from the industry's standpoint, the question of bird and bat mortality is just one of the risks to be considered. How do we balance the need to assess the potential risk to birds and bats with developers' need to "cap" or somehow manage the risk of having to shut down turbines once they are up and operating?

Areas of agreement

Workshop participants agreed that, among the human activity-related threats to birds and bats, wind energy is at the margin. Nevertheless, it is important to understand where on the margin it is. Other areas of agreement included:

- Need to address site selection criteria as well as guidance on site development.
- Need to be prepared with reasonable, practical protocols for studying proposed offshore sites.
- Research information needs to be both credible and readily available.
- Both habitat loss and mortality matter.
- There is a need for tools, techniques, metrics to address bats
- Do we need to develop a national strategy?

CONCLUDING OBSERVATIONS AND NEXT STEPS

The Workshop concluded with a discussion led off by David Blockstein of the National Council for Science and Environment. Facilitator Abby Arnold then asked Workshop participants to brainstorm suggestions for next steps.

Concluding Observations

Discussion led by David E. Blockstein, Ph.D.
National Council for Science and Environment

Reconciling wind energy development with minimizing impact on birds and bats: a tractable problem

Dr. Blockstein began the discussion by offering some observations about the state of conversation and collaboration among the participants of the Wind Energy and Birds/Bats Workshop. Having commended the participants on engaging in this process, and having noted that all aspects of the issue were represented and that everyone seemed committed to working together in good faith, Dr. Blockstein observed that the group seems to be at a good point because there has been some development of wind energy that has allowed an assessment of its potential and its potential problems. Where research has been done, it generally has been conducted carefully. He noted that, even at places such as Altamont Pass and Mountaineer where excessive mortality has occurred, it appears to be related to specific turbines. Thus with additional analysis, the community may be able to pinpoint causes of avian mortality at Altamont Pass and Mountaineer and thus be able to determine ways to prevent future incidents there and elsewhere. Given these observations, Dr. Blockstein expressed the opinion that the challenge of how to move forward with wind power development while minimizing impacts on birds, bats and other wildlife is “very tractable.”

How do we create a process to do move the science forward in a productive way?

Dr. Blockstein suggested an alternative approach to simply prioritizing the list of research needs brainstormed by the group. The National Council for Science and Environment (NCSE) received funds in 2001 to put together a National Commission on Science for Sustainable Forestry (NCSSF). NCSSF is a results-oriented program with a mandate to provide practical information and approaches that serve the needs of forest managers, practitioners and policymakers. The program’s mission is to improve the scientific basis for the development, implementation, and evaluation of sustainable forestry in the United States. This commission consists of a science panel as well as a stakeholder panel including a State forester and representatives of the US Forest Service, industry, and environmental NGOs. Dr. Blockstein noted that the group has been able to identify the key issues around sustainable forestry and the state of science to date, and to make a plan for what can practically be done to improve sustainable forestry within a five-year time frame. The Commission has received foundation funding that it has re-granted on a peer-reviewed basis to research, synthesis and tool-development projects with a goal of providing the knowledge to improve management on the ground (see www.ncse.org/ncssf).

Dr. Blockstein emphasized that he was not implying that this example was a perfect analogue for the challenge facing the wind/avian parties. His primary point was that workshop participants had already come together as individuals, and that they may want to work on formalizing their relationship – perhaps by creating a partnership to meet the research needs discussed and to move forward to provide the basis for wind energy that does not cause problems for wildlife.

Facilitator Abby Arnold noted that the NWCC Wildlife Workgroup provides some of the role that Dr. Blockstein described. However, she said it may need to be more formalized and that environmentalists should be more involved than they are at the moment. Nevertheless, the NWCC Wildlife Workgroup could provide the framework for doing this although research funding would have to be sought via other avenues.

Next Steps

Brainstorming Session led by Abby Arnold,
RESOLVE, Inc.

THE FOLLOWING IDEAS WERE SUGGESTED BY PARTICIPANTS AS FOLLOW-UP ACTIONS TO CARRY FORWARD THE WORK PRESENTED AND DISCUSSED AT THE WIND ENERGY BIRDS/BATS WORKSHOP.

- Synthesize existing research/information.
- Synthesize “on-the-ground”/cutting edge and new research/information.
- Develop communication tools for the field/issue area.
- Organize a meeting with state wildlife departments and regulatory agencies.
- Potentially use NWCC Wildlife Workgroup as a platform to launch a more formalized internal organization process around the Wind-Birds/Bats issue:
- Flesh out and define parameters of research questions;
- Conduct analysis of gaps in research funding;
- Conduct analysis of state (and possibly county) level permitting policies/regulations to gain understanding of current wind power landscape; and
- Examine/analyze NGO policies to determine which organizations should work together on mapping.
- Recruit new members for the NWCC Wildlife Workgroup.
- Determine how funds will be generated to carry out future research, either by workshop participants or by a potential NWCC-affiliated group. Identify funding sources for this endeavor.
- What can this group do to influence, modify, or create state or national law and policies regarding the development of wind power facilities?

- Facilitate interstate communication on wind-bird/bat issues between State agencies (wildlife, utility, regulatory).

APPENDIX A: RESEARCH TOPICS

General Tasks:

- Review and update NWCC methods and metrics document.
  - Add Offshore?
  - Add Newer Technologies?
- Work on gaining consensus regarding peer review protocols for monitoring studies.
  - What kind of "peer review" is appropriate, credible, feasible?
    - Type
      - Methods and Protocols
      - Site Specific research
      - Long–term questions
    - Location
      - Journals
      - Web (NREL, NWCC, elsewhere?)
  - Look to other models such as FIFRA.

Existing Science Gaps and Research Questions for the Future:

- Are newer bigger breeds of turbines "safer" for birds and bats than older smaller turbines?
- How do birds detect turbines?
- How/Why do birds not detect turbines?
- Are there technological ways to help birds detect turbines?
- When during the night do fatalities occur: leaving, in route, putting down?
- How does weather, especially low ceilings, affect birds?
- What models are available and how can they help predict risk (e.g., Richard Podolsky's Avian Risk of Collision model)?
- What is the relationship between nocturnal passage rates at or below turbine heights, weather, diurnal use and bird mortality at turbines?
- Direct and indirect human impacts on habitat for grassland Prairie Grouse.
- What are the cumulative effects of windows, buildings and other man-made structures on bird/bat populations? How are bird/bat populations defined?

- What are the cumulative effects of wind development on bird/bat populations?
- What is the overall impact of all power generation technologies on wildlife?
- Initiate proactive state-wide survey efforts.
- Develop more controlled experiments on aspects such as turbine lighting and mitigation measures.
- Determining impacts of offshore wind farm construction (before, during and after) on whales, migrating songbirds, and bats. What is the effect of artificial reefs?
- Analyze gaps in research funding. Which issues are being funded and how much is being spent by various entities/institutions?
    - Private
    - Federal: FWS, USGS, DOE, NOAA
    - States
- How can we compress time frame of research and still produce accurate results?
- Who can help connect the dots between developments and "areas of concern"?
    - NGOs, Natural Heritage, State with TNC (diversity mapping), States, Federal Gov.… overlaying maps?
- Develop "red, yellow, green" areas for development at regional level.
- Where are the "important bird areas"? Where are the "important bat areas"?
- Where are the fly-ways for birds and bats?
- Need data on diurnal and nocturnal use of ridges, passes, notches. Need data on the same geographic features under different weather scenarios.
- What is an acceptable risk in terms of bird and bat mortality? When is an estimate suitable?
- Follow-up with BCI bat research.
- What is the risk cap for shutting down turbines and still being financially viable?
- How do we measure "hidden" events (i.e. Injury/crippling of birds/bats).
- Is there a magnetic field around the grid of a wind farm and will it impact birds/bats?
- We need to gather more data around the coasts. What are the risks and how should they be assessed?
- How exactly are birds and bats being killed?
- Develop Risk Assessment model.

APPENDIX B: MEETING PARTICIPANTS

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APPENDIX C: WORKSHOP AGENDA

The following is the draft agenda circulated before the workshop and accepted by the attendees at the beginning of the workshop.

Tuesday May 18, 2004

7:30-8:15 am **Registration**

8:15-8:40 **Introductions**
[Tom Gray, American Wind Energy Association and Gerald Winegrad, American Bird Conservancy]

- What are the questions that bring us to this meeting?

8:40-8:50 **Review Purpose of Meeting, Agenda, Ground Rules**
[Abby Arnold, RESOLVE]

- Purpose of meeting
- Review agenda
- Review ground rules for meeting discussions

8:50-9:40 **Wind Industry Project Development**
[Tom Gray, American Wind Energy Association and Sam Enfield, Atlantic Renewable Energy Corporation]
Presentations 8:50-9:25

- State of the Wind Industry in 2004 and projected development: Where are turbines operating and planned?
- Criteria which determine qualifications of candidate sites
- Project and turbine design features influencing avian risk

Questions and Answers 9:25-9:40

9:40-10:45 **Pre-Development Project Risk Assessment**
[Andy Linehan, CH2MHill and Dick Curry, Curry & Kerlinger]
Presentations 9:40-10:30

- Practices and methodologies for assessing risk to birds and bats at candidate project sites.
- Examples of predevelopment siting evaluation requirements set by states or federal agencies.

Questions and Answers 10:30-10:45

10:45-11:05 **BREAK**

11:05-12:00pm **Monitoring Wind Turbine Project Sites for Avian Impacts.**
[Wally Erickson, West, Inc.]
Presentation 11:05-11:35

- How many existing wind energy projects are or have been monitored for avian impacts? Are there case examples of requirements for such monitoring? Options for how to design and implement scientifically sound monitoring programs for avian mortality--how is monitoring conducted (frequency, duration, time of year), and are results made public?
- Metrics for measuring impacts.

Questions and Answers 11:35-12:00

12:00-12:30 **LUNCH**

12:30-1:00Lunch Speaker and Discussion: Why Avian Impacts Are A Concern In Wind Energy Development.
[Gerald Winegrad, American Bird Conservancy]

1:00-1:45 **What Can We Learn From Areas That Have Been Developed I Altamont Wind Resource Area**
[Carl Thelander, BioResource Consultants]
Presentation 1:00-1:30

- What does the existing science tell us about wind turbine impacts to birds at Altamont: mortality, avoidance, direct habitat impacts from terrestrial wind projects, species and numbers killed, per turbine rates/per MW generated, impacts to listed T& E species and U.S. FWS Birds of Conservation Concern, and California listed species?
- How is avian habitat affected at Altamont, 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?

Questions and Answers 1:30-1:45

1:45-2:30 **What We Can Learn From Areas that Have Been Developed II Direct Impacts to Birds at New Generation Wind Plants Outside of California**

[Wally Erickson, West, Inc.]

Presentation 1:45-2:15

- What does the existing science tell us about land-based wind turbine impacts to birds outside of California: mortality, avoidance, direct habitat impacts from terrestrial wind projects, species and numbers killed, per turbine rates/per MW generated, impacts to listed T& E species and U.S. FWS Birds of Conservation Concern, and state listed species?
- What factors contribute to direct impacts on birds by wind turbines? How do use, behavior, avoidance and other factors affect risk?
- Are there sufficient data for wind turbines and avian impacts for projects in the eastern U.S., especially on ridge tops?
- Regional Factors Affecting Impacts (California, Northwest, Mid-west, East)
    - Habitat, use, behavior, and other differences.
    - State of data about direct wind impact on birds in different regions.

Questions and Answers 2:15-2:30

2:30-3:15 **Indirect (non-fatality) and Habitat Impacts on Birds from Wind Development**

[Dale Strickland, West, Inc]

Presentation 2:30-3:00

- How is avian habitat affected, and do birds avoid turbine sites?
- Discussion of impacts from habitat fragmentation, disturbance, and site avoidance from wind turbines, roads, transmission facilities, and other related construction.
- How is avian habitat affected, and do birds avoid turbine sites?
- Do birds habituate to the presence of turbines?
- Regional Factors Affecting Indirect Impacts (California, Northwest, Mid-west, East)
    - Habitat, use, behavior, and other differences.
        - State of data about indirect wind impact on birds in different regions
        - Species specific differences

Questions and Answers 3:00-3:15

3:15-3:30 **BREAK**

3:30-4:30 **Offshore Wind**

[Jette Gaarde, Elsam Engineering and Bonnie Ram, Energetics]

Presentations 3:30-4:15

- Summary of existing studies from operating wind turbine projects in Denmark, including birds, fish and mammals; Lessons from offshore developments in Europe
- Brief update on current permit applications in the US for offshore wind projects; Lessons in Europe that may be applied in the US

Questions and Answers 4:15-4:30

4:30-5:45 **Bat Ecology Related to Wind Development and Lessons Learned About Impacts on Bats from Wind Development**

[Tom Kunz, Boston University and Greg Johnson, West, Inc.]

Presentations 4:30-5:30

- Lessons learned about direct and indirect impacts on bats.
- What is planned to address these issues?
- What does the existing science tell us about land-based wind turbine impacts to bats: mortality, avoidance, direct habitat impacts from terrestrial wind projects, species and numbers killed, per turbine rates/per MW generated impacts to listed T& E species?
- Is there sufficient data for wind turbines and bat impacts for projects in the eastern U.S., especially on ridge tops?
- What does the existing science tell us about off-shore wind turbine impacts to bats: mortality, avoidance, direct habitat impacts from off-shore European wind projects? What lessons learned in Europe can be applied to the U.S.

Questions and Answers 5:30-5:45

5:45-6:30 **What Do We Know About Cumulative or Population Impacts?**

[Paul Kerlinger, Curry & Kerlinger, Al Manville, U.S. Fish and Wildlife Service, Bill Kendall, U.S. Geological Service]

Presentations 5:45-6:00

- What is currently known?
- What laws apply?
- Usefulness of population modeling
- What sources of mortality should be included in cumulative impacts?
- Comparison of impacts from different modes of energy generation
- Beyond birds and bats
- What is needed?

Questions and Answers 6:00-6:30

6:30-8:00 **ADJOURN TO RECEPTION/DINNER**

Wednesday May 19, 2004

8:30-9:15am **Observations, Insights, Questions from Day One**
[Abby Arnold, RESOLVE, facilitated group discussion]

9:15-10:15 **Avian Migration and Implications for Wind Power Development in the Eastern U.S.**
[Sarah Mabey, North Carolina State University and Brian Cooper, ABR, Inc.]
Presentations 9:15-10:00

- What do we know about avian migration, particularly in the Eastern U.S.?
- Summary of radar studies at wind sites in the Eastern U.S.
  - Mount Storm
  - Clipper Wind
  - Others

Questions and Answers 10:00-10:15

10:15-10:45 **What Have Studies of Communications Towers Suggested Regarding the Impact of Guy Wires and Lights on Birds and Bats?**
[Paul Kerlinger, Curry & Kerlinger]
Presentation 10:15-10:30

- Lessons learned from communication towers about guy wire and light impacts on birds and bats and other issues.

Questions and Answers: 10:30-10:45

10:45-12:15pm **Avoiding, Minimizing, and Mitigating Avian and Bat Impacts**
[Carl Thelander, BioResource Consultants, Paul Kerlinger, Curry & Kerlinger]
Presentations 10:45-12:00

- What Have We Learned About:
  - Location/Siting Evaluations to Minimize Avian and Bat Impacts
  - Construction and Operation
  - Lighting
  - Alignment of facilities
- What Have We Learned From Operating Turbines and Mitigation Of Impacts Where Unavoidable: Altamont Experience?
- Where Impacts Occur, Should There Be Mitigation Measures Such As Habitat Creation, Land Conservation, etc.

Questions and Answers 12:00-12:15

12:15-1:30 LUNCH

1:30-2:30 **Development and Application of Guidelines for Siting, Constructing, Operating and Monitoring Wind Turbines**

[Al Manville, US Fish and Wildlife Service and Greg Hueckel WA Department of Fish and Wildlife]

Presentations: 1:30-2:15

- An examination and comparison of the U.S. FWS Voluntary Guidelines (May 2003) and the Washington Department of Fish and Wildlife Guidelines (August 2003) for wind projects.
- Is there a need or desire for uniform national or state criteria? Should there be uniform requirements/guidelines/check-lists for the siting, operation, monitoring, and mitigation to prevent/minimize avian, bat and other wildlife impacts? Why or why not?

Questions and Discussion 2:15-2:30

2:30-2:45 BREAK

2:45-5:00 **Outstanding Research Needs**

[Tom Kunz, Boston University and Group Discussion]

- What are the outstanding research needs that need to be addressed?
- Is there a need for continued sharing on information/research on wind energy and avian and bat impacts? How should we continue this dialogue?

5:00-5:30 **Break for Good Food and Beverages**

5:30-6:30 **Summation**

Where can we agree?

- What are the avian and bat impacts from wind energy?
- What can be done to prevent or at least minimize avian and bat impacts from wind energy
- What are remaining issues to be resolved or addressed?
  - How do we propose to address these issues?

6:30-7:00 **Next Steps**

- In light of the discussion throughout the two days, are there items we should pursue collectively?
- What are the NWCC plans for additional collaborative work and where do the issues we have discussed fit in?

7:00pm ADJOURN MEETING