Proceedings

Onshore Wildlife Interactions with Wind Developments:
Research Meeting V

Lansdowne, VA
November 3-4, 2004

Organized by
The National Wind Coordinating Committee
Wildlife Workgroup

Meeting Facilitated by
RESOLVE, Inc.
Washington, DC

March 2005

Suggested Citation Format

This volume:

POWIWD-V. 2005. Proceedings of the **Onshore Wildlife Interactions with Wind Developments: Research Meeting V**. Lansdowne, VA November 3-4, 2004. Prepared for the Wildlife Subcommittee of the National Wind Coordinating Committee by RESOLVE, Inc., Washington, DC, Susan Savitt Schwartz, ed. 120 pp.

Preceding volumes:

PNAWPPM-IV. 2001. Proceedings of the National Avian-Wind Power Planning Meeting IV, Carmel, CA, May 16-17, 2000. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by RESOLVE, Inc., Washington, DC, Susan Savitt Schwartz, ed., 179 pp.

PNAWPPM-III. 2000. Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego, CA, May 1998. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by LGL, Ltd., King City, Ont., 202 pp.

PNAWPPM-II. 1996. Proceedings of the National Avian-Wind Power Planning Meeting II, Palm Springs, CA, September 1995. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by RESOLVE, Inc., Washington, DC, and LGL, Ltd., King City, Ont., 152 pp.

PNAWPPM. 1995. Proceedings of the National Avian-Wind Power Planning Meeting IV, Denver, CO, July 1994. Repot DE95-004090. RESOLVE, Inc., Washington, DC, and LGL, Ltd., King City, Ont., 145 pp.

Ordering Information

These Proceedings are available in PDF format with accompanying powerpoint presentations available as separate files. Proceedings may be ordered on CD from the NWCC c/o RESOLVE, Inc., Washington, DC: nwcc@resolv.org or by calling: (888) 764-WIND. They may also be downloaded from the NWCC website: www.nationalwind.org

Table of Contents

INTRODUCTION

This is the fifth in a series of meetings organized by the National Wind Coordinating Committee (NWCC)'s Wildlife Workgroup (formerly the Avian Subcommittee). Bringing together representatives from government and non-government organizations, from private business, and from academia, these meetings are convened to examine current research on the impacts of wind energy development on wildlife and to discuss the most effective ways to mitigate such impacts. Earlier meetings focused on birds; the scope has been expanded to examine study methods and metrics, impacts and mitigation strategies related to bats and other wildlife.

Wind energy is able to generate electricity without many of the environmental impacts (conventional and toxic air pollution and greenhouse gases, water use and pollution, and habitat destruction) 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 of a wide range of human activities, including energy production and consumption.

Objectives of the Meeting

The objectives of the Wildlife Research Meeting are: to bring the community of stakeholders up to date on the research being done to understand the interaction of birds, bats, and other wildlife with wind energy development; to look at what we've learned about ways to minimize or mitigate wind energy's impacts on wildlife; and, to identify gaps in knowledge and research needs.

Introductory Comments

Dick Anderson, CEC wildlife biologist, Chair, NWCC Wildlife Workgroup. This is our fifth planning meeting. We have found broad stakeholder participation to be productive, especially when it comes to identifying solutions and research needs. The presenters we will hear from today and tomorrow will be giving us progress reports and reviewing what we've learned from ongoing research. Together we will be talking about what we hope to learn as we take this research forward into the future.

Bear in mind that some of these presentations are preliminary. In many cases, presenters are reporting preliminary findings from fieldwork conducted this fall. Please be fair and honest when using information presented here and when reporting it out.

Abby Arnold, Facilitator, RESOLVE, Inc. Like the National Wing Coordinating Committee, those of you participating in this meeting represent the wide range of interests concerned with wind energy, both its benefits and its impacts. Collectively, you share a desire to foster the development of wind energy as a clean, renewable alternative to fossil fuel while minimizing the impacts of wind energy facilities on bird and bat populations.

Ten years ago, the NWCC started an Avian Subcommittee, having identified avian interaction with wind energy development as a primary concern. The group has since broadened its focus and now functions as the NWCC Wildlife Workgroup. The Workgroup's organizing committee was responsible for planning this meeting, deciding on the topics and issues to be addressed, and identifying panelists and moderators to invite. If anyone has any questions or concerns about the structure or conduct of the meeting, please bring them to my attention, and I will bring them up with the organizing committee.

Process Guidelines

The Facilitator reviewed the draft agenda circulated before the workshop (Appendix B). There were no suggestions for changes. The format was a series of plenary sessions, each devoted to a specific topic. Panel moderators coordinated the presentations, and questions were fielded by panel participants after all presenters for a particular session had completed their formal presentations. These Proceedings present summaries of each presentation (presentation slides may be downloaded from www.nationalwind.org as a series of separate Powerpoint files), with question and answer sessions summarized at the end of 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 report or 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. Panel presentation and discussion summaries will be reviewed by panel moderators and participants, and a review draft of the complete Proceedings will be circulated to all meeting attendees prior to being finalized and made available to the public.

Research Meeting Participants

The following is a list of the people who took part in Wildlife Research Meeting V, along with their organizational affiliations. Also noted are the following:

W indicates a member of the Wildlife Workgroup;
P indicates a panel moderator or presenter.

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

Non-Governmental Organizations

Almy, Jessica [W]	Wildlife Advocate	HSUS Cape Wildlife Center
Arnett, Ed [P, W]	BWEC Program Coordinator	Bat Conservation International
Boone, Dan		Coalition for Responsible Wind Power
Cullinan, Tim [W]	Director of Bird Conservation	Audubon Washington
DeFranciso, Leonard		Chautauqua County Citizens for Responsible Wind Power
Deyette, Jeff	Analyst	Union of Concerned Scientist
Dunscomb, Judy	Director of Conservation Science	The Nature Conservancy
Korth, Ted	Director of Policy	New Jersey Audubon
Miller, Lucile	Board Member	Valley Conservation Council Conservation Council
Mizrahi, David	Vice-President for Research	New Jersey Audubon
Mosher, Jim [W]	Executive Director	North American Grouse Partnership
Randell, Gil		Chautauqua County Citizens for Responsible Wind Power
Salin, Corrine	Field Conservation Program Coordinator	Defenders of Wildlife
Schoch, Nina		Wildlife Conservation Society -
Smith, Jeff [P]		Hawk Watch International
Southerland, Mark [W]		
Tillinghast, Eleanor	Principal Ecologist and NEPA Director	Versar, Inc.
Tuttle, Merlin [P, W]	President	Bat Conservation International
Young, Frank		West Virginia Highlands Conservancy

Academics

Anderson, Stan [P]	Professor	University of Wyoming
Bohn, Kirsten	Graduate Student	University of Maryland
Gates, J. Edward		University of Maryland
Horn, Jason [P]		Boston University
Kerns, Jessica [P]	Doctoral Student	University of Maryland Center for Environmental Science
Kunz, Tom [P]	Director	Boston University
Larkin, Ron [P]		Illinois Natural History Survey
Lohr, Bernard	Research Associate	University of Maryland
Lott, Keith		University of Maryland Center for Environmental Science
Mabey, Sarah [P]	Post-Doctorate	North Carolina State University
Moore, Frank [P]	Chair of Biological Sciences	University of Southern Mississippi

	Department	
Sheffield, Steve [W]		George Mason University
Spanjer, Genevieve		University of Maryland

State Agencies

Anderson, Dick [W]	Wildlife Biologists	California Energy Commission
Boydston, Kathy	Program Coordinator,	Texas Parks and Wildlife Department
Brewer, Gwen [W]	Science Program Manager	Maryland Natural Heritage Program
Burke, Kristen	Project Manager Renewable Energy	Massachusetts Technology Collaborative
Connelly, Jack [P, W]	Wildlife Research Biologist	Idaho Department of Fish and Game
Edick, Rudyard [W]	Project Manager, Land-Based Wind Farms	New York State Department of Environmental Conservation
Golden, David	Senior Biologist	New Jersey Division of Fish and Wildlife
Hammond, Forrest	Biologist	Vermont Fish & Wildlife Department
Hicks, Alan		New York State Department of Environmental Conservation
Hunter, Benjamin [W]	Renewable Energy Program Administrator	New Jersey Board of Public Utilities
Kelly, Jeff [P]		Oklahoma Biological Survey and Department of Zoology
Limpert, Dana	Ecologist	Maryland Department of Natural Resources
Mast, Beth	Renewable Energy Specialist	NC Solar Center
Reynolds, Rick		Virginia DGIF
Sherwell, John [W]		Maryland Department of Natural Resources
Spiegel, Linda [P, W]	Conservation Biologist	California Energy Commission
Stauffer, Aura	Biologist	Pennsylvania Department of Conservation and Natural Resources
Stihler, Craig	Wildlife Biologist	West Virginia Division of Natural Resources
Turner, Greg	Wildlife Biologist	Pennsylvania Game Commission
Ugoretz, Steve	Environmental Analyst	Wisconsin Dept. of Natural Resources
Watson, Mark		NYSERDA
Woythal, Mark		New York State Department of Environmental Conservation
Zadnick, Andrew		Virginia DGIF

Federal Agencies

DOE/ NREL / ORNL		
Efroymson, Rebecca [W]	Senior Scientist	Oak Ridge National Laboratory
Miner-Nordstrom, Laura [W]		U.S. Department of Energy

Newcomb, Charles	Program Support Engineer	National Wind Technology Center
Sinclair, Karin	Senior Engineer II	National Renewable Energy Lab - NWTC
Thresher, Bob [W]	Director	National Wind Technology Center
USDA		
Duvarney, Andree		Natural Resources Conservation Service
Misso, Bob		Natural Resources Conservation Services
Torres, Joseph	Natural Resource Biologist	Forest Service - Green Mountain National Forest
USGS		
Dawson, Deanna	Wildlife Biologist	USGS Patuxent Wildlife Research Center
Holcomb, Glen	Program Manager	USGS ER BRD
O'Connell, Allan	Research Wildlife Biologist	USGS Patuxent Wildlife Research Center
Robbins, Chandler		USGS
FWS		
Barnett, Jessica	Biologist	U.S. Fish and Wildlife Service
Constantino, Maricela	Biologist	U.S. Fish and Wildlife Service
Dettmers, Randy		U.S. Fish and Wildlife Service
Forsell, Doug		U.S. Fish and Wildlife Service
Harmon, Stephanie [W]		U. S. Fish and Wildlife Service
Hoar, Alex [W]	Fish and Wildlife Biologist	U.S. Fish and Wildlife Service
Johnston, Scott [W]	Branch Chief, Populations	U.S. Fish and Wildlife Service
Jones, Tim	Science Coordinator,	U.S. Fish and Wildlife Service
Krueper, David	Ass't Nongame Bird Coord., Region 2	U.S. Fish and Wildlife Service
Lance, Ellen	Wildlife Biologist	U.S. Fish and Wildlife Service
Manville, Al [W]	Office of Migratory Bird Management	U.S. Fish and Wildlife Service
Pendleton, Frank		U.S. Fish and Wildlife Service
Tibbott, Cindy	Biologist	U.S. Fish and Wildlife Service
Von Oettingen, Susanna		U.S. Fish and Wildlife Service
Willis, Robert	Fish and Wildlife Biologist	U.S. Fish and Wildlife Service

Consultants

Albano, Dan [W]	Ecologist	Global Winds Harvest
Bairlein, Franz [P]	Director	Institute of Avian Research
Connare, Thomas		URS Corp
Connelly, John		Energy Unlimited, Inc.
Cooper, Brian	Senior Scientist	ABR Inc. - Environmental Research & Services
DeMeo, Ed [W]	President	Renewable Energy Consulting Services, Inc.

Erickson, Wally [P, W]	Biometrician/Project Manager	Western EcoSystems Technology
Hagner, Thomas		Ecogen, LLC
Hecklau, John	Principal	EDR
Henthorn, Jennie	Environmental Chemist	Bowles Rice McDavid Graff & Love
Johnson, Greg [P, W]		Western EcoSystems Technology
Kearns, Matt [W]		Tetra Tech FW
Kerlinger, Paul [P, W]	Principal	Curry & Kerlinger
Koehler, Chris		Geo-Marine
Kronner, Karen [W]	Wildlife Biologist	Northwest Wildlife Consultants
Mastic, Peter		Noble Power
Mitchell, Rob [W]		Environmental and Energy Consulting
Mohagen, Thomas	Environmental Project Manager	Hamer Environmental L.P.
Morgante, Michael	Avian Specialist	Ecology and Environment, Inc.
Newman, Jim [P, W]	Principal Scientist	Pandion Systems
Papiech, Joyce [W]	Developer	FPC Services Inc.
Papiech, Bruce		Sustainable Energy Foundation
Pelletier, Steve	Vice President	Woodlot Alternatives, Inc.
Podolsky, Richard [P, W]	President	Avian Systems
Pruitt, Elizabeth	Manager, Newport News Office	Geo-Marine, Inc.
Ram, Bonnie [W]	VP Environmental Programs	Energetics
Reynolds, Tim [P, W]		TREC, Inc.
Romme, Russ [W]	Director Natural Resources Management	BHE Environmental
Sharp, Lynn [P, W]	Senior Ecologist	TetraTech FW
Shoenfeld, Peter	Chair, Wind Energy Committee	West Virginia Highlands Conservancy
Stover-Catha, Peggy	Program Manager	Constellation Generation Group
Strickland, Dale [P, W]	Vice President and Senior Ecologist	Western EcoSystems Technology
Sutter, Crissy	Staff Scientist	Pandion Systems, Inc.
Warren-Hicks, William [P, W]	CEO	EcoStat
Yonker, Terry [W]	President	Marine Services Diversified, LLC

Wind Industry

Braud, Rene [W]	Principal	FPL Energy
Cowan, David [W]	Vice President, Environmental Affairs	UPC Wind Management
Enfield, Sam [W]	Vice President of	Atlantic Renewable Energy Corporation

	Development	
Gray, Tom [W]	Deputy Executive Director	American Wind Energy Association
Jodziewicz, Laurie [W]	Communications & Policy Specialist	American Wind Energy Association
Lindsay, Jim [W]	General Counsel Environmental Services	FPL Energy
Linehan, Andy [W]		PPM Energy
Niessen, Jerome [W]	President	NedPower
Perri, David	Executive Vice President	Jasper Energy
Piper, Rich	Environmental Manager	FPL Energy
Rackstraw, Kevin [W]	Eastern Regional Leader	Clipper Windpower
Saliterman, P.J.	Project Manager, Western New York	Zilkha Renewable Energy
Stein, Kenny	Sr. Environmental Specialist	FPL Energy
Walker, Wayne [W]	Project Manager	Zilkha Renewable Energy
Wilkins, Neal	Project Manager	Synergics Wind Energy

SESSION I:
STUDIES CONDUCTED OR TO BE CONDUCTED ON BATS

Moderator: Merlin Tuttle, Bat Conservation International

This session consisted of seven presentations, framed by an **Overview of Current Issues and Research Needs** and a **Wrap-up of Current Knowledge and Next Steps** presented by the panel moderator.

- **Overview of Available Mortality Studies** — *Greg Johnson, WEST, Inc.*
- **Introduction of Bats and Wind Energy Cooperative** — *Ed Arnett, BCI*
- **New Protocol for Mortality Monitoring`** — *Wally Erickson, WEST, Inc.*
- **Patterns from Daily Mortality Searches at Meyersdale, PA** — *Wally Erickson, WEST, Inc.*
- **Patterns from Daily Mortality Searches at Backbone Mountain, WV** — *Jessica Kerns, University of Maryland*
- **Preliminary Radar Observations of Fall Passage Rates vs. Daily Mortality Searches at Backbone Mountain, WV** — *Brian Cooper, ABR, Inc.*
- **Thermal Imaging Observations of Bat and Insect Behavior Relative to Mortality at Backbone Mountain, WV** — *Jason Horn* and *Tom Kunz, Boston University*

Overview of Current Issues and Research Needs

presented by
Merlin Tuttle, Bat Conservation International

Panel moderator Merlin Tuttle introduced this panel with a note of thanks to the presenters, who put great effort into designing studies, collecting data. In many cases, these researchers have only just finished compiling data collected this summer and early fall, to be able to present findings from this year's fieldwork.

Why bats merit being on the agenda. Bats comprise nearly a quarter of world's mammal species. Diverse in appearance, behavior, and ecological needs, bats are important to American farmers as essential predators of night-flying pests.

Before the arrival of European settlers on this continent, some bats may have rivaled passenger pigeons. But bats are vulnerable because they are relatively long-lived mammals, slow to reproduce. One of the formerly most abundant species, the Indiana bat, is now endangered. (The population has dropped from millions in single caves to about 350,000 range wide.) The formerly abundant Gray bat also has become endangered. The Red bat, still widely distributed, has experienced an apparently dramatic population decline. In the 1870s, Edgar Burns noted that it took days for Red bats to migrate over New York State, a phenomenon that no one has seen in our lifetime. (That magnitude would be hard to miss.)

We are here today because all of us recognize a serious need to develop renewable energy. But energy must be developed in a manner that is compatible with preserving wildlife and the health of our environment. Our goal is to share preliminary findings, identify knowledge gaps, and suggest next steps. The findings to be presented here today include the first of their kind in many cases.

Overview of Available Bat Mortality Studies at Wind Energy Projects

presented by
Greg Johnson, WEST, Inc.

The United States has approximately 125 multiple-turbine wind energy facilities in place, with commercial projects completed so far in 32 states. Bat fatalities have been documented at nearly all wind energy facilities in the U.S., but bat mortality estimates have been made only for 11 of these projects, and studies to specifically examine bat interactions with wind projects have so far been conducted at only six sites. This presentation summarizes what has been found at the following project sites:

REGION/ Project site	**Topography and Habitat**	**Number and Size of Turbines**
MIDWEST		
Buffalo Ridge, MN	Relatively flat: crop fields, CRP, pasture	281 – 750 kW
Lincoln, WI	Flat crop fields	31 – 660 kW
Top of Iowa	Relatively flat crop fields	89 – 900 kW
ROCKY MOUNTAINS		
Foote Creek Rim, WY	Rim top: short grass prairie; forested areas within 1 mile	133 – 660 kW and 750 kW
Ponnequin, CO*	Relatively flat short grass prairie	44 – 660 kW and 750 kW
PACIFIC NORTHWEST		
Stateline,	Rolling hills and ridges: grasslands,	399 – 660 kW

OR/WA*	shrublands, croplands	
Klondike, OR*	Flat crop fields	16 – 1.5 MW
Vansycle, OR*	Ridges: crop fields and grasslands	38 – 660 kW
Nine Canyon, WA*	Rolling hills and ridges: grasslands, shrublands, croplands	37 – 1.3 MW
EAST		
Buffalo Mountain, TN	Ridge top: reclaimed mined land in forested area	3 – 660 kW
Backbone Mtn, WV	Forested ridge top	*Described in detail in separate presentation*
Meyersdale, PA	Forested ridge top	*Described in detail in separate presentation*

* Bat findings incidental to bird studies; no bat mortality estimate made for this site.

Region	**Installed Capacity** # of Turbines per MW output/year	**Mean # Fatalities / Turbine**
MIDWEST 4 studies (at 3 sites)	*254 MW installed capacity ~ .63 turbines per MW per year*	1.7
Rocky Mountains 2 studies	*68 MW installed capacity ~ .6 turbines per MW per year*	1.2
Pacific Northwest 4 studies	*397 MW installed capacity ~ .7 turbines per MW per year*	1.2
EAST 2 studies	*68 MW installed capacity ~ 1.45 turbines per MW per year*	46.3

Methodology

Carcass searches were conducted and fatality estimates in most cases adjusted to account for searcher efficiency and carcass removal rates. At Buffalo Ridge, MN, Foote Creek Rim, WY, and Buffalo Mountain, TN, bat use was measured using mist nets and bat echolocation detectors. At Lincoln, WI, thermal (infrared) cameras were also used. At the four Northwestern sites and the Ponnequin, CO case study, bat mortality estimates were incidental to bird studies and – with the exception of limited bat acoustical surveys conducted for a month at the Top of Iowa site – bat use was not measured at these sites.

Mortality surveys have also been conducted at small wind projects sited on farmland in NY (2) and PA (1), and in forested habitats in MA (1) and VT (1). Only one bat fatality (a little brown bat) was found, at the Pennsylvania site. A handful of bat fatalities have been found in the course of extensive (raptor-focused) mortality surveys conducted at older wind farms in open habitat in California.

Findings

In general, bat mortality rates are highest in forested environments such as those found in the East, moderate in open areas close to forests (typical of Midwestern sites), and lowest in open areas (Rocky Mountain states and Pacific Northwest). Differences may be due to region, habitat, bat population sizes, combinations of these factors, or other factors altogether. Available data from existing wind developments suggest that migrant tree bats are most at risk, namely the hoary, eastern red, and silver-haired bats. There are, however, regional differences in species composition. (For example, eastern pipistrelle fatalities were among the most common at Buffalo Mountain, TN.) Bat fatalities occur primarily in late summer and early fall at most wind developments, with a peak in August, during bat migration periods. Estimated annual per-turbine mortality ranged from a high of 47.5 bats per turbine (Backbone Mountain) to a low of 0.7 bats per turbine (Vansycle, OR).

Various other findings include the following:

- Buffalo Mountain, TN, differed from other sites in that bat activity was positively correlated with mortality levels, and mist net surveys showed relatively similar species composition as turbine fatalities. (Although fatalities occurred during the migration period, it is not known whether migrating or foraging bats were involved.) Bat activity decreased as mean nightly wind speeds increased.
- At Lincoln, WI, no bats were observed circling the turbines, acting confused, or foraging at the red lights on top of the turbines.
- At the Top of Iowa project, Anabat (echolocation) data indicated no difference in activity between crop fields with and without turbines, suggesting that turbines did not attract bats.

Research Needs / Questions

- Studies conducted to date in the West and Midwest suggest relatively low levels of mortality in non-forested habitats; however, these data should not be extrapolated to forested environments in the West and Midwest where wind projects are planned.
- There is no data from the southwest (Southern California and Texas).
- What can be done to assess risk to bats during pre-construction studies? Rigorous analysis of a few sites using several methods may prove more useful than many small studies at several sites.
- What affect does collision mortality have on bat populations? We cannot put this in perspective without more data on bat population sizes. In particular, we need to look at the potential for wind power to impact listed bats, especially (in the Eastern U.S.) the endangered Indiana bat.
- Possible collision factors – such as weather conditions, habitat, and turbine operation – need to be determined. Shorter intervals (e.g., 1-2 days) between carcass searches (at least for a subset of turbines) are required to allow for such correlations to be made.
- More scavenger removal and searcher efficiency trials overlapping fatality search periods are needed to refine mortality estimates.
- Bat behavior near turbines needs to be documented and better understood so that we can begin to develop methods to repel bats, and eliminate or mitigate mortality.

Cooperative Efforts to Assess the Impact of Wind Power on Bats

presented by
Edward B. Arnett, Bat Conservation International

Bat mortality [at wind energy projects] has been with us for some time. It first was documented in Australia in 1972, but only recently has come up as an issue to be studied and addressed. A lot of the studies we have available to us were not designed for bats, bat mortality was documented incidentally, so that these findings raise more questions than they answer. It is important to learn from past experiences and to move forward.

While bat mortality has been estimated to be relatively low (<2 bats/turbine/year) at many sites, particularly in the West, large numbers of bat fatalities from Buffalo Mountain, TN and the Mountaineer wind facility at Backbone Mountain, WV (47.5 bats/turbine/year) have brought the issue of bat-wind energy interaction to the forefront.

In response to growing awareness of the potential for wind energy-related bat fatalities, the Bats and Wind Energy Cooperative (BWEC) was formed in 2003 by Bat Conservation International (BCI), US Fish and Wildlife Service (US FWS), the American Wind Energy Association (AWEA), and the US Department of Energy's National Renewable Energy Laboratory (NREL). An alliance of state and federal agencies, private industry, academic institutions, and non-governmental organizations, BWEC's members cooperate to develop solutions to minimize or, where possible, to prevent mortality of bats at wind turbines. BWEC's role is to set priorities, implement and provide peer review of required research, and develop uniform standards and methodologies for assessing risks and mortality. Since its inception less than a year ago, BWEC has launched a focused research effort to understand bat interactions with wind turbines and to develop solutions.

In February 2004, a meeting of bat experts and wind energy developers was held in Florida to discuss problems, knowledge gaps, and studies that might address those gaps. Cooperative funding for this year's research efforts was secured from the following partners: AWEA, BCI, Community Foundation for the Alleghenies, FPL Energy, Massachusetts Technology Collaborative, New York State Energy Research and Development Authority, PPM Energy, and the Rhode Island Renewable Energy Fund.

Why collaborate?

Working relationships are critical, both for enabling stakeholders to find common ground, and for bringing together the resources necessary to conduct the kind of research that is needed. (There are a lot of smaller research efforts ongoing, but research efforts needed to understand bat-wind energy interactions and to avoid, minimize, or mitigate negative impacts are expensive and logistically challenging to implement.) In addition, collaboration enhances the credibility of findings, which is very important for both wildlife conservation and wind energy development. In the case of wind project developers, "data is the currency required to purchase continued public license to operate."

BWEC's committee structure includes an Oversight Committee, a Scientific Advisory Committee (primarily from the academic community) and a Technical Advisory Committee that includes both agency and industry representatives. The coordinator administers the cooperative's activities and facilitates advisory committee activities, ensures that research protocols, proposals, and other documents are peer-reviewed, and coordinates activities designed to disseminate information among BWEC partners and diverse audiences.

BWEC maintains a running list of peer reviewers, including specialists in radar-avian acoustics, study design and analysis. Information about BWEC, including the Cooperative's charter, a bibliography of available literature, results of research, and upcoming meetings and symposia are posted on the organization's website: http://www.batcon.org/wind/.

This year's research effort was pulled together on extremely short notice. Funding was pulled together between the February "experts" meeting and June of this year for this summer's research. Priorities identified included:

- Conducting daily carcass searches
- Understanding how bats interact with turbines
- Assessing different methods and tools for understanding bat-turbine interactions and fatalities.

The study proposal for intensive fatality searches to determine bat mortality at wind energy facilities during the fall migration period was developed by Wally Erickson and Jessica Kerns. The protocol was peer-reviewed, and some adjustments were made after field visits to account for varying vegetative and topographic conditions. The study consisted of an intensive six-week effort during the period when reported mortality is highest, from late-July to mid-September. (Erickson's and Kerns' findings will be presented during this session.)

Researchers tested a carcass search protocol that included daily and weekly searches by human observers, as well as the use of dogs to find bat carcasses. The daily carcass searches along with the tools used to monitor bat activity (thermal imaging, radar, and night-vision goggles) allowed us to correlate mortality with weather conditions, turbine characteristics, and other factors. Thermal imaging generated our first look at bat interactions with turbines. Day-to-day anecdotal observations enhanced our understanding. For example, we were able to observe local bats foraging in parts of forested areas that had been cleared for wind turbines.

These data will help us begin to understand bat interactions with turbines and to design experiments to test potential solutions. However, it is important to bear in mind that these are preliminary results; we haven't yet had a chance to model all the complex relationships. Also, because we looked only at a six-week period, findings from this study cannot be extrapolated to temporal mortality patterns. Other caveats: sample sizes were small, and inferences are limited to the study sites. However, we can use findings from these sites to develop further hypotheses and to begin thinking about pre-construction risk assessment.

Noting that he had spent 14 years in Oregon, including seven years working with the timber industry, the presenter noted that a similar collaborative effort had not been employed to deal with understanding the impact of timber harvest on the northern spotted owl prior to its Federal listing as a threatened species. He suggested that BWEC offers an opportunity to work proactively with diverse stakeholders toward solutions to avoid some of the "train wrecks" that could derail the wind industry or the future of bat species.

Bat Fatality Monitoring Methods: Fall 2004 Mountaineer and Meyersdale

presented by
Wally Erickson, WEST, Inc.

This presentation summarizes the bat fatality monitoring methods tested over a six-week period (July 31-September 13, 2004) at two wind energy project sites in West Virginia and Pennsylvania. Preliminary results from these monitoring efforts are presented separately.

Study Objectives

The basic protocol was to conduct daily and weekly searches for bat fatalities at the Meyersdale (PA) and the Mountaineer (Backbone Mountain, WV) wind energy sites during the six-week period corresponding with fall bat migration. In addition to gathering the fatality data needed for estimating mortality rates, our objectives were to:

- compare the precision and accuracy of intensive (daily) v. weekly searches;
- identify potential biases and determine searcher efficiency and scavenging/carcass removal rates;
- develop recommendations for improving and standardizing fatality search protocols; and,
- associate fatality location and timing to turbine and environmental characteristics.

Potential Biases

There are several types of potential biases that may occur when estimating fatality rates, and I discuss at least two of them. The first is that dead or fatally injured bats may land or move *outside* the search area. This bias has often been ignored when there has been reason to believe the number of carcasses outside the plot represents a small percentage of the total. The alternative approach is to estimate the percentage of fatalities that fall (or move) outside the search area.

In a forested area, the size and shape of the search area is limited to the cleared area around the base of the turbine. (It would not be worthwhile to try to search the still-forested area, because searcher efficiency would be too low.) At the Stateline wind project (OR/WA), where the fairly open terrain permits us to check how many fatalities show up outside the immediate turbine area, most fatalities can be found within 40 m of the turbine base. At Mountaineer, because the forested edge is in some cases within 30 m of the turbines, estimating the bias is important. We have not estimated this bias yet, but will do so based on the distribution of fatalities as a function of distance from turbines in searched areas.

The second type of bias has to do with how well we are able to determine scavenging rates. There are several possible problems with the use of trial carcasses to represent actual wind turbine casualties. One potential bias could result from putting out so many trial carcasses that you start attracting scavengers. (Some scavengers may even be attracted by the sight (or scent) of people placing the carcasses.) Small bird carcasses are easier to obtain than bat carcasses, but may not necessarily provide accurate information about the rate at which bat carcasses are scavenged. Frozen carcasses may not be scavenged at the same rate as fresh carcasses. Carcasses identified during scheduled searches were either left in place or in some cases re-located for purposes of testing scavenger removal rates.

Plot/Transect Design and Fatality Recording

Search plots were defined as 130 m x 120 m rectangles around the base of the turbine. Actual plot boundaries were defined by the forested edge or other unsearchable habitats (e.g., tall brush piles). Habitat within the search plot was then delineated on the basis of predominant cover type: bare ground, short, medium, or tall vegetation, large rocks/boulders, piled brush. Areas that can be searched are rated using a “visibility index” indicative of the likelihood of a searcher finding a carcass in the type of cover predominating.

Transects are oriented north-south, 10 m apart (13 per plot). Observers walk each transect, recording the date, time and location of each fatality found, the observer’s distance from the carcass at the time of first detection, distance from the carcass to the nearest point on the transect line, and information about the predominant cover type and visibility of the carcass. Observers photograph most of the carcasses, assign them identification numbers, and record information about their species, age, sex and condition (i.e., evidence of scavenging, injuries, estimated time of death). Fresh carcasses are used for carcass removal trials.

Searcher Efficiency Testing

Searcher efficiency was tested using both human observers and dogs working with human observers. (In the latter case, the human is primarily observing the behavior of the dog, not looking for carcasses.) Searchers were unaware of testing. Carcasses in various conditions (fresh, dessicated, scavenged) were distributed randomly throughout the study period and throughout the study plots, under various weather conditions and in various habitat types. Searcher efficiency rates were very different at the Meyersdale and Mountaineer sites.

Scavenging and Carcass Removal Trials

Carcasses found during fatality searches were subsequently used (either in situ or elsewhere in the search plot) to determine scavenger removal rates. Some frozen carcasses were also used. Attempts to avoid attracting scavengers included placing the carcasses before daylight and using gloves and boots to avoid imparting human smell that might attract scavengers to the carcasses.

Analysis of Data

Adjusted fatality rates are calculated as the observed per-turbine fatality rate divided by the estimated average probability a carcass is available during a search and is found. The denominator in this formula is a function of carcass removal, searcher efficiency, interval between searches, search area visibility index, etc. This analysis is still being completed, and will be subject to peer review before it is released. Other analyses to be completed will include correlations of fatality metrics with environmental and turbine characteristics, e.g., wind speed, turbine rpm, lighting, etc.

Preliminary Fatality Results: Meyersdale Wind Energy Facility

presented by
Wally Erickson, WEST, Inc.

The Meyersdale Wind Energy Facility is located in southern Pennsylvania, approximately 50-60 miles northeast of the Mountaineer (WV) site. The site, which became operational in December 2003, consists of 20 1.5-MW turbines, 116 m maximum height at blade tip, with rotor blades 35 m in length (for a rotor diameter of 70 m). Six of the turbines are lit with red strobe lights on the nacelle. The facility is situated on a forested ridge top which has been cleared for the turbines.

Working with two full-time and two part-time technicians, the research team set up a search schedule which involved conducting fatality searches at all 20 turbines every Monday over the six-week study period. Half the turbines were also searched on a daily basis, with odd-numbered turbines searched daily during the first three weeks, and even-numbered turbines searched daily during the second three weeks.

Bat Fatality Results

Every one of the 20 turbines had at least three bat fatalities over the six-week period. The mean observed fatality rate was 13.1 fatalities per turbine. Approximately 300 bat fatalities were identified, including nine fatalities found during the three-day set-up period (July 30-Aug.1), 262 found during scheduled search days, and 19 incidental fatalities. Incidentally identified fatalities were collected (for species identification purposes) or left in field to see if they were scavenged or identified during a subsequent search.

Searchers estimated the approximate time of death. About half of the fatalities found were estimated as having occurred the night before. Based on fresh fatality finds only, the timing of red bat and hoary bat fatalities appear to be highly correlated. We also found a high correlation in the timing of fresh fatalities between fatalities found at Meyersdale and those found at the Mountaineer site.

Preliminary data suggest that lighting on wind turbines was not attracting bats.

Searcher Efficiency

Approximately 200 trial carcasses (both fresh and decomposed) were used to test searcher efficiency at Meyersdale. Overall, searchers identified 25% of the test carcasses, based on a single day's search; higher detection rates were achieved with multiple searches. In a limited (6-day) trial, humans working with trained search dogs did 2-4 times better on average than human observers working without dogs. (Dog-human search teams achieved 71% searcher efficiency at Meyersdale, as compared with 25% overall for human searchers.) In areas with low visibility habitats, dog-human teams were more than four times as effective as humans working alone.

Carcass Removal Trials

Carcass removal rates were extremely low at Meyersdale. Approximately 140 bat carcasses were used to test carcass removal/scavenging rates. Most of these were fresh carcasses, left where they had been found during fatality searches. Some of the bats found by searchers were moved to less visible locations and subsequently monitored for scavenging. Some previously frozen carcasses were also used. Approximately 5% of trial carcasses were removed within 24 hours of placement. ("Removed" means technician who placed the carcass couldn't find it on a subsequent day.) Only 20% of carcasses were removed within 16 days of placement. Because the carcass removal rate was so low at Meyersdale, daily searches yielded only 2.1 times the number of bat fatalities as weekly searches, despite having seven times the search effort. (This is a very site-specific result, as carcass removal rates vary considerably from one site to another. At Mountaineer, for example, scavenging rates were noticeably higher.)

Next Steps

- We need to adjust fatality estimates for searcher efficiency, carcass removal, search area, and habitat to yield estimates of site mortality rates. This data still needs to be written up and peer-reviewed.
- Our recommendations for study design include using carcass removal rates in selecting search intervals, and possibly moving toward intensive searches at a small number of turbines, less intensive searches at a wider sample of turbines. Final recommendations will be included in the final report.
- We saw a negative correlation of fatalities with wind speed, plotting fatalities against

average wind speed from nine p.m. to six a.m. It may be that bats are less active on windier nights. We will need to look at other weather factors (fronts) as well as wind speed and other factors to better understand what's going on here. Correlation of fatality timing with environmental factors may be useful in coming up with solutions.

Preliminary Fatality Results – Mountaineer Wind Energy Center, WV

presented by
Jessica Kerns, University of Maryland

The Mountaineer Wind Energy Center is located at an elevation of 1,025 m. on Backbone Mountain in West Virginia. The site began operation in December of 2002, and consists of 44 1.5-MW turbines and two meteorology towers. The turbines are 116 m tall, with blades rotating at 17 rpm. Twelve of the turbines (every 3-4 turbines) are lit with FAA-recommended L-864 red strobe lights. The site is primarily linear along the ridge, with a slight curve at the southern end of string. A highway cuts across the ridge at approximately the middle of the turbine string.

During the first year post-construction (2003), a survey was conducted that consisted of weekly searches (in concentric circles up to 60 m from turbine base) during the spring and fall, and monthly searches during the summer. Results were adjusted based on a single removal/searcher efficiency trial conducted in October. The mean number of bird fatalities for the entire study period (April 4-November 11) was 4.04 per turbine (4.8 birds per turbine with the addition of a single fatality event in May). During the same period, a total of 2,092 bat fatalities – and average of 47.53 bats per turbine – were identified.

The 2004 study effort followed the same protocol used at Meyersdale (see above). Six full-time technicians were devoted to the 6-week effort, from July 31 to September 11, 2004. All of the turbines were searched on Saturday, while half of the turbines were searched four days a week. (Odd-numbered turbines were searched more intensively during the first half of the study period; even-numbered turbines were searched more intensively during the second half.) Depending on the searchable area around the base of the turbine and the type of habitat, searchers spent 30-90 minutes at each turbine.

Fatality Results

A total of 456 bats were found during the six-week period, 398 found during searches, and 68 found incidentally. (Incidental finds include fatalities found after a search, at an unsearched turbine, and carcasses seen on the road but scavenged prior to the next scheduled search.) During the same period, a total of 15 bird carcasses were found (12 during scheduled searches, another 3 incidental finds).[1]

[1] One of the bird fatalities was a raptor, one a vulture; the rest were passerines.

One question raised by last year's study was whether the size of the area searched determined fatality findings. Comparing the distribution of bat fatalities by turbine with the area searched around each turbine suggests this isn't the case. There is only a weak positive correlation (r = 0.2) between the total amount of area searched and the number of bat fatalities found. In open habitat where the likelihood of carcass detection is higher, there is actually a weak negative correlation (r= -0.2) between size of area searched and number of fatalities found. It may be that scavenging rates are higher in higher-visibility habitat.

One turbine (# 11) was freewheeling – essentially not moving. No fatalities were found at this location.

Ninety-three percent of the fatalities were found within 40 m of the turbines, with only 1.5% found more than 50 m away. A somewhat higher distribution of fatalities was found to the east of turbines, possibly because the service road running along the ridge to the east of the turbine string made it easier to find those fatalities. A distribution of bat fatalities by species was also plotted, with hoary bats being found a mean distance of 24.6 m from the nearest turbine, red bats 23.5 m, and Eastern pipistrelle's an average of 21.8 m away.

Timing is critical at Mountaineer. Hoary and red bat fatalities are temporally correlated. Pipistrelle fatalities were spread fairly evenly throughout the study period. These three species represent the bulk of the fatalities found. Brown bat and silver bat fatalities occured in periodic fluxes. There were two spikes in overall fatality levels, one in early August and the second in early September. The first was during a period of low wind, with turbines hardly turning; the second followed a weather front. It will be interesting to see how these spikes relate to weather conditions.

Fatalities are mostly adults, and include far more males than females. Male and female bat fatalities appear to be correlated temporally. Thirty-five percent of the fatalities showed no visible injuries; 25% had wing injuries; 10% had suffered lacerations, and 8% had both a wing injury and one or more other injury. A quarter of the fatalities found could not be assessed due to the condition of the carcass.

As at Meyersdale, no difference was detected in the rate of fatalities at lit v. unlit turbines. Likewise, it doesn't appear to be the case that anemometer operation affects mortality. Site anemometers were turned off from August 26 to September 11, and fatalities continued to occur at turbines with non-operating anemometers.

Searcher Efficiency

Searcher efficiency was higher than expected, 43.6% overall. However, efficiency varies greatly by habitat type, from over 60% in high-visibility habitat to less than 10% in extremely low-visibility habitat (brush, tall grass). Distance from transect lines was also a factor. (The highest find rate was actually 2-3 m from the transect line.)

Carcass Removal

Carcass removal is a big factor at the Mountaineer site. Overall, 328 bat carcasses were tracked for removal, including 255 carcasses randomly distributed throughout the study area (under various weather conditions and in various habitat types). Searcher-identified carcasses were left where they were found and subsequently tracked for scavenging removal rates. (However, if searchers happened to see these carcasses, scavengers are also likely to see them, so these may have been scavenged at a higher rate.) Corvids (ravens) especially were a big factor in carcass removal. These birds learn quickly; it may be that we will see more scavenging at Meyersville during the second year of operation.

Of the randomly distributed carcasses, 35% are gone within 24 hours, and 68% gone within 3 days. Of the incidental finds, 25% gone in the first 9 hours. Bat carcasses in the road, 40% removed that morning, 87% removed within 24 hours.

There is a faster removal rate of fresh carcasses compared to frozen carcasses, especially during the first few days. A total of 56 bird carcasses were also tracked for scavenging/removal. Two of these were found carcasses; the rest were sparrows, pigeons, and a few smaller passerines randomly distributed throughout the study site. Only 14% of bird carcasses were removed after 24 hours, 43% removed within three days. It should also be noted that bats disappear more completely than birds (no feather spots).

Key Points

- Fatalities at Mountaineer are comprised of 6-7 bat species, none of them endangered. (No Indiana bats found.)
- Timing of fatalities is correlated at the Mountaineer and Meyersdale sites.
- Weather is a factor; mortality is lower on nights with higher wind speeds.
- Fatalities were fairly evenly distributed throughout the turbine string, independent of lighting, anemometer operation, and amount/ease of area searched.
- Carcass removal may be a learned activity, which might account for higher scavenging rates observed at Mountaineer (now in its second year of operation) and Meyersdale.

Next Steps

We now need to adjust our fatality estimates for searcher efficiency, search area, and scavenger removal biases, and incorporate habitat into our modeling. We will need to evaluate daily v weekly search intervals, and correlate the timing of fatalities with weather and turbine operation characteristics. The findings presented here are limited to a six-week study period, and are not representative of all bat activity. We will need more information to begin developing deterrents.

Preliminary Comparison of Nocturnal Passage Rates and Bat Fatalities in Pennsylvania and West Virginia

presented by
Brian Cooper, ABR, Inc.

One hypothesis offered to explain the high number of bat fatalities found at the Mountaineer wind energy facility in 2003 is that they may have been related to high levels of bat activity. We collected pilot data to begin to investigate this possibility by looking at nocturnal passage rates between Aug 10 and Aug 14 at the Mountaineer site. Between August 15 and September 13, we also made opportunistic comparisons of fatality rates at the Meyersdale wind energy site in southern Pennsylvania with nocturnal passage rates over Casselman (about 25 km to the west) and Martindale (about 75 km to the north).[2]

Methodology

We used a combination of radar and visual data to calculate passage rates at or below turbine heights. Mobile radar was used in surveillance mode to determine flight direction and passage rates. We alternated between (horizontal) surveillance mode and vertical mode, which was used to determine flight altitudes. Bats cannot be distinguished from birds using radar data alone. Visual observation using night vision goggles and filtered spotlights enabled us to make this distinction, and these tools give us a greater range than ultrasonic technology. We conducted daily searches (discussed in the preceding two talks) to pick up the fatalities.

Findings

Through visual techniques, we determined that there was a higher proportion of bats to birds early in the study period (Aug 10-20). The proportion of birds to bats grew as bird migration intensity increased later in the study period.

Passage rates were defined as the number of bat targets per kilometer per hour within turbine height. At Mountaineer we were able to get only three days' worth of data due to rainy weather. This small sample at Mountaineer was suggestive of a correlation between passage rates and fatalities, but the data set is too small to draw any conclusions.

No correlation was found between passage rates at Martindale and Casselman and the fatality index at Meyersdale, although there were sources of variation in the data that were not addressed in this analysis. Briefly:

---

[2] The question was raised why passage rates were not collected at the Meyersdale site itself. The Meyersdale study was not originally designed to include passage rate data collection; B. Cooper happened to be collecting data in the area of Martinsdale and Casselman at the time the fatality searches were being conducted at Meyersdale. Given the proximity of those sites to Meyersdale, researchers took advantage of the opportunity to look for any correlations. It was noted that B. Cooper donated his time to conduct and synthesize this research.

- Passage rates and fatality data were not collected at same sites. Casselman is 25 km due west of Meyersdale; Martindale is 75 km away, to the north and slightly east of the wind site at Meyersdale.
- There was an apparent time lag between fatalities and passages that could have resulted from difficulties in determining how fresh the fatalities were (fatality rates were based only on "fresh" carcasses).
- Bat passage rates included all species of bats, not just those prevalent in fatality data.
- The Casselman and Martindale ridges are not highly linear as the Meyersdale ridge is.

Research Needs

Preliminary results of this pilot study are inconclusive regarding the correlation between passage rates and bat fatalities. This was an opportunity to collect a very limited data set in the hope of illuminating something about a possible relationship, but clearly, more study is needed. To conduct a more rigorous analysis, we recommend collecting concurrent radar and fatality data from the same facilities for whole seasons. We also need to develop ways to refine bat passage rate measurements to focus on those species at risk of fatalities.

The correlation between fatality rates at Mountaineer and Meyersdale (see Erickson and Kerns presentations, above) suggests that fatality rates may be associated with regional environmental factors. More study is needed to determine what these factors are (if they exist), and whether passage rates are affected by similar factors.

Bats and Wind Turbines: infrared analysis of abundance, flight patterns and avoidance behavior

presented by
Jason Horn, Boston University and BCI

This presentation summarized findings from an infrared (thermal imaging) analysis of bat abundance and flight patterns in the vicinity of wind turbines at the Mountaineer wind energy site at Backbone Mountain, WV. While we can make hypotheses about what is happening in the air, we don't have any visual observations of how bats are actually getting killed. Are bats attracted to some physical attribute of the turbines, such as ultrasonic noise or the motion of the blades? To increased prey density? Or are fatalities merely random events: a case of bats being in the wrong place at the wrong time?

This study was designed to observe bats among the turbines. Our aim was not only to document mortality events, but also to characterize behavior, look for evidence of attraction, test the effect of blade rotation, and also the impact of lighting.

Methodology

We used FLIR S60 thermal infrared thermography to produce digital radiometric data. Each pixel represents a temperature value. (See Tom Kunz' presentation in Session V for a more detailed description of this technology and its application.) For each turbine, we filmed at a 50-degree angle from the ground, using three cameras with 45-degree field-of-view (FOV) lenses, to look at the left, right and lower portions of the rotor swept area. Each camera recorded 15 GB per hour of data, requiring 45 250-GB drives to store the information.

We spent a total of 20 nights filming. Half of those nights were spent filming lit turbines, the other half the time at unlit turbines. Observations were coordinated with ground fatality searches.

Object Classification

The following criteria are used to distinguish bats from insects and birds. While both birds and bats have a visible fast wing beat frequency, birds exhibit constant velocity and high inertia. Bats, by contrast, exhibit variable attitude and/or velocity, and pursuit maneuvers. Insects have low inertia, appear fainter because they are not warm, and can only be seen when they are flying low, beneath the camera's focal plane.

Behavioral Observations

For each object observed, we recorded the time; the type of object (bat, bird, insect, or unknown); its orientation and heading while entering and exiting the frame; its perceived distance (low, medium, high); and the type of behavior exhibited.

Avoiding the blade. Real time video clips show a bat appearing to avoid the turbine blade. While we can't tell from the clip exactly how far the bat is from the blade, it seems (based on the size) to be somewhere in the plane of the blade. (In some cases we noted avoidance near the blades' tips, in other cases near the hub.) Note that the bat's course and velocity are changing, as the bat appears to avoid the blade and continue to fly.

Contact with blades. Other video clips show what appear to be glancing blows, indicated by an abrupt change in the bat's attitude and velocity. The bat changes course at the point where bat and blade meet, and the bat appears to tumble, rather than continue to fly.

Investigative behavior. One of the behaviors we noticed was what we describe as "investigative" behavior – bats circling within rotor swept area, or near hub of the turbine. This sort of investigative behavior is typical. When bats alight or roost, they often make several "check" passes first to investigate the object before landing.

Buffeting. Apart from avoidance, it appears that bats flying within the range of the turbine rotor are buffeted by turbulence from blade.

Flight patterns. One case where three bats move through the rotor swept area together on same flight pattern is atypical; bats do not typically follow the same flight patterns.

Preliminary Analysis

Given the sheer quantity of the data (8 TB of digital radiometric data over a 20-night period), it is extremely time-consuming to analyze. For example, we have begun comparing bat passage rates with mean sky temperature to see whether there is a relationship between weather and bat activity, but we've only been able to look at three nights' worth of data so far. Some of our preliminary conclusions are:

- Most activity takes place within the first few hours after dusk.
- Individuals often fly through the rotor-swept area, apparently "investigating" both moving and non-moving blades.
- Bats seem to be able to avoid moving blades, and the ratio of avoidance to contact is high. (Again, however, only a small portion of the data has been analyzed so far.)
- Activity level is highly variable across nights.

Next Steps

As we complete our analysis of this data, some of the things we will be looking for will include: an analysis of orientation and wind direction; whether the rate of bat activity varies with turbine rotation and orientation; and, whether bats appear to be attracted to lit v. unlit turbines.

Wrap-up: Current Knowledge and Next Steps

presented by
Merlin Tuttle, Bat Conservation International

[Panel moderator acknowledged] a "Herculean effort" on the part of Ed Arnett, Wally Erickson, Jessica Kerns, and Jason Horn and their co-workers for resolving research issues and "contributing a tremendous amount" to the knowledge base on very short notice. "When we met [in Florida] last February we were almost paralyzed for lack of data to look at. I've never seen any project that did better at resolving more issues faster than this group." This year's accomplishments have included:

- Testing sampling protocols and improving estimates of searcher efficiency and scavenging bias in varied habitats
- Assessing the effectiveness of different methods and technologies
- Obtaining, for the first time, a data set that will allow us to correlate mortality with weather, turbine activity, and other risk factors.

It is important to keep in mind that the findings presented here represent a very rough preliminary analysis of data just recently gathered. When analysis of the 2004 data set is completed, we should be able to:

- Recommend standardized mortality assessment protocols and procedures
- Develop experiments to further test habitat, weather, turbine, and topography-related risk factors
- Begin experimentally testing potential solutions

Clearly, we cannot assume little or no risk to bats on the basis of what we've found in studies designed to detect bird fatalities. A lot of work remains to be done to find out the reality for bats. To date, most studies on bats have come from open prairie and croplands where bat mortality appears to be lowest. We're seeing something very different in forested areas, so it's clear that we cannot extrapolate from the open sites to the forested sites. Wooded areas do seem to raise the risk to bats. Likewise, we cannot assume that there is not a problem for bats in the West simply because we have not seen it at a few open prairie/cropland sites. Very little has been studied. Very different bat species inhabit the South and Southwest, and their behavior and mortality may be very different. (For example, the Mexican free-tailed bat forages in the kinds of open areas where we have tended to find fewer fatalities of more northern bat species in the West.)

Given the estimated number of bats killed per turbine at Mountaineer in 2003 and plans to build at least 366 more turbines in the immediate vicinity, the potential for bat fatalities is alarming. This highlights the urgency of collaborating to find solutions as quickly as possible.

Next steps

We need to document mortality from spring through fall, looking at the potential for cumulative impacts.

Comparative data on the magnitude and predictability of fatality events under varied topographic and habitat conditions could help with pre-project risk assessment and project design.

Finally, we need to begin testing measures that may help prevent or mitigate impacts, including: alteration of turbine sounds and surfaces to repel or at least avoid attracting bats; and the cost-effectiveness and conservation impact of feathering turbine blades during periods of peak risk.

Session I: Questions and Observations

[The first two questions were directed toward Ed Arnett]

<u>The focus here is on general habitat use; have you looked at proximity to hibernation sites and other habitat features?</u>
Response [E. Arnett]: Most of the sites we've looked at have not been anywhere near to hibernacula.

<u>How do data on rate of nightly fly-throughs translate into rate of kill per fly-through, and how does that relate to anybody's model of bats flying through wind developments?</u>
Response [B. Cooper]: There currently is no information available on the rate of bat kills per fly-through.

<u>BCI's website said 2004 research "priority" for the "Cooperative" was to "stop" a representative sample of turbine rotors to evaluate whether or not moving turbine blades are differentially causing greater bat mortality. Was this priority research done, and if not, why? Please elaborate…</u>
Response [Ed Arnett]: BWEC had originally proposed this as an opportunity to try to figure out bat interactions with moving v. non-moving turbines. We designed an experiment for summer 2004 and worked with FPL on the issue of locking turbines, but did not reach an agreement on doing that experiment in 2004. (There were a number of issues surrounding damage to the gearboxes, difficulty of "locking" them from company's standpoint – see definitions of turbine modes, below.) We are still interested in looking at that in the future. There was one turbine at Mountaineer that was "freewheeling" over the summer, and as it happens no fatalities were found there.

Comment: This was "a Herculean effort" conceived just last December – only seven months before this year's research teams began collecting data. Original proposals called for "stopping" turbines to determine impact of blade rotation on bat mortality. However, you can't just turn turbines on and off with a flick of a switch – the terms of power purchase agreements need to be considered, as well as mechanical and warranty issues. (See below.)

Comment: When not actually operating, turbines can be in one of three states (see blade mode definitions, below).

- ***Operating*** - An operating turbine's blades are almost flat-wise (perpendicular) to the wind.
- ***Parked/Feathered*** - When you "park" and feather the blade, you turn the blade so that the leading edge is facing into the wind. The rotor will rock a bit in the wind but the blades will not turn. In this mode oil is not being pumped through the mechanism, so the turbine bearings are not being lubricated.
- ***Freewheeling*** – In "freewheeling" mode, the blades are partly but not completely feathered, so that the rotor will turn slowly, pumping oil through the mechanism and

keeping everything lubricating, ready to get up and running quickly.

- ***Locked*** - If the blades are not merely "parked" but "locked" so that they cannot move at all, you get a flat-spotted bearing. Normally, the turbine rotor would be locked only to perform annual maintenance. Leaving blades in locked mode for more than 12 hours can damage the gearbox (hence the warranty issues alluded to above).

<u>Can you comment on high mortality at Mountaineer and Meyersdale and weather?</u>
Response [W. Erickson]: We observed higher mortality after fronts went through during low wind times. We are still looking at what the explanation for that might be.

<u>What are the effects of clearing forests on ridge tops regarding creating open feeding habitat for bats (Ed) and regarding introducing crows/ravens to the interior forest bird community (Jessica)?</u>
Response [E. Arnett]: Bat literature on habitat ecology suggests that bats tend to respond negatively to heavily "cluttered" forest environments (e.g., high-density stocking of small-diameter trees). Bats don't do very well in these forest conditions with respect to using their echolocation systems for navigation and foraging activity. Small openings and thinnings create more favorable conditions, and have been shown to increase bat activity. Thus, openings created in forests where turbines are erected may offer attractive habitat for at least some species of bats.

Response [J. Kerns]: We do see a lot more crows and ravens at Mountaineer than we do at Meyersdale. It could be just because Mountaineer has been opened up longer. Crows and ravens are very anthropogenic. Linear sites along ridge tops are like a "buffet line" for corvids.

<u>Where were carcasses for scavenging trials placed? Did scavengers see the placement? Thus is there a greater chance that a placed carcass would be scavenged than a "natural" carcass? [Similar questions were raised as to whether carcasses placed – either for searcher efficiency or for scavenging rate trials – are more likely to be scavenged than fatalities.]</u>
Response [J. Kerns]: Carcasses placed out in the afternoon are less likely to be scavenged by crows and ravens unless they get to them the next morning. We did try to outwit the scavengers to avoid attracting them, but that is very hard to do.

<u>Were met towers also surveyed at Mountaineer Project for mortality? If so, with what results?</u>
Response [J. Kerns]: There are two met towers at the Meyersdale site, one freestanding and one guyed. No fatalities were found at either tower. The guyed tower was near a turbine and was searched. The other met tower was in an unsearchable area.
Response [E. Arnett]: Dogs were used on a few occasions and didn't find any fatalities at either met tower.

<u>Is searcher attention consistent throughout a search, or does it vary? If so, how, and what is the effect, and how would this vary if a dog, instead of a human, was searching?</u>
Response [E. Arnett]: When a human is searching with a dog, the human is "working" the dog – watching for cues it may give when it smells a dead bat. Thus, although humans

using dogs do look for carcasses, the search image is different.

Response [M. Tuttle]: It would be a good idea to check a lot of sites that have been determined to be “low mortality” (e.g., alfalfa fields) using dogs. It would be hard for a human to find a bat in an alfalfa field, but a dog could.

<u>What about the number of bats killed immediately, v. those merely wounded that might be able to hide?</u>
Response [E. Arnett]: We do not know the exact proportion of bats killed instantly and those crippled and capable of hiding in vegetation once landing on the ground. We did record the condition of bats once they were found and this information may offer some insight to questions regarding a searchers ability to find bats assumed to have been killed instantly versus those that were crippled and lived or died later. However, those data have yet to be tallied.

<u>How does the much higher scavenger removal rate in 2004 in Mountaineer compare with 2003, and does it call into question the mortality estimate of bats/birds in 2003?</u>
Response [J. Kerns]: Last year there was a much higher probability of finding carcasses on the road, and of finding older carcasses. However, last year we were using birds to determine the removal rate, not bats, and frozen birds at that.

Response [E. Arnett]: I do not feel that the removal rates can be compared, because different methodologies were employed during the two surveys and because only one carcass removal trial was conducted in 2003. The estimate for 2003 is valid based on the assumptions of the model and the data gathered; the deficiencies and assumptions of the 2003 effort have been pointed out thoroughly, and we used that information to improve data collection standards for assessing bias correction factors in 2004.

<u>Regarding the mortality data break down by age and sex – are there any data or existing knowledge on the overall population breakdown by age and sex of these bat species? (In other words, do the mortality data breakdown match the population demographic breakdown?)</u>

<u>How do the mortality rates for adults v. juveniles compare to the distribution of adults v. juveniles in the population?</u>
Response [J. Kerns]: We do not have the demographic breakdown for this population.

Response [M. Tuttle]: As a generality we find more males than females at higher elevations, because it is harder for females to raise young successfully in cooler climate.

<u>How much professional statistical consultation was involved in the study design?</u>
Response [E. Arnett]: We had two external reviewers (a consulting biometrician from Oregon State University as well as an assistant professor from Clemson University) review the study proposal, and three members of the BWEC Scientific Advisory Committee who subsequently reviewed and commented on the study design.

Could turbine-to-turbine variation be drawn from a common Poisson distribution? Is there statistical or other evidence otherwise? (Likewise with time interval – however, the correlation between the two sites is much more convincing.)
Response [W. Erickson]: We still need to look at some of the other factors that could affect turbine to turbine differences.

Would it make sense to concentrate future searches in high probability areas (e.g., downwind of turbine)? Higher probability would lead to lower variance. [Ref: Theory of Optimal Search, Larry Stone; Search Theory, Washburn.]
Response [W. Erickson]: Although the distribution of fatalities for birds is more concentrated downwind, bat fatality distribution appears to be more circular.

Response [J. Horn]: When winds are low, the turbines "search" for wind direction and in the morning you find them facing all different directions.

Response [E. Arnett]: Concur. Based on what I have seen, I wouldn't concentrate on any one quadrant.

At the long linear ridges, has bat activity north or south of the wind projects been examined and compared to activity at the sites?
Response: No.

Can you convince us that your night vision technique could reliably distinguish bats from birds?
Response [B. Cooper]: With the equipment we have been using (night-vision goggles with a filtered light source), wing beat patterns often are quite distinctive for birds and bats up to about 100-150 m away. Bats have steady, quick wing beats, and make more adjustments in body/flight orientation. Birds are more regular, and often glide after two to three wing flaps. I am fairly confident that a practiced observer can reliably distinguish the two, but there always will be a portion of targets that will be classified as unknown, particularly as distance to target increases.

Response [J. Horn]: We do still have issues of focus, depth of field, angle of vision. Tom Kunz will have more to say about this in Session V.

Are the Casselman and Martindale sites correlated temporally? Are these sites forested now, and if so, will they be cleared?
Response [B. Cooper]: We could not test to determine if the passage rate data from Casselman and Martindale are temporally correlated because the two areas were sampled on different nights. Martindale was in a small clearing within uniform forest. The Casselman site was located in a large field between scattered forests. I do not know what plans there may be (if any) for clearing those areas.

Why didn't you measure passage rates at Meyersdale?
Response [E. Arnett]: Brian Cooper happened to be doing other work at the Casselman and Martindale sites while we were doing our study at Meyersdale. He shared this data with us

and graciously donated his time for the five nights at Mountaineer.

Based on radar observations, were bats more active during certain hours of the night?
Response [E. Arnett]: Jason Horn's thermal imaging data showed peak activity in the early evening for a few hours after sunset.

How were the two radar modes (horiz and vert) used to collect data relative to time of day? Were data collected using the same mode during same time period night to night and site to site? Why use a bar radar and not a parabolic disc?
Brian: We sampled for 6-7 hours each night. During each of those hours, we sampled in the horizontal mode for 0.5 hour and in the vertical mode for 0.5 hour. We have used both the bar antenna and parabolic disk for the vertical radar observations, and now prefer the bar antenna because a much larger area can be sampled.

Are more bats passing through Alleghany Plateau than other areas of East?
Response [M. Tuttle]: We have no evidence – can't even speculate.

[B. Cooper] said that ridgelines and other leading lines don't seem to focus bird concentrations, but ABR's work at Ripley suggests that focusing does occur.
Response [B. Cooper]: When we looked at nocturnal bird movements at Mount Storm (a highly linear Appalachian ridgeline), we found that most birds crossed the front rather than followed it. At Chautauqua, night migrating birds did follow the ridgeline in the spring, but there the ridge parallels (and is in close proximity to) the Lake Erie shoreline, so it may be the shoreline that the birds are following rather than the ridge. In fall at Chautauqua, most nocturnally migrating birds crossed the ridge, (presumably) after crossing Lake Erie.

Why aren't we seeing forest bats?
Response [J. Horn]: We have no sampling information. We don't know what their movements look like.

Regarding forested ridge hypothesis:

1) These are primarily migrating bats; do the bats restrict their migration path to forested areas?

2) Is there an alternative explanation for the high mortality when the site is forested?
Response [M. Tuttle]: There is evidence that mortality goes up during migratory periods, but we are not convinced this involves only migratory bats. Many of those killed in forested areas may well be locally feeding bats.

Has anyone evaluated correlation between bat mortality and distance to nearest tree cover/forest vegetation?
Response [M. Tuttle]: We have done a "seat of our pants" analysis of open farmland in Pennsylvania. Bats are not easy to find in crop fields without dogs. Yet I had the distinct impression that bat mortality was lower over open farmlands in the Somerset area. The only bat I found was near some trees.

Response [W. Erickson]: We did find some correlation in activity near wood lots at Buffalo Ridge out West.

<u>Has there been any attempt to evaluate the physiological condition (e.g. fat composition) of bats killed at any or all sites? (Is there any indication of whether fat loads compromise their ability to avoid turbines?)</u>
Response [M. Tuttle]: We don't have any evidence.

Response [E. Arnett]: It would be helpful to have more physiological information, but we required all fresh bats this year to increase the sample size of our carcass removal trials. Future efforts will have to balance the use of fresh bat carcasses for different objectives.

<u>What do we know about the correlation between wind energy production (on an hourly or short-term basis) on bats? [Facilitator added: "or for any other type of energy production?"]</u>
Response [W. Erickson]: We suspect a relation between wind speed and energy production and bat fatalities, but we do not have enough information to be able to say.

Response [M. Tuttle]: It is only recently that we have been looking at wind sites, and certainly we don't have comparable data on the impact of coal mining or other energy extraction/use. We do have bat mortality of many kinds (e.g., communication towers, automobiles – red bats esp.) but generally far less than we are seeing at wind power sites. When it comes to species that already are declining precipitously, anything could be the straw that breaks the camel's back.

<u>Should wind energy facilities be sited on prominent Appalachian ridge tops without addressing and minimizing bat mortality concerns first?</u>
Response [M. Tuttle]: As a scientist, based on the data we have, I would have to say that if I were a wind power investor, and I wanted to maintain my good green image, I'd be extremely careful about putting major facilities on wooded ridge tops until we know more about how to prevent fatalities.

SESSION II:
UPDATE ON THE ALTAMONT

Moderator: Richard Anderson, California Energy Commission

- **Developing Methods to Reduce Bird Fatalities at the Altamont Pass Wind Resource Area** — *Linda Spiegel, California Energy Commission*
- **Study Plan for Effectiveness of Potential Management Measures to Reduce Bird Risk** — *Dale Strickland WEST, Inc.*

Developing Methods to Reduce Bird Fatalities at the Altamont Pass Wind Resource Area

presented by
Linda Spiegel, California Energy Commission

This presentation is a briefing on the report, "Bird Risk Behaviors and Fatalities at the Altamont Pass Wind Resource Area," prepared for the California Energy Commission by BioResource Consultants (BRC), Inc.[3]

Background

The Altamont Pass Wind Resource Area (APWRA) consists of 140 square km of rolling grassland, with varied topography, including rolling hills, flat areas, canyons and ridges. Wind energy generation began in the APWRA in the mid-1970s. By 1980, a California Energy Commission (CEC) biologist identified a "bird kill problem" at the Altamont. Several studies were initiated, including a large-scale golden eagle study by Dr. Grainger Hunt. In 1998, BioResource Consultants (BRC) began to research bird behaviors and mortality in the Altamont. As with the golden eagle study, initial funding for this research came from NREL, and was continued by the CEC.

There are currently about 5,400 turbines installed throughout the Altamont, comprising diverse turbine models and sizes, including many older turbine designs. These range in height from 14-43 m, in rotor diameter from 13-33 m, and in energy output from 40-400 kW. Turbine ownership is diverse, with owners in most cases leasing sites from cattle ranchers.

The permitted capacity of the APWRA is 800 MW. However, installed capacity is currently at about 580 MW, with output at 35-40% of that. The APWRA currently

[3] Report co-authored by K. Shawn Smallwood and Carl Thelander, BioResource Consultants, P.O. Box , Ojai, CA.

provides about 29% of California's 3.5 billion kWh of emission-free energy, and is critical to California's renewable energy portfolio standard of meeting 20% of the state's electricity needs from renewables by 2017. Repowering the Altamont with newer, much larger turbines could significantly aid in meeting the state's renewables portfolio standard. However, Alameda County has placed a moratorium on issuing permits to increase the capacity of the APWRA until there is demonstrable progress towards significantly reducing bird mortality in the Altamont.

Study Objectives

The ultimate goal of the 4-year BRC research project was to support the development of renewable energy resources by resolving the bird mortality issue. Specific objectives were as follows.

- *Identify attributes associated with bird fatalities*. Researchers looked at bird behaviors, prey availability, turbine/tower designs, turbine array characteristics, landscape attributes, and range management practices.
- *Generate a large enough sample size to reveal relatively robust patterns*. These patterns were then used to develop a predictive model showing how each attribute contributes to fatalities.
- *Relate bird behaviors and activity levels to mortality and the predicted risk of collisions*. All bird species were included in the fatality sampling, but the emphasis was on associating raptor behavior and other attributes with raptor mortality.
- *Develop mitigation measures*.

Methodology

Fatality searches. Fatality searches were conducted over a four-year period, covering an area that extended to a radius of 50 m around the turbines. Much of the analysis was done at the string level, as opposed to sampling individual 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 2,548 turbines in 308 strings was sampled from November 2002 to May 2003 (Phase II). Fatality searches were conducted an average of seven or more times per year at each turbine/string being sampled, and annual fatality estimates were based on findings from both study periods, adjusted for differential search efforts among the groups of turbines.

Output-adjusted fatality metric. Because there is such a wide range of turbine designs in the Altamont – including different heights, rotor diameters, tower types, and energy outputs – the metric fatalities/turbine/year was not considered useful. The metric chosen, fatalities/MW/year, is based on the rated output of the sampled turbines and avoids the false appearance that larger turbines kill more birds. Additionally, it was determined that mortality estimates are a function of fatality searches over time, and that searches conducted over a period of less than three years yield unreliable results.

Behavioral observations. In addition to counting fatalities, a total of 1,958 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.) Behavioral observations included numbers of bird sightings, and percentage of time birds spent flying v. perching.

Findings

A total of 1,162 turbine collision-related fatalities were found. (Of these, 198 were estimated as being over 90 days old, and were excluded from the rate calculations.) Approximately 40 bird species and one bat species were found among the fatalities; however, proper bat sampling protocol was not implemented. Based on three years of fatality search data, the estimated annual number of raptor fatalities for the entire APWRA is projected to range from 881.4 to 1,300.3 birds killed. The low-end estimate was adjusted for searcher detection bias, while the high end was adjusted to account for both searcher detection bias and scavenging rates.

It is interesting to note that, over time, bird use has increased in the Altamont. This is likely due to an increase in the number of gulls and ravens following the development of a landfill in the area. However, there was no corresponding increase in the number of birds colliding with turbines; gulls and ravens tend not to collide with turbines. Raptor use, by contrast, has remained relatively constant in the APWRA, but raptor mortality has increased over the same three-year period, suggesting that the degree of collision risk is increasing for raptors. Species-specific behavioral information, considered together with the fatality data, offers many possible insights about species-specific bird interactions with wind turbines in the Altamont.

Perching. One of the early hypotheses for explaining raptor fatalities was that latticed towers offered perching opportunities for raptors, and that birds' risk of collision increased as they sought to perch on the towers of moving turbines. However, the vast majority of perching activity observed during the study period took place on non-operating turbines, suggesting that collisions are not necessarily related to perching on operating towers.

Flying within 50 m of turbines. Several raptor species spend more time than would be expected by chance flying within 50 m of the turbines, suggesting some attraction factor or factors. (See implications, below.) For most bird species, however, there is no significant relationship between fatality numbers and observations of flights within 50 m of the turbines.

Seasonal variation. Fatality data were analyzed by season for each species. A *chi*-square analysis of fatalities by season for three species of raptors, for example, showed that American kestrel fatalities are higher in winter than would be expected by chance, and that the burrowing owl fatalities were much higher in summer than expected by chance. (Overall, raptor mortality in the Altamont is higher in summer and winter than in spring or fall.)

Implications

A key finding of this study is that many complex factors contribute to turbine-caused fatalities, and that these factors are often species-specific. An important implication is that solutions will also be (at least in some cases) species-specific. The implications of several key associations are outlined here.

Attraction factors. The fact that raptors appear to spend more time flying nearer (within 50 m) the turbines than would be expected by chance points to several possible attraction factors.

- Cattle also spend a lot of time near the turbines (this has not been documented, just noted anecdotally). Cattle dung attracts grasshoppers, which in turn attract kestrels and red tail hawks.
- Vertical and lateral edges associated with turbine locations attract rodents, and lagomorphs tend to den under turbine pads. The presence of these prey species in turn attracts predators (e.g., golden eagles) too close to the turbines. Rodent control efforts have been effective for decreasing numbers of ground squirrels, but also resulted in increased clustering of pocket gophers at the turbines. The net effect was that eagle kills were slightly higher in areas of no rodent control, but that red-tailed hawk and burrowing owl kills were slightly higher in areas with rodent control.
- Rock piles, constructed near the turbines to mitigate impacts on kit foxes in the APWRA, have also attracted prey animals and appear to be associated with disproportionately more fatalities of some raptor species.

Bird flight and height of rotor swept areas. Bird observations yielded that 73% of flights occurred at heights within the high and low blade reaches of the existing turbines in the Altamont (4 to 52 m above ground). Therefore, most bird flights are occurring with the turbine blade or collision zone. A 1998 plan to repower the Altamont with newer turbines noted that new turbine designs ranged from 13.8 to 80.5 m above ground, a height range that includes 59% of flights or a reduction in the likelihood that birds would be flying within the potential collision zone. The tallest of these proposed newer turbines were 25.8 to 80.5 m above ground, where only 16% of bird flights were documented. In our data set, 25 m towers appear to increase collision danger when compared to 14 m towers. However, our data also suggest that replacing many of the existing turbines with towers tall enough for blades to clear the ground by 29 meters or more would avoid the height zone that birds spend most time flying, and, therefore, likely substantially reduce mortality.

Turbine location. Various location-related attributes are significant.

- Turbines operating in proximity to canyons or steeper slopes are generally more dangerous to raptors.
- Wind walls prove less dangerous than isolated turbines.
- Turbines at the ends of rows or on the edges of the wind farm (or of a cluster of

turbines) kill disproportionately more birds.

Calculating the contribution of various attributes to species-specific mortality. Based on the turbines for which we have both attributes and species-specific fatality data, we can predict how each of the various attributes contributes to mortality for various species. For golden eagles, for example, siting a turbine on a steeper slope ("slope grade" attribute) contributes to an increase of 13% in golden eagle mortality. Turbines having a lower blade-reach contribute to a 25% increase in golden eagle mortality relative to turbines with the highest ground clearance.

Mitigation Priorities

Based on BRC's research findings, several mitigation measures have been identified:

- Repower turbines with blade reaches high above the ground.
- Relocate turbines having the highest combination of mortality-related site attributes to low-risk locations within the APWRA.
- Place pylons at ends of turbine strings to divert flights.
- Cluster turbines to reduce gaps and avoid the phenomenon of isolated turbines.

It will be necessary to monitor the impacts of these measures, using data both from before and from three years following to find out the impact of each measure. (See following presentation for details of the study plan to test measure effectiveness.)

Limitations

While these findings are very useful, the following limitations should be taken into consideration.

- Some of the factors are confounding.
- Some of the fatalities may simply be random.
- Predictive results of modeling efforts range for various species (highest for golden eagles, lowest for red-tail hawks).

Wind turbine output data would be helpful in refining mortality estimates. For example, if two turbines are killing the same number of birds, but one is operating all the time and the other is operating only part of the time, the latter turbine has a higher mortality rate per unit of energy output. This information is an important factor when looking at turbine associations with fatality incidents.

Study Plan for Effectiveness of Potential Management Methods to Reduce Bird Risk

presented by
Dale Strickland, WEST, Inc.

This presentation outlines a study plan for testing the effectiveness of some of the mitigation measures suggested by BRC’s work [described in preceding presentation]. The study will look at eight potential management measures:

A. Shutting down, removing, or relocating “high risk” turbines, and possibly creating stationary structures to try to divert raptors from turbines at the ends of rows
B. Range management to reduce insect prey and presence or visibility of small prey mammals
C. Painting of blades to increase their visibility to raptors
D. Repowering with new, larger turbines (increasing ground clearance of blades)
E. Retrofitting turbine tower platforms to prevent burrowing by small mammals
F. Removing derelict turbines and other structures creating unnecessary collision risk
G. Upgrading electrical collection system components to prevent/reduce raptor electrocutions
H. Non-participation in the rodent control program

Statistical Power

Our ability to detect the effect of risk reduction measures is a function of sample size (number of turbines in both the treatment and reference groups), length of study period, data variability, and the magnitude of the treatment effect. Each measure presents a separate set of challenges with respect to sample selection, implementation, and monitoring. Achieving reasonable sample sizes is made particularly difficult in the Altamont Pass Wind Resource Area (APWRA) because turbine ownership is diverse and dispersed throughout the wind resource area.

An Adaptive Management Approach

Adaptive management is a problem-solving approach used to resolve uncertainty. First we assess what we know, defining the problem, developing hypotheses, selecting the appropriate indicators, and identifying the management alternative we wish to evaluate. We then design the experiment, identifying the expected outcome. As we begin to implement the study plan, we will monitor and evaluate the findings. Are the results what we expected? If not, why not? We will then recommend adjustments to the management measure in response to what we are finding.

Identifying the expected outcome by necessity is based on models of turbine risk. It is recognized that “all models are wrong, but some models are useful.” The hope is that by testing the various measures, monitoring what happens, and then making adjustments as we proceed, we will learn more about raptor-wind turbine interactions (improve our models) and about how to prevent or significantly reduce raptor fatalities in the Altamont (improve our management).

Implementation Issues

A. *Remove/relocate or shutdown turbines.* The hypothesis is that the existing data and models accurately predict high-risk turbines and that shutting down or relocating these turbines will reduce raptor fatalities. The difficulty with selecting a sample of "high risk" turbines (for removal, relocation, or inclusion in a reference group) is that limited fatality sampling data make it hard to predict risk with great certainty. The timing of repowering and ownership issues also present challenges for implementing the study of this management measure. We looked for turbines having high levels of the attributes that appear to be associated with mortality as well as having high levels of actual fatalities. Relocation has begun, and should be complete in early 2005.

B. *Range management.* This measure will focus on the impact of preventing cattle from congregating and grazing close to turbines. The hypothesis is that cattle leave droppings that contain undigested vegetation, that these attract insects, and that the insects in turn attract burrowing owls and other raptors, exposing them to greater risk of collision with turbines. Range management (i.e., excluding grazing near turbines) is expected to result in fewer cow droppings near turbines, reducing the density of insects which provide a food source for some raptors. Excluding grazing near turbines is also expected to result in higher grass cover at the bases of turbines, making prey less visible. We will use radio telemetry to track burrowing owls' use of the areas that are either grazed or ungrazed and use closer and further away from turbines where cattle are prevented from grazing. We will look for owl fatalities at both treated (ungrazed) and control (grazed) turbines.

C. *Blade painting (Hodos scheme).* Dr. Bill Hodos at the University of Maryland developed several blade-painting schemes that appeared to increase the visibility of blades to test birds in a laboratory setting. The hypothesis is that painted blades will be more visible and thus more easily avoided by raptors, resulting in reduced raptor fatalities. Approximately 260 turbines located around the edges of the wind plant are being considered for field testing this measure, which is designed to increase the visibility of moving turbine blades to raptors. We are looking at turbines for which there are no near-term repowering plans, identifying those turbines with high risk as well as historically high golden eagle fatality rates.

D. *Repowering.* This measure focuses on replacing smaller, shorter turbines with a smaller number of larger, taller turbines with higher blade tip ground clearance. The hypothesis is that taller turbines will have a rotor swept area above the altitude where most raptors hunt, and that this, in combination with fewer bigger turbines, will reduce raptor fatalities. Two wind energy companies (Altamont Power [FPL] and Buena Vista) will participate. Altamont Power has new turbines already permitted; Buena Vista is in the process of obtaining repowering permits. Modern turbines (e.g., the 660-kW V-47 and the 1-MW Mitsubishi) will replace older turbine models (e.g., 100-kW 56-100). The

56-100 with its 18-m diameter rotor used to be considered a moderate sized turbine; by contrast, the V-47 has a 47-m diameter rotor, and the Mitsubishi's rotor measures 61 m in diameter. The lowest blade reaches on the larger, more modern turbines are above the level of the smaller turbine's nacelle.

E. *Retrofit tower platforms.* The treatment in this case will consist of eliminating the vertical edge created by the concrete turbine pad by surrounding the base with a beveled gravel bed. We also will remove nearby rock piles as the opportunity allows. In both cases, the objective is to eliminate burrows near the bases of turbines, making the turbines less attractive to raptors.

F. *Remove derelict equipment.* There is a lot of derelict equipment that remains standing in the Altamont, including inoperative turbines, guyed met towers, and unused overhead lines. A lot of these unused structures are potential perches for raptors, and these are being removed to reduce the attractiveness of the area to perching birds.

G. *Retrofit high-risk power lines.* Although it is estimated that they account for less than one percent of avian fatalities in the APWRA, some electrocutions still do occur in the Altamont. All participating companies have evaluated overhead poles, and are in the process of retrofitting them with measures designed to reduce use by raptors. We will monitor 100 of the 277 riser poles that have been retrofitted so far.

H. *Off-site mitigation.* An off-site mitigation approach is being considered for addressing concerns over remaining mortality in the APWRA. Methods for determining mitigation levels need to be developed and a settlement negotiated among stakeholders.

The study plan includes a design to experimentally test treatments A-D, in most cases using either a Before-After Control Impact (BACI) design. In some cases we will switch the control and treatment plots to better detect the effect of the management measure (BACI + Crossover). Our primary metrics will be measures of fatality and of use/behavior. Treatments E-H will be implemented and resulting turbines will be monitored for avian fatalities, but these measures will not be experimentally tested. The study plan presented here is in draft and is still being developed, with input and comments having been solicited from stakeholders and peer reviewers.

Implementation is [expected] to begin by the end of November 2004.

Session II - Questions and Observations

<u>How long will the study run? Can you comment on whether the burrowing owls are migratory or resident?</u>
Response [D. Strickland]: We have proposed a two-year study of burrowing owls; however, the California Energy Commission (CEC) is considering asking for three years. According to anecdotal reports from local burrowing owl experts, some birds leave and some stay, while still others may move in from other areas.

Response [L. Spiegel]: A lot of birds are getting killed in the summer, and we suspect a lot of these may be juveniles dispersing. We hope to collect feathers and send them to a Canadian lab to determine from the DNA whether these are local or migratory owls that are getting killed.

<u>The ground squirrel control program sounds like a "scorched earth" approach to reducing raptor (golden eagle) fatalities.</u>
Response [L. Spiegel]: The target of the County's rodent control program was to eliminate ground squirrels. However, we feel the return (somewhat lower golden eagle fatalities) was not worth the trade-offs (somewhat higher red-tailed hawk and burrowing owl fatalities, and threats to non-target species).

Response [D. Strickland]: Instead of trying to eliminate the ground squirrels, we are trying to alter management of the wind plant (e.g., grazing management, turbine relocation) and to adapt our management after finding out what works to reduce fatalities. We consider this a more positive approach to reducing raptor fatalities.

SESSION III:
HABITAT EFFECTS FROM TALL STRUCTURES ON PRAIRIE BIRDS

Moderator: Stan Anderson, University of Wyoming

- **Prairie Grouse and Elevated Structures: an Environmental Planning Challenge** — *Jack Connelly, Idaho Dept. of Fish and Game*
- **Structural Additions and their Effects on Birds** — *Stan Anderson, University of Wyoming*
- **Information Review: Habitat Impacts of Wind Power on Sage Grouse** — *Lynn Sharp, Tetra Tech*
- **The Cotterel Mountain Sage Grouse Study** — *Tim Reynolds, TREC, Inc.*
- **Methods and Metrics for Understanding Indirect Impacts from Wind Projects** — *Dale Strickland, WEST, Inc.*

Opening Remarks. Some of the biggest changes are occurring in the prairie ecosystem. When thinking about what constitutes a “tall” structure, it is important to keep in mind that even a fence post can be tall relative to a bird on the prairie. This session differs from the previous one in that the focus is on indirect impacts of wind power, notably habitat fragmentation and other habitat impacts.

Prairie Grouse and Elevated Structures: An Environmental Planning Challenge

presented by
Jack Connelly, Idaho Department of Fish and Game

How does wind development lead to prairie grouse habitat fragmentation, disruption, or disturbance, and to what extent does this result in behavioral avoidance or habituation? Prairie grouse as a whole are a landscape species; they occupy expanses of land as large as the state of Rhode Island. Sage grouse have evolved in areas with few natural “structures” (trees, large rock piles). These birds are in trouble. Greater, Gunnison, and lesser prairie chickens are declining significantly; greater prairie chickens have been extirpated from seven states. There are a host of reasons for these declines, ranging from outright loss of prairie habitat to degradation and fragmentation. West Nile Virus is a big (relatively recent) factor; other factors include grazing and other management practices, hunting and predation. In the context of these threats to prairie grouse populations, we need to look carefully at how these birds are affected by structural changes to their habitat.

From the grouse's perspective, there are a number of man-made features interrupting the prairie landscape. In many cases these "elevated" features – fence posts, sign posts, buildings, power poles and wires, etc. – are not isolated. (For example, fencing and signage often parallel road development.) Can we establish a buffer area around developments to protect prairie grouse? Given that grouse range over an area as large as 80 square miles, a five-mile buffer may not be sufficient; something more like an 8-10 mile buffer may be necessary, though possibly less if the goal is to protect a specific lekking or breeding ground.

Evidence of Effects

What are the potential negative effects of structures in grouse habitat, and do we have any evidence that any of these are occurring? (And, if so, what are the population impacts?)

Direct effect – collision fatalities. In spring 2003, 21 incidents of sage grouse striking barbed wire fence were recorded in one central Wyoming area. Given high scavenging rates, the survey may have picked up only a fraction of the actual collisions.

Indirect effect – habitat avoidance. We have data on sage grouse avoidance of several types of man-made structures. A survey of leks (breeding grounds) along Interstate 80 found no leks within two miles of the interstate; lek distribution increases with distance from the interstate, but we do not find the expected number of leks until we reach a distance of seven miles from the highway.

Nesting sites are also affected by a variety of structures. Hens disperse from the leks to nest. A Kansas survey found that prairie chickens seldom nest within 400 m of transmission lines or improved roads and buildings. It is hard to know in the case of roads whether birds were avoiding noise, associated structures, or what. We do know that any type of elevated structure near a nesting area provides an excellent perching opportunity for nest predators such as ravens.

Research Needs

At this point we are just scraping the surface in terms of understanding the impacts of elevated structures on prairie grouse. We know they are in trouble, and we know that elevated structures are common and increasing. (Consider the example of cell phone towers, which didn't exist 30 years ago.) Our observational data suggest a problem, but as yet we have little empirical data with which to work. Specifically, we need to:

- do the kind of landscape assessment for structures that has been done with the interstates;
- look at other species of prairie grouse, and at other kinds of structures, to see what kind of correlations exist;
- conduct empirical studies to assess the impacts of structures on breeding (this may

involve building structures in pristine habitat to see what happens); and

- incorporate what we're seeing and learning into the planning and implementation of projects.

An adaptive management approach (such as was discussed in an earlier presentation) would help us to learn more about how to avoid critical habitats and mitigate impacts. We need to begin to implement mitigation measures that seem promising and monitor the results, making changes as necessary.

Structural Additions and their Effects on Birds

presented by
Stan Anderson, University of Wyoming

Human fascination with birds and flight goes back throughout history. But what effects do human activities have on birds? We know that bird fatalities are associated with human structures of all kinds. However, because fatality estimates range so widely[4] – and because we know even less about the population sizes – it is hard to know how the impacts from something specific, such as wind towers, affect bird populations.

A wide variety of species-specific behavioral factors determine how birds are affected by structural additions to the natural landscape. Some birds migrate at night, some during the day. We know that cloudy nights have a big impact on migrating passerines. Different species of birds rely on different navigational techniques, including celestial navigation, use of landmarks, geomagnetic fields, etc. Birds that get lost or are unfamiliar with a route may follow other birds that knew the way. Lighted structures (including lighthouses, communications towers) can attract birds on cloudy nights when visibility is not good, sometimes with fatal results.

Documented threats to prairie birds

Birds that make their home in prairie habitat are adapted to open areas with very few natural structures. The addition of even relatively small structures to such landscapes can have a measurable effect.

Collision with cars. Burrowing owls nest in the ground, in squirrel, prairie dog or other existing burrows. Some migrate, some do not, depending on how far north their habitat. On dark and stormy nights, they tend to fly lower, and it is not unusual for them to hit cars.

Open oil pits. Open oil pits are another example of a threat to prairie birds. Birds are attracted to water in the pits, and existing flag-and-fencing arrangements don't do much to

[4] A 2001 study by WEST, Inc. estimated that anywhere from 100 million to one billion birds are killed annually by human structures.

keep them from getting stuck in the oily pool. Short of putting netting (or live wires) over the pits, these structures will remain a hazard.

Habitat avoidance. A study of five species of birds (sage thrasher, Brewer's sparrow, vesper sparrow, sage sparrow, and horned lark) in western Wyoming indicated that habitat avoidance behavior is species-specific. For example, sage birds and sparrows did not nest within 100 m of four low-traffic (10-700 vehicles/day) roads, but horned larks did. Sage grouse also have been found to avoid burned areas.

Predator "subsidies." We know that ravens use oil well towers and tanks as nesting places. Where they are situated near grouse nesting areas, such structures give ravens an advantage in preying on Sage Grouse eggs and the eggs and young of many of the five (above-mentioned) species studied. Towers such as old derrick structures create perches for a wide variety of raptors.

Power lines. Sand hill cranes have been observed flying in large flocks over power lines. Cranes in the front of the flock are able to see the wires and avoid them, but further back in the pack, birds are more likely to collide and be injured or killed. Stormy conditions also lead to many collision deaths of cranes. Putting yellow balls on static wires seems to be an effective way to make the wires easier for the cranes to see and avoid.

Prairie falcons are capable of very high speeds, and when they fly fast (e.g., to capture prey), they are more likely to collide with power lines.

USFWS Guidelines

On June 13, 2003, the US Fish and Wildlife Service (USFWS) published a guidance document recommending that structures not be built within five miles of any lek. This document is now in a comment period (until July 10, 2005). As was mentioned in the previous presentation, lek location affects the amount of buffer area required. We're finding that the minimum radius from leks to successful nesting sites is 3.5 km, but that in some cases it is much further. The problem with trying to establish general guidelines is that sage grouse of different ages, sexes and stages of brood-rearing have different habitat needs, all of which have to be taken into consideration in planning changes to the landscape.

Information Review: Habitat Impacts of Wind Power on Sage Grouse

presented by
Lynn Sharp, TetraTech EC, Inc.

An information review was conducted to look at the potential impact on sage grouse of a proposed wind project on Bureau of Land Management (BLM) land in southwestern Idaho. Sage grouse leks and nests currently occur on the proposed project site.

There is no case history of wind impacts on sage grouse habitat, and few well-designed quantitative studies. Based on professional judgment, we can predict that habitat impacts will include loss and degradation of habitat, fragmentation, behavioral avoidance, increased predation, poaching, and vehicle collisions. Confounding variables such as habitat type and condition are not well documented or considered, and "control" (or "reference") data are lacking. No sage grouse collisions or other fatalities have been recorded at the Foote Creek Rim (WY) wind facility; however, there were no leks located near this development, and we cannot extrapolate from it to the Idaho site.

Habitat Impacts from Other Types of Development

We therefore focused on reviewing studies of habitat impacts from other types of development (e.g., energy and mining, fences and power lines, road development) with similar features. We looked for both quantitative data and anecdotal observations where no other data were available. Some impacts, such as noise and lighting, have not been well researched.

Energy development. There have been some studies of the effect of other types of energy development on sage grouse. In particular, a number of studies have looked at the impact of oil development. Findings include sage grouse displacement or disturbance (Braun 1987, Braun 1998, Aldridge 1998) as a result of vegetation removal, roads, and facilities that decrease habitat availability. Lyon and Anderson (2003) found that nesting females move farther from oil exploration sites, and Lyon (2000) found some evidence that nesting continues at greater distances over the long term. Some studies have found evidence only of short-term impacts, while other studies have found that some populations do not recover from the disturbance/displacement. A study of leks near oil wells found that leks within 0.4 km (0.25 miles) of wells attracted fewer male grouse than leks on less disturbed sites (Braun et al., 2002).

Fences, power lines, and communications towers. Fence-associated impacts include collision and avoidance. Fences, power lines and communication towers provide perches for raptors, making adjacent habitat less safe for sage grouse. One study found that grouse numbers increased with distance from power lines up to a distance of 600 m (Braun 1998). At an Idaho communication tower site, there are no leks within a kilometer of the tower, despite being otherwise suitable habitat.

Mining. Sage grouse and other species may react to a new disturbance based on learned responses to other disturbances the population has experienced. Several studies found evidence of sage grouse being displaced or disturbed by mining (Braun 1987, Braun 1998, Aldridge 1998). However, in at least one case where a gold mine was developed near an existing road, grouse had already habituated to the road, and remained on the site when the mine was developed and after it was closed.

Roads. A number of studies have been made of the impact of roads on sage grouse habitat and behavior. In the interior Columbia Basin, Wisdom et al. (2000) found that road density was higher in the areas from which sage grouse were extirpated, and lower in the range still occupied by sage grouse. While leks have been formed on roads (Patterson 1952), leks within a kilometer (0.8 mi) of roads are used less than leks situated farther away from roads (in otherwise comparable habitat). Even lightly trafficked roads (1-12 vehicles/day) have been correlated with less successful nesting (Lyon 2000), and it appears that light traffic near leks may reduce nest-initiation rates and increase distances moved from leks during nest-site selection (Lyon and Anderson 2003).

Other observations. At another site where a met tower was located 150 m from a sage grouse lek, male grouse were not affected. (They were, in fact, observed strutting directly below the tower.) Connelly et al. (1981) noted two gravel pits and one recent burn site being used as leks.

Recommendations

In the absence of data specific to wind development, we recommended the following suite of actions taken to minimize impact of wind power development on sage grouse.

- Formation of a Technical Advisory Committee (TAC), including environmental groups, agency biologists, etc.) to review the initial study protocol and oversee monitoring and mitigation
- Long-term commitment to high-quality reclamation and enhancement, including weed management program during and after construction to prevent invasive weeds from changing the composition of habitat vegetation.
- Minimal fencing (no woven-wire fences) and no guy wires
- No public access during lek and winter seasons
- During the lekking season, limit construction activities within 0.4 km of leks to between 10 am and 4 pm
- Bury power lines or implement measures to prevent raptor perching within 2 km of grouse habitat
- Strict no-poaching/harassing policies, speed limits for construction and other vehicles, and driver training
- Enhancement of local habitat acreage

- Focus mitigation actions on reducing limiting factors to the population or provide agreed-upon off-site mitigation.

Bibliography

Selected References on Sage Grouse [Sharp NWCC 2004 References.doc] and a PowerPoint presentation showing a *Tiered Mitigation Approach* [Sage Grouse Tiered Mitigation Approach 030405.ppt] may be downloaded separately from the NWCC website: www.nationalwind.org

The Cotterel Mountain Sage Grouse Study

presented by
Tim Reynolds, TREC, Inc.

Cotterel Mountain is part of a 12-mile north-south tilted block formation with a western slope and sharp eastern escarpment, located on the Idaho/Utah border, in Cassia County, Idaho. A superior wind resource area, Cotterel Mountain is the first wind power project proposed on public lands. It is also important sage grouse habitat. There are several active sage grouse leks on the mountain, and an unknown number of grouse occupy the site throughout the year. It is suspected that grouse from the surrounding area use Cotterel Mountain at some time during the year, and that it may be a significant wintering area for grouse from the surrounding areas during severe winters. Cotterel may provide the best northernmost point for genetic exchange between northern and southern grouse populations separated by two interstate highways.

The purpose of this study is to gather data on sage grouse activity on the mountain, in the area of the proposed wind development. This will give us a baseline against which to measure impacts of wind power development on the sage grouse population.

Study Objectives

Data gathered on Cotterel Mountain sage grouse and its use of the habitat will be compared with a control site about five miles away, in a mountain valley to the west.

- *Breeding population* based on lek searches (by helicopters) and lek counts (on the ground)
- *Movement and distribution* based on radio telemetry data (hens and cocks will be radio-collared on leks and additional birds collared in late summer; a control group of birds from the Ski Hill lek will also be collared and tracked)
- *Productivity* data include nesting effort, nest success, clutch size, egg fertility, hatching success, and fledging success. *Survivorship* will be measured using radio telemetry data, and compared with survivorship among the control group (from Ski Hill lek).

Results

Lek counts. Prior to this project, there were four known Cotterel Mountain leks monitored by the Idaho Department of Fish and Game and/or the Federal Bureau of Land Management (BLM). The existence of these leks has been known for as long as 22 years, but they have not been looked at very often, which means that there is very limited background information. Three new leks have been found since beginning of this study, of which two are known to be active. One is an area where there had been a big fire.

We found about seven displaying males per lek, a relatively small number that suggests there are not many birds on Cotterel Mountain. Our initial plan was to deploy 30 radio-collar transmitters; however, we were not able to get as many birds collared on the mountain as had been hoped.

Productivity. All of the 13 hens collared at the leks nested, with a 54% overall success rate. Four of the nine hens collared on the mountain site, or 44%, nested successfully, compared to three of the four, or 75%, of the hens collared at the Ski Hill lek. Again, it should be noted that these are very small numbers. All of the eggs that survived through the nesting period hatched. Survival of chicks was higher on Cotterel Mountain (12 of 28, or 43%) than in the Ski Hill control area (3 of 23, or 13%). Total fledging success was 29% (15 of 51 chicks).

We also looked at re-nesting attempts. Overall, only one in six hens attempted to re-nest. Re-nesting clutch size was smaller (five per nest, v. 6.5 to 7.7 per nest in the initial nesting attempt), egg fertility and hatching success were lower, and none of the chicks hatched from this second set of clutches survived.

Overall per-hen productivity was 1.00 in the Ski Hill control group, and 1.20 for the Cotterel Mountain hens.

Movements. During the spring, most of the male grouse stayed within a kilometer of the lek where they were captured/collared. They moved farther off in the summer, though generally not too far off.

Most of the nesting females nested within 1.3 km of the lek where they were collared. All hens from Cotterel Mountain leks nested on Cotterel Mountain. Ski Hill (control group) hens nested further from leks than Cotterel Mountain hens, and one Ski Hill hen moved more than 13 km from Ski Hill to nest on Cotterel Mountain. Non-nesting hens and hens with failed nests or lost broods moved further from the leks.

How do roads and other structures affect movements? There is a road that goes through the lek areas, and these birds do not seem to be avoiding it. (It is a road with relatively light traffic.)

Conclusions

The leks on Cotterel Mountain are small, and the breeding population in 2004 was approximately 60 birds.

Cotterel Mountain hen nesting success (44%) is above average for Idaho (34%), and below the national average (55%)

The percentage of yearlings attempting to nest is higher (100%) than the range-wide average (30%), but yearling productivity (1.15 overall for Cotterel Mountain and Ski Hill) is too low to sustain the population. (A sustainable value would be 2.25 surviving chicks per hen.) Six of the 12 yearlings collared on Cotterel Mountain in the spring moved off the Mountain. Given these findings, the level of legal and illegal harvest is significant.

Methods and Metrics for Understanding Indirect Impacts from Wind Projects

presented by
Dale Strickland, WEST, Inc.

Some studies focus on the issue of birds (and other flying wildlife) colliding with wind turbines and being killed or injured. Wind projects, like any developments, also have indirect impacts on wildlife, and these habitat effects are of two kinds:

- Direct loss of habitat (turbine pads, roads, substations)
- Indirect loss of habitat (behavioral response to turbines and related facilities)

Impacts may be long- or short-term, depending on whether habitat is restored and to what extent wildlife habituates to the facility.

Design Options and Sampling Plans

The preferred study design option depends on what data can be collected. Preferred design options associated with different sets of conditions are shown here and discussed below.

Conditions	Preferred Design Option
Pre-impact data and reference area possible	Before-After Control (Reference)-Impact (BACI) or Matched Pair Design with BACI
Pre-impact data not possible	Impact-reference or Matched Pair design with Impact-reference
Pre-impact data possible/ No reference area	Before-After
Small homogeneous area	Impact-Gradient (can be used w/BACI, IR, BA)

The value of a *Before-After Control-Impact* (BACI) design can be illustrated by an example from the Foote Creek Rim wind site in Wyoming. Approximately 50 adult mountain plovers were estimated to be at the site before construction. Those numbers dropped during and after construction of the wind plant. This appeared to be an "obvious" impact of the wind development. However, numbers also dropped significantly in the reference area, and observations by other researchers (Fritz Knopf, personal communication) suggested a reduction in the regional mountain plover population. Taken together, these findings and observations argue against the hypothesis that the wind plant had been responsible for the decline of plovers at Foote Creek Rim.

A *gradient analysis* uses a response variable (e.g., density of breeding grassland birds) and a covariate, typically distance from the potential source of impact (e.g., turbine). In the example given (from the Stateline Wind Project), the negative change in the density of grassland species pre- to post-construction suggests an impact within the first 50 m of the turbines. By contrast, when the same type of analysis is applied only to horned larks, no effect was documented. In choosing covariates, it is important to consider the important physical attributes (such as distance from a turbine), environmental variables (such as vegetation), and animal behavior (e.g., horned larks' attraction to gravel roads) that may impact use.

With respect to sampling plans, any plan selected should be probability-based. Here again, however, site and study-specific conditions will determine the preferred type of plan.

Conditions	Preferred Sampling Plan
Homogeneous area (*very rare*)	Simple random sample
Distinct strata and short-term study	Stratified random sample
Heterogeneous area and/or long-term study	Systematic sample with a random start

The *stratified random sampling* approach is very appealing to most biologists, but it can be problematic. Reviewers may suggest stratifying the sample based on vegetation. However, one cannot necessarily do that if vegetation might change (e.g., 75% of the vegetation is corn), or if the length of the study encompasses an extended time period, increasing the likelihood that strata boundary will change (e.g., more than one crop season with the fields being rotated). *Systematic sampling* with a random start mathematically is very similar to a simple random sample and is the preferred approach, so long as there is not a repeated pattern in some variable that is correlated with the systematic sample.

Common Parameters

What measures can we use to learn about how animals select habitat and how are they affected by impacts to that habitat? Typical parameters to measure in observational studies include:

- *Abundance* – use per unit area or per unit time, as measured by passage rates and flight height
- *Reproduction* – young per breeding pair
- *Habitat use* – use as a function of availability
- *Covariates* – vegetation, topography, distance, other species, weather, season, etc.
- *Telemetry*. Radio-telemetry is a very useful tool for studying habitat selection and response to development, because it provides a very direct measure of response. In western Wyoming, for example, we were able to look at the impact of a gas field development on mule deer with GPS radio transmitters. By looking at snapshots of use over time, we can see that deer use first declines around the wells themselves, and as time goes by around the roads as well. The results are expressed in terms of the probability of use of areas with varying distances to the impact, allowing estimates of the magnitude of the impact. The same sort of data-gathering approach could be used to look at the impact of wind development on prairie grouse habitat. Telemetry studies are costly, however, and one tends to have to rely on small sample sizes.

Confounding Effects and Solutions

It is hard to separate direct from indirect impacts by making visual observations alone, or by relying on anecdotal information and surrogate data. This is particularly true of responses that may change over time. Over an extended time period, habitat may recover or species may habituate to the changes. Conversely, there may be no apparent change (e.g., males may return to an existing lek in proximity to a development) when in fact there has been an impact (females avoid the lek, resulting in no reproduction); or the decline may be gradual (e.g., attrition over time as new males are not recruited to the lek).

Further Research Needs

It is best to learn as much as we can about what actually happens when development occurs so that guidance and permitting decisions can be based on actual data – rather than create overly conservative guidelines based on estimated impacts. Wildlife biologists often are tempted to extrapolate from a single study. It is important to combine observational studies with cause-and-effect studies so as to be able to make more plausible extrapolations.

Session III - Questions and Observations

With the exception of Altamont, the fatality and habitat data presented today focus on taller towers and longer blades. Can industry confirm that the trend is to these larger, longer turbines, and do scientists have concerns about impacts of these taller towers to birds and bats?
Response [B. Thresher]: Regarding tower heights, yes, the trend is to 70-80 m tower heights and will likely top off with next generation of turbines reaching 150 m above ground level (top of rotor blades?)

Response [D. Strickland]: Regarding impacts of taller towers – I'm not sure "concern" is the right question. Am I interested in how the taller turbines will impact birds relative to the existing turbines, yes. Data from CEC study suggest that the taller towers may have a lower impact on raptors in the Altamont. It does concern me that we don't know what to expect in other places.

Response [B. Cooper]: I would echo Dale's view. As you get up above the 120-150 m level, the density of birds increases.

How does tip speed change play out in terms of bird and bat impacts?
Response [B. Thresher]: As the rotor size goes up, the rotation rate goes down but the tip speed remains approximately the same. (Tip speed can be speeded up or slowed down slightly, but I don't expect to see tip speeds above 160 mph – about 4-5 times the wind speed is optimal for tip speed.)

Given blade length increase, does width also increase, so that surface area increases?
Response [B. Thresher]: Yes. About 3-5% of the rotor swept area is blade surface area. Rotor swept area increases as a function of blade length, and the portion of the RSA that is "blocked" by the blade surfaces increases proportionately.

Response [D. Strickland]: Keep in mind that when you're talking about larger turbines, you may be producing the same amount of power with fewer turbines, spaced further apart. As diameter goes up, spacing between turbines goes up.

Given low sample size of marked sage grouse, are you concerned about statistical significance?
Response [T. Reynolds]: Yes. But we do have 20% of this small population in our sample, which is a high percentage.

How do you distinguish the impact of hunting and poaching from other (development-related) impacts?
Response [T. Reynolds]: We do have the control area, which also has hunting and poaching. If this project is given the go-ahead, the developer won't start construction until next summer at the earliest. So we should have two to three years pre-construction data

from both the development and control (reference) areas.

Who paid for gas field study, and how much did it cost?
Response [D. Strickland]: The gas company paid most of study costs ($125-$130,000 per year). BLM pitched in $50,000 for the telemetry equipment, and the wildlife agency contributed some data and logistical support.

Response [T. Reynolds]: The cost of the Cotterel Mountain study is being paid for by the project proponent. (This year's costs were in the $60,000 range.)

What confidence can we have that inferences aren't "pseudo replication?"[5]
Response [D. Strickland]: Pseudo replication is a problem, and that's one reason we seldom use a single turbine as the sample unit. It is rare that we would be looking at a single turbine's impacts. In Altamont studies, for example, the sampling unit almost always is the turbine string, not individual turbines.

Response [T. Reynolds]: In our case (Cotterell Mountain), we're looking at impacts of entire process of construction and operation of wind farm development.

Response [J. Connelly]: To give another example, when we're looking at reproduction, the sampling unit is a sage grouse brood, not individual chicks.

Could a wind company purchase an easement to prevent hunting ?
Response [T. Reynolds]: Obviously, such an action would prevent only legal take, not illegal take. I don't know about conservation options on BLM land.

Response [D. Strickland]: It's common to have this issue raised at the state wildlife agency level – with sage grouse, fatality rates are high enough that it is hard to affect it by restricting hunting. May be the case in a very isolated population like Cotterel Mountain, but not generally. For prairie grouse, the greatest concern is for habitat loss and habitat fragmentation. I doubt that developers want to suggest hunting restrictions on BLM land.

Response [J. Connelly]: Habitat is absolutely the overriding issue for sage and grouse survival, but I disagree with Dale – the research in Idaho and Wyoming suggests that we can over-hunt long-lived but low-reproductive rate game birds.

What other issues critical for long-term survival of grouse besides habitat?
Response []: Early brood-rearing conditions also critical (insects and other food for chicks, good cover, etc.)

Are there landscape criteria about where facilities should be sited within a region?
Response [S. Anderson]: Yes. I question the "five-mile guideline" approach. It's more important to look at the regional picture, and maybe that should be added to the USFWS

[5] Pseudo replication occurs when non-independent units are included in the sample, resulting in an overestimation of sample size.

briefing report.

Could you comment on the reasonableness of 5-mile buffer zone?
Response [J. Connelly]: At times and places 5 miles is a reasonable buffer, but in other situations, something bigger is needed; e.g., 8-10 mile radius around leks to protect not just the lekking site but the nesting sites around it.

Contradictory information on what buffer around leks (for constructing wind turbines) should be (distance of nests from leks)?
Response [L. Sharp]: Appropriate buffer area around leks varies – "it's all over the map" – depends, for example, on the intervening terrain.

Response [T. Reynolds]: I agree.

Response [S. Anderson]: The US Fish and Wildlife briefing paper has a good discussion about how they chose "five mile" guideline, but sage grouse habitat needs do vary over life cycle. For example, if there is a lek near an oil well, there are a lot of dynamics involved. Males would continue to come back, but new males would not be attracted, so that after seven years there would be no males using the lek. Of necessity, we need to look at a range of factors. It's not an easy topic to deal with.

Response [J. Connelly]: Prairie and especially sage grouse have a high fidelity to seasonal ranges. When we muck up their habitat, it's difficult for them to adapt. So we may see the males continuing to go back to leks that are no longer suitable until they die out and no new males are recruited. If what we're concerned about is population impacts, we need to look not just at whether the lek remains active but at hen productivity and chick survival rates. Also, we need to take into consideration not only the turbines but also the roads and auxiliary support infrastructure. Five miles may not be enough if the goal is to protect not just the lek but the nesting and the survival of the chicks.

Comment [R. Willis]: The five-mile buffer around sage grouse leks recommended in the guidelines was intended to protect the lek, not the entire range of the population using the lek. It was based on the best information we had at the time. Please submit comments on this and other aspects of the guidance document, including any suggestions for improving it. The comment period extends until July 10, 2005.

How would you speak to the issue of cumulative (species) impacts of development v. impact of a project on local populations?
Response [D. Strickland]: The question to ask is, what does a given project's impact mean to a population *in light of all the other things that are going on with that species/ population*? Cumulative impact is a function not just of wind energy being developed at various sites. The question is, what is the cumulative impact of adding wind energy development to existing land uses such as hunting and – even more significantly – grazing, and other forms of energy development, which potentially have huge impacts.

Comment [A. Arnold]: What we are hearing is that there are many confounding variables.

Trying to establish the impact of a particular development on a local population, let alone on a species, is very complex.
Comment [D. Anderson]: The NWCC Wildlife Work Group would appreciate input as to how to address this issue.

Comment [J. Mosher]: It is a complex issue, and we tend to make our decisions (about project-specific impacts and how to address them) in isolation. This is not the best approach; rather, we should be considering information on the range of stressors and their cumulative effects when we make decisions about specific projects.

<u>For rule-makers, the question remains, how should we make decisions regarding wind turbines? How much data do we need to assess risk? What methods should we be using?</u>
Response [S. Anderson]: Descriptive information is useful, but we need to be able to compare studies from one area to another. One suggestion is that sampling plans be developed collaboratively.

Comment [A. Arnold]: This is the similar to the message communicated by the NWCC Wildlife [formerly Avian] Workgroup's "Methods and Metrics" document.

<u>What is the aesthetic value of a natural landscape and how do you measure it?</u>
Response [S. Anderson]: The answer to that differs with every subject who's asked.

<u>What are some of the other (non-wind) mechanisms and are they being studied?</u>
Response [J. Connelly]: One is the invasion of these [grouse habitat] areas by noxious weeds (e.g., cheat grass, etc.) which can lead to total degeneration of sagebrush landscapes. Another is off-road vehicles. Fire also has a tremendous impact.

Response [D. Strickland]: Don't forget grazing.

Response [T. Reynolds]: I'd say habitat fragmentation – the big effects are hard for agencies to grasp and deal with.

Response [S. Anderson]: There is a lot of information from the WEST study[6] about what's causing avian fatalities.

Comment [D. Strickland]: In that study we presented what is known about causes of [collision] fatalities, not about perturbations affecting habitat, or about the various kinds of contaminants that exist and are growing. We know that a lot of species are in trouble. It would be great if we could focus as much energy on the impact of other developments as we are focusing on wind power's impacts on birds and bats.

Comment [T. Kunz]: With the exception of bats concentrated in caves, we know very little

[6] "Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the US." August 2001. Produced by WEST, Inc. for the NWCC [http:/www.nationalwind.org/workgroups/wildlife/]

about anthropogenic impacts on bats. We know that forest management practices, pollutants in rivers, pesticide applications in agriculture, diseases – to name a few stressors – affect bats' reproductive rates. Unfortunately, all the studies that have been done are specific to particular locations. As others have pointed out, we cannot extrapolate from one region to another.

SESSION IV: BIRD MIGRATION

Moderator: Frank Moore, *University of Southern Mississippi*

- **Bird Migration and Wind Power Development: A Spatial-Dependent Perspective** — *Frank Moore, University of Southern Mississippi*
- **Experience from European Migration Studies** — *Franz Bairlein, Institute of Avian Research*
- **Western Songbird Migration** — *Jeff Kelly, Oklahoma Biological Survey*
- **Light Attraction** — *Paul Kerlinger, Curry and Kerlinger*
- **Spatial and Temporal Dynamics** — *Jeff Smith, Hawk Watch International*
- **Population Impact Risks** — *Sarah Mabey, North Carolina State University*

Bird Migration and Wind Power Development: A Spatial-Dependent Perspective

presented by

Frank Moore, University of Southern Mississippi

This presentation provides an overview for the more focused talks that follow. (The emphasis here is on songbirds, although some of the points can be generalized to other migratory birds and bats.) Wind power developments can affect migrating birds in any or all of three ways:

- Increasing the risk of collision;
- Causing migrants to change their flight patterns to avoid wind developments; and,
- Altering the quality or availability of stopover habitat.

When considering the impact of wind energy development on migratory birds, it is important to recognize that migration has both spatial and temporal aspects, and that the nature of the relationship between migrant and habitat is *scale-dependent*.

Temporal (Seasonal and Diel) Patterns

Migration is characterized by seasonal and diel temporal patterns, and within each pattern there is variation. The temporal course of migration varies from species to species and within species according to sex, age, and specific populations. These temporal patterns are also affected by weather conditions.

- Migration is seasonally predictable, but within the seasonal migration periods there are variations among species and even within species (e.g., by age, sex). The magnitude of movement at a given location will vary from year to year.
- Migration activity follows diel patterns as well (nocturnal vs. diurnal migration). In central Illinois, for example, birds that typically are active during the day migrate at night, with birds taking off shortly after sunset, and landing before sunrise. Other species, such as swallows, migrate during the day. Volume aloft will vary from night to night (and from day to day).
- Even among night migrants, migratory activity continues during the day, in some cases to correct any drift or misplacement that occurred during the previous night. Due to atmospheric structure, this activity is most likely to occur in the early morning.

Once aloft, migrants will select an *altitude*. Again, at any given site, there is variation in flight altitude. Typically, migrants are flying below 500 m (even below 300 m), but on the coast they may be flying higher.

Spatial Patterns

Apart from the question of flight altitude at various locations and times, the spatial patterns of migration need to be considered on the continental scale. Some points to consider include the following.

- There are more intercontinental migrants in eastern North America, more *intra*-continental migrants in the west.
- Literally millions of migrants lifting off (beginning in the east, and moving west as the sun sets).
- Passage is a broad-front phenomenon, but there are variations among species as well as age- and sex-specific variations within species. The population structure of spatial migration patterns is not well understood on the continental scale.
- Routes are species-specific and also follow seasonal wind patterns. (The blackpoll warbler, for example, swings further east, out over Bermuda, during its southerly fall migration from North to South America. During the spring migration, this warbler follows a more westerly route north, over Cuba and Florida.) Migratory birds respond to topographic features such as riverine corridors and coastal features.

Use of Habitat

Habitat chosen by migrants along the way is different in spring than it is in fall. As with other aspects of migratory activity, the use of habitat by migrating birds is scale-dependent. Migrants make a series of decisions as they migrate, from the broad geographic scale (e.g., where to make landfall when crossing a large feature like the Gulf of Mexico) all the way down to the point of landing (e.g., what specific landscape or landscape feature to select). Even when pausing for just a few hours or a few days, migrants choose their habitat, based on considerations such as food availability, cover, etc. Birds' use of habitat is not proportionate to the availability of a particular type of habitat, indicating that birds are selective.

Migrating birds must accomplish a number of critical objectives if they are to survive:

- Acquire food in a short period of time
- Avoid predators
- Stay healthy
- Orient themselves and correct any directional errors they may make
- Cope with adverse weather conditions or events

Migrants' success depends on their ability to adjust to and make use of unfamiliar habitat to resolve conflicting demands and accomplish these objectives. The rest of this session includes a presentation of two European studies focusing on the interaction of migrating birds and wind power developments; reviews of what is known about western songbird and eastern hawk migration in the U.S., and the effect of lighting on migrating birds. A final presentation will discuss the need to develop a regional perspective when considering the impact of development on migrating birds.

Migrating Birds and Wind Power

presented by

Franz Bairlein, Institute of Avian Research

We know that local residents/breeding birds can become well habituated to windfarms, but migrating birds are another story. Unlike resident or breeding birds, which may become accustomed to navigating a particular set of obstacles, migrants have to navigate on the large scale. Often they are moving in massive numbers, and then having to make decisions about and within landscapes with which they aren't familiar. Because migrants concentrate along ridges well suited to wind power development, bird migration has implications for wind turbine placement.

This presentation focuses on two locations where large-scale wind developments are located or planned that also happen to be areas where hundreds of millions of Europe-Africa migrants congregate. The first is a 25,000-sq. km. area of the North Sea scheduled for wind turbine development off the German coast. The second location considered here is Cape Sim, a 25-sq. km area at the Moroccan Atlantic coast south of Essaouira where wind development is anticipated.

Issues to Anticipate and Address

Three types of interactions between migrating birds and wind development were considered in these analyses.

1) *Collision risk*. Factors at work in addressing this issue include the placement of turbines, migrants' flight altitude, species maneuverability, and the visibility of the

turbines to approaching migrants.

2) *Barrier effect*. Both the North Sea and Cape Sim developments are extensive enough that it is necessary to consider their impact on the effective geography of the region. From the perspective of migrating birds, if scale of development is large enough, it could create a migratory barrier where one did not formerly exist.

3) *Area avoidance/desertion*. Depending on the species, stopover migrants may desert a habitat as a stopover. For example, in one area where wind turbines are located along the shore, shorebirds maintain a distance of 500 m from wind turbines, avoiding what would otherwise be identical stopover habitat.

Methods

Our data-gathering methods included:

- *visual observation* from land, from on-board ships, and from the air;
- *line transect surveys*, including an analysis of habitat/vegetation types;
- *radar*, including continuous recording from vertical and horizontal radar locations (this important tool was supplemented by acoustic and video recording to learn more about species); and,
- *thermal imaging*.

At Cape Sim, Morocco, for example, we looked at the horizontal distribution and abundance of diurnal migrants, broken down by taxonomic groups and (in the case of endangered species) by species. We also looked at the vertical distribution, finding that a significant proportion of migrants were flying at lower altitudes than previously thought – low enough to be within reach of the turbine rotors. Radar was used to look at both seasonal and diurnal patterns (rate of passage as measured by number of radar echoes per hour).

Our assessment identified a high risk portion of the proposed wind development area by identifying high stopover areas (predominantly along the coastal, or western portion of the area). Using this information, we were able to get an agreement from the developer(s) to focus development on the eastern part of the proposed area.

At the North Sea wind development site, we are using similar tools to assess the risk of offshore impacts. Over water, migrants apt to fly at still lower altitudes, making the large offshore wind developments a potential risk. We are doing seabird surveys, mapping the density of birds across the proposed development area, trying to identify sensitive spots for seabird migrants.

We developed and applied a vulnerability index that scales the possible adverse effects of marine wind farms on seabirds. The Wind farm Sensitivity Index (WSI) is a function of bird density at sea and species-specific sensitivity issues, including flight behavior, habitat use, population size, and conservation status.

Songbird Migration in the West

presented by
Jeff Kelly, Oklahoma Biological Survey

A songbird's annual cycle comprises a "summer" breeding season and the wintering-over months, with two shorter migratory periods (spring and fall) bridging the summer and winter residency periods. Although migration activity totals only about a quarter of a songbird's annual cycle, songbirds are at highest risk during these migratory periods. The point is illustrated succinctly by a figure from the Sillett and Holmes paper *Variation in survivorship of a migratory songbird throughout its annual cycle*. For *D. caerulescens*, the probability of survival is highest during the four-month summer breeding season (0.99 $\pm$ 0.01), and only slightly lower during the 5-month winter season (0.93 $\pm$ 0.05). However, during the six-week spring and fall migration periods, survival estimates range from 0.67 to 0.73 (Sillett and Holmes 2002).

As Frank Moore pointed out in his presentation, migrating songbirds are choosing a route, looking for macrohabitat, and within that, identifying microhabitat, or an actual stopover site. Keep in mind that these decisions are being made by individuals, not by populations or by species.

U.S. migration routes follow an east-west divide. Western coastal migrants tend to overwinter in Mexico, while eastern migrants (or western migrants that go east before heading south) overwinter primarily in Central and South America. Thus western migrants stay over land, while eastern migrants have to cross the Gulf of Mexico. We know less about western migratory activity than we know about eastern songbird migration. Some key points that we do know include the following.

- Lowland riparian habitat is a critical microhabitat type in the west, particularly in the spring. This habitat is easily defined, not particularly critical to wind developers, and makes up a tiny percentage of the landscape in the arid southwest.
- Elevation matters. For birds that don't stopover in the lowland riparian areas, there is recent evidence that many birds migrate through the uplands (mountain shrub and forest).
- 99% of the interior Western landscape is Upland. For 50% of the birds to be in the riparian zone, the density would have to be 100 times greater there than in the uplands. This not being the case, biologists conclude that more than half of migrating western songbirds make use of uplands during migration, particularly in the fall. However, because lowland riparian habitat makes up such a tiny percentage of the western landscape, its importance to western migrants cannot be overemphasized.

Molecular markers (combining DNA samples, isotopic probes) are being used to identify populations of origin for migratory birds. These tools are helpful in tracing the migratory routes, and it would be extremely useful if people studying bird-wind interactions would collect and curate fresh bird carcasses. (Museums, such as the Sam Nobel Oklahoma Museum of Natural History, are a possible repository for such specimens.) Developing a protocol for collecting and curating fresh carcasses (or at least for collecting and curating feathers – which, unlike whole carcasses, are not perishable) would help us learn more. One such call for feather sampling was published in *The Auk* in 2003.

References

Sillett, T. Scott and Richard T. Holmes, *Variation in survivorship of a migratory songbird throughout its annual cycle*, Journal of Animal Ecology 71, 296-308. 2002.

Smith, et al., *A call for feather sampling,* The Auk 120(1): 218-221, 2003.

Attraction of Night Migrating Birds to FAA and other Types of Lights

presented by

Paul Kerlinger, Curry & Kerlinger, LLC

There is a lot of evidence to show that lights attract birds. A wide variety of types of lighted structures have been found to attract birds. These include: lighthouses (bird attraction documented in the 1800s); commercial and residential building lights, street lights, and flood lights; ceilometers (airport lights from the 1950s and 1960s, responsible for some of the biggest bird-kill events of all that have been documented); communication tower lights (some systematic investigations of these have been documented since the 1950s).

In reviewing the literature, it is important not to confound lighting and structural variables. Structural variables include the presence of guy wires, typically used to support communications towers but generally not used on modern commercial-scale wind turbines. Lighting variables also are important. The literature to date suggests that the brightest lights and those that burn steadily are most attractive to birds. Blinking lights (by themselves) have not been shown to attract birds. In some cases bird kills have been associated with unlit (or blinking lighted) tall towers when the structure responsible for attracting the birds may have been a less prominent but steadily lighted building adjacent to the tower. (For example, in a case where many birds collided with a communications tower in West Virginia, it was most likely the sodium vapor lights on an adjoining natural gas pumping station that attracted the birds.)

The Federal Aviation Administration (FAA) does not *require* lighting for tall structures. However, the FAA does offer lighting *guidelines,*[7] providing recommended lighting

[7] See FAA Advisory Circular AC 70/7460-1K (2000), available on the Web.

specifications for a wide variety of towers, turbines, bridges, water towers, etc. For communications towers, the FAA recommends multiple sets of L-864 flashing red and (or) L-821 steady red lights. For towers over 500 feet, L-865 white strobe lighting is recommended. FAA guidelines recommend lighting for only one in three or four turbines, typically using two L-864 flashing red lights.

Lighting and turbine collisions

There are many examples, primarily from the western U.S., where unlit turbines and turbines with flashing lights have been found with <1 night migrant fatality per year. Many other examples from the east (PA, WI, WV, Ontario) suggest that not many night migrants are attracted to either lit (red strobe lighting) or unlit turbines. Night migrant fatalities in the east are on the order of ~3 night migrants/turbine/year.

Two turbine sites where large numbers of night migrants have collided with wind turbines occurred in Minnesota (Buffalo Ridge) and at the Mountaineer site in West Virginia. In the Minnesota case, 76 of the 353 turbines were lit, apparently with L-810 “solid red” lights. An estimated 1.5-4.0 night migrant fatalities per turbine occur at the Buffalo Ridge site. During one mortality event, 14 birds were found at two turbines (one lit, one unlit). At Mountaineer, WV, approximately 3 night migrant fatalities per year have been found with no difference between lit and unlit turbines. However, one big night migrant kill event did occur at two turbines located next to a substation with sodium vapor lights. Other turbines, including other lit turbines, did not have significant numbers of fatalities on that same foggy night. This is a good example of the care that needs to be taken not to confound variables when drawing conclusions, especially from single events.

The largest number of migrant songbird fatalities at a wind turbine site has been documented at Buffalo Mountain, Tennessee. This is a small site, with three 88-m turbines constructed on a forested mountain ridge. All three turbines have flashing strobe lighting, and the per-turbine fatality rate has been 6-8 fatalities per turbine per year over the past three years, with little variation from one year to the next.

Michigan State Police tower FAA lighting test

A three-year study is underway to assess the impact of different types of FAA-recommended lighting on communications towers operated by the Michigan State Police. The 23 towers range in height from 400 to 1000+ feet. FAA variances were obtained to test red strobes v. white strobes v. red flashing v. red steady-burning lights on 400-475 foot guyed communication towers. To date, no large-scale fatality events have occurred at towers 475 feet or shorter. Guy wires are responsible for over 95% of the fatalities. The study will continue for another two years. The Michigan study was set up with the cooperation of FAA technicians, who have expressed interest in learning about what differences lighting can make.

Conclusions

Night migrating song birds are attracted to steady-burning lights at communications towers and other structures, sometimes leading to large-scale fatality events. Specific recommendations include the following.

- When doing risk assessments it is important to keep in mind taxonomic susceptibility. Night migrating songbirds are attracted to lights, but shorebirds, water fowl, etc. are not.
- FAA red flashing (L-864) lights on wind turbines do not appear to attract night migrants, based on the weight of evidence.
- The FAA should be urged to eliminate use of steady-burning lights on all structures, and to reduce lighting for all structures less than 500 feet in height (except in proximity to airports, military bases, and helipads).
- Care should be taken in how lighting is used on auxiliary buildings. Motion-sensitive lights are preferable to steady-on lights in the vicinity of turbine towers.

Spatial and Temporal Dynamics of Raptor Migration in North America

presented by

Jeff Smith, Hawk Watch International

North American raptors exhibit a range of migration patterns and behaviors. Most are partial migrants, meaning that their breeding and winter ranges overlap. Partial migrants typically travel less than 3,000 km, and may exhibit differential migration behavior by sex or age within a given population. (For example, mature adults may remain sedentary while younger birds migrate.) Complete migrants, such as the osprey, Mississippi kite, Swainson's hawk, broad-winged and rough-legged hawks vacate their breeding grounds entirely for southern winter ranges, and travel distances of over 3,000 km.

Partial migrant populations exhibit a variety of dispersion patterns. Sharp-shinned hawks, for example, follow a type I or "chain" migration pattern, with later-breeding populations migrating from northern Canada and Alaska to the southwestern United States and earlier breeding populations migrating from the northern U.S. into Mexico. Peregrine falcons exhibit a "leap frog" pattern, with northern tundra birds migrating over southern breeders to winter farthest south in South America. Still other species, such as prairie falcons, follow a loop pattern, moving east over the Rockies in late summer before migrating south in the fall and early winter.

Some species are short-distance or “irruptive” migrants, migrating in response to shifts in prey populations (or to severity of winter conditions). In the mountainous West, migration may consist of a shift in altitude more than distance covered north-south. In some species, the mature adults are sedentary while younger birds migrate.

Another dichotomy in raptor migration concerns reliance on powered flight vs. soaring flight. A relatively small number of species (peregrine falcons, merlins, ospreys, northern harriers) travel primarily by powered flight, and therefore need not rely on thermal updrafts as most species do. Raptors that utilize soaring behavior to save energy during migration rely on updrafts, either “surfing” along ridges or circling upward on thermal updrafts and then gliding downward in the direction of migration.

Some species are “broad-front” migrators (e.g., peregrines, which are power flyers), whereas other species (e.g., Swainson’s hawk) – although not normally exhibiting “gregarious” behavior – become highly concentrated during relatively brief migration periods. The magnitude of migration at selected watch sites shows that western sites tend to be more dispersed, while eastern sites have higher numbers and are more highly concentrated, in some places (such as the Gulf coast) even reaching concentrations of hundreds of thousands.

Geographic migration patterns

The continental geography of North America focuses raptor migration along the long north-south mountain ranges (in the west, this is a habitat issue, for birds that prefer forest cover to open desert); along coastlines and major lakeshores; and along major river corridors and major peninsulas. Specific geographic features that serve to concentrate migrants include the following.

- The “Great Salt Lake Barrier” effect. A combination of mountains to the west and the inhospitable landscape of the Great Salt Lake to the east funnels birds down to the Goshute Mountain ridge.
- Migrants funneling down the San Francisco peninsula make up one of the largest western concentrations. The vast majority of birds concentrating along the west coast are younger birds, poorer navigators ultimately constrained by the ocean barrier. (The same phenomenon occurs on the Atlantic coast.)
- The Great Lakes and Gulf Coast also concentrate birds along densely populated migratory routes.

Tracking methods

Historically, most of our information about migratory patterns has come from banding individual birds and recovering them. Band return data has shown that individual birds are faithful to specific routes, but our understanding of broader patterns have been limited to information from specific locations where birds have been banded and recovered. Radio telemetry has supplemented our understanding of migration patterns by allowing us to see patterns that we had not otherwise picked up because we didn’t have researchers all the places the birds were traveling.

Migration volume

Hawk migration is more highly concentrated in the east and midwest than it is in the west, due in part to differences in habitat and geography, and in part to the dominance of more gregarious species in the eastern U.S. However, the heaviest concentrations of migrants are found in South Texas, Veracruz, and Central America, reflecting the continental-scale funneling of four raptor species (broad-winged hawks, Swainson's hawks, turkey vultures, and Mississippi kites). Both eastern and western hawk migrations are characterized by higher concentrations in the autumn compared to spring, a function of higher winter mortality rates among immature birds, adults bent on more rapid (and dispersed) return in the spring, and wind/weather patterns less conducive to migrant concentration.

Seasonal and diel activity patterns

The primary activity periods are mid-August through mid-November for fall migration, and late February through mid-May for spring migration. Harsher winter climate and habitat conditions in the West contribute to earlier passage in the fall and later passage in the spring, compared with the Midwest and East. There is considerable species-specific variation in the timing and degree of temporal concentration, with species (e.g., kites) that make their fall passage earliest returning later in spring, and species that leave later in the fall (e.g., eagles, rough-legged hawks, and goshawks) returning earlier in the spring.

Unlike songbirds, which tend to migrate at night, hawks and other raptors migrate primarily between mid-morning and late afternoon, peaking at mid-afternoon when solar heating produces mountain updrafts and thermals. A "noon lull" pattern is common where strong thermals are the primary source of lift (e.g., coastal plains), or where soaring migrants have achieved such a high flight altitude that they are above detection limits. Unique local environments or combinations of species and habitat can produce unusual site-specific patterns.

Weather-related migration behavior

In the East and Midwest, most autumn migration activity tends to concentrate after cold fronts, when good solar input, dropping temperatures, rising barometric pressure, and westerly winds create ideal conditions for good thermal production. In the West, by contrast, the highest autumn migration activity precedes cold fronts. Weather following the front is too cold, and light moderate southwesterly or strong westerly to northwesterly winds preceding the front create ideal conditions for strong mountain updrafts. Species such as peregrine falcons, ospreys, northern harriers and bald eagles that rely on powered flight are less affected by weather, while smaller accipiters, red-tailed hawks, and golden eagles readily alter their flight strategy to take advantage of variable lift conditions.

Spatial dynamics and the potential for wind turbine exposure

Observations of migrating raptors at ridgeline sites can be used to estimate the risk to birds of exposure to wind turbines operating on those ridgelines during spring and fall migration periods. For each raptor observed, the predominant flight line is plotted in terms of both altitude (above the ridge) and horizontal distance (from the ridge). Birds flying at relatively low altitudes (e.g., within 50 m, or close enough to be seen with the naked eye) and whose dominant flight lines are directly overhead (within 5 m on either side of the ridge) have a high risk of exposure to ridge-sited wind turbines. Birds flying at high altitudes (e.g., above 300 m) or far out from the ridge have a low risk.

Using this set of metrics, observations of migrating raptors in the Delaware Mountains of Texas indicated that exposure risk is higher in the spring than in the fall. Whereas only 4% of 152 fall migrants were observed flying close (in terms of both lateral and vertical distance) to the ridge, 18% of 282 spring migrants were observed within this range. Of the remaining 82% of spring migrants observed, about half were flying within the “moderate” risk range, and half were at low risk of exposure. By contrast, the vast majority of fall migrants (83%) were observed flying far enough above and/or away from the ridge that they would be considered at low risk of wind turbine exposure.

More often than not, the spatial distribution of birds around a ridge is such that birds are not going to be threatened by wind turbines, because the birds will be too high or too far out from the ridge. *However, during prolonged periods of moderate to strong westerly winds, migrating raptors are more likely to be close in along mountain ridges and coastlines.* These *same conditions* are most productive for wind power generation.

Modeling and research needs

Modeling. Two novel approaches to modeling flight dynamics may be useful for studying the interactions between migrating raptors and wind turbines. Spaar et al. (2000) forecasts flight altitudes and the soaring performance of migrating raptors by the altitudinal profile of atmospheric conditions. This approach has good potential for predictive modeling of flight altitudes and shifting flight strategies in response to changing atmospheric conditions. In the Journal of Raptor Research, Brandes and Ombalski (2004) discuss a fluid-flow analogy for modeling raptor migration pathways. This approach offers the possibility of modeling migratory flight paths at regional scales in relation to shifting winds.

Research needs. Additional landscape-level observational studies are needed to better quantify relative migration volume across the myriad ridgelines of the interior West. Satellite tracking and stable isotope analyses can be used to continue refining our understanding of population affinities of migrants associated with specific concentration points. Where wind energy facilities are developed, we need to study the actual responses of migrating raptors to turbines operating under varying weather and flight conditions, and to monitor the impact on resident raptor populations as well.

Linking Risks Across the Landscape: Developing a Regional Perspective

presented by
Sarah Mabey, North Carolina State University

This presentation is intended to shift the focus from the impact of individual turbines or individual wind power developments to the broader impact on migrating birds as we work towards realizing wind power's full potential. It is important to understand the magnitude of stress that a stressor imposes on migratory bird populations. A stressor that is severe enough or persistent enough may threaten not just an individual bird but an entire population. As we think about reaching the "build out" potential for wind power, we have to figure out how to move forward in the face of the unknown.

Why worry about migrating birds?

The presentations we've seen so far have focused on why migrating birds are more physiologically vulnerable and more concentrated, and why they exhibit different behavior and responses than at other times during their annual cycle. Many factors determine whether a migrating bird survives migration, and also whether it successfully survives and reproduces once it reaches its breeding ground.

The challenge remains how to measure the "significant impact" of migration mortality. First of all, migration mortality is hard to quantify. At present, we have no reliable means of tracking individuals across the annual cycle to empirically determine the probability that a songbird will survive migration. Satellite telemetry, genetic markers, and other recently developed technologies will help us with the important task of linking breeding, migrating, and wintering populations. This may allow us to estimate migration mortality and possibly begin integrating the indirect impacts of migration events into overall survival and reproduction rates.

Population cohesion

We are only beginning to track populations across the annual cycle. For most species it is not known whether breeding populations remain distinct and cohesive as they move from breeding grounds to wintering grounds or whether, for example, they merge with other populations during migration and diverge again (or merge and then revert to their breeding group) during the wintering period. (New techniques with stable isotopes and DNA sampling will help us begin to trace these patterns.)

What factors affect migration mortality?

Migration mortality can be a consequence of events with direct effects (accidents, predation), indirect effects (competition for seasonally scarce food), or both (weather events). It is safe to assume that there is migration mortality in the natural world. We assume that the evolutionary benefits of migration outweigh the risks. However, in a rapidly changing world, at what point do the risks begin to outweigh the benefits? When does migration become too risky, and what change tips it that way? This is an important question, because the consequence of that tipping is a steady decline to the eventual extinction of species.

Human-caused constraints on the cost/benefit ratio of migration include the increasing impermeability of the airspace, and decreasing habitat choices. Unlike the occasional hurricane, anthropogenic changes are non-random; they take place in particular locations for particular reasons. Moreover, these changes are persistent. Consider, for example, that younger birds migrating for the first time tend to concentrate along coastlines, whereas older migrating birds are more dispersed. Coincidentally, human development also concentrates along coastlines. If human coastal development increases the risk of migration, it will have a greater impact on juvenile birds. Young adult birds have a higher reproductive value than older birds (i.e., they have a greater probability of breeding for more years). So, the persistent removal of young birds from a population may have a greater impact on the population growth rates over time.

Likewise, one communications tower in North Carolina hardly seems to matter in terms of the overall risk of migration; even a few towers hardly seem to matter. But consider a map of North Carolina showing the location of communications towers in 1998; already by that year the landscape was dotted with tall towers, and these numbers are increasing exponentially, accelerating the rate of change with which migrating birds must try to cope. And any increased risk associated with those towers will persist as long as the towers remain on the landscape.

The message to take away from this presentation is that we have to think about long-term (persistent) impacts, to think on the large (intercontinental) scale, and to think in terms of regional (not just project-specific) planning. We cannot wait to have “enough” empirical data on migration mortality from tall structures and the ultimate effect of wind development on migrant populations (i.e., “significant impact”). We need to start with what we *do* know, using this information to create models to assess when and where we might hit that cost/benefit tipping point.

Session IV - Questions and Observations

Franz [Bairlein] made a general comment that migrating birds tend to compress on ridgelines. This is inconsistent with some of what I've seen, at least in this country. If I'm a bird flying over a ridge, do I stay at a constant altitude above ground level, or do I compress as I cross the ridge?
Response [F. Bairlein]: It depends on the orientation of the ridge with respect to the migration direction. We need to refine our analysis, for diurnal as well as nocturnal migration. In the instance of birds migrating over the Alps, the mountains run perpendicular to the migration pattern, so birds concentrate (at very low altitudes above ground level) in the Alpine passes – where wind projects are also being developed.

Response [F. Moore]: The more general question might be to what extent do birds concentrate with respect to topographic features (whether ridgelines or riverine corridors).

What additional research is needed to understand what's going on along the eastern US ridgelines?
Response [F. Moore]: It is difficult to generalize from, say, Franconia Notch in New England to ridges farther south in the Alleghenies. Site-specific studies such as the one Franz [Bairlein] described in Morocco are needed to determine what risks a particular development may pose.

Response [J. Smith]: We have done relatively little to quantify what risks are posed by developments on ridgelines in the west. We need to do radar studies, gather more data.

Response [F. Bairlein]: In Europe, we were successful in recommending guidelines for collecting common data so that studies of different sites could be compared.

The observation was made that migrants fly "lower than expected": please discuss.
Response [F. Moore]: What is meant by "expected"? Migrants seek out favorable winds and will concentrate at these altitudes, but there is a lot of variation.

Response [F. Bairlein]: In the past we relied on radar detection that didn't pick up lower levels of migration.

Response [J. Smith]: Or, if we were using visual observation, we might have missed higher levels of migration. Key is to use a multifaceted detection approach to get the full picture.

In general, are there differences in migration altitude between inter- and intracontinental migrants?
Response [F. Moore]: We can't really generalize. It depends on the topography over which the migrant is moving.

Response [P. Kerlinger]: There are taxonomic differences between species with respect to altitude, e.g., songbirds v. raptors.

Response [J. Kelly]: We don't really know how high migrants are flying in the west.

[Frank Moore] showed that the north Gulf coast sometimes has high densities of spring or fall migrants. Given the interest in developing wind energy in the coastal plain of south Texas, what can you tell us about the spring and fall migration of songbirds in the western Gulf?
Response [F. Moore]: Migrants concentrate along coastal Texas and Louisiana during both spring and fall migrations; however, the extent of concentration differs in spring and fall.

Does the sex-related difference in migration timing apply to first-year juvenile birds, or is it established only once birds reach sexual maturity?
Response [S. Mabey]: It's difficult to sex birds when they're young, so it's harder to tell whether first-year juveniles exhibit sex-related passage differences in the fall. It's easier to see that there are sexual passage differences in the spring.

Response [J. Smith]: With raptors we do see sex-related differences in migration timing among younger as well as older birds.

[For J. Smith]: Might your characterization of the spatial distribution of migrating raptors be biased toward an inland perspective? What about coastal migration routes?
Response [J. Smith]: We do have pretty good information about coastal routes. What we see is very constrained behavior along the West Coast, and likewise on the East Coast.

[For Paul Kerlinger]: How does one explain the phenomenon of "bird storms" on fishing boats with sodium lights, if not by light attraction?
Response [P. Kerlinger]: Certain birds are attracted to the sodium lights on fishing boats.

How large are the projects described [by F. Barlein]? How are pre-construction studies funded in Europe and N. Africa? For the Morocco site, how long were studies conducted, and was wind resource potential taken into account in determining "no use" zones?
Response [F. Bairlein]: The (North Sea) offshore plants cover an area of 25,000 square km, with up to eight towers per square kilometer. Studies of the offshore site were financed by the German government, at the level of about $1 million per year.

The Cape Sim (Morocco) project is planned for 90 1-MW towers. In this case, studies were paid for by the investor. Wind resource potential was taken into account in determining the "no use" zones.

[Franz] indicated using both horizontal and vertical radar 24/7 for the entire migration season. How many seasons do you do this? Also, what size (in MW) do you consider "large scale"?
Response [F. Bairlein]: We conduct our research for two seasons, spring and fall, covering the entire season in both cases.

What is the altitude at which migrants will have significant conflict with wind power? (This question directed to Frank and to Franz, not in relation to ridges.)
Response [F. Bairlein]: There are no data on the height at which the turbulence may influence birds. Moreover, small birds may be affected more than larger ones.

[For Franz]: In applying the results of your Wind Farm Sensitivity Index, how do you decide at what point to identify an area as being an "area of concern"? In other words, how do we know when a level of risk is too high to allow siting of turbines?
Response [F. Bairlein]: There is a paper in the *Journal of Applied Ecology* that explains how these risk indices are used.[8]

Franz Barlein's presentation confounded "ridgetop compression" risk to migrants with the situation at Tarifa, Spain. However, migrants were not impacted at Tarifa, relative to local raptors, and radar showed flight heights above turbine heights. Please clarify.
Response [F. Bairlein]: The Tarifa study protocol is still being debated. Previous findings are of limited value.

Can presenters comment on whether risk increases with height of turbines?
Response [P. Kerlinger]: Look at height of migration (Cooper) as compared with tower height.

Response [F. Moore]: Keep in mind that birds are departing and landing at night, not just flying aloft at cruising altitude

Can one use data such as the Veracruz data to estimate total populations? If so, how many broad-wing hawks do **not** pass the big counting spots?
Response [J. Smith]: We don't have a handle on it yet; more radar studies are needed. We count on average 4-5 million birds there (in Veracruz) in the fall, but there may be twice that many that we miss.

Are the tall tower studies in Michigan going to look at bat as well as bird mortality?
Response [P. Kerlinger]: Yes.

[Kerlinger] presented several case studies of migrant fatalities, but did not discuss the methods used to sample for bird fatalities. Were the protocols consistent among case studies? And were these protocols *peer reviewed* by a group of unaffilitated experts?
Response [P. Kerlinger]: The studies presented used variations on basically the same search model. Different search areas and search time periods were used, depending on specific conditions. Most of the studies I referenced had technical advisory committees, or were similar to other study protocols that had been reviewed.

Response [D. Strickland]: The methods and metrics we use [for the studies in question] were independently peer-reviewed by unaffiliated scientists. The specific protocols are always reviewed by agency scientists, and sometimes by stakeholder experts as well.

[8] Garthe, S. and O. Hüppop, 2004. "Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index." Jounal of Applied Ecology 41:724-734.

Earlier this year (2004), the FAA conducted a turbine lighting study in which airplane pilots flew through an existing wind development (in the Texas/Oklahoma area) under various lighting conditions. Have you heard anything from the FAA regarding this effort? If pilots conclude that not all turbines need to be lit, might the FAA lighting advisory circular be amended as a result?
Response [S. Enfield]: Such a study was conducted in response to a meeting we had about five years ago (with FAA technical personnel). In a multiyear FAA/DOE study, the pilot flew around a number of sites, and we tried a number of configurations of lighting at a wind site in Oklahoma. The findings will be used to modify the circular Paul Kerlinger referred to – we should see results by end of year.

Response [P. Kerlinger]: This underscores the value of going to the FAA technicians as opposed to the bureaucrats; the technical people are open to checking this stuff out.

Comment: At some of the western wind projects presented today, horned larks comprise a high percentage (30-40%) of the observed fatalities. If horned lark fatalities are excluded from fatality figures found during migration periods, the figures could be way off.
Response: Studies focused on migrant fatalities would not include resident horned larks in the counts.

Radar data for the only study summarized in the East (Chautauqua, NY) shows a continuously increasing number of migrants between 75 and 200 m. Why, then, is 125 m (400 feet) above ground level considered an important threshold for high collision risk for nocturnal migrants?
Response [P. Kerlinger]: In the communications tower literature, very few fatality events occur at towers below 500 ft., unless there are sodium vapor lights in proximity. The concentration of migrants is much higher above 400-500 ft. than what we find flying below 200 ft. We have to refine this generalization.

Response [B. Cooper]: Migrant numbers do increase geometrically with height up to a certain point.

Is there any indication of a correlation between the direction turbines are pointing and fatalities?
Response[s]: Not that anyone is aware of.

Several presenters have noted variations in the numbers of migrating birds, both season to season and year to year. This suggests that censuses may need to extend over multiple seasons and multiple years to ensure adequate risk assessment. Yet in 2002, WEST, Inc. published a report asserting that a single season's census data might be sufficient to assess risks to birds at a site. How can these viewpoints be reconciled?
Response [F. Moore]: Not only is it important to census over multiple seasons, but one should sample as frequently as possible within a season – daily if possible.

Response [J. Kelly]: There is enormous variation even in very good habitats year to year. Most protocols for migrating birds call for monitoring 95% of the days during the migration period, over multiple years.

Response [S. Mabey]: A researcher would need to provide three years of data to meet academic peer-review standards.

Sarah Mabey's presentation mentions climate change impacts. Within the community of those studying bird population impacts, what is the level of concern about climate change impacts relative to the level of concern raised by the kinds of impacts we've discussed today?

Response [S. Mabey]: Climate change affects migration in ways that are both intuitive and not. There is no single response. Different species in different situations will respond differently to climate change. The population impacts of a compressed breeding season are likely to be quite significant.[9]

Response [F. Bairlein]: Some effects will benefit some species while hurting others. That climate change is occurring we know, but the impacts are complex. There is a recent multi-author publication which may be of interest.[10]

Response [R. Larkin]: You cannot ask a more complex question than about how climate change impacts migration.

Response [J. Kelly]: If what you are trying to get at are the relative impacts on migratory birds of wind development v. climate change resulting from CO_2 emissions from fossil fuel-based energy – that would depend on whether you're substituting one for the other or adding one to the other.

In my opinion, the only advantage that wind power has is its potential to replace fossil fuel consumption. Wind power development's impacts on birds would be much less of a concern if there were a concrete plan to replace fossil fuel consumption rather than the current strategy of augmenting [fossil fuel] energy consumption.

---

9 References:

Ahola, M., T. Laaksonen, K. Sippola, T. Eeva, K. Rainio, and E. Lehikoinen. 2004. Variation in climate warming along the migration route uncouples arrival and breeding dates. Global Change Biology 10:1610-1617.

Both, C., and M. E. Visser. 2001. Adjustment to climate change is constrained by arrival date in a lo ng-distance migrant bird. Nature 411:296-298.

Cotton, P. A. 2003. Avian migration phenology and global climate change. Proceedings of the National Academy of Sciences 100:12219-12222.

Cotton, P. A. 2004. Correction to "Avian migration phenology and global climate change". Proceedings of the National Academy of Sciences 101:5696.

Strode, P. K. 2003. Implications of climate change for North American wood warblers (Parulidae). Global Change Biology 9:1137-1144.

Winkler, D. W., P. O. Dunn, and C. E. McCulloch. 2002. Predicting the effects of climate change on avian life-history traits. Proceedings of the National Academy of Sciences 99:13595-13599.

10 Moller, A.P., P. Berthold, ad W. Fiedler (eds., 2004): Migratory birds and climate change. *Advances in Ecological Research*.

SESSION V:
WHAT TOOLS ARE AVAILABLE?
WHAT DO EACH OF THESE TOOLS OFFER?

Moderator: Ron Larkin, Illinois Natural History Society

- **Application of Radar and Other Tools on Avian Species** *Brian Cooper*
- **Application of Thermal Imaging and Other Tools on Bat Species** *Thomas Kunz*
- **Review of Strengths, Weaknesses and Application of Tools** *Ron Larkin*

Application of Radar and Other Tools on Avian Species

presented by
Brian Cooper, ABR, Inc.[11]

Studying nocturnal migration activity requires both radar and visual study methods. A mobile radar lab can be used in horizontal (surveillance) mode to determine important information such as passage rates, flight paths, and flight direction. For instance, flight direction can be used to determine the importance to migrants of topographical features such as ridges and mountain passes. Radar studies conducted at the West Virginia Mount Storm wind project in fall 2003 were useful in determining that most migrating birds flew across the Allegheny Front rather than funneling along it.

The same radar instrument can be flipped into vertical mode to determine flight altitude. It is necessary to assess flight altitudes as well as passage rates to estimate the number of birds flying within range of the turbine blades. But radar alone cannot give us the information we need to distinguish birds from bats, which may be migrating in large numbers during the same period. Visual observation is required for making this distinction, using a tool such as night vision goggles with an infrared filtered spotlight.

Seasonal Passage Indices

Nocturnal migration is a "pulsed" phenomenon, with major variation in passage rates and flight altitudes from one night to the next, between seasons, and among sites. Some sites have been found to have higher passage rates in spring than in fall, and vice versa. To get

[11] This presentation was co-authored by Brian Cooper, Todd J. Mabee, and Jonathan H. Plissner of ABR, Inc. – Environmental Research & Services.

the best migration information, it therefore is necessary to collect data night after night through a large portion of both migration seasons.

Radar and visual data can be used to calculate a seasonal passage index, where the basic metric is the *passage rate below turbine height*, or targets (migrants) per km per hour. This index could then be multiplied by the number of hours of migration per night, the number of nights per migratory season, and the project area width (in km) to yield a seasonal passage index for the wind resource area. That total may then be divided according to the proportion of birds v. bats. For example, if total passage rate below turbine height equals 162,000 targets for the season, and 80% of those are estimated to be birds, the seasonal bird passage index would be 129,600. Using such a standardized metric from one project area to another would facilitate comparison of bird and bat use at various (actual and proposed) wind sites.

Research Directions

Beyond the need to further develop and apply such standardized radar and visual metrics to facilitate comparison among wind power site studies, further steps include:

- Collecting concurrent radar and fatality data to determine the relationship between numbers of night migrants flying within turbine height and fatality rates
- Behavioral studies using visual techniques to determine how (and to what extent birds and bats detect and avoid turbines)

Application of Thermal Imaging, Acoustics and other Tools on Bat Species

presented by
Tom Kunz, Boston University

We know that bats encounter wind turbines, and that some bats are killed as a result of collision with turbines. What we need to do is to try to understand what's going on when bats encounter wind turbines, and how various characteristics of turbines may affect bat behavior. The first challenge we encounter is how to observe what's going on. Most of the available tools used in bat research have limitations when it comes to studying bat interactions with wind turbines.

Bat detection. Bats use echolocation to detect and capture insects. Echolocation calls have a limited detection range (generally 2-6 m), and this range is even more limited under high humidity conditions. Ultrasonic bat detection and recording devices detect bats by picking up echolocation calls. The range of these devices is limited to within about 30 m. Another limitation of these tools is that they are biased towards detecting higher-intensity echolocating bat species as opposed to "whispering" bats. The best detectors to use are those that pick up the full range of echolocation calls. The German company Avisoft Bioacoustics [http://www.avisoft-saslab.com/] manufactures and distributes high quality ultrasonic microphones and software that make it possible to determine how echolocating bats navigate in 3-dimensional space.

Species identification. We can identify most North American bat species using a combination of bat detection devices that record ultrasounds and mist nets, but to do this effectively we need to deploy these devices high enough, either on meteorological (met) towers or on tethered balloons, to detect bats flying in the vicinity of turbine blades. Capturing bats with mist nets remains an important tool for capturing bats and for species identification when used in combination with ultrasonic detection devices. However, 90% of the studies that have been conducted with mist nets alone have deployed mist nets at ground level (at most two meters high). Most of the bats in forested regions fly at altitudes above 2 m, thus emphasizing the need for researchers to deploy canopy nets

Thermal Imaging

Thermal imaging is a tool that can enable us to "see" what is happening within the range of wind turbine blades. Moreover, unlike radar or radio tracking tools, thermal imaging enables us to distinguish bats from birds, based on body profiles, wing profiles, and wing beat frequencies. Use of thermal imaging cameras does not allow one to distinguish different species of bats.

One cannot just go out in the field with an inexpensive thermal camera to see bats and birds or to distinguish between them. There are a number of issues to consider before selecting and deploying infrared thermal imaging equipment. The first consideration is to identify what monitoring or research questions one is trying to answer. Personnel qualifications (for use of equipment and analysis of data) also need to be considered. Analytical and data storage capacity are also issues; data captured with infrared thermal cameras can require several terabytes of memory in addition to what may be required for data analysis and storage.

Once appropriate questions have been identified, one is ready to consider equipment options. Format size, frame rate, availability of lenses, and power requirements are important characteristics to consider in the purchase or lease of one or more cameras. There are tradeoffs to be made in terms of cost and quality of imaging. Lower-end cameras have a slow frame rate, creating motion smear, and a low frame size can result in low-resolution images. A wider-field lens will not provide the same depth-of-field, as one would obtain with a narrower-field lens.

Another cost/capacity-quality trade-off involves the question of whether to use a single camera or two (or more) synchronized cameras. A single camera can provide data only in two dimensions of a flight trajectory. To obtain sufficient depth-of-field to "see" what is going on in the range of the wind turbine blades, it may be necessary to use more than one camera (stereo-imaging). We are working with computer scientists to develop algorithms (based on stereo-imaging) to model bat trajectories using a single IR camera. However, at this point, our recommendation for investigating how bats/birds collide with turbines is to use two high-end cameras in stereo with different sets of lenses to make recording under different conditions.

Review of Strengths, Weaknesses, and Application of Tools

presented by
Ron Larkin, Illinois Natural History Survey

This talk focuses on research east of the Rockies. I want to emphasize the point that Tom Kunz made in the preceding presentation: it is much harder to observe flying bats and nocturnal birds than it is to observe the behavior of flying animals during the daytime. Keep in mind that all kinds of animals are out there flying around at night: insects, arachnids, birds, bats, etc. The types of tools and techniques that we have at our disposal include radar and radio telemetry, thermal imaging, acoustic imaging, and tools designed to aid or amplify visual observation.

Radar

Large stationary radar. One of the tools that has proved useful for biologists studying birds and other flying animals is NEXRAD. This is a large doppler-type radar, designed for weather research, but also an excellent tool for biological studies. NEXRAD detects the radial motion of flying animals moving towards and away from the radar (example showing directional flight over Illinois map). It can quantify both targets (animals) and their speed. NEXRAD is good for providing a broad-brush picture of movement over an area. (Example given: overview of Chicago showing bird migration activity after sunset.)

There are NEXRAD stations established around the country, although not necessarily within range of every wind energy site or proposed site. Note also, that because of the earth's curvature, there is a limit of about 60 km from NEXRAD location for which that detector cannot detect animals flying at or below turbine height. Another caveat to keep in mind is that a bigger target on radar is not necessarily a larger mass.

Small (mobile) radar. Small radar can pick up wing beat frequencies. It can be used to follow a particular "target" – e.g., a bird (or bat) circling a communications tower. However, as Cooper, Kunz, and others have pointed out, it cannot yet be used to distinguish a bird from a bat.

With radar, as with any tool, the application has to be informed by what we might call the "ground truth" – you have to know what you're looking at/for, as well as how to use the instrument you're using.

Telemetry. Telemetry, or radio tracking, may be the only tool for tracking bat migration patterns. Either stationary or mobile radio tracking devices can be used for this purpose; however, mobile devices are easier to use in flat terrain with a good road grade.

Visual Observation Tools

Spotlights and ceilometers are needed for making spot visual observations of nighttime flying activity. These are inexpensive tools. However, in the eastern US at night, humidity is a very limiting factor in being able to see flying animals. Moreover, shining a light out from the turbine tower will provoke a reaction/response to the light from the animal(s) under observation; therefore it is necessary to use spot lighting from the ground for observation directly overhead. Night vision goggles are another, more expensive, tool to assist with nighttime visual observation.

Acoustic Techniques

Tom Kunz mentioned some of the limitations of using bat detectors to identify bats by their echolocation cries. Migratory bird flight calls can be used to identify night migrants, but the limitation is that there are very few people who can interpret them accurately. Moreover, it is difficult to estimate numbers on the basis of flight calls. We have, for example, acoustical recordings of Dick cissel calls in South Texas and corresponding NEXRAD data – from this we can infer either that there are an awful lot of Dick cissels, or perhaps that these birds are good indicators for other migrating birds.

The other potential use of acoustical devices is not to record bird or bat activity but to try to produce sounds that would help flying animals avoid wind turbines. There is some evidence that birds react to the sound of thunder, but only on cloudy (not clear) nights, however, there is no evidence to substantiate the hypothesis that infrasound devices can be used to scare birds away from towers or other potential obstacles.

Summary of Research Tools

Methodologies useful for some aspect of research on nocturnal flying animals such as bats and night migrating birds are summarized below.

- *Large radar* – depending on wind site location with respect to NEXRAD site – has the advantage of providing cheap data that can be used to identify passage timing, direction, and velocity, but not for determining height or species.
- *Small radar* is a good-to-excellent tool for measuring passage rates, but specialized equipment capable of being used in vertical as well as horizontal mode is required, and complementary methodologies are needed to distinguish birds from bats.
- *Ultrasound microphones* may be helpful in picking up species-specific bat calls, but their range is limited to less than 30 m, and not all bat species will be detected.
- *Infrared thermal imaging* is a powerful technology, capable of discriminating birds v. bats, but the equipment is expensive and requires significant data processing capability.
- *Night vision goggles* are a useful tool for complementing radar with visual observation, but the equipment is rather expensive.
- *Radio tracking* is useful for tracking migration patterns over continental scales, but it is expensive.

Session V - Questions and Observations

<u>Bottom line – can you distinguish between birds and bats using radar?</u>
Response [B. Cooper]: In general, no. We have to depend on visual observation to make that distinction.

<u>Are there regional differences in ability to use long-range radar?</u>
Only a small portion of the country is susceptible to assessment with NEXRAD radars. It is not going to be useful in mountainous areas.

<u>What's the range for the small radar and how close to the ground can birds be detected?</u>
Response [B. Cooper]: The range of the radar unit we typically use is approximately 1,000 m for songbirds. How low above ground level a bird can be detected depends on factors such as the position of the radar and radar fences, but under perfect conditions (i.e., over the water) we have detected a flock of waterfowl as low as a few meters above water level.

<u>Any observations of birds funnelling along ridgelines? Do they cross one ridge to get into valley/flyway in nearby valley or ridgetop?</u>
Response [B. Cooper]: In the few studies I've conducted in areas with linear ridges and can comment on, I have not ever observed a majority of nocturnal migrants funneling along the ridge.

<u>Have you compared passage rate and fatality results from simultaneous studies at same ridge?</u>
Response [B. Cooper]: No, no one has compared nocturnal passage rates with fatalities at the same site at the same time. In fact, there are no studies I am aware of that have even collected concurrent radar and fatality information at any wind farms. This is an important data gap that needs to be addressed.

Clipper Criterion study is on same ridge approximately 20 m north of the Mountaineer site; however, this study hasn't been released. The initial agreement was that our Criterion migration study results would not be released to either the developer or other parties until the wind facility was built. Since then, the developer has agreed to release the data early but the other group has not agreed to change the original agreement. Thus, to date, those data have not been released to anyone. It is a nice data set from an important area, however, and the data would be valuable to help address some of the migration issues that have been raised in this meeting.

<u>Is there any advantage of using a single radar, alternating between horizontal and vertical modes, to using two radars?</u>
Response [B. Cooper]: The advantage of using a single radar is cost and ease of transportation. We used to do simultaneous observations of horizontal and vertical radar, but it is not necessary to sample an entire hour to determine the rate or altitude of birds within that hour. For instance, in a recent study in central New York, over 90% of the variation in 25-minute passage rates was explained by a 5-minute count of passage rate,

while ~96% was explained by a 10-minute count. Nearly 95% of the variation in a 25-minute flight-altitude sampling session was explained by sampling only 15 min. Thus, it is possible to flip between vertical and horizontal radar modes for just a portion of each hour and still get good, representative data.

Response [R. Larkin]: We point the beam at an angle to get a larger sample than you would get if you were relying on strictly vertical or horizontal.

<u>What promise in the bird strike indicator (BSI) in determining the number of bird or bat strikes at wind turbine blades?</u>
Response [L. Spiegel]: Right now the BSI is too big and heavy to mount on a blade.

Comment/Question for All Participants

Facilitator Abby Arnold noted that "there are two big questions that are being raised" at this meeting:

1. How much should be spend on research, and what is the level of cost that a developer should put forth when doing pre-site-selection surveys? What is the business formula that wind industry companies use when figuring out how much they can afford to invest in pre-surveys?

    - Environmentalists, academic researchers are expressing the concern that we aren't paying enough for adequate pre-site selection surveys.
    - Developers are expressing the concern that the cost of doing surveys that would satisfy academic research standards is too high, and that they will be asked or required to put so much capital at risk up-front that it will bankrupt projects.

2. What is the role of peer review? More broadly, what is required for the data and analysis used in these studies to be considered credible by all stakeholders?

The NWCC's Wildlife Work Group will be discussing these issues at the meeting later this week.

SESSION VI – RISK ASSESSMENT

Moderator: William Warren-Hicks, Ecostat

- **Overview** — *William Warren-Hicks*
- **Avian Risk of Collision Model** — *Richard Podolsky*
- **Phase I Avian Risk Assessment for Wind Power Facilities** — *Paul Kerlinger*
- **Design-Based Quantitative Characterization of Risks for Birds at Wind Developments** — *Dale Strickland*
- **Quantitative Risk Assessments for Proposed Projects Based on Bird Abundance and Avoidance** — *Jim Newman*

Introductory Remark [A. Arnold]: I want to acknowledge that federal (USFWS) and state agencies are represented here, as well as advocates and researchers and industry. Several presenters have made a point of reminding us that their research is ongoing and that many of the findings being presented here are still preliminary. Given the preliminary nature of our information, this session focuses on the question of how we manage resources in a situation of uncertainty.

Overview of Risk Assessment

presented by
William Warren-Hicks, EcoStat

The purpose of this session is to help us understand what it means to conduct a "risk assessment."

- What is a risk factor?
- What are the pros/cons of various risk assessment approaches?
- How do these issues apply to assessing risk to birds/bats of wind power?

A simple model of risk (Kaplan and Garrick, 1981) states that it is a function of three things: adverse effect, the probability that the effect occurs, and the consequence of the effect ("so what") In an ecological context, we have the EPA's definition of Ecological Risk Assessment:

> "The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors."

This paradigm typically sets up a More specifically, in our context, this definition could be modified to focus on “the likelihood that adverse effects may occur or are occurring *to individual birds or bats, or populations of birds or bats*, as a result of the ecological stress *caused by wind power generation*.”

Problem Formulation

Note that risk assessment is a process designed to gather information not for its own sake, but for the purpose of making decisions. The question to keep in mind when thinking about conducting and evaluating risk assessments is, *How do we get to a solution at the end of the day?*

Therefore, the first step in conducting a risk assessment is to figure out what it is you care about: what decisions are to be made? Having identified this, the next step is to determine what measurements you can use to measure the effect on what you care about. The metric used to measure effect must effectively represent what it is you care about. A second metric is needed to measure exposure.

Risk Characterization: a Tiered Approach

Agencies use a tiered approach to decision-making. The less data you have, the more conservative (“protectionist”) the assumptions you use in making a decision. Progress towards a decision utilizes a feedback mechanism much like Dale Strickland talked about (adaptive management model). At each tier, the characterization of risk (combining effects and exposure) is evaluated. If there less-than-sufficient certainty to make a decision, more data are required, and the risk assessment progresses to a higher tier, requiring better information and a more refined assessment.

Most of what I’ve heard this group discuss is problem formulation. So far there has been very little discussion of how you characterize the risk, that is, how do you measure and combine effects and exposure to get your “risk characterization.” By “risk characterization” I mean something that would respond to the question, *What is the probability that [the effect we care about] occurs?* In the presentations and discussion so far, we haven’t seen a lot on probabilistic methods. Risk characterization requires us to focus on a smaller number of biological metrics.

Decision-making Curves

A risk-based decision making curve charts risk along the x axis, with the y-axis representing uncertainty, or (in other words), the probability of the adverse effect occurring. Risk is always scaled on a percentage basis (for example, the percentage of population affected). The baseline risk curve can be compared to different curves showing risk reduction (or increase) associated with various measures or development options (each with associated costs).

Levels of Risk Assessment

The first level of risk assessment is the determination of a risk “quotient” – that is, the concentration of exposure divided by concentration of effects. Exposure (e.g., the chance that a bird or bat will encounter a wind turbine) can be defined in terms of an individual bird or bat, or at the level of a flock or population of birds/bats. Effect might be measured in terms of bird/bat mortality, behavior modification, survival/vulnerability, etc.

Levels 2-4 are probabilistic assessments: level 2 characterizes spatial and temporal patterns; level 3 focuses on the species of highest risk; level 4 is still more tightly focused with collection of data on broad scale.

Case studies illustrating the application of various levels of risk assessment are presented by panel-members (below), followed by round-table discussion of the following questions.

- Is a tiered risk framework appropriate for wind turbine construction?
- Given the current state of science, what methods are appropriate for lower- and upper-tiered assessments of risk?
- What biological metrics are appropriate for risk-based decisions?
- What are the advantages and disadvantages of models v. field-based assessments?
- How and why do we analyze uncertainty in conducting bird/bat risk assessments with respect to wind energy development?

References

Kaplan and Garrick, 1981

Application of Risk Assessment Tools: Avian Risk of Collision Model

presented by
Richard Podolsky, Avian Systems

Other presenters have made the distinction of direct v. indirect effects. The direct effect, in most cases, is the result of a bird (or bat) colliding with a rotating turbine blade. Field studies at existing wind farms document avian mortality from collision in the range of 0-4.5 birds per turbine per year. Larger mortality "events" are occasionally observed, and appear to be weather-, site-, or species-dependent. From what has been documented, we can conclude that collision risk is low overall, but quite variable.

I have been working for about a year-and-a-half on developing a probabilistic/kinetic model to assess the risk of avian collision with turbines. By comparing different types of turbines and different types of facilities, I have tried to come up with parameters indicative of factors that make some wind farms more dangerous to birds/bats than others. Although the data are not yet rich enough to plug into the model – we don't know enough about avoidance behavior, in particular – the hope is that this model could be useful in helping us to predict the relative danger of a wind farm during the planning/pre-construction stages, and to design wind farms that minimize collision mortality.

The goals of the Avian Risk of Collision (ARC) modeling project are to:

1. develop an interactive, kinetic model with the ability to simulate bird/bat collisions in wind farms
2. Simulate the risk of collision for any model of turbine and any species of flying organism
3. Use the model to examine the parameters with the greatest impact on collision mortality
4. Reduce collision mortality rates in future wind farms.

Data Inputs

There are three sets of data inputs for the model. The first set of inputs characterize the bird, bat or other flying animal for which risk is being assessed. These include things like air speed, body length, flight elevation, etc. They also include behavioral information concerning the proportion of the population that avoid or are attracted to turbine blades. The latter turn out to be critical inputs – even if the proportion of the population attracted to the turbines is very small, the resulting number of fatalities turn out to be significant – however, we do not yet have real data on avoidance/attraction behavior.

The second set of inputs characterizes the various parts of the wind turbine: rotor blade, nacelle, and tower (pole). The third set of inputs characterizes the design of the wind farm, including numbers of rows and columns, and the distances between them.

Model Output

The output of the ARC model is Collision Risk Probability, calculated as:

Collision Flight Paths / Total Flight Paths

A lot of details go into determining what portion of the rotor swept area should be considered a collision path. (Put simply, the faster the blades are moving, the greater portion of the RSA is "blocked".) The model runs as if the birds cannot see the turbine. At high speeds, nothing can get through the blades; at slower speeds, it is possible to fly through the rotor swept area without collision.

How to account for birds' angle (direction relative to rotor plane) of approach to the wind farm? We decided to run a "worst case" (approach perpendicular to rotor plane) and "best case" (approach parallel to rotor plane). The difference between worst and best case approach angles isn't as high as one might expect; it would be best to just avoid the turbines all together. Based on the model, several observations can be made.

- The hub is most risky part to go, even though the tip is moving faster (best off to fly towards the tip).
- Rotor RPM does not matter (does not make a significant difference in collision probability).
- Bird speed does matter; the faster a bird is flying, the better its chance of survival.
- Larger birds are at greater risk.

Modeling Repowering at Altamont

We used the ARC model to forecast what might be expected if all 5,600 0.1 MW turbines were replaced by (taller) 900 1.8 MW turbines. The model indicates that, for the most common turbine type in operation at Altamont (0.1 MW turbine), birds are at highest risk within the rotor plane. Switching to other (larger, taller) types of turbines reduces the number of fatalities, according to the model. For Red Tail hawks, the model shows a reduction in fatalities from 265 to 25 birds per year. Other specific factors expected to change collision risk with repowering included:

- Collision risk increases with the number of turbine rows, and will decrease with fewer rows of turbines
- Decreasing distance between turbine rows also decreases the risk of collision

In other words, switching to fewer and larger machines, farther apart, means lowering collision risk.

Comment [W. Warren-Hicks]: What this model gives us is a distribution probability:

Risk distribution = overlay probability of collision w/probability of survival

Phase I Avian Risk Assessment for Wind Power Facilities

presented by
Paul Kerlinger, Curry & Kerlinger

A wind farm developer's first step to determine what avian species may be present at a site – including species known (based on our empirical knowledge of what happens at a wind development) to be susceptible to impacts – is a Phase I risk assessment. The Phase I assessment is conducted early in the development process, ideally when the developer is still screening potential sites (at the same time if not before erecting meteorology towers).

Elements of the Phase I risk assessment include:

- contacting relevant state and local agencies to request lists of threatened and endangered species;
- reviewing available data about the site and surrounding areas;
- visiting the site to examine habitat (note that this is not meant to be an inventory, but rather to see what can be observed, and what may need further investigation);
- interviews with local or regional experts; and
- review of the literature on avian impacts at wind and other tall structure sites.

The Phase I risk assessment uses empirical data (what's out there, what risks have been documented, not what people think would happen). Note that the elements listed here do not necessarily cover all the bases with respect to bats, although some of the same steps are applicable to bats as well as birds.

The product of a Phase I risk assessment generally is in the form of a report to the developer and other stakeholders. It provides a description of the site and surrounding habitat areas, including a description of any threatened or endangered species likely to be present, significance of the site as migratory stopover habitat or sensitive nesting habitat. It would also include a review of the literature on wind power impacts and impacts from other structures in the area, and an assessment of the risk to specific taxa or species groups (raptors, nesting waterfowl, night migrants, etc.).

An important element of the Phase I report is a determination of whether available information was sufficient to assess risk. The report should identify information gaps and recommend studies that might be needed if the project is to proceed.

Examples of Phase I Avian Risk Assessments

Two examples serve to illustrate the elements that go into a Phase I risk assessment, and how the assessment findings may be applied to decision-making at this early stage of project development.

Somerset, Pennsylvania. This small site adjacent to the Pennsylvania Turnpike was assessed as a potential site for a 9-MW wind power development, to consist of 6 turbines. The site under consideration was “disturbed” habitat, consisting of agricultural field and small forest patches. Previous uses had included a reclaimed coal strip mine and land fill.

The small number of turbines, combined with the degraded quality of the habitat and the absence of any threatened or endangered species (and low likelihood of any sensitive species), resulted in the conclusion that the proposed development presented minimal risk. No significant information gaps were identified, and the project was allowed to proceed with no further studies recommended.

Flint Hills, Kansas. This was a large grassland site, heavily grazed by cattle. Unlike the Pennsylvania site, this site provided nesting habitat to sensitive grassland birds and was also used by birds exhibiting aerial courtship behavior and other activity within the range of proposed turbine blades. The 66-turbine, 100 MW proposed wind power project posed minimal risk to most birds, but its relatively large footprint nevertheless posed sufficient risk of disturbance/displacement to sensitive species that further studies were recommended. As a result of this Phase I assessment, a prairie grouse expert was hired to conduct further studies, and the project was abandoned.

Other types of outcomes from Phase I assessments may include recommendations for hardware (e.g., no guy wires), or for positioning of turbines within a site. The Phase I assessment is a robust first step, based on empirical findings from other wind plants and other structures with relevant characteristics. It may be the only step needed for determining risk.

Comment [W. Warren-Hicks]: If you’re screening, and you let a project pass your screen, you want to be conservative (in the Kansas example, by recommending further studies).

Design-Based Quantitative Characterization of Risks for Birds for Existing and New Wind Projects

presented by
Dale Strickland, WEST, Inc.

This presentation presents two examples of studies conducted to further investigate potential impacts identified during "Phase I" site assessments at proposed wind plant sites. In both cases, risk was defined as "the magnitude and probability of adverse impacts from a perturbation," (with "perturbation" including both wind project development and operation). Risk was assumed to be a combination of two factors:

1. whether and to what extent (abundance, spatial and temporal distribution) species of interest used the site; and
2. whether and to what extent these animals' behavior at the site (i.e., the *way they used the site*) either increased or decreased their risk, and whether these animals had been shown to be subject to high risk at operating wind plants.

Foote Creek Rim, Wyoming. At this Western flat-topped ridge (mesa), the species of interest were resident and migrating raptors (particularly golden eagles, ferruginous hawks, and Swainson's hawks), resident mountain plovers, and pronghorn antelope that were known to use the rim habitat seasonally.

Estimates of pronghorn use during the months of June, November, and December did not suggest any seasonal concentration of pronghorns on or near the proposed wind plant site, eliminating that concern. Raptors of concern did use the area; however, an analysis of raptor abundance and flight altitudes on the rim, off the rim, and directly above the rim edge enabled researchers to identify where birds activity was concentrated. About 85% of raptor use was determined to be within 50 m of the rim edge, and the company responded by pulling their turbines 50 m back from the rim edge.

Finally, data on mountain plover use of the site before and after the wind plant was installed documented a significant decline in plover use. However, plover use at a reference area suffered a similar decline. Evidence from a regional survey of plovers by the USGS Biological Research Division indicated a regional decline of mountain plovers, suggesting that the decline on the rim could not be attributed to the wind energy plant.

Mount Storm Wind Project, West Virginia. At this site, studies focused on the risk to nocturnal migrating passerines. Reasons for concern were the supposition that migrating birds might be concentrating along the Allegheny Front within the proposed project area, and also that nocturnal migrants would be flying at a low altitude above-ground level along north-south trending mountain ridges in the East.

To study these hypotheses, radar was used to quantify the spatial distribution of nocturnal fall migrants, both over the site and in nearby areas. Five sampling stations were established (three on site, one to the east, and one to the west of the ridge). Data included passage rates as well as flight directions and altitudes.

The findings of the radar studies were that:

- migrating birds showed little response to presence of Allegheny Front;
- 16% of targets were within 125 m of ground level, potentially putting them at risk.

To estimate the potential number of migrating bird fatalities should the wind plant be built, we used fatality rates from the Backbone Mountain wind site (a similar ridge paralleling Mount Storm and ten miles to the west of the site) to represent expected fatalities from proposed Mount Storm site. Combining the exposure estimate (based on radar studies) with what we assumed was a comparable fatality rate (from Backbone Mountain), we estimated approximately 474 nocturnal migrant fatalities could result (0.16% of fall migrants over the entire season) from a 300 MW wind plant with 200 turbines along the Mount Storm ridge.

Spring migration passage rates were measured using radar at three wind sites (Buffalo Ridge in Minnesota, the Nine Canyon site in Washington, and Stateline on the Oregon/Washington border). These passage rates were compared with fatality data gathered at these sites during the same period, yielding collision risk indices for spring migrants ranging from below 0.01% to 0.08%.

Quantitative Risk Assessments for Proposed Wind Turbine Projects: Utilization and Avoidance/Mortality Model

presented by
Jim Newman, Pandion Systems[12]

In the case of a project that has passed the Phase I risk assessment screen, a higher-tiered risk assessment model/methodology may be required to resolve questions about the quantitative risk of the project.

Background

Chatauqua Windpower is a 51 MW project consisting of 34 turbines, proposed to be sited over a three square mile area in western New York State, about two-and-a-half miles south of Lake Erie. The regulatory process required a draft environmental impact statement, including a scoping process that was used to identify the potential problem, or concern – namely, that resident and migratory raptors and land birds occupying (or passing through) the region might be killed if this project were to be built. For this project, a quantification of mortality risks to migrating raptors and land birds was required.

Problem Formulation

We followed the U.S. Environmental Protection Agency (EPA)'s four-step Ecological Risk Assessment framework[13] to characterize the risk of the proposed project and to develop a quantitative model to predict mortality. Step 1 was to formulate the problem as a quantitative question: How many raptors and land birds (both resident and migratory) are likely to collide annually with wind turbines if the project is developed?

Utilization/Avoidance Mortality (UAM) Model

The next steps involved characterizing and quantifying the potential exposure (Step 2) and potential effects (Step 3). Both steps included include measures of uncertainty.

Exposure Characterizaton (Step 2). The exposure characterization step defined an area dubbed the "Project Exposure Area" (PEA) as the width and length of the project footprint by the height and width of the rotor blades of the most external turbines. We then defined bird utilization as the number of birds (i.e. bird abundance) within that PEA over the course of a season. An assumption was made that different birds have different exposures based on their proximity to wind turbines within the PEA and that this is a function of biological and environmental factors. Specifically, individual exposure is also a function of the flight characteristics of different species, changes in daily and seasonal abundance and different weather conditions, such as rain, wind speed and direction that may effect flight

---

[12] This presentation was co-authored by C. Sutter (Pandion Systems), D. Perri (Jasper Energy), and M. Morgante (Ecology & Environment). See www.chautauquawind.ene.com for an updated version of this presentation.

[13] EPA Guidelines for Ecological Risk Assessment: http://cfpup.epa.gov/ncea/raf/recordisplay.cfm?deid+12460

behavior. To account for these factors, seasonal radar and visual studies of both raptors and land birds were used to measure both diurnal and nocturnal utilization of raptors and songbirds. Maximum seasonal utilization values (i.e., species abundances), were used to account for different environmental and biological factors affecting exposure.

Effects Characterization (Step 3). For a bird flying through or within the PEA, it was assumed that there are two possible effects: either the bird avoids the turbines, or the bird collides with a turbine and is killed or injured. Literature on bird collisions with wind turbines and rotor swept physics models of bird flight and turbine rotation, such as Podolsky's ARC model, indicate that the majority of birds passing through a rotating turbine can survive. A bird's ability to avoid wind turbines varies due to differences in species type, flight behavior, weather conditions, etc. For the purposes of our risk assessment model, we developed a metric called "avoidance mortality" (AM), which is a ratio of the number of fatalities to bird abundance in a specified portion of the PEA (includes active or passive avoidance of turbines and/or blades).
Avoidance/mortality ratios (ratios of passage rates to expected fatalities) for various bird groups was developed from rotor swept physics models, behavioral studies of birds' ability to detect and avoid wind turbines, and post-construction mortality studies and passage rates from other operating wind projects.

Risk Characterization. Step 4 involved multiplying the utilization values (U) developed in Step 2 by the avoidance mortality ratios (AM) in Step 3 to characterize the risk of collision. Mortality risks were developed for raptors and songbirds for each season and summed to develop an annual mortality risk. The biological significance of this risk or predicted mortality was expressed by comparing the predicted annual and seasonal mortality for resident and migratory birds to estimates of local and regional raptor and land bird abundance.

Risk Management

One of the final steps in an ecological risk assessment is the use of the characterized risk in decision-making. This is termed ecological risk management. An example of this risk management step is seen in questions asked by the lead agencies for the Chautauqua Project. Having reviewed the Avian Risk Assessment report's predictions of annual mortality for the various species of birds, the lead agencies (from the Chautauqua County towns of Ripley and Westfield) posed several questions to the U.S. Fish & Wildlife Service and to the New York State Department of Environmental Conservation to assist the lead agencies in their decision-making. These questions dealt with methods and interpretation of the results and included the following.

- Are there standard risk assessment methods that should be used in predicting mortality for new projects including standard methods for determining abundance and avoidance mortality?
- What is an appropriate standard for signifying risk?
- Is biological significance an <u>appropriate standard</u> to use when evaluating the significance of potential project-related impacts?

Specific answers to these questions are still pending.

Conclusion

In conclusion, a quantitative ecological risk assessment can be conducted to answer questions on the mortality that may result from a proposed wind turbine project. Reasonable conservatism is in order when predicting mortality risk at the pre-construction stage. EPA's ecological risk assessment framework is a good template for developing such a risk assessment.

For projects in which ecological risk assessments have been conducted, post construction monitoring should be coordinated with both agencies and wildlife groups, for the purposes of evaluating actual changes to avian abundance and behavior and confirming model predictions; and for developing adaptive management strategies, if necessary.

Future research needs to focus on developing information to develop standards and methods for determining abundance and avian use of a WRA or PEA (exposure) and avoidance mortality (effects). Specifically, research studies as well as construction studies using radar and other techniques should simultaneously monitor mortality and abundance to refine and develop avoidance mortality factors for different environmental conditions, and to determine contributing variables to avoidance mortality.

Decision-makers need to come [to the risk assessment process] decided on acceptable methods for measuring risk and acceptable standards of risk for new projects.

Session VI - Questions and Observations

<u>[With respect to Warren-Hicks contention that there hasn't been much discussion of "risk characterization"]: Exposure and effects come together – effects we have an idea of, it's the measure of exposure that we're struggling with.</u>
Response [W. Warren-Hicks]: Actual dynamic of birds being exposed to wind turbines (how often, when) – building an international model is a big expensive problem.

<u>Since we're adding more electricity to the grid, the real risk assessment is not just wind turbine or not a turbine, but wind v. meeting energy demand from other energy resources. The risk of not putting up wind turbines, in other words, is not zero.</u>
Response [W. Warren-Hicks]: I could agree with the last statement, but the "real risk," as you put it – of meeting energy demand from other energy resources other than wind (v. meeting them with wind power) – is too big a problem for anybody to get a handle on. Need a more specific question. Could agree with the last statement, but that's about it.

<u>During the last presentation, the examples given of risk estimates didn't show uncertainty</u>

estimates.
Response [J. Newman]: The exposure data have a fairly high degree of certainty. I used an asterisk to indicate where uncertainty exists; I didn't have a chance to discuss this during the presentation.

Comment [W. Warren-Hicks]: A well-formulated uncertainty analysis is a requirement for a good risk assessment.

Comment [Abby Arnold]: I'm sure we could have more such exchanges at a day-long workshop…

Comment [G. Randell]: Unfortunately, real-world decision-makers don't have the sophistication about risk assessment that our ideal reader would have. We have to do risk assessments and present them clearly so that decision-makers can use them well.

Steve Ugoretz [Wisconsin Department of Natural Resources]
Before trying to make the analogy between chemical and ecological risk assessments, you have to understand the difference between the dose-response model for risk assessment of chemical effects and an open natural system in which birds have choices to make when they're exposed to a wind site.

Response [W. Warren-Hicks]: I understand the grayness you're talking about. There's actually variability in response to chemicals as well, so the analogy is not inapt.

Response [R. Efroymson]: In terms of exposure you could look at the size and distribution of habitat removal as exposure parameters. Methods for extrapolation (from one species to another or one site to another), and estimates of uncertainty are important components of ecological risk assessment. Risk assessment depends on management goals. For example, it is possible to do comparative assessments of risks associated with different energy technologies.

Question addressed to all participants [A. Arnold]: Does any of this discussion of risk assessment help answer the questions participants are facing?

Response [P. Stover-Catha]: It is absolutely important to take all the work everyone's doing and focus it in on decision-making.

Response [R. Larkin]: I would question Bill [Warren-Hicks]' analogy to the chemical industry. In our case, we can almost never tell one "chemical" from another, we don't have any dose-response data, and we don't know what the risks are of *not* doing something. In this case it is environment v. environment, so it is hard to make the analogy with the chemical industry.

Response [E. Lance]: From the regulatory perspective, with respect to making decisions about projects that may affect endangered species, we have 135 days to come up with a risk assessment for a species. We have to deal with risk, and with limited data. We are going to come down on the side of conservation of the species, and anything industry can do to protect endangered species will help.

Response [P. Shoenfeld]: Coming from an advocacy position, with a background in probabilistic analysis, I would point out that we are working in an arena where there are not a lot wind farms, we're moving into new areas. In this situation, we the unexpected is to be expected, and we need depth of study to address that in our decision-making.

Response [S. Ugoretz]: The proof of the pudding is in the eating. From the perspective of a state natural resources agency, we can hope that these methods will prove to be predictive, but we need to look back after getting the post-construction performance data to see how well these tools are serving us.

Response [T. Kunz]: There are variables for which we have no values at this point. It's foolish to build a model with no data. What I would like to see incorporated into our risk assessment is an economic analysis of wind power v other sources of energy upon which we all depend.

Response [D. Anderson]: Over the last half-dozen years, the Wildlife Work Group has been encouraging people to use the same types of (comparable) methods and metrics. The purpose of this is to build a base of comparable data so that we can feel more confident about making decisions.

Response [S. Enfield]: We have made an effort to standardize our study methods and metrics, and I think we do have a fairly good data set and are getting fairly good data from a number of sites around the country. Probably we need to be more rigorous in the east where our experience is low, and where impacts seem to be slightly higher and (so far) we have fewer data.

In terms of what is asked of industry for risk assessment – using what we've learned, results from other sites around the country over the past 10-15 years.

Wrap-up comment [W. Warren-Hicks]: These are typical responses. People don't like the concept of risk. What I like about the risk assessment framework is that it allows people to communicate on the same terms.

SESSION VII – PRACTICAL APPLICATION

Facilitator: Abby Arnold, RESOLVE

Question for Panel Moderators

For this final session, panel moderators from sessions I-VI were asked to respond to the question, ***What has been presented here that we can apply immediately?***

Responses

Frank Moore [Bird Migration, Panel Moderator]

I would emphasize:

- The value of standardized protocols to enable us to make more progress
- A recognition that sampling efforts have to be more intense, regardless of tools used
- The value of collecting specimen information to gain insight into connectivity and population structure to assess risk at that population level – there is a need to scale up from fatality estimates at individual turbines or projects to estimate population-level impacts.
- An understanding of risk in terms of behavior in relation or response to wind farms (like what Franz is doing)
- We need to know more about how the factors built into risk indices interact.

Stan Anderson [Habitat Effects from Tall Structures on Prairie Birds, Panel Moderator]

We have different ideas of what tall structures are. In some landscape settings and for certain species particularly, even things quite low to the ground are significant.

We have heard excellent presentations of individual results, but we need to combine and coordinate results from different studies – to begin to create a composite picture of impacts. Impacts like habitat fragmentation can't be assessed on an individual project basis.

Ed Arnett [For Bat Studies Panel Moderator Merlin Tuttle]

Tom Kunz will be drafting a conceptual framework paper for immediate application of findings from BWEC's first year of field research. Other points I would make:

- Specific study protocols to be followed in future studies will depend on the questions being asked, so we have to be careful how we ask the questions.
- There is a risk of assuming that data gathered to answer a particular set of siting objective questions are correct. We need to keep in mind that ongoing data collection efforts (such as mist netting and bat detector studies) may yield good information, but it may not be the information needed to make good decisions on siting a particular project.

The BWEC web site presents a long list of data needs. We need to coalesce the resources to do the work across different project sites. We don't have any silver bullet deterrence or mitigation measures we can apply immediately. NWCC can continue to support these efforts; it may be useful to have break-out sessions at meetings like this on solution-oriented topics.

Ron Larkin [Availability and Application of Tools, Panel Moderator]
One point that I would take away from this meeting is that the bat problem may be 10 times or more the size of the bird problem. We need to look at this issue on two scales:

- On a regional scale, we need to know where bats are flying in the eastern U.S. We have virtually no information on this. Radio tracking might be used (not easy but can be done) Maybe specialized radar that could distinguish bats from birds.
- On the project-specific level, we need to know more about height bats fly and how they behave around turbines. We cannot rely on radar for this, but stereo infrared imaging might help.

We may want to do some trials with ultrasound microphones at mountain ridges to see what we can pick up.

William Warren-Hicks [Risk Assessment, Panel Moderator]
It might be useful to conduct a full-day workshop to work through the risk assessment framework, taking the time to build consensus among stakeholders. Check out EPA website "ecofram" [http://www.epa.gov/oppefed1/ecorisk/index.htm].

Participant Comments/ Discussion

Wind Developer
As project developers, we have 1-2 year windows to get work done, given the way tax credits and financing works. Longer development times are beyond are investors' timeframes. The issue is not the dollar cost of research, [but the cost] as a percentage of what you spend to plan and build a project. Increasing the outlay of risk capital is problematic. I know people don't like to hear this, but any way that we can compress the timeframe would help. For example, if we can do one year of NEXRAD-type data collection, instead of three years of studies, it would make an enormous difference [in terms of being able to finance project development].

Conservationist
Wouldn't it be most helpful if developers knew what they have to do from the get-go? The research done in Germany is very rigorous compared to what we do, and consequently there is a high degree of confidence in the results. [One of the problems here is that] there will always be an apparent conflict of interest when the developer pays the researcher. Peer review is one solution – maybe the only solution likely to work here in the U.S., if we cannot get the government [i.e., the public] to pay for rigorous studies. I would like to hear

more from Franz about how things are structured in Europe, and see what we can apply here.

State Fish and Wildlife Agency Representative
One of the questions we keep coming back to is: *What is a level of acceptable loss for birds?* If there were a standardized way to present bird loss per kilowatt from wind power so that we could compare that to bird loss per kilowatt from coal power, it might help [to put the question of acceptable loss in perspective].

Environmental Scientist, US Government
Other factors influence population abundance, including things like success in finding a mate and habitat impacts that affect successful nesting, hatching, and fledging. In addition to extrapolating from fatalities to population impacts, we need to factor in how these other (indirect) impacts affect the population. Perhaps we can come up with methods for spatial optimization of turbines.

Conservationist
We all acknowledge the limitations of site-by-site basis for assessing risk to migrating animals. We need to bump up the scale when we talk about risk at multiple sites or a sequence of sites. What might be considered an acceptable risk (in terms of the number of fatalities/turbine/year) at this stage is not necessarily what will be acceptable twenty years from now when we have significantly more turbines.

Facilitator Abby Arnold thanked all for participating and adjourned the meeting.

APPENDIX A: MEETING PARTICIPANTS

Dan Albano
Ecologist
Global Winds Harvest
197 North Street Road
Argyle, NY 12809
Phone: 518/638-6938
E-mail: dalbano@globalwinds.com

Jessica Almy
Wildlife Advocate
Humane Society of the United States
Cape Wildlife Center
185 Meadow Lane
W. Barnstable, MA 02668
Phone: 508/362-0111 x105
Fax: 508/362-0268
E-mail: jalmy@hsus.org

Dick Anderson
Wildlife Biologist
California Energy Commission
1516 Ninth St.
Sacramento, CA 95814
Phone: 916/654-4166
Fax: 916/951-8868
E-mail: danderso@energy.state.ca.us; danderson@cal.net

Stan Anderson
Professor / Leader of the Wyoming Cooperative Fish & Wildlife Research Unit
Department 3166
1000 University Ave.
Laramie, WY 82071
Phone: 307/766-5415
E-mail: anderson@uwyo.edu

Ed Arnett
Bat Conservation International
P.O. Box 162603
Austin, TX 78716
Phone: 512/327-9721
Fax: 512/327-9724
E-mail: earnett@batcon.org

Franz Bairlein
Director
Institute of Avian Research
An der Vogelwarte 21
Wilhelmshaven, Germany D-26386
Phone: [++49] (0) 4421-96890
Fax: [++49] (0) 4421-968955
E-mail: franz.bairlein@ifv.terramare.de

Jessica Barnett
Biologist
U.S. Fish and Wildlife Service
315 South Allen Street, Suite 322
State College, PA 16801
Phone: 814/234-4090
Fax: 814/234-4090
E-mail: jessica_barnett@fws.gov

Kirsten Bohn
Graduate Student
University of Maryland
Department of Biology
College Park, MD 20742
Phone: 301/405-0374
E-mail: kbohn@wam.umd.edu

Dan Boone
Coalition for Responsible Wind Power
8111 Chestnut Avenue
Bowie, MD 20715-4521
Phone: 301/704-5632
E-mail: ddanboone@yahoo.com

Kathy Boydston
Program Coordinator, Wildlife Habitat Assessment
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744
Phone: 512/389-4638
Fax: 512/389-4599
E-mail: Kathy.Boydston@tpwd.state.tx.us

Rene Braud
Principal
FPL Energy
4512 Holly
Bellaire, TX 77401
Phone: 713/449-6129
E-mail: Rene_Braud@fpl.com

Gwen Brewer
Science Program Manager
Maryland Natural Heritage Program- MD DNR
580 Taylor Ave., E-1
Annapolis, MD 21401
Phone: 410/260-8558
Fax: 410/260-8596
E-mail: gbrewer@dnr.state.md.us

Kristen Burke
Project Manager Renewable Energy
Massachusetts Technology Collaborative
75 North Drive
Westborough, MA 01581
Phone: 508/870-0312
Fax: 508/898-2275
E-mail: burke@masstech.org

Thomas Connare
URS Corp
Thomas_connare@urscorp.com

Jack Connelly
Wildlife Research Biologist
Idaho Department of Fish and Game
1345 Barton Road
Pocatello, ID 83221
E-mail: Jcsagegrouse@aol.com

John Connelly
Energy Unlimited, Inc.
100 Four Falls, Suite 215
W. Conshohocken, PA 19428
Phone: 610/940-1994
Fax: 610/940-4422
E-mail: cwhitearg@aol.com

Maricela Constantino
Biologist
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401
Phone: 410/573-4542
Fax: 410/269-0832
E-mail: maricela_constantino@fws.gov

Brian Cooper
Senior Scientist
ABR, Inc. Environmental Research & Services
P.O. Box 249
Forest Grove, OR 97116
Phone: 503/359-7525
Fax: 503/359-8875
E-mail: bcooper@abrinc.com

David Cowan
Vice President, Environmental Affairs
UPC Wind Management
102 Tuttle Road
Cumberland, ME 04021
Phone: 207/829-6055
Fax: 207/829-3785
E-mail: davecowan@upcgroup.org

Tim Cullinan
Director of Bird Conservation
Audubon Washington
421 Washington Harbor Rd.
Sequim, WA 98382
Phone 360/683-6257
E-mail: tcullinan@audubon.org

Deanna Dawson
Wildlife Biologist
USGS Patuxent Wildlife Research Center
12100 Beech Forest Road
Laurel, MD 20708
Phone: 301/497-5642
Fax: 301/497-5826
E-mail: deanna_dawson@usgs.gov

Leonard DeFranciso
Chautauqua County Citizens for Responsible Wind Power;
Ripley Hawk Watch
405 West Everett Street
Falconer, NY 14733
Phone 716/665-4999

Ed DeMeo
President
Renewable Energy Consulting Services, Inc.
2791 Emerson Street
Palo Alto, CA 94306-2313
Phone: 650/327-3090
Fax: 650/327-3090
E-mail: edemeo@earthlink.net

Randy Dettmers
U.S. Fish and Wildlife Service
300 Westgate Center Driv e
Hadley, MA 01035
Phone: 413/253-8567
E-mail: randy_dettmers@fws.gov

Jeff Deyette
Union of Concerned Scientists
Two Brattle Square
Cambridge, MA 02238-9105
Phone: 617/547-5552
E-mail: jdeyette@ucsusa.org

Judy Dunscomb
Director of Conservation Science
The Nature Conservancy
490 Westfield Road
Charlottesville, VA 22901
Phone: 804/295-6106
Fax: 804/979-0370
E-mail: jdunscomb@tnc.org

Andree Duvarney
USDA Natural Resources Conservation Service
1400 Independence Ave. SW, Rm 6151-S
Washington, DC 20250
Phone: 202/720-4925
E-mail: Andree.Duvarney@usda.gov

Rudyard Edick
Project Manager, Land-Based Wind Farms
New York State Dept. of Environmental Conservation
625 Broadway
Albany, NY 12233-1750
Phone: 518/402-9150
Fax: 518/402-9158
E-mail: rgedick@gw.dec.state.ny.us

Rebecca Efroymson
Senior Scientist
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6036
Phone: 865/674-7397
E-mail: efroymsonra@ornl.gov

Sam Enfield
Vice President of Development
Atlantic Renewable Energy Corporation
22170 Dickerson School Road
Dickerson, MD 20842-8926
Phone: 301/407-0424
Fax: 301/349-2393
E-mail: sam.enfield@atlantic-renewable.com

Wally Erickson
Biometrician/Project Manager
Western EcoSystems Technology
2003 Central Ave.
Cheyenne, WY 82001
Phone: 307/634-1756
Fax: 307/637-6981
E-mail: werickson@west-inc.com

Doug Forsell
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401
Phone: 410/573-4542
Fax: 410/269-0832
E-mail: doug_forsell@fws.gov

J. Edward Gates
University of Maryland
Center for Environmental Science
Appalachian Laboratory
301 Braddock Road
Frostburg, MD 21532
Phone: 301/689-7173
E-mail: gates@al.umces.edu

David Golden
Senior Biologist
New Jersey Division of Fish and Wildlife
Endangered and Nongame Species Program
2201 County Route 631
Woodbine, NJ 08270
Phone: 609/628-2103
Fax: 609/628-2734
E-mail: dgolden@gtc3.com

Tom Gray
Deputy Executive Director
American Wind Energy Association
PO Box 1008
175 Kerwin Hill Rd.
Norwich, VT 05055
Phone: 802/649-2112
Fax: 802/649-2113
E-mail: tomgray@igc.org

Thomas Hagner
Ecogen, LLC
E-mail: Thagner@ecogenllc.com

Forest Hammond
Biologist
Vermont Fish & Wildlife Department
100 Mineral Street, Suite 302
Springfield, VT 05156
Phone: 802/885-8832
Fax: 802/885-8832
E-mail: forest.hammond@anr.state.vt.us

Stephanie Harmon
U.S. Fish and Wildlife Service
222 S. Houston, Suite A
Tulsa, OK 74127
Phone: 918/581-7458 x229
E-mail: stephanie_harmon@fws.gov

John Hecklau
Principal
EDR
238 West Division Street
New York, NY 13204
Phone: 315/471-0688
Fax: 315/471-1061
E-mail: jhecklau@edrpc.com

Jennie Henthorn
Environmental Chemist
Bowles Rice McDavid Graff & Love
600 Quarrier Street
Charleston, WV 25301
Phone: 304/347-1162
E-mail: vswain@hotmail.com

Alex Hoar
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
300 Westgate Center Dr.
Hadley, MA 01035
Phone: 413/253-8631
Fax: 413/253-8482
E-mail: alex_hoar@fws.gov

Glen Holcomb
Program Manager
USGS ER BRD
11649 Leetown Rd.
Kearneysville, WV 25430
Phone: 304/724-4526
Fax: 304/724-4505
E-mail: gholcomb@usgs.gov

Jason Horn
Boston University
P.O. Box 2292
Westerly, RI 02891
Phone: 401/588-2766
E-mail: jhorn@bu.edu

Matt Kearns
TetraTech EC, Inc.
133 Federal Street, 6th Floor
Boston, MA 02110
Phone: 617/457-8205
E-mail: MKerns@tteci.com

Jeff Kelly
Oklahoma Biological Survey and Department of Zoology,
University of Oklahoma
111 East Chesapeake Street
Norman, OK 73019
Phone: 405/325-2440
Fax: 405/325-7702
E-mail: jkelly@ou.edu

Paul Kerlinger
Principal
Curry & Kerlinger
P.O. Box 453
Cape May Point, NJ 08212
Phone: 609/884-2842
Fax: 609/884-4569
E-mail: pkerlinger@snip.net

Jessica Kerns
Ph.D. Student
Appalachian Laboratory, University of Marlyand
Center for Environmental Science
Frostburg, MD 21532
Phone: 301/689-7178
E-mail: jkerns@al.umces.edu

Chris Koehler
Geo-Marine
550 E. 15th Street
Plano, TX 75074
Phone: 972/423-5480
E-mail: ckoehler@geo-marine.com

Ted Korth
Director of Policy
New Jersey Audubon Society
80 Scotts Corner Road
Cranbury, NJ 08512
Phone: 609/897-9399
Fax: 609/897-0287
E-mail: ted.korth@njaudubon.org

Karen Kronner
Northwest Wildlife Consultants Services, Inc.
815 NW 4th St
Pendleton, OR 98620
Phone: 541/278-2987
Fax: 541/278-2986
E-mail: kronner@oregontrail.net

Tom Kunz
Director Center for Ecology and Conservation Biology
Boston University
5 Cummington Street
Boston, MA 02215
Phone: 617/353-2474
Fax: 617/353-5383
E-mail: kunz@bu.edu

Ellen Lance
Wildlife Biologist
U.S. Fish and Wildlife Service
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G61
Anchorage, AK 99501
Phone: 907/271-1467
E-mail: ellen_lance@fws.gov

Ron Larkin
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820
Phone: 217/ 333-7513
E-mail: r-larkin@uiuc.edu

Dana Limpert
Ecologist
Maryland Dept. of Natural Resources
Tawes State Office Building, E-1
Annapolis, MD 21401
Phone: 410/260-8556
E-mail: dlimpert@dnr.state.md.us

Jim Lindsay
General Counsel Environmental Services
FPL Energy
700 Universe Bvd
Juno Beach, FL 33408
Phone: 561/691-7032
E-mail: Jim_Lindsay@fpl.com

Andy Linehan
Vice President, Portland Area Manager
CH2M Hill
825 NE Multnomah
Suite 1300
Portland, OR 97232
Phone: 503/235-5022 x4230
E-mail: Andy.linehan@ppmenergy.com

Bernard Lohr
Research Associate
University of Maryland
Department of Psychology
College Park, MD 20742
Phone: 301/405-5940
E-mail: blohr@psyc.umd.edu

Keith Lott
University of Maryland Center for
Environmental Science
301 Braddock Road
Frostburg, MD 21532
Phone: 301/689-5892
E-mail: klott@al.umces.edu

Sarah Mabey
Post-Doctorate
North Carolina State University
Department of Zoology
Raleigh, NC 27695-7617
Phone: 919/513-0506
E-mail: semabey@ncsu.edu

Al Manville
Office of Migratory Bird Management
U.S. Fish and Wildlife Service
4401 N. Fairfax Drive - Suite 634
Arlington, VA 22203
Phone: 703/358-1963
Fax: 703/358-2272
E-mail: Albert_Manville@fws.gov

Beth Mast
Renewable Energy Specialist
NC Solar Center – NC State University
Industrial Extension Service
Campus Box 7401
Raleigh, NC 27695-7401
Phone: 919/515-5689
Fax: 919/515-5778
E-mail: beth_mast@ncsu.edu

Peter Mastic
Noble Power
masticp@noblepower.com

Lucile Miller
Education Committee Chair
Valley Conservation Council
17 Barristers Row
Staunton, VA 24401
Phone: 434/296-1308
E-mail: lucilemiller@mac.com

Laura Miner-Nordstrom
U.S. Department of Energy
1000 Independence Ave., Rm.5H-072
Washington, DC 20585
Phone: 202/586-9940
Fax: 202/586-5124
E-mail:
laura.miner-nordstrom@ee.doe.gov

Bob Misso
USDA Natural Resources Conservation Services
E-mail: Bob.misso@usda.gov

Rob Mitchell
Environmental and Energy Consulting
93 Candlewyck Terrace
Portland, ME 04102
Phone: 207/240-0907
E-mail: rjmjr7@earthlink.net

David Mizrahi
Vice-President for Research
New Jersey Audubon Society
600 Route 47 North
Cape May Court House, NJ 08210
Phone: 609/861-0700
Fax: 609/861-1651
E-mail: david.mizrahi@njaudubon.org

Thomas Mohagen
Environmental Project Manager
Hamer Environmental L.P.
19997 State Route 9
Mount Vernon, WA 98274
Phone: 360/422-6510
E-mail: hamert@aol.com

Frank Moore
Chair of Biological Sciences Department
University of Southern Mississippi
2701 Hardy Street
JST 720 P.O. Box 5018
Hattiesburg, MS 39406
Phone: 601/266-4778
E-mail: frank.moore@usm.edu

Michael Morgante
Avian Specialist
Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, NY 14086
Phone: 716/684-8060
E-mail: mmorgante@ene.com

Jim Mosher
Executive Director
North American Grouse Partnership
P.O. Box 408
Williamsport, MD 21795
Phone: 301/466-7465
Fax: 301/223-1533
E-mail: jim.mosher@grousepartners.org

Charles Newcomb
Program Support Engineer
National Wind Technology Center
901 D Street, NW, Suite 930
Washington, DC 20024-2157
Phone: 202/646-5280
Fax: 202/646-7780
E-mail: Charles_newcomb@nrel.gov

Jim Newman
Principal Scientist
Pandion Systems
5200 NW 43rd Street, Suite 102-314
Gainesville, FL 32606-4482
Phone: 352/372-4747
Fax: 352/372-4714
E-mail: jnewman@pandionsystems.com

Jerome Niessen
NedPower US LLC
5160 Parkstone Drive, Suite 260
Chantilly, VA 20151
Phone: 540/675-3904
Fax: 540/675-3932
E-mail: HNiessen@nedpower.com

Allan O'Connell
Research Wildlife Biologist
USGS Patuxent Wildlife Research Center
PWRC – Beltsville Lab, BARC E308
10300 Baltimore Avenue
Beltsville, MD 20705
Phone: 301/497-5525
E-mail: oconnell@usgs.gov

Bruce Papiech
Sustainable Energy Foundation
1771 Sublette Rd.
Sublette, IL 61367
Phone: 815/849-5135
E-mail: sef@foreverpowerwind.com

Joyce Papiech
Developer
FPC Services, Inc.
1771 Sublette Rd.
Sublette, IL 61367
Phone: 815/849-5135
Fax: 815/849-9055
E-mail: jbpapiech@yahoo.com

Steve Pelletier
Vice President
Woodlot Alternatives, Inc.
30 Park Drive
Topsham, ME 04086
Phone: 207/729-1199
E-mail: spelletier@woodlotalt.com

Frank Pendleton
U.S. Fish and Wildlife Service
West Virginia Field Office
694 Beverly Pike
Elkins, WV 26241
Phone: 304/636-6586
E-mail: frank_pendleton@fws.gov

David Perri
Executive Vice President
Jasper Energy
550 Mamoroneck Avenue
Harrison, NY 10528
Phone: 914/698-5800 x112
Fax: 914/698-0850
E-mail: dperri@jasperenergy.com

Richard Piper
Environmental Manager
FPL Energy
700 Universe Blvd.
Juno Beach, FL 33408-2683
Phone: 561/691-7058
Fax: 561/691-7070
E-mail: rich_piper@fpl.com

Richard Podolsky
President
Avian Systems
P.O. Box 732
31 Main Street
Rockport, ME 04856-0732
Phone: 207/236-6198
E-mail: podolsky@att.net

Elizabeth Pruitt
Manager, Newport News Office
Geo-Marine, Inc.
11846 Rock Landing Drive, Suite C
Newport News, VA 23606
Phone 757/873-8253
Fax: 757/873-3703
E-mail: epruitt@geo-marine.com

Kevin Rackstraw
Eastern Regional Leader
Clipper Wind
6500 Pyle Rd.
Bethesda, MD 20817
Phone: 301/263-0028
Fax: 301/263-0042
E-mail: krackstraw@clipperwind.com

Bonnie Ram
VP Environmental Programs
Energetics
901 D St, SW, Suite 100
Washington, DC 20024
Phone: 202/479-2748 x112
Fax: 202/479-0154
E-mail: bram@energeticsinc.com

Gil Randell
Chautauqua County Citizens for
Responsible Wind Power
P.O. Box 223
Westfield, NY 14787
Phone: 716/326-6825
E-mail: wind@cecomet.net

Rick Reynolds
Virginia DGIF
E-mail: Rick.reynolds@dgif.virginia.gov

Tim Reynolds
TREC, Inc.
4276 E. 300 N.
Rigby, ID 83442
Phone: 208/745-6913
E-mail: trecinc@msn.com

Chandler Robbins
USGS
Patuxent Wildlife Center
Laurel, MD 20708-4000
Phone: 301/497-5641
E-mail: chan_robbins@usgs.gov

Russ Romme
Director Natural Resources Management
BHE Environmental
11733 Chesterdale Rd
Cincinnati, OH 45246
Phone: 513/326-1500
Fax: 513/326-1178
E-mail: rromme@bheenv.com

Corrine Salin
Field Conservation Program Coordinator
Defenders of Wildlife
1130 17th Street, NW
Washington, DC 20036
Phone: 202/772-3200
Fax: 202/463-3074
E-mail: csalin@defenders.org

P.J. Saliterman
Project Manager, Western New York
Zilkha Renewable Energy
41 E. Main Street
Springville, NY 14141
Phone: 716/592-1800
E-mail: pjsaliterman@zilkha.com

Nina Schoch
Wildlife Conservation Society –
Adirondack Cooperative Loon
Program
P.O. Box 195
Ray Brook, NY 12977
Phone: 518/891-8836
E-mail: aclp2@juno.com

Lynn Sharp
Senior Ecologist
TetraTech EC, Inc.
1020 SW Taylor, Suite 530
Portland, OR 97205-2543
Phone: 503/222-4546
Fax: 503/228-8631
E-mail: lsharp@tteci.com

Steve Sheffield
Affiliate Professor
George Mason University
Environmental Science Policy
4400 University Drive
Fairfax, VA 22030
Phone: 301/593-6251
E-mail: srsheffield@att.net

John Sherwell
Maryland Department of Natural Resources
Tawes Building B-3
Annapolis, MD 21401
Phone: 410/260-8667
E-mail: jsherwell@dnr.state.md.us

Peter Shoenfeld
Chair, Wind Energy Committee
West Virginia Highlands Conservancy
713 Chesapeake Avenue
Silver Spring, MD 20910
Phone: 301/587-6197
Fax: 707/371-1163
E-mail: peter@mountain.net

Karin Sinclair
Senior Engineer II
National Renewable Energy Lab – NWTC
1617 Cole Blvd.
Golden, CO 80401
Phone: 303/384-6946
Fax: 303/384-6901
E-mail: Karin_Sinclair@nrel.gov

Jeff Smith
Hawk Watch International
1800 South West Temple, Suite 226
Salt Lake City, UT 84115
Phone: 801/484-6808 x109
Fax: 801/484-6810
E-mail: jsmith@hawkwatch.org

Mark Southerland
Principal Ecologist and NEPA Director
Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045-1934
Phone: 410/740-6074
Fax: 410/964-5156
E-mail: southerlandmar@versar.com

Genevieve Spanjer
4850 Connecticut Ave. NW, Apt. 616
Washington, DC 20008
Phone: 706/271-5343
E-mail: grspanjer@yahoo.com

Linda Spiegel
Conservation Biologist
California Energy Commission
1516 Ninth Street, MS-50
Sacramento, CA 95814
Phone: 916/654-4703
E-mail: lspiegel@energy.state.ca.us

Aura Stauffer
Biologist
Pennsylvania Dept. of Conservation and Natural Resources
Bureau of Forestry
P.O. Box 8552
Harrisburg, PA 17105-8552
Phone: 717/783-0380
Fax: 717/783-5109
E-mail: astauffer@state.pa.us

Kenny Stein
Senior Environmental Specialist
FPL Energy
E-mail: Kenneth_Stein@fpl.com

Craig Stihler
Wildlife Biologist
West VA Division of Natural Resources
P.O. Box 67
Elkins, WV 26241
Phone: 304/637-0245
E-mail: craigstihler@wvdnr.gov

Peggy Stover-Catha
Program Manager
Constellation Generation Group
111 Market Place
Baltimore, MD 21202
Phone: 410/230-4751
E-mail: peggy.stover-catha@constellation.com

Dale Strickland
Vice President and Senior Ecologist
Western EcoSystems Technology
2003 Central Avenue
Cheyenne, WY 82003
Phone: 307/634-1756
Fax: 307/637-6981
E-mail: dstrickland@west-inc.com

Crissy Sutter
Staff Scientist
Pandion Systems
5200 NW 43rd Street, Suite 102-314
Gainesville, FL 32606-4482
Phone: 352/372-4747
Fax: 352/372-4747
E-mail: csutter@pandionsystems.com

Bob Thresher
Director
National Wind Technology Center
1617 Cole Blvd.
Golden, CO 80401
Phone: 303/384-6922
Fax: 303/384-6999
E-mail: robert_thresher@nrel.gov

Cindy Tibbott
Biologist
U.S. Fish and Wildlife Service
315 South Allen Street, Suite 322
State College, PA 16801
Phone: 814/234-4090
Fax: 814/234-4090
E-mail: cindy_tibbott@fws.gov

Eleanor Tillinghast
Green Berkshires, Inc.
P.O. Box 342
Great Barrington, MA 01230
Phone: 413/528-9363
E-mail: etillinghast@greenberkshires.org
www.greenberkshires.org

Greg Turner
Wildlife Biologist
Pennsylvania Game Commission
9760 Hunter Lane
Petersburg, PA 16669
Phone: 814/667-2763
E-mail: grturner@state.pa.us

Merlin Tuttle
President
Bat Conservation International
P.O. Box 162603
Austin, TX 78716
Phone: 512/327-9721
Fax: 512/327-9724
E-mail: mtuttle@batcon.org

Steve Ugoretz
Environmental Analyst and Review Specialist
Wisconsin Dept. of Natural Resources
P.O. Box 7921
101 S. Webster Street
Madison, WI 53707-7921
Phone: 608/266-6673
Fax: 608/267-7559
E-mail: ugores@dnr.state.wi.us

Susanna von Oettingen
U.S. Fish and Wildlife Service
70 Commercial St., Suite 300
Concord, NH 03301
Phone: 603/223-2541
Fax: 603/223-0104
E-mail: Susi_vonOettingen@fws.gov

Wayne Walker
Zilkha Renewable Energy
Suite 1740
Houston, TX 77002
Phone: 713/870-5503
E-mail: wwalker@zilkha.com

William Warren-Hicks
CEO, EcoStat
P.O. Box 425
Mevane, NC 72302
Phone: 919/304-6029
E-mail: billwh@mindspring.com

Mark Watson
NYSERDA
E-mail: Mwl@nyserda.org

Neal Wilkins
Project Manager
Synergics Energy Services, LLC
Synergics Centre
191 Main Street
Annapolis, MD 21401
Phone: 410/268-8820
Fax: 410/269-1530
E-mail: nwilkins@synergics.com

Robert Willis
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
4401 N. Fairfax Drive, Suite 400
Arlington, VA 22203
Phone: 703/358-2183
Fax: 703/358-1869
E-mail: robert_willis@fws.gov

Mark Woythal
New York State Department of
Environmental Conservation
625 Broadway
Albany, NY 12233-4756
Phone: 518/402-8847
Fax: 518/402-8925
E-mail: mswoytha@gw.dec.state.ny.us

Terry Yonker
President
Marine Services Diversified, LLC
139 Jackson Street
Youngstown, NY 14174-1003
Phone: 716/745-9129
E-mail: TerryYonker@cs.com

Frank Young
West Virginia Highlands Conservancy
Rt. 1, Box 108
Ripley, WV 25271
Phone: 304/372-3945
E-mail: fyoung@wvhighlands.org

Andrew Zadnick
Virginia DGIF
Andrew.zadnick@dgif.virginia.gov

RESOLVE Staff

Abby Arnold
Senior Mediator and Vice President
RESOLVE
1255 23rd Street, NW, Suite 275
Washington, DC 20037
Phone: 202/965-6218
Fax: 202/338-1264
E-mail: aarnold@resolv.org

Rachel Permut
Outreach Associate
RESOLVE
1255 23rd Street, NW, Suite 275
Washington, DC 20037
Phone: 202/965-6387
Fax: 202/338-1264
E-mail: rpermut@resolv.org

Miles Keogh
Associate
RESOLVE
1255 23rd Street, NW, Suite 275
Washington, DC 20037
Phone: 202/965-6214
Fax: 202/338-1264
E-mail: mkeogh@resolv.org

Stephanie Nelson
Associate
RESOLVE
1255 23rd Street, NW, Suite 275
Washington, DC 20037
Phone: 202/965-6218
Fax: 202/338-1264
E-mail: snelson@resolv.org

Consultant – Proceedings Editor

Susan Savitts Schwartz
Proceedings Editor
3257 N Mount Curve Ave.
Altadena, CA 91001
Phone: 626/345-0307
E-mail: ssavitts@pacbell.net

APPENDIX B: MEETING AGENDA

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

NATIONAL WIND COORDINATING COMMITTEE

ONSHORE WILDLIFE INTERACTIONS WITH WIND DEVELOPMENTS: RESEARCH MEETING V

November 3-4, 2004
National Conference Center
Lansdowne, VA

Draft Agenda

Purpose:

Provide participants with update on research, studies, methods, and tools to assess wind development bird, bat interactions and habitat impacts on land.

DAY ONE: WEDNESDAY, NOVEMBER 3, 2004

7:30 –8:00 am **Registration**

8:00 – 8:30 **Introductions** ***Abby Arnold, RESOLVE***

- Welcome and introductions
- Review purpose of meeting
- Review agenda
- Review meeting protocols

8:30 – 12:15 **Session I: Studies Conducted or to be Conducted on Bats**
Moderator: **Merlin Tuttle, Bat Conservation International**

- Overview of Current Issues and Research Needs *Merlin Tuttle, BCI*
- Overview of Available Mortality Studies *Greg Johnson, WEST, Inc.*
- Introduction of Bats and Wind Power Cooperative *Ed Arnett, BCI*
- New Protocol for Mortality Monitoring` *Wally Erickson, WEST, Inc.*
- Patterns from Daily Mortality Searches at Meyersdale, PA *Wally Erickson, WEST, Inc.*

- Patterns from Daily Mortality Searches
  Backbone Mountain, WV — *Jessica Kerns, University of Maryland*
- Preliminary Radar Observations of Fall Passage Rates v.
  Daily Mortality Searches at Backbone Mtn., WV — *Brian Cooper, ABR, Inc.*
- Thermal Imaging Observations of
  Bat and Insect Behavior — *Jason Horn, Boston University*
- Wrap up of Current Knowledge and Next Steps — *Merlin Tuttle, BCI*
- Questions and Observations — *Facilitated Discussion*

12:15-1:00 pm ***Lunch***

1:00 – 2:00 **Session II: Update on the Altamont**

Moderator: ***Dick Anderson, California Energy Commission***

- Bird Risk Behaviors and Fatalities at the
  Altamont Pass Wind Resource Area — *Carl Thelander, BioResource Consultant*
- Study Plan for Effectiveness of Potential Management
  Methods to Reduce Bird Risk — *Dale Strickland, West, Inc.*
- Questions and Observations — *Facilitated Discussion*

2:00 – 6:00 pm **Session III: Habitat Effects from Tall Structures on Prairie Birds**

Moderator: Stan Anderson, University of Wyoming

- Setting the stage — *Jack Connelly, Idaho DNR*
- Lessons Learned — *Stan Anderson, University of Wyoming*
- Field Study: Impacts of Wind Sites on Prairie Grouse — *Lynn Sharp, TetraTech*
  Tim Reynolds, Trec, Inc.
- Methods/Metrics for Determining Effects — *Wally Erickson, West, Inc.*
- Questions and Observations — *Facilitated Discussion*

DAY TWO: THURSDAY, NOVEMBER 4, 2004

8:30 – 11:30 **Session IV: Bird Migration**
Moderator: Frank Moore, University of Southern Mississippi

- What Do We Know About Bird Migration — *Frank Moore, University of Southern Mississippi*
- Experience from European Migration Studies — *Franz Bairlein, Institute for Avian Research*
- Western Migration — *Jeff Kelly, Oklahoma Biological Survey*
- Raptor Migration in the East — *Jeff Smith, Hawk Watch International*
- Population Impact Risks — *Sarah Mabey, North Carolina State University*
- Light Attraction — *Paul Kerlinger, Curry and Kerlinger*
- Questions and Observations — *Facilitated Discussion*

11:30-11:45 **Break**

11:45 - 12:30 **Session V: What Tools Are Available, What Do Each of These Tools Offer?**
Moderator: Ron Larkin, Illinois Natural History Society

- Review of Strengths, Weaknesses, and Application of Tools — *Ron Larkin, INHS*
- Case Studies:
  - Application of Radar and other tools on Avian Species — *Brian Cooper, ABR, Inc.*
  - Application of Acoustics and other tools on Bat Species — *Ed Arnett, BCI*
- Questions and Observations — *Facilitated Discussion*

12:30-1:30 ***Lunch***

1:30 – 3:00 **<u>Session VI: Risk Assessment</u>:**
Moderator: William Warren-Hicks, EcoStat

- Overview of Risk Assessment — *William Warren-Hicks, Ecostat*
- Application of Risk Assessment Tools: Case Studies
  - *Richard Podolsky*
  - *Jim Newman, Pandion Systems*
  - *Dale Strickland, WEST, Inc.*
  - *Other, TBD*

3:00 – 3:30 **<u>Session: VII: Practical Application</u>**
Facilitator: Abby Arnold, RESOLVE

- What has been presented here that we can apply immediately?

3:30 – 4:00 **<u>Session VIII: Planning/Next Steps</u>**
Facilitator: Abby Arnold, RESOLVE

Facilitated Discussion among Moderators and Meeting Participants

- Where is more knowledge needed?
- How can it be obtained?
- What are proposed next steps for the Wildlife Work Group to Consider?