

Status of Avian Research at the National Renewable Energy Laboratory

K. Sinclair

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1617 Cole Boulevard
Golden, Colorado 80401-3393

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STATUS OF AVIAN RESEARCH AT THE NATIONAL RENEWABLE ENERGY LABORATORY

Karin C. Sinclair
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401
U.S.A.

ABSTRACT

As the use of wind energy expands across the United States, concerns about the impacts of commercial wind farms on bird and bat populations are frequently raised. Two primary areas of concern are (1) possible litigation resulting from the killing of even one bird if it is protected by the Migratory Bird Treaty Act, the Endangered Species Act, or both; and (2) the effect of avian mortality on bird populations. To properly address these concerns, the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) supports scientifically based avian/wind power interaction research. In this paper I describe NREL's field-based research projects and summarize the status of the research. I also summarize NREL's other research activities, including lab-based vision research to increase the visibility of moving turbine blades and avian acoustic research, as well as our collaborative efforts with the National Wind Coordinating Committee's Avian Subcommittee.

INTRODUCTION

Although energy produced from the wind is generally viewed as environmentally benign, concerns about the impact of the technology on bird and bat populations are frequently raised, especially during the permitting process for commercial wind farms in the United States. Concerns are primarily in two areas: (1) potential litigation over the killing of even one bird if it is protected by the Migratory Bird Treaty Act (MBTA), the Endangered Species Act (ESA), or both, and (2) the effect of avian mortality on bird populations.

The U.S. Fish and Wildlife Service (USFWS) may grant a permit that allows the incidental take of an endangered species under the ESA, but the MBTA prohibits the take of migratory birds, including species listed under the ESA. Through its Division of Law Enforcement, the USFWS has the authority to take action against violators. Wind farms that violate the law without making an effort to significantly reduce the level of avian fatalities are at risk for enforcement action by the USFWS.

As the use of wind power continues to expand, then, understanding the interactions between avian populations and the technology becomes increasingly important.

DOE/NREL AVIAN RESEARCH

The U.S. Department of Energy (DOE) has funded avian research at the National Renewable Energy Laboratory (NREL) since 1994. Before NREL became involved, several studies were conducted in direct response to concerns about bird fatalities during the early years of commercial wind development. Of particular concern were the golden eagle (*Aquila chrysaetos*) carcasses found near wind turbines in the Altamont wind resource area (WRA) in California. In 1994, DOE and NREL helped to organize the first National Avian/Wind Power Planning meeting. The meeting's goal was "to define a research program that addresses wind power-related avian mortality issues" (LGL, Ltd. 1995).

Two previous papers presented at the American Wind Energy Association's (AWEA) WINDPOWER describe the history and approach of the federal government's avian research (Sinclair 1999; Sinclair and Morrison 1997). NREL's approach remains consistent, collaborating with stakeholders, and consulting with experts in fields including wildlife biology, ornithology, statistics and biostatistics, population modeling, epidemiology/mortality, and others as needed. We also seek advice from these experts when designing new research projects on the various issues related to avian research, and ask them to critically review reports submitted to NREL in response to subcontract requirements.

In addition, NREL is involved with the National Wind Coordinating Committee (NWCC), which is a consensus-based collaborative. The objectives of the NWCC are to identify issues that affect the use of wind power, establish dialogue among key stakeholders, and catalyze appropriate activities to support the development of an environmentally, economically, and politically sustainable commercial market for wind power. Members include a wide range of stakeholder groups—utilities, state legislatures, state utility commissions, consumer advocacy offices, wind equipment suppliers and developers, green power marketers, environmental organizations, and state and federal agencies (see <http://www.nationalwind.org/>). In March 1998, the NWCC Siting Subcommittee released a consensus document entitled *Permitting of Wind Energy Facilities, A Handbook*. This document was written for stakeholders who are making permitting decisions about proposed wind projects. Currently, NREL is participating in an NWCC activity to revise and improve this document to make it more useful. Since the document was originally published in March 1998, there have been numerous experiences with permitting wind facilities throughout the United States; the lessons learned will be used to revise the document.

NREL also participates on the NWCC Avian Subcommittee. The subcommittee comprises representatives from a wide range of stakeholders and functions as an advisory group on avian issues. One of the early tasks assigned to this subcommittee was the development of a guidance document for conducting avian research at wind energy sites. A document entitled *Studying Wind Energy/Bird Interactions: A Guidance Document, Metrics and Methods for Determining or Monitoring Potential Impacts on Birds at Existing and Proposed Wind Energy Sites*, was adopted by consensus and published in December 1999. In addition, NREL produced a document entitled *Avian Risk and Fatality Protocol* to help evaluate the potential risk of bird fatalities at small projects using the same general protocol (Morrison 1998). Both these NWCC documents can be accessed through the NWCC Web site at <http://www.nationalwind.org/>.

By using a scientifically based, consistent set of methodologies and metrics, the results of a large number of studies can be normalized. Our understanding of the factors that contribute to adverse avian-wind turbine interactions will be enhanced, enabling us to advance recommendations for resolving the problem.

CALIFORNIA-SPECIFIC AVIAN RESEARCH PROJECTS

Altamont WRA

NREL has been involved in research in the Altamont Pass WRA since the mid-1990s. NREL assumed responsibility for a study initiated by Kenetech (now Green Ridge Services) on the ecology of golden eagles. This project was expanded to include the development of models for predicting the viability of the golden eagle population in the WRA. The results of this 4-year study (1994–1997) suggested that the wind development might be affecting the stability of the golden eagle population in the WRA (Hunt et al. 1995; Hunt et al. 1997; Hunt et al. 1998). Subsequently, the California Energy Commission supplied additional funding for this project. Results of the extended study have not yet been published.

Since early 1998, NREL has supported a study in the Altamont WRA to determine the behavior of birds flying near and perching on turbines; to determine the relationship between flight behavior and perching and bird mortality; to explore factors responsible for bird/turbine interactions and bird deaths; and to develop recommendations for reducing bird/turbine interactions. Although perching was originally thought to be an important risk factor that caused fatalities (i.e., birds flew into blades while attempting to land or take off), the data from this research suggest it is not. Instead, it appears that topographical features, prey base (abundance and distribution of prey such as California ground squirrels and gophers) and gaps of more than 30 meters between some turbines within a string of turbines are factors contributing to avian collisions with wind turbines (Thelander and Rugge 2000).

NREL has published a first-year progress report (Thelander and Rugge 2000), and the 2-year report is expected in the fall of 2001. Because of these findings, we have changed the scope of the project. The research now focuses on developing a robust baseline data set that will then be used to determine the effectiveness of a treatment or treatments designed to reduce bird fatalities at wind turbines, as well as to develop a predictive model. We hope that industry will use the predictive model as a tool when making decisions on siting new turbines within the WRA. Although access to turbines within the WRA has been limited, NREL will continue to work to expand the location of turbines included in this research to develop a more robust baseline data set of bird abundance, behavior, and fatality rates for this predictive model. Once the model is complete, NREL hopes to gain industry support to test the model in the field. A detailed presentation on this research is included in the proceedings of this meeting.

In addition to NREL's avian research in the Altamont WRA, we have commissioned a prey distribution and abundance study. The principal objectives of the research are to determine the relationship between raptor flight behavior and specific characteristics of the topography and weather conditions on a seasonal basis; explore the correlation between prey abundance and raptor activity; and establish the relative contribution of both topographic characteristics and prey abundance in explaining raptor distribution. We expect a report on this work in the fall of 2001.

Tehachapi and San Gorgonio WRAs

Two major studies were conducted in the Tehachapi Pass WRA and the San Gorgonio Pass WRA in California. Preliminary data indicate that this research will offer a significant contrast to the concerns raised in the Altamont WRA. The objectives of these studies, which were co-funded by the California Energy Commission, were to investigate the influence of tower type (tubular versus lattice) and size (small and larger turbines) on bird use, behavior, and mortality. Preliminary results indicate that some birds collide with wind turbines, and that raptors appear to be at a higher risk for collision. However, the number of bird collisions is relatively small, especially when compared to those occurring in the Altamont WRA. A subsequent phase of the research evaluated repowered turbines in the San Gorgonio WRA near the recharge ponds. We expect a final report on this multiple-year study in the fall of 2001.

Vandenberg Air Force Base (AFB)

An avian research project will be conducted at the Vandenberg AFB before wind turbines are installed. The project is designed to result in a preconstruction biological assessment of the proposed wind development, to estimate the potential risks to birds and bats, and to recommend additional on-site studies that may be needed. We expect this project to start in July 2001.

NON-CALIFORNIA AVIAN RESEARCH PROJECTS

National Wind Technology Center, Colorado

NREL is conducting a site-wide environmental assessment (EA), which includes an avian research project, at its National Wind Technology Center (NWTC), located just south of Boulder, Colorado. This project is designed to quantify the current and potential impacts of the NWTC facilities on birds and bats by (1) determining the amount and pattern of bird/bat activity near NWTC facilities; (2) quantifying bird/bat fatalities associated with NWTC facilities; (3) locating off-site concentrations of birds/bats that could be affected by NWTC facilities; and (4) identifying factors that influence the use of the NWTC by birds/bats (e.g., prey availability). The EA should allow us to develop recommendations for minimizing negative bird/bat impacts caused by current and proposed NWTC facilities. We started this project in May 2001, and the fieldwork is scheduled to last for 1 year.

Ponnequin Wind Farm, Colorado

NREL furnished funding to support a reference site study to complement Xcel Energy's (the local investor-owned utility) preconstruction site study at the Ponnequin Wind Farm in Colorado. The study was designed to:

- Document avian use of and relative abundance on reference sites before and during construction
- Document the use of existing power line poles and fence posts on and adjacent to the reference areas
- Record burrowing activities of ground squirrels on the reference sites in tandem with the studies done on the project site before and during all phases of project development
- Record and report avian fatalities on the reference sites during construction and operation of the project
- Include reference sites in raptor nesting surveys
- Document raptor nesting populations in reference sites.

NREL supported this research during 1998, and then Xcel began funding the activity. We have published a report documenting NREL's involvement during 1998 (Kerlinger 2000). At least 23 avian species were identified on all sites, with 16 on the project site. Seven raptor species (northern harrier, Swainson's hawk, rough-legged hawk, ferruginous hawk, golden eagle, American kestrel, and prairie falcon) and nine non-raptor species were discovered. During fatality searches, two songbird carcasses were found, and two other carcasses were found during site visits, although not during the scheduled fatality searches. One was in the study area, the other was not. No raptor carcasses were found during the 1-year study period.

Xcel's consultant on this project formed a Technical Review Committee (TRC), of which NREL is a member. The TRC was expected to meet in the first quarter of 2001, when the consultants were to present and discuss summaries of fatalities for 1999 and 2000. This meeting, however, has not yet occurred.

Searsburg, Vermont

Impacts from three different aspects of avian behavior—night migration of songbirds, daytime migration of hawks, and breeding—were evaluated at Green Mountain Power's wind turbine development in Searsburg, Vermont. The work covered by this project was the first attempt to study the impacts of wind turbines on migrating birds during both pre- and postconstruction periods in eastern North America. During the study period, no avian fatalities were found. NREL has received a draft final report on this work (Kerlinger, draft).

CARES, Washington

A preconstruction study was conducted at the Conservation and Renewable Energy System's (CARES) proposed wind facility site near Goldendale, Washington. The objectives of this research were to record the patterns of WRA use by birds before and after turbine installation, to determine bird fatalities in the WRA and the influence of scavengers on estimates of bird fatalities, and to develop recommendations for reducing bird/turbine interactions. After the completion of 1 year of preconstruction surveys, bird abundance and utilization appeared to be low (Erickson et al. 1999). Few bird fatalities were found, and the avian research project was cancelled pending site development.

Foote Creek Rim WRA, Wyoming

At the Foote Creek Rim WRA in Arlington, Wyoming, researchers have been collecting data to assess avian impacts around turbines with and without ultraviolet (UV) gel coating applied to the blades. This research is designed to determine if applying UV-based gel to turbine blades will reduce bird deaths in a wind farm. Investigators collected data to estimate the spatial and temporal behavior of birds near turbines treated with and without UV reflective gel, to compare number of carcasses between turbines with and without UV reflective gel, and to develop recommendations for reducing bird mortality in wind farms. Approximately two-thirds of the turbines included in the study have UV gel on the blades; the others do not. This research piggybacks avian monitoring work that the developer is conducting concurrently. Fieldwork has been completed on this project; a report analyzing the data is due to NREL later this summer. Early data suggested that turbines with UV had no advantage over non-UV turbines in reducing the mortality of passerines (*National Wind Power Planning IV Proceedings*, in press).

Norris Hill, Montana

NREL supported preconstruction avian research at the Norris Hill WRA in Montana. Because of the volume of nighttime bird activity, we used marine surveillance radars to collect nighttime data. The study refined the use of radar for application to small areas and showed that approximately 75% of the birds present at the site went undetected through visual observation. Bird activity included migratory birds, breeding and local raptors, and breeding and local non-raptor birds. For business reasons, development of the site has been indefinitely postponed. NREL has published several reports on this research (Harmata et al. 2000; Harmata et al. 1999; Harmata et al. 1998).

OTHER PROJECTS

In addition to NWCC activities described above, NREL is providing comments to the Avian Subcommittee on two other documents. The first, *Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Collision Mortality in the United States* (Erickson et al., draft), puts avian collision mortality resulting from wind facility development in the United States into perspective with avian collisions with other sources in the United States.

A second document, *Avian/Wind Turbine Interaction: A Short Summary of Research Results and Remaining Questions* (Gray, draft) is intended to summarize what is and is not known about bird collisions and wind turbines. Both these documents should be published sometime this year.

Motion Smear

NREL recently began a study to learn whether motion smear (the degradation of the visibility of rapidly moving objects) is contributing to the problem of bird collisions with wind turbines. Although there has been much discussion on whether painting blades with a certain type of pattern would help birds to see the blades, potentially reducing bird fatalities, the issue of motion smear of wind turbines had not been studied. The first phase of this project is being conducted in the laboratory using a pattern electroretinogram to determine which blade patterns offer the highest contrast.

Preliminary results from the laboratory look very promising. The investigators have identified antimotion smear patterns that statistically increase the visibility of the moving turbines blades at a given distance. The next phase of this research will be to seek industry partners to test the best (statistically) pattern in the Altamont WRA where there are a large number of turbines and bird fatalities. The solution must prove to significantly reduce fatalities before we will recommend it for large-scale application. A detailed presentation on this research is included in the proceedings of this meeting.

Avian Hearing and Wind Turbines

NREL is working with the University of Maryland's Department of Psychology to evaluate the feasibility of funding research in the area of avian acoustics. The initial approach was to understand what work has already been done in this area. A summary of the basic hearing capabilities of birds has been compiled (Dooling, draft), and it summarizes issues of hearing measurement, the effects of noise on hearing, and the relationship between hearing and the general noise level of turbines. It also includes a table of all known avian audiograms.

SUMMARY

Findings from work completed over the last several years suggest that numerous factors affect avian/wind turbine interactions. Topography, weather, habitat, fragmentation, urban encroachment, habitat loss, species abundance, distribution and behavior, and turbine location are some of the more important factors that may influence bird interactions with wind turbines. The nighttime activity of owls, migratory birds, and bats can also be risky (Thelander 2000, Harmata 1998).

From the studies summarized here, data suggest the most significant U.S. avian/wind turbine interaction problem continues to be isolated in the Altamont Pass Wind Resource Area (WRA). From what has been learned over the last several years, avian issues should not be a concern for future wind farm development because potential problems can be identified and dealt with before micrositing (determining the specific location of the turbines and turbine strings across the WRA) occurs. As wind resources are developed across the country, developers will need to assess potential avian impacts *before* forging ahead with development. If fatalities do occur in the developed WRA, it is important to consider the number of bird fatalities in proportion to the local population size. The absolute number of fatalities may not be as important as the impact on the population. For example, if 10 birds of a particular species are killed, it is important to know if this is out of a local population of 30 or 3,000. The overall impact of 10 birds being killed will be different depending on the size of the local population.

Near-Term Activities

We have seen that a number of parameters play a role in this issue, and one solution will not fit all situations. As NREL continues to work to find solutions to reduce avian fatalities, research will focus on near-term activities, such as:

- Developing a predictive model based on Altamont WRA data. NREL-sponsored research in the Altamont WRA suggests that prey distribution, topographical features, and gaps between turbines correlate with avian fatalities—not tower type or perching as originally thought.
- Field-testing specific strategies to reduce avian impacts with wind turbines. Near-term field tests will likely include testing of painted blades to reduce motion smear.

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