Developing a Research Framework for Increasing Understanding of Interactions between Eagles and Wind Energy

American Wind Wildlife Institute

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The American Wind Wildlife Institute is a partnership of leaders in the wind industry, wildlife management agencies, and science and environmental organizations who collaborate on a shared mission: to facilitate timely and responsible development of wind energy while protecting wildlife and wildlife habitat. We envision a future where wildlife and wind energy thrive, allowing all of us — wildlife and habitat included — to reap the climate change mitigation benefits that wind energy makes possible.

More information about AWWI is available at www.awwi.org.

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Table of Contents

I. Introduction

I.A. Goals and Scope

In this document, we outline a framework for a national, hypothesis-driven research program on eagles and wind energy. The principal goals of this framework are to guide research that improves our ability to predict and estimate take of eagles at wind energy facilities, to develop measures intended to avoid and minimize the take of eagles at operating wind energy facilities, and to compensate for, or offset, remaining eagle take.

The framework is based on an evaluation of the needs of agencies with the legal responsibility for protecting eagles and wind energy developers and operators seeking permits in compliance with the 2009 Eagle Rule and consistent with the Eagle Conservation Plan (ECP) Guidance (Module 1, Version 2) developed by the U.S. Fish and Wildlife Service (Service). Research projects developed during implementation of this program are intended to complement and not duplicate existing research efforts but could include the analysis of existing information.

The research consistent with this framework will be conducted at individual wind energy facilities, but in order to promote meaningful statistical inference and robust conclusions, data collected at individual projects will have to be pooled. Communication and coordination among research projects at individual wind energy facilities will promote the collection of data appropriate for the pooling needed to achieve the goals of this framework.

I.B. Relationship of this Framework to the Eagle Rule and ECP Guidance

In 2009, the Service released the Eagle Rule, which defined the legal framework by which programmatic permits may be obtained to allow for the incidental take of bald and golden eagles by entities otherwise conducting lawful activities. The Service released the ECP Guidance, Module 1, Version 2, in April 2013[1] to describe in detail the process by which wind energy project developers can voluntarily comply with the 2009 Eagle Rule and receive programmatic take permits. The steps of this process include:

1. Collect data on eagle use at the proposed site to accurately predict potential take of eagles by collisions and disturbance.
2. Implement Advanced Conservation Practices (ACPs) that will reduce the predicted take to the maximum extent practicable.
3. Implement compensatory mitigation to numerically offset the remaining eagle take, thus achieving the Eagle Rule standard of no net loss for golden eagles range-wide, and for bald eagles in certain management units.

<u>Adaptive Management as Outlined in the ECP Guidance and its Relationship to this Research Framework</u>
The ECP Guidance recognizes that there is substantial uncertainty regarding the risk of wind energy projects to eagles and the best measures to minimize that risk. The Service's long-term approach for moving forward in the face of this uncertainty is to implement the permitting of eagle take in a formal adaptive management framework.

The Service anticipates four specific sets of adaptive management decisions: (1) adaptive management of wind project siting and design recommendations; (2) adaptive management of wind project operations; (3) adaptive management of compensatory mitigation; and (4) adaptive management of population-level take thresholds.

This research framework will help inform strategies for achieving these adaptive management objectives, particularly objectives 1-3. Improved estimates of eagle take can contribute to refining regional population-level take thresholds established in the context of a regional conservation strategy that sets eagle population targets. This hypothesis-driven research framework also is intended to guide data collection and facilitate learning that can be rapidly incorporated into the application of the ECP Guidance and the permitting process at individual projects.

[1] Version 1 was released in February 2011.

II. Premises of this Framework

There is substantial overlap between (a) the geographic ranges of bald and golden eagles, and (b) operating wind energy projects and potential wind energy development. There also are records of eagle fatalities from both systematic surveys and incidental reports at wind energy projects. The number of eagle fatalities appears to be higher at some facilities and possibly higher at some turbines, and synthesizing available data as well as gathering additional data on eagle take would be useful in better understanding factors that put eagles at risk.

Research conducted under this framework will evaluate whether the collision of an eagle with a turbine blade is solely a function of exposure and is random with respect to other potential covariates or alternatively that there are covariates (e.g., eagle demographics and behavior, topography and other habitat features, turbine attributes) that predict with the desired precision when the probability of take at a specific turbine or wind energy facility is greater than expected by chance alone. Better understanding of the contribution of these covariates, or risk factors, to the probability of eagle take will lead to: 1) improved predictions of eagle take, 2) development of ACPs designed to minimize predicted take, and 3) reduced take that otherwise must be offset.

Most research involving the testing of ACPs will necessarily be tied to statistically robust fatality monitoring. However, some research to evaluate risk factors, such as eagle behavior or how eagles use the landscape, may not necessarily be tied to fatality monitoring. In addition, when a better understanding of risk factors has been established, the use of surrogate indicators of fatality risk related to eagle use or behavior at a project site may also be used to evaluate the effectiveness of ACPs. Evaluation of eagle behavior will need to include consideration of how eagle behavior and site occupancy would change, or has changed, in response to the presence of turbines.

III. Scope and Potential Users of this Framework

This framework is not intended to address all questions relevant to a comprehensive implementation of the 2009 Eagle Rule and ECP Guidance in relation to wind energy siting and operation. For example, this framework does not seek to address, nor is it intended to duplicate, research into:

1. Population status of bald and golden eagles, including resident, migrant, and wintering eagle distribution and abundance
2. Evaluation of trends in eagle population numbers relevant to establishing take thresholds in eagle management units
3. Determining the total number of eagles killed at wind energy facilities nationwide and the relative importance of this mortality source to eagle populations

An estimate of total mortality attributed to wind energy would improve understanding of the impacts of wind energy development on eagles. This estimation, however, should be conducted in the overall context of improving estimates of all known anthropogenic sources of eagle mortality, which extends beyond the scope of this research framework. The Service, with others, is conducting a large telemetry study to help provide relatively unbiased, quantitative estimates of the contributions of different anthropogenic factors to golden eagle mortality.

Potential users of this framework include:

1. State and federal agencies responsible for permitting wind energy facilities
2. Companies in the wind industry seeking programmatic take permits under the Eagle Rule and in accordance with the ECP Guidance
3. Conservation organizations and research scientists interested in understanding the impacts of wind energy development on eagles and improving efforts to conserve eagles
4. Private and public funders of scientific research interested in promoting wind energy development that minimizes impacts to eagles and other wildlife

IV. Research Objectives

Research conducted under this framework will collect data to evaluate whether the collision of an eagle with a turbine blade is solely a function of exposure and is random with respect to other potential covariates, or alternatively, that there are covariates (e.g., eagle demographics and behavior, topography and other habitat features, turbine attributes) that can predict with desired precision when the probability of take at a specific turbine or wind energy facility is greater than expected by chance alone.

The research objectives outlined in this framework are intended to improve the ability to complete the following steps in the development of ECPs consistent with the Service's ECP Guidance (Module 1, Version 2). These steps are:

1. Gather information necessary for predicting annual take of eagles at the proposed facility.

   As the ECP Guidance describes, "the relationships between eagle abundance, fatalities, and their interactions with factors influencing collision probability are still poorly understood and appear to vary widely depending on multiple site-specific factors" (From ECP Guidance, Module 1, Version 2, Appendix G).

2. Implement ACPs that will avoid and minimize predicted take to the maximum extent practicable.

   As the ECP Guidance describes, "the process of developing ACPs for wind energy facilities has been hampered by the lack of standardized scientific study of potential ACPs. The Service has determined that the best way to obtain the needed scientific information is to work with industry to develop ACPs for wind projects as part of an adaptive-management regime and comprehensive research program tied to the programmatic-take permit process…… ACPs will be implemented at operating wind facilities with an eagle take permit on an "experimental" basis …….The experimental ACPs would be scientifically evaluated for their effectiveness…and, based on the results of these studies, could be modified in an adaptive management regime…" (From the ECP Guidance, Module 1, Version 2).

3. Implement scientifically credible and verifiable management actions that will numerically offset remaining and unavoidable eagle take to a level that falls below the allowable species-specific threshold (e.g., no net loss for golden eagles and <5% of the estimated annual production of a regional management unit for bald eagles).

   Although a variety of potential options for offsetting eagle take have been identified, with the exception of retrofitting electric power poles, the effect of these options on eagle survival or productivity has not been sufficiently established. Multiple initiatives are in progress to develop additional options for compensatory mitigation; research consistent with this framework should integrate with and expand these efforts.

V. Research Questions/Hypotheses and Recommendations on Study Designs and Project Characteristics

V.A. General Recommendations on Study Design

1. Wind energy facilities where estimated eagle take is high would be the best sites for evaluating potential risk factors and testing the effectiveness of ACPs.
2. Research evaluating risk factors could and should include facilities where recorded or expected eagle take is low so that such sites can be evaluated in conjunction with projects that have high take.
3. The design for a specific research project will depend on the questions being addressed, e.g., whether risk factors are evaluated or ACPs tested. However, data on the same variables and covariates should be collected consistently at each research project and at the finest temporal and spatial scales possible to facilitate pooling and “scaling-up” of data across projects.
4. For most questions, the turbine will be the sample unit of interest, but there will be questions, such as those relating to eagle activity and eagle use of the landscape, where turbine strings or plots independent of turbine location would be the appropriate sample unit.

A discussion of probability theory is beyond the scope of this framework, but any project design should explicitly describe any assumptions about the statistical distribution of fatality estimates, the mean of that distribution, and the anticipated precision of those estimates. Even with relatively large estimated or predicted average take (e.g., 3-4 eagles per year), less than average take could be recorded during a typical research time frame (e.g., 2-3 years). This is one reason why pooling data across projects is essential to providing meaningful statistical inferences and robust conclusions.

V.B. Improving Estimation and Prediction of Eagle Take

Better estimates and predictions of eagle take will come from an improved understanding of the factors that put eagles at risk. Take occurs when eagles collide with wind turbines or when eagles are disturbed during construction and operation of the wind energy facility, resulting in nest abandonment or displacement from breeding territories, communal roost sites, winter concentration areas, migration corridors, and/or other important foraging areas. The discussion below focuses primarily on collision fatalities, but because disturbance to eagles is also a form of take, we encourage research to evaluate potential sources of disturbance and how these sources of take could be minimized.

It is certain that we don’t have all of the data regarding eagle take at wind energy facilities, but evaluating existing take estimates and developing accurate estimates of eagle take at wind energy facilities is an important step in developing accurate models to predict take and in testing avoidance and minimization measures to reduce predicted take. We suggest two approaches for developing improved estimation and prediction of take:

1. Evaluation of all existing data on eagle take to determine the extent to which the data are suitable for developing estimates of eagle fatality rates; to identify the sources of variation in those rates among projects, turbines, seasons, and/or years; and to evaluate potential factors leading to higher risk. These evaluations may be tested further by additional fatality monitoring.
2. Enhanced fatality monitoring (described below) and the concurrent collection of data on relevant covariates to enable the investigation into potential factors leading to higher risk of eagle take.

Enhanced fatality monitoring tailored to eagles refers to monitoring that will increase the likelihood of recording a fatality when it occurs. The details of such monitoring will depend on the covariates or specific questions of interest, but we recognize that in many cases there will be a cost tradeoff between more frequent searches and more spatially comprehensive coverage. Available evidence suggests eagle carcasses usually persist,[2] increasing the probability of detection; this suggests that increasing spatial coverage (i.e., increasing plot size and the number of turbines searched) generally would be more effective in improving take estimates than conducting more frequent searches. However, for evaluating some risk factors such as weather or eagle condition, more frequent, or at least temporally targeted, searches may be warranted. Evaluating the efficacy of different fatality survey designs for addressing different research objectives is encouraged.

If research objectives warrant a higher degree of certainty about the timing or location of fatalities than is practically feasible with searches, alternative approaches for documenting fatalities could be explored, such as automated photographic surveillance at turbines or blade-borne sensor technology, which is currently being investigated for detecting offshore blade strikes.

The ECP Guidance outlines an approach for estimating eagle fatalities at a proposed wind energy facility using exposure data based on eagle use and rotor swept area at the scale of the proposed wind energy facility. Improving take prediction as described in this framework is based on the evaluation of the hypothesis that the probability of an eagle fatality at a wind energy facility, or at a particular turbine, is solely a function of exposure and is random with respect to eagle behavior and demographics, and turbine attributes. Research under this framework will simultaneously evaluate hypotheses that the probability of take is significantly associated with covariates related to eagle behavior and demographics and turbine attributes, including turbine location and operation.

The categories of covariates, or risk factors, to be measured will depend on the question(s) being addressed. Potential covariates include:

[2] For example, see Orloff, S., and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas: 1989-1991. Report to California Energy Commission, Sacramento, California.

- Turbine location including topographical position, location relative to prevailing wind patterns, proximity to nests and communal roosts, and proximity to areas of high food abundance
- Environmental features such as season or day of year, topographic roughness and diversity, meteorological features, vegetation, prey availability, and distribution of perching and nesting substrates
- Turbine attributes such as turbine height or type, rotor speed, rotor swept area, and operating status (i.e., factors that generally affect exposure)
- Eagle demographics, ecology, and behavior as they affect collision risk of individual eagles including eagle age, residency status, flight style, interactions with other eagles or birds, experience with human activity and disturbance regimes

The selection of covariates to evaluate at a particular project should be determined following a review of available literature, a preliminary evaluation of any available eagle fatality data from a facility, and an assessment of the site and the local eagle population, including population age structure, topography, wind conditions, availability of live prey and carrion, and distribution of nests.

We don't expect that each project will evaluate all of the covariates listed above, but when projects evaluate similar covariates, data should be standardized across projects to promote pooling of individual research projects.

V.C. Developing and Evaluating Advanced Conservation Practices

In the application of the ECP Guidance at a proposed wind energy facility, after the Stage 3 risk assessment, project developers are to apply ACPs to avoid and minimize eagle take consistent with the risk factors identified at the potential project site. As described above, the evaluation of possible ACPs under this framework will occur primarily at operating projects with existing eagle take. As our knowledge of risk factors and possible ACPs improves, further evaluation of proposed ACPs and surrogates of fatality risk can be usefully undertaken at future projects with high predicted take, but where take has not yet been recorded.

The evaluation of experimental ACPs[3] at a particular project will be based on an assessment of the fatality risk factors determined for that project location or projects at similar locations. The following list of potential experimental ACPs that can be evaluated at individual projects is *not in order of priority or effectiveness*, reflecting our current lack of knowledge of possible ACPs. The particular ACPs to be tested will depend on site-specific characteristics, but as we have emphasized previously, there needs to be coordination across projects to achieve robust evaluation of specific ACPs.

[3] The usage of the phrase "experimental ACP" is intended to be consistent with the Service's Eagle Conservation Plan Guidance, Module 1, Version 2, released in April 2013.

Potential Advanced Conservation Practices

1. Turbine micro-siting: This includes turbine setbacks from ridges and steep slopes and avoiding high eagle use areas and flight zones. The decision to test turbine setbacks would be influenced by eagle behavior/use and the orientation of slopes to the prevailing winds.
2. Curtailing operation of specific turbines that appear to represent higher fatality risk during appropriate periods, where turbine covariates are consistent with presumed risk factors: This also could provide results useful for micro-siting at future projects.
3. Operational curtailment linked with the detection of flying eagles in proximity to the turbines: This technique, a modification of number 2, is being implemented at specific projects to avoid collisions of rare and protected species, such as whooping crane or California condor. This ACP may not be practical without simultaneously evaluating hypothesized, risky eagle behavior.
4. Flight diverters: Some projects have begun installing pylons in select locations to determine whether the pylons divert birds from using otherwise popular and risky flight corridors. This ACP could be combined with light, noise, or moving devices to increase effectiveness.
5. Noise or light deterrence: This includes testing technologies intended to startle or otherwise increase awareness and avoidance of collision risk zones, while avoiding habituation from such technologies, as is often seen at airports.
6. Perch management: This includes actions such as limiting perches in risky areas or providing perches to encourage use of less risky areas.
7. Nest management/nesting deterrence: Like prey management described below, this ACP would evaluate whether eagles can be induced to move to less risky areas by modifying outcrops or cliffs, removing trees, or providing or removing suitable nesting substrates.
8. Management of eagle prey, including scavenging opportunities: This ACP would evaluate the hypothesis that we are able to shift eagle foraging activity to less risky areas by simultaneously reducing food resources in the wind energy facility and augmenting food resources away from the facility.

V.D. Developing and Evaluating Options for Compensatory Mitigation

When it is necessary to offset unavoidable, predicted take of eagles at a wind energy facility, a developer must propose actions that either reduce eagle mortality from other anthropogenic sources or increase eagle productivity by a sustained increase in carrying capacity. Productivity increases would need to take into account variable survival rates of different eagle age classes; for example, how many fledged nestlings are lost for every nestling that makes it to adulthood?

AWWI's goal is to develop credible options in addition to power pole retrofitting for offsetting unavoidable eagle take. The following list was developed at AWWI's November 2011 Wind Energy-Eagle Workshop and further refined in subsequent expert-based work:

1. Power-pole retrofitting – currently the only option that provides a credible and quantifiable mortality offset

2. Voluntary lead abatement
3. Vehicle collision reduction
4. Nest-site enhancement leading to increased production of young
5. Prey-habitat enhancement leading to increased eagle carrying capacity

The scientific challenge for utilizing these options, other than power-pole retrofitting, for mitigation is providing a credible prediction of the numerical effects of these mitigation options on eagle survival or productivity, especially when the empirical data needed for making these predictions are not available.

AWWI is conducting a process of expert elicitation to create credible predictive models for offsetting eagle take at wind energy facilities. The first completed model predicts the effects of voluntary lead abatement (by removal of gut piles and substitution of lead ammunition used in hunting) on eagle survival. AWWI is developing additional options to provide project developers with a toolbox of mitigation options, enabling selection of mitigation appropriate to the geographic region of a project.

For example, nest-site enhancement (e.g., improving nest locations, providing shading, or otherwise improving nest sites to increase eagle productivity) would be applicable in specific cases. Enhancement of prey habitat may be limited to areas where vegetation composition and structure will respond to management in the time frame needed to meet the mitigation requirements (e.g., in relatively higher precipitation zones), although certain kinds of enhancement may achieve relatively rapid benefits in other habitats.

Actions that have been considered inappropriate as options for offsetting eagle take include captive breeding and release and funding of rehabilitation centers.

VI. Implementation of Research Framework

As described in the introduction, this framework is intended to guide a national, hypothesis-driven research program on eagles and wind energy that will be conducted at individual wind energy projects. ***We anticipate that research conducted and consistent with this framework will be funded by both public and private sources.*** In many cases, the decision to participate in research suggested by this framework will be voluntary. Coordination of research at individual wind energy facilities is essential, regardless of funding, so that research will address individual site needs as well as provide the information needed to perform the larger scale analyses necessary for improving our ability to avoid and minimize risk to eagles from the siting and operation of wind energy facilities.

Coordination, consistent data collection, and research designs that promote pooling of data across projects would be enhanced by the creation of a Technical Advisory Committee (TAC). The TAC would review research conducted under this framework to ensure that the research is: 1) proceeding according to proposed schedules; 2) collecting information in ways that are useful to eagle permitting decision-makers; and 3) meeting its objectives. The TAC would advise funding sources on the success of projects in achieving the objectives and could be constituted under the Federal Advisory Committee Act.

We recommend that the TAC comprise representatives from industry (including consultants), eagle research scientists and experts in project design, conservation NGOs, and federal and state agencies (USGS, Service, etc.).

We recommend, as appropriate, that data from research conducted under this framework be contributed to a secure database to (a) promote data sharing and storage of metadata for synthesis and (b) provide robust analysis of treatments across multiple projects. Investigators' priority in publishing should be recognized with any contribution to the database. We acknowledge that issues related to permitting may restrict data access and recommend the creation of data management policies that take into account data priority and confidentiality concerns. Policies and procedures developed for AWWI's Research Information System (RIS) provide a model; the RIS could also serve as the data repository.

A Note on Coordination among Research Projects

We have emphasized throughout this framework the need to coordinate research among projects at individual wind energy facilities, in order to facilitate the pooling of data to achieve the goals of this framework. We do not, however, describe in detail how that might be achieved. Several options are available, which are not mutually exclusive. The Sage-Grouse Research Collaborative initiated by the National Wind Coordinating Collaborative and now facilitated by AWWI offers a model for the kind of coordination and data standardization described here.

1. Funders could develop conditions that would require standardization of methods for the collection of relevant data, as well as define consistent standards for project management.
2. Project investigators seeking public funding could organize multiple wind energy facilities under the umbrella of a single research project.