U.S. Fish and Wildlife Service

Eagle Conservation Plan Guidance

Module 1 – Land-based Wind Energy
Version 2

Credit: Brian Millsap/USFWS

U.S. Fish and Wildlife Service
Division of Migratory Bird Management

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EXECUTIVE SUMMARY

1. Overview

Of all America's wildlife, eagles hold perhaps the most revered place in our national history and culture. The United States has long imposed special protections for its bald and golden eagle populations. Now, as the nation seeks to increase its production of domestic energy, wind energy developers and wildlife agencies have recognized a need for specific guidance to help make wind energy facilities compatible with eagle conservation and the laws and regulations that protect eagles.

To meet this need, the U.S. Fish and Wildlife Service (Service) has developed the Eagle Conservation Plan Guidance (ECPG). This document provides specific in-depth guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities. The ECPG guidance supplements the Service's Land-Based Wind Energy Guidelines (WEG). WEG provides a broad overview of wildlife considerations for siting and operating wind energy facilities, but does not address the in-depth guidance needed for the specific legal protections afforded to bald and golden eagles. The ECPG fills this gap.

Like the WEG, the ECPG calls for wind project developers to take a staged approach to siting new projects. Both call for preliminary landscape-level assessments to assess potential wildlife interactions and proceed to site-specific surveys and risk assessments prior to construction. They also call for monitoring project operations and reporting eagle fatalities to the Service and state and tribal wildlife agencies.

Compliance with the ECPG is voluntary, but the Service believes that following the guidance will help project operators in complying with regulatory requirements and avoiding the unintentional "take" of eagles at wind energy facilities, and will also assist the wind energy industry in providing the biological data needed to support permit applications for facilities that may pose a risk to eagles.

2. The Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA) is the primary law protecting eagles. BGEPA prohibits "take" of eagles without a permit (16 USC 668-668c). BGEPA defines "take" to include "pursue, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb," and prohibits take of individuals and their parts, nests, or eggs. The Service expanded this definition by regulation to include the term "destroy" to ensure that "take" includes destruction of eagle nests. The term "disturb" is further defined by regulation as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause,….injury to an eagle, a decrease in productivity, or nest abandonment" (50 CFR 22.3).

3. Risks to Eagles from Wind Energy Facilities

Wind energy development can affect eagles in a variety of ways. First, eagles can be killed by colliding with structures such as wind turbines. This is the primary threat to eagles from wind facilities, and the ECPG guidance is primarily aimed at this threat. Second, disturbance from pre-construction, construction, or operation and maintenance activities might disturb eagles at concentration sites or and result in loss of productivity at nearby nests. Third, serious disturbance or mortality effects could result in the permanent or long term loss of a nesting territory. Additionally, disturbances near important eagle use areas or migration concentration sites might stress eagles so much that they suffer reproductive failure or mortality elsewhere, to a degree that could amount to prohibited take. All of these impacts, unless properly permitted, are violations of BGEPA.

4. Eagle Take Permits

The Service recognizes that wind energy facilities, even those developed and operated with the utmost effort to conserve wildlife, may under some circumstances result in the "take" of eagles under BGEPA. However, in 2009, the Service promulgated new permit rules for eagles that address this issue (50 CFR 22.26 and 22.27).

Under these new rules the Service can issue permits that authorize individual instances of take of bald and golden eagles when the take is associated with, but not the purpose of, an otherwise lawful activity, and cannot practicably be avoided. The regulations also authorize permits for "programmatic" take, which means that instances of "take" may not be isolated, but may recur. The programmatic take permits are the most germane permits for wind energy facilities. However, under these regulations, any ongoing or programmatic take must be unavoidable even after the implementation of advanced conservation practices (ACPs).

The ECPG is written to guide wind-facility projects starting from the earliest conceptual planning phase. For projects already in the development or operational phase, implementation of all stages of the recommended approach in the ECPG may not be applicable or possible. Project developers or operators with operating or soon-to-be operating facilities and who are interested in obtaining a programmatic eagle take permit should contact the Service. The Service will work with project developers or operators to determine if the project might be able to meet the permit requirements in 50 CFR 22.26. The Service may recommend that the developer monitor eagle fatalities and disturbance, adopt reasonable measures to reduce eagle fatalities from historic levels, and implement compensatory mitigation. Sections of the ECPG that address these topics are relevant to both planned and operating wind facilities (Appendices E and F in particular). Operators of wind projects (and other activities) that were in operation prior to 2009 that pose a risk to golden eagles may qualify for programmatic eagle take permits that do not automatically require compensatory mitigation. This is because the requirements for obtaining programmatic take authorization are designed to reduce take from historic, baseline levels, and the preamble to the Eagle Permit Rule specified that unavoidable take remaining after implementation of avoidance and minimization measures at such projects would not be subtracted from regional eagle take thresholds.

5. Voluntary Nature of the ECPG

Wind project operators are not legally required to seek or obtain an eagle take permit. However, the take of an eagle without a permit is a violation of BGEPA, and could result in prosecution. The methods and approaches suggested in the ECPG are not mandatory to obtain an eagle take permit. The Service will accept other approaches that provide the information and data required by the regulations. The ECP can be a stand-alone document, or part of a larger bird and bat strategy as described in the WEG, so long as it adequately meets the regulatory requirements at 50 CFR 22.26 to support a permit decision. However, Service employees who process eagle take permit applications are trained in the methods and approaches covered in the ECPG. Using other methodologies may result in longer application processing times.

6. Eagle Take Thresholds

Eagle take permits may be issued only in compliance with the conservation standards of BGEPA. This means that the take must be compatible with the preservation of each species, defined (in USFWS 2009a) as "consistent with the goal of stable or increasing breeding populations."

To ensure that any authorized "take" of eagles does not exceed this standard, the Service has set regional take thresholds for each species, using methodology contained in the National Environmental Policy Act (NEPA) Final Environmental Assessment (FEA) developed for the new eagle permit rules (USFWS 2009b). The Service looked at regional populations of eagles and set take thresholds for each species (upper limits on the number of eagle mortalities that can be allowed under permit each year in these regional management areas).

The analysis identified take thresholds greater than zero for bald eagles in most regional management areas. However, the Service determined that golden eagle populations might not be able to sustain any additional unmitigated mortality at that time, and set the thresholds for this species at zero for all regional populations. This means that any new authorized "take" of golden eagles must be at least equally offset by compensatory mitigation (specific conservation actions to replace or offset project-induced losses).

The Service also put in place measures to ensure that local eagle populations are not depleted by take that would be otherwise regionally acceptable. The Service specified that take rates must be carefully assessed, both for individual projects and for the cumulative effects of other activities causing take, at the scale of the local-area eagle population (a population within a distance of 43 miles for bald eagles and 140 miles for golden eagles). This distance is based on the median distance to which eagles disperse from the nest where they are hatched to where they settle to breed.

The Service identified take rates of between 1 and 5 percent of the total estimated local-area eagle population as significant, with 5 percent being at the upper end of what might be appropriate under the BGEPA preservation standard, whether offset by compensatory mitigation or not. Appendix F provides a full description of take thresholds and benchmarks, and provides suggested tools for evaluating how these apply to individual projects.

7. An Approach for Developing and Evaluating Eagle ACPs

Permits for eagle take at wind-energy facilities are programmatic in nature as they will authorize recurring take rather than isolated incidences of take. For programmatic take permits, the regulations require that any authorized take must be unavoidable after the implementation of advanced conservation practices (ACPs). ACPs are defined as "scientifically supportable measures that are approved by the Service and represent the best available techniques to reduce eagle disturbance and ongoing mortalities to a level where remaining take is unavoidable" (50 CFR 22.3).

Because the best information currently available indicates there are no conservation measures that have been scientifically shown to reduce eagle disturbance and blade-strike mortality at wind projects, the Service has not currently approved any ACPs for wind energy projects.

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. In this scenario, ACPs will be implemented at operating wind facilities with an eagle take permit on an "experimental" basis (the ACPs are considered experimental because they would not currently meet the definition of an ACP in the eagle permit regulation). The experimental ACPs would be scientifically evaluated for their effectiveness, as described in detail in this document, and based on the results of these studies, could be modified in an adaptive management regime. This approach will provide the needed scientific information for the future establishment of formal ACPs, while enabling wind energy facilities to move forward in the interim.

Despite the current lack of formally approved ACPs, there may be other conservation measures based on the best available scientific information that should be applied as a condition on programmatic eagle take permits for wind-energy facilities. A project developer or operator will be expected to implement any reasonable avoidance and minimization measures that may reduce take of eagles at a project. In addition, the Service and the project developer or operator will identify other site-specific and possibly turbine-specific factors that may pose risks to eagles, and agree on the experimental ACPs to avoid and minimize those risks. Unless the Service determines that there is a reasonable scientific basis to implement the experimental ACPs up front (or it is otherwise advantageous to the developer to do so), we recommend that such measures be deferred until such time as there is eagle take at the facility or the Service determines that the circumstances and evidence surrounding the take or risk of take suggest the experimental ACPs might be warranted. The programmatic eagle take permit would specify the experimental ACPs, if circumstances warrant, and the permit would be conditioned on the project operator's agreement to implement and monitor the experimental ACPs.

Because the ACPs would be experimental, the Service recommends that they be subject to a cost cap that the Service and the project developer or operator would establish as part of the initial agreement before issuance of an eagle permit. This would provide financial certainty as to what maximum costs of such measures might be. The amount of the cap should be proportional to overall risk.

As the results from monitoring experimental ACPs across a number of facilities accumulate and are analyzed, scientific information in support of certain experimental ACPs may accrue, whereas other ACPs may show little value in reducing take. If the Service determines that the available science demonstrates an experimental ACP is effective in reducing eagle take, the Service will formally approve that ACP and require its implementation up front on new projects when and where warranted.

As the ECPG evolves, the Service will not expect project developers or operators to retroactively redo analyses or surveys using the new approaches. The adaptive approach to the ECPG should not deter project developers or operators from using the ECPG immediately.

8. Mitigation Actions to Reduce Effects on Eagle Populations

Where wind energy facilities cannot avoid taking eagles and eagle populations are not healthy enough to sustain additional mortality, applicants must reduce the unavoidable mortality to a no-net-loss standard for the duration of the permitted activity. No-net-loss means that these actions either reduce another ongoing form of mortality to a level equal to or greater than the unavoidable mortality, or lead to an increase in carrying capacity that allows the eagle population to grow by an equal or greater amount. Actions to reduce eagle mortality or increase carrying capacity to this no-net-loss standard are known as "compensatory mitigation" in the ECPG. Examples of compensatory mitigation activities might include retrofitting power lines to reduce eagle electrocutions, removing road-killed animals along roads where vehicles hit and kill scavenging eagles, or increasing prey availability.

The Service and the project developer or operator seeking a programmatic eagle take permit should agree on the number of eagle fatalities to mitigate and what actions will be taken if actual eagle fatalities differ from the predicted number. The compensatory mitigation requirement and trigger for adjustment should be specified in the permit. If the procedures recommended in the ECPG are followed, there should not be a need for additional compensatory mitigation. However, if other, less risk-averse models are used to estimate fatalities, underestimates might be expected and the permit should specify the threshold(s) of take that would trigger additional actions and the specific mitigation activities that might be implemented.

Additional types of mitigation such as preserving habitat – actions that would not by themselves lead to increased numbers of eagles but would assist eagle conservation – may also be advised to offset other detrimental effects of permits on eagles. Compensatory mitigation is further discussed below (Stage 4 – Avoidance and Minimization of Risk and Compensatory Mitigation).

9. Relationship of Eagle Guidelines (ECPG) to the Wind Energy Guidelines (WEG)

The ECPG is intended to be implemented in conjunction with other actions recommended in the WEG that assess impacts to wildlife species and their habitats. The WEG recommends a five-tier process for such assessments, and the ECPG fits within that framework. The ECPG focuses on just eagles to facilitate collection of information that could support an eagle take permit decision. The ECPG uses a five-stage approach like the WEG; the relationship between the ECPG stages and the WEG tiers is shown in Fig. 1.

Tiers 1 and 2 of the WEG (Stage 1 of the ECPG) could provide sufficient evidence to demonstrate that a project poses very low risk to eagles. Provided this assessment is robust, eagles may not warrant further consideration in subsequent WEG tiers, and Stages 2 through 5 of the ECPG and pursuit of an eagle take permit might be unnecessary. A similar conclusion could be reached at the end of Stage 2, 3, or 4. In such cases, if unpermitted eagle take subsequently occurs, the wind project proponent should consult with the U.S. Fish and Wildlife Service to determine how to proceed, possibly by obtaining an eagle take permit.

The following sections describe the general approach envisioned for assessing wind project impacts to eagles (also see the Stage Overview Table at the end of the Executive Summary).

Tiers 1 and 2 of the WEG, Stage 1 of the ECPG

Tier 1 of the WEG is the preliminary site evaluation (landscape-scale screening of possible project sites). Tier 2 is site characterization (broad characterization of one or more potential project sites). These correspond with Stage 1 of the ECPG, the site-assessment stage. As part of the Tiers 1 and 2 process, project developers should carry out Stage 1 of the ECPG and evaluate broad geographic areas to assess the relative importance of various areas to resident breeding and non-breeding eagles, and to migrant and wintering eagles. During Stage 1, the project developer or operator should gather existing information from publicly available literature, databases, and other sources, and use those data to judge the appropriateness of various potential project sites, balancing suitability for development with potential risk to eagles.

To increase the probability of meeting the regulatory requirements for a programmatic take permit, biological advice from the Service and other jurisdictional wildlife agencies should be requested as early as possible in the developer's planning process and should be as inclusive as possible to ensure all issues are being addressed at the same time and in a coordinated manner. Ideally, consultation with the Service, and state and tribal wildlife agencies is done before wind developers make any substantial financial commitment or finalize lease agreements.

Tier 3 of the WEG, Stages 2, 3, and 4 of the ECPG

During Tier 3 of the WEG, a developer conducts field studies to document wildlife use and habitat at the project site and predict project impacts. These site-specific studies are critical to evaluating potential impacts to all wildlife including eagles. The developer and the Service would use the information collected to support an eagle take permit application, should the developer seek a permit. As part of Tier 3, the ECPG recommends project developers or operators implement three stages of assessment:

- Stage 2 - site-specific surveys and assessments;
- Stage 3 - predicting eagle fatalities; and
- Stage 4 - avoidance and minimization of risk and compensatory mitigation.

Stage 2 – Site Specific Surveys and Assessments

During Stage 2 the Service recommends the project developer collect quantitative data through scientifically rigorous surveys designed to assess the potential risk of the proposed project to eagles. The Service recommends collecting information that will allow estimation of the eagle exposure rate (eagle-minutes flying within the project footprint per hour per kilometer^2), as well as surveys sufficient to determine if important eagle use areas or migration concentration sites are within or in close proximity to the project footprint (see Appendix C). In the case of small wind projects (one utility-scale turbine or a few small turbines), the project developer should consider the proximity of eagle nesting and roosting sites to a proposed project and discuss the results of the Stage 1 assessment with the Service to determine if Stage 2 surveys are necessary. In many cases the hazardous area associated with such projects will be small enough that Stage 2 surveys will not be necessary.

Stage 3 – Predicting Eagle Fatalities

In Stage 3, the Service and project developers or operators use data from Stage 2 in models to predict eagle risk expressed as the average number of fatalities per year extrapolated to the tenure of the permit. These models can compare alternative siting, construction, and operational scenarios, a useful feature in constructing hypotheses regarding predicted effects of conservation measures and experimental ACPs. The Service encourages project developers or operators to use the recommended pre-construction survey protocol in this ECPG in Stage 2 to help inform our predictive models in Stage 3. If Service-recommended survey protocols are used, this risk assessment can be greatly facilitated using model tools available from the Service. If project developers or operators use other forms of information for the Stage 2 assessment, they will need to fully describe those methods and the analysis used for the eagle risk assessment. The Service will require more time to evaluate and review the data because, for example, the Service will need to compare the results of the project developer or operator’s eagle risk assessment with predictions from our models. If the results differ, we will work with the project developers or operators to determine which model results are most appropriate for the Service’s eventual permitting decisions.

The Service and project developers or operators also evaluate Stage 2 data to determine whether disturbance take is likely, and if so, at what level. Any loss of production that may stem from disturbance should be added to the fatality rate prediction for the project. The risk assessments at Stage 2 and Stage 3 are consistent with developing the information necessary to assess the efficacy of conservation measures, and to develop the monitoring required by the permit regulations at 50 CFR 22.26(c)(2).

Stage 4 - Avoidance and Minimization of Risk and Compensatory Mitigation
In Stage 4 the information gathered should be used by the project developer or operator and the Service to determine potential conservation measures and ACPs (if available) to avoid or minimize predicted risks at a given site (see Appendix E). The Service will compare the initial predictions of eagle mortality and disturbance for the project with predictions that take into account proposed and potential conservation measures and ACPs, once developed and approved, to determine if the project developer or operator has avoided and minimized risks to the maximum degree achievable, thereby meeting the requirements for programmatic permits that remaining take is unavoidable. Additionally, the Service will use the information provided along with other data to conduct a cumulative effects analysis to determine if the project's impacts, in combination with other permitted take and other known factors, are at a level that exceed the established thresholds or benchmarks for eagle take at the regional and local-area scales. This final eagle risk assessment is completed at the end of Stage 4 after application of conservation measures and ACPs (if available) along with a plan for compensatory mitigation if required.

The eagle permit process requires compensatory mitigation if conservation measures do not remove the potential for take, and the projected take exceeds calculated thresholds for the eagle management unit in which the project is located. However, there may also be other situations in which compensatory mitigation is necessary. The following guidance applies to those situations as well.

Compensatory mitigation can address pre-existing causes of eagle mortality (such as eagle electrocutions from power poles) or it can address increasing the carrying capacity of the eagle population in the affected eagle management unit. However, there needs to be a credible analysis that supports the conclusion that implementing the compensatory mitigation action will achieve the desired beneficial offset in mortality or carrying capacity.

For new wind development projects, if compensatory mitigation is necessary, the compensatory mitigation action (or a verifiable, legal commitment to such mitigation) will be required up front before project operations begin because projects must meet the statutory eagle preservation standard before the Service may issue a permit. For operating projects, compensatory mitigation should be applied from the start of the permit period, not retroactively from the time the project began. The initial compensatory mitigation effort should be sufficient to offset the predicted number of eagle fatalities per year for five years. No later than at the end of the five year period, the Service and the project operator will compare the predicted annual take estimate to the realized take based on post-construction monitoring. If the triggers identified in the permit for adjustment of compensatory mitigation are met, those adjustments should be implemented. In the case where the observed take was less than estimated, the permittee will receive a credit for the excess compensation (the difference between the actual mean and the number compensated for) that can be applied to other take (either by the permittee or other permitted individuals at his/her discretion) within the same eagle management unit. The Service, in consultation with the permittee, will determine compensatory mitigation for future years for the project at this point, taking into account the observed levels of mortality and any reduction in that mortality that is expected based on implementation of additional experimental conservation measures and ACPs. Monitoring using the best scientific and practicable methods available should be included to determine the effectiveness of the resulting compensatory mitigation efforts. The Service will modify the compensatory mitigation process to adapt to any improvements in our knowledge base as new data become available.

At the end of Stage 4, all the materials necessary to satisfy the regulatory requirements to support a permit application should be available. While a project operator can submit a permit application at any time, the Service can only begin the formal process to determine whether a programmatic eagle take permit can be issued after completion of Stage 4. Ideally, National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) analyses and assessments will already be underway, but if not, Stage 4 should include necessary NEPA analysis, NHPA compliance, coordination with other jurisdictional agencies, and tribal consultation.

Tier 4 and 5 of the WEG, Stage 5 of the ECPG

If the Service issues an eagle take permit and the project goes forward, project operators will conduct post-construction surveys to collect data that can be compared with the pre-construction risk-assessment predictions for eagle fatalities and disturbance. The monitoring protocol should include validated techniques for assessing both mortality and disturbance effects, and they must meet the permit-condition requirements at 50 CFR 22.26(c)(2). In most cases, intensive monitoring will be conducted for at least the first two years after permit issuance, followed by less intense monitoring for up to three years after the expiration date of the permit. Project developers or operators should use the post-construction survey protocols included or referenced in this ECPG, but we will consider other monitoring protocols provided by permit applicants though the process will likely take longer than if familiar approaches were used. The Service will use the information from post-construction monitoring in a meta-analysis framework to weight and improve pre-construction predictive models.

Additionally in Stage 5, the Service and project developers or operators should use the post-construction monitoring data to (1) assess whether compensatory mitigation is adequate, excessive, or deficient to offset observed mortality, and make adjustments accordingly; and (2) explore operational changes that might be warranted at a project after permitting to reduce observed mortality and meet permit requirements.

10. Site Categorization Based on Mortality Risk to Eagles

Beginning at the end of Stage 1, and continuing at the end of Stages 2, 3, and 4, we recommend the approach outlined below be used to assess the likelihood that a wind project will take eagles, and if so, that the project will meet standards in 50 CFR 22.26 for issuance of a programmatic eagle take permit.

Category 1 – High risk to eagles, potential to avoid or mitigate impacts is low

A project is in this category if it:

(1) has an important eagle-use area or migration concentration site within the project footprint; or
(2) has an annual eagle fatality estimate (average number of eagles predicted to be taken annually) > 5% of the estimated local-area population size; or
(3) causes the cumulative annual take for the local-area population to exceed 5% of the estimated local-area population size.

In addition, projects that have eagle nests within ½ the mean project-area inter-nest distance of the project footprint should be carefully evaluated. If it is likely eagles occupying these territories use or pass through the project footprint, category 1 designation may be appropriate.

Projects or alternatives in category 1 should be substantially redesigned to at least meet the category 2 criteria. The Service recommends that project developers not build projects at sites in category 1 because the project would likely not meet the regulatory requirements. The recommended approach for assessing the percentage of the local-area population predicted to be taken is described in Appendix F.

Category 2 – High or moderate risk to eagles, opportunity to mitigate impacts

A project is in this category if it:

(1) has an important eagle-use area or migration concentration site within the project area but not in the project footprint; or
(2) has an annual eagle fatality estimate between 0.03 eagles per year and 5% of the estimated local-area population size; or
(3) causes cumulative annual take of the local-area population of less than 5% of the estimated local-area population size.

Projects in this category will potentially take eagles at a rate greater than is consistent with maintaining stable or increasing populations, but the risk might be reduced to an acceptable level through a combination of conservation measures and reasonable compensatory mitigation. These projects have a risk of ongoing take of eagles, but this risk can be minimized. For projects in this category the project developer or operator should prepare an Eagle Conservation Plan (ECP) or similar plan to document meeting the regulatory requirements for a programmatic permit. The ECP or similar document can be a stand-alone document, or part of a larger bird and bat strategy as described in the WEG, so long as it adequately meets the regulatory requirements at 50 CFR 22.26 to support a permit decision. For eagle management populations where take thresholds are set at zero, the conservation measures in the ECP should include compensatory mitigation and must result in no-net-loss to the breeding population to be compatible with the permit regulations. This does not apply to golden eagles east of the 100th meridian, for which no non-emergency take can presently be authorized (USFWS 2009b).

Category 3 – Minimal risk to eagles

A project is in this category if it:

(1) has no important eagle use areas or migration concentration sites within the project area; and
(2) has an annual eagle fatality rate estimate of less than 0.03; and
(3) causes cumulative annual take of the local-area population of less than 5% of the estimated local-area population size.

Projects in category 3 pose little risk to eagles and may not require or warrant eagle take permits, but that decision should be made in coordination with the Service. Still, a project developer or operator may wish to create an ECP or similar document or strategy that documents the project's low risk to eagles, and outlines mortality monitoring for eagles and a plan of action if eagles are taken during project construction or operation. This would enable the Service to provide a permit to allow a *de minimis* amount of take if the project developer or operator wished to obtain such a permit.

The risk category of a project can potentially change as a result of additional site-specific analyses and application of measures to reduce the risk. For example, a project may appear to be in category 2 as a result of Stage 1 analyses, but after collection of site-specific information in Stage 2 it might become clear it is a category 1 project. If a project cannot practically be placed in one of these categories, the project developer or operator and the Service should work together to determine if the project can meet programmatic eagle take permitting requirements in 50 CFR 22.26 and 22.27. Projects should be placed in the highest category (with category 1 being the highest) in which one or more of the criteria are met.

11. Addressing Uncertainty

There is substantial uncertainty surrounding the risk of wind projects to eagles, and of ways to minimize that risk. For this reason, the Service stresses that it is very important not to underestimate eagle fatality rates at wind facilities. Overestimates, once confirmed, can be adjusted downward based on post-construction monitoring information with no consequence to eagle populations. Project developers or operators can trade or be credited for excess compensatory mitigation, and debits to regional and local-area eagle-take thresholds and benchmarks can be adjusted downwards to reflect actual fatality rates. However, the options for addressing underestimated fatality rates are extremely limited, and pose either potential hardships for wind developers or significant risks to eagle populations.

Our long-term approach for moving forward in the face of this uncertainty is to implement eagle take permitting 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. These are discussed in more detail in Appendix A. The adaptive management process will depend heavily on pre- and post-construction data from individual projects, but analyses, assessment, and model evaluation will rely on data pooled over many individual wind projects. Learning accomplished through adaptive management will be rapidly incorporated into the permitting process so that the regulatory process adjusts in proportion to actual risk.

12. Interaction with the Service

The Service encourages early, frequent and thorough coordination between project developers or operators and Service and other jurisdictional-agency employees as they implement the tiers of the WEG, and the related Stages of the ECPG. Close coordination will aid the refinement of the modeling process used to predict fatalities, as well as the post-construction monitoring to evaluate those models. We anticipate the ECPG and the recommended methods and metrics will evolve as the Service and project developers or operators learn together. The Service has created a cross-program, cross-regional team of biologists who will work jointly on eagle-programmatic-take permit applications to help ensure consistency in administration and application of the Eagle Permit Rule. This close coordination and interaction is especially important as the Service processes the first few programmatic eagle take permit applications.

The Service will continue to refine this ECPG with input from all stakeholders with the objective of maintaining stable or increasing breeding populations of both bald and golden eagles while simultaneously developing science-based eagle-take regulations and procedures that are appropriate to the risk associated with each wind energy project.

Stage Overview Table - Overview of staged approach to developing an Eagle Conservation Plan as described in the ECPG. Stages are in chronological order. Stage 5 would only be applicable in cases where a permit was issued at the end of Stage 4.

Stage	Objective	Actions	Data Sources
1	At the landscape level, identify potential wind facility locations with manageable risk to eagles.	Broad, landscape-scale evaluation.	Technical literature, agency files, on-line biological databases, data from nearby projects, industry reports, geodatabases, experts.
2	Obtain site-specific data to predict eagle fatality rates and disturbance take at wind-facility sites that pass Stage 1 assessment. Investigate other aspects of eagle use to consider assessing distribution of occupied nests in the project area, migration, areas of seasonal concentration, and intensity of use across the project footprint.	Site-specific surveys and intensive observation to determine eagle exposure rate and distribution of use in the project footprint, plus locations of occupied eagle nests, migration corridors and stopover sites, foraging concentration areas, and communal roosts in the project area.	Project footprint: 800-m radius point count surveys and utilization distribution studies. Project area: nest surveys, migration counts at likely topographic features, investigation of use of potential roost sites and of areas of high prey availability. Ideally conducted for no less than 2 years pre-construction.
3	As part of pre-construction monitoring and assessment, estimate the fatality rate of eagles for the facility evaluated in Stage 2, excluding possible additions of conservation measures and advanced conservation practices (ACPs). Consider possible disturbance effects.	Use the exposure rate derived from Stage 2 data in Service-provided models to predict the annual eagle fatality rate for the project. Determine if disturbance effects are likely and what they might be.	Point count, nest, and eagle concentration area data from Stage 2.

Stage	Objective	Actions	Data Sources
4	As part of the pre-construction assessment, identify and evaluate conservation measures and ACPs that might avoid or minimize fatalities and disturbance effects identified in Stage 3. When necessary, identify compensatory mitigation to reduce predicted take to a no-net-loss standard.	Re-run fatality prediction models with risk adjusted to reflect application of conservation measures and ACPs to determine fatality estimate (80% upper confidence limit or equivalent). Calculate required compensatory mitigation amount where necessary, considering disturbance effects, if any. Identify actions needed to accomplish compensatory mitigation.	Fatality estimates before and after application of conservation measures and ACPs, using point count data from Stage 2. Estimates of disturbance effects from Stage 3.
Permit Decision	Determine if regulatory requirements for issuance of a permit have been met.	The Service will issue or deny the permit request based on an evaluation of the ECP or other form of application.	Data from Stages 1, 2, 3 and 4; results of NEPA analysis; and considering information obtained during tribal consultation and through coordination with the states and other jurisdictional agencies.
5	During post-construction monitoring, document mean annual eagle fatality rate and effects of disturbance. Determine if initial conservation measures are working and should be continued, and if additional conservation measures might reduce observed fatalities. Monitor effectiveness of compensatory mitigation. Ideally, assess use of area by eagles for comparison to pre-construction levels.	Conduct fatality monitoring in project footprint. Monitor activity of eagles that may be disturbed at nest sites, communal roosts, and/or major foraging sites. Ideally, monitor eagle use of project footprint via point counts, migration counts, and/or intensive observation of use distribution.	Post-construction survey database for fatality monitoring, Comparable pre- and post-construction data for selected aspect of eagle use of the project footprint and adjoining areas. All post-construction surveys should be conducted for at least 2 years, and targeted thereafter to assess effectiveness of any experimental conservation measures or ACPs.

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INTRODUCTION AND PURPOSE

The mission of the Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. As part of this, we are charged with implementing statutes including the BGEPA, MBTA (Migratory Bird Treaty Act), and ESA (Endangered Species Act). BGEPA prohibits all take of eagles unless otherwise authorized by the Service. A goal of BGEPA is to ensure that any authorized take of bald and golden eagles is compatible with their preservation, which the Service has interpreted to mean allowing take that is consistent with the goal of stable or increasing breeding populations. In 2009, the Service promulgated regulations authorizing issuance of permits for non-purposeful take of eagles; the ECPG is intended to promote compliance with BGEPA with respect to such permits by providing recommended procedures for:

(1) conducting early pre-construction assessments to identify important eagle use areas;
(2) analyzing pre-construction information to estimate potential impacts on eagles;
(3) avoiding, minimizing, and/or compensating for potential adverse effects to eagles; and
(4) monitoring for impacts to eagles during construction and operation.

The ECPG calls for scientifically rigorous surveys, monitoring, risk assessment, and research designs proportionate to the risk to both bald and golden eagles. The ECPG describes a process by which wind energy developers, operators, and their consultants can collect and analyze information that could lead to a programmatic permit to authorize unintentional take of eagles at wind energy facilities. The processes described here is not required, but project developers or operators should coordinate closely with the Service if they plan to use an alternative approach to meet the regulatory requirements for a permit.

1. Purpose

The Service published a final rule (Eagle Permit Rule) on September 11, 2009 under BGEPA (50 CFR 22.26) authorizing limited issuance of permits to take bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) ''for the protection of ... other interests in any particular locality'' where the take is compatible with the preservation of the bald eagle and the golden eagle, is associated with and not the purpose of an otherwise lawful activity, and cannot practicably be avoided (USFWS 2009a). The ECPG explains the Service's approach to issuing programmatic eagle take permits for wind energy projects under this authority, and provides guidance to permit applicants (project developers or operators), Service biologists, and biologists with other jurisdictional agencies (state and tribal fish and wildlife agencies, in particular) on the development of *Eagle Conservation Plans* (ECPs) to support permit issuance.

Since finalization of the Eagle Permit Rule, the development and planned development of wind facilities (developments for the generation of electricity from wind turbines) have increased in the range of the golden eagle in the western United States. Golden eagles are vulnerable to collisions with wind turbines (Hunt 2002), and in some areas such collisions could be a major source of mortality (Hunt *et al.* 1999, 2002; USFWS unpublished data). Although significant numbers of bald eagle mortalities have not yet been reported at North American wind facilities, deaths have occurred at more than one location (USFWS, unpublished data), and the closely related and behaviorally similar white-tailed eagle (*Haliaeetus albicilla*) has been killed regularly at wind facilities in Europe (Krone 2003, Cole 2009, Nygård *et al.* 2010). Because of this risk to eagles, many of the current and planned wind facilities require permits under the Eagle Permit Rule to be in compliance with the law if and when an eagle is taken at that facility. In addition to being legally necessary to comply with BGEPA and 50 CFR 22.26, the conservation practices necessary to meet standards required for issuance of these permits should offset the short- and long-term negative effects of wind energy facilities on eagle populations. Because of the urgent need for guidance on permitting eagle take at wind facilities, this initial module focuses on this issue. Many of the concepts and approaches outlined in this module can be readily exported to other situations (*e.g.*, solar facilities, electric power lines), and the Service expects to release other modules in the future specifically addressing other sources of eagle take.

The ECPG is intended to provide interpretive guidance to Service biologists and others in applying the regulatory permit standards as specified in the rule. They do not in-and-of themselves impose additional regulatory or generally-binding requirements. An ECP *per se* is not required, even to obtain a programmatic eagle take permit. As long as the permit application is complete and includes the information necessary to evaluate a permit application under 50 CFR 22.26 or 22.27, the Service will review the application and make a determination if a permit will be issued. However, Service personnel will be trained in the application of the procedures and approaches outlined in the ECPG, and developers who choose to use other approaches should expect the review time on the part of the Service to be longer. The Service recommends that the basic format for the ECP be followed to allow for expeditious consideration of the application materials.

Preparation of an ECP and consultation with the Service are voluntary actions on the part of the developer. There is no legal requirement that wind developers apply for or obtain an eagle take permit, so long as the project does not result in take of eagles. However, take of an eagle without an eagle take permit is a violation of BGEPA, so the developer or operator must weigh the risks in his/her decision. The Service is available to consult with the developer or operator as he/she makes that decision.

The ECPG is written to guide wind-facility projects starting from the earliest conceptual planning phase. For projects already in the development or operational phase, implementation of all stages of the recommended approach in the ECPG may not be applicable or possible. Project developers or operators with operating or soon-to-be operating facilities and who are interested in obtaining a programmatic eagle take permit should contact the Service. The Service will work with project developers or operators to determine if the project might be able to meet the permit requirements in 50 CFR 22.26. The Service may recommend that the developer monitor eagle fatalities and disturbance, adopt reasonable measures to reduce eagle fatalities from historic levels, and implement compensatory mitigation. Sections of the ECPG that address these topics are relevant to both planned and operating wind facilities (Appendices E and F in particular). Operators of wind projects (and other activities) that were in operation prior to 2009 that pose a risk to golden eagles may qualify for programmatic eagle take permits that do not automatically require compensatory mitigation. This is because the requirements for obtaining programmatic take authorization are designed to reduce take from historic, baseline levels, and the preamble to the Eagle Permit Rule specified that unavoidable take remaining after implementation of avoidance and minimization measures at such projects would not be subtracted from regional eagle take thresholds (U. S. Fish and Wildlife Service 2009a).

The ECPG is designed to be compatible with the more general guidelines provided in the *U.S. Fish and Wildlife Service Land-based Wind Energy Guidelines* (WEG) *http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee.html*. However, because the ECPG describes actions which help to comply with the regulatory requirements in BGEPA for an eagle take permit as described in 50 CFR 22.26 and 22.27, they are more specific. The Service will make every effort to ensure the work and timelines for both processes are as congruent as possible.

2. Legal Authorities and Relationship to Other Statutes and Guidelines

There are several laws that must be considered for compliance during eagle take permit application review under the 50 CFR 22.26 and 22.27 regulations: BGEPA, MBTA, ESA, the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et. seq.*), and the National Historic Preservation Act (NHPA) (16 U.S.C. 470 *et seq.*). BGEPA is the primary law protecting eagles. BGEPA defines "take" to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" and prohibits take of individuals, and their parts, nests, or eggs (16 USC 668 & 668c). The Service expanded this definition by regulation to include the term "destroy" to ensure that "take" includes destruction of eagle nests (50 CFR 22.3). The term "disturb" is defined by regulation at 50 CFR 22.3 as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, … injury to an eagle, a decrease in productivity, or nest abandonment…" (USFWS 2007). A goal of BGEPA is to ensure that any authorized take is compatible with eagle preservation, which the Service has interpreted to mean it can authorize take that is consistent with the goal of stable or increasing breeding populations of bald and golden eagles (USFWS 2009b).

In 2009, two new permit rules were created for eagles. Under 50 CFR 22.26, the Service can issue permits that authorize individual instances of take of bald and golden eagles when the take is associated with, but not the purpose of an otherwise lawful activity, and cannot practicably be avoided. The regulation also authorizes ongoing or programmatic take, but requires that any authorized programmatic take be unavoidable after implementation of advanced conservation practices. Under 50 CFR 22.27, the Service can issue permits that allow the intentional take of eagle nests where necessary to alleviate a safety emergency to people or eagles, to ensure public health and safety, where a nest prevents use of a human-engineered structure, and to protect an interest in a particular locality where the activity or mitigation for the activity will provide a net benefit to eagles. Only inactive nests are allowed to be taken except in cases of safety emergencies.

The new Eagle Permit Rule provides a mechanism where the Service may legally authorize the non-purposeful take of eagles. However, BGEPA provides the Secretary of the Interior with the authority to issue eagle take permits only when the take is compatible with the preservation of each species, defined in USFWS (2009a) as "…consistent with the goal of stable or increasing breeding populations." The Service ensures that any take it authorizes under 50 CFR 22.26 does not exceed this preservation standard by setting regional take thresholds for each species determined using the methodology contained in the NEPA Final Environmental Assessment (FEA) developed for the new permit rules (USFWS 2009b). The details and background of the process used to calculate these take thresholds are presented in the FEA (USFWS 2009b). It is important to note that the take thresholds for regional eagle management populations (eagle management units) and the process by which they are determined are derived independent from this or any other ECPG module.

Many states and tribes have regulations that protect eagles, and may require permits for purposeful and non-purposeful take. Project developers or operators should contact all pertinent state and tribal fish and wildlife agencies at the earliest possible stage of project development to ensure proper coordination and permitting. The Service will coordinate our programmatic take permits with all such jurisdictional agencies.

Wind projects that are expected to cause take of endangered or threatened wildlife species should still receive incidental take authorizations under sections 7 or 10 of ESA in order to ensure compliance with Federal law. A project developer or operator seeking an Incidental Take Permit

(ITP) through the ESA section 10 Habitat Conservation Plan (HCP) process may be issued an ITP only if the permitted activity is otherwise lawful (section 10(a)(1)(B)). If the project and covered activities in the HCP are likely to take bald or golden eagles, the project proponent should obtain a BGEPA permit or include the bald or golden eagle as a covered species in the HCP in order for the activity to be lawful in the event that eagles are taken. When bald or golden eagles are covered in an HCP and ITP, the take is authorized under BGEPA even if the eagle species is not listed under the ESA (see 50 CFR 22.11(a)).

If bald or golden eagles are included as covered species in an HCP, the avoidance, minimization, and other mitigation measures in the HCP must meet the BGEPA permit issuance criteria of 50 CFR 22.26, and include flexibility for adaptive management. If take of bald or golden eagles is likely but the project developer or operator does not qualify for eagle take authorization (or chooses not to request such authorization), an ITP may be issued in association with the proposed HCP. The project proponent must be advised, in writing, that bald or golden eagles would not be included as covered species and take of bald eagles or golden eagles would not, therefore, be authorized under the incidental take permit. The project developer or operator must also be advised that the incidental take permit would be subject to suspension or revocation if take of bald eagles or golden eagles should occur.

In addition to ESA, wind project developers or operators need to address take under MBTA. MBTA prohibits the taking, hunting, killing, pursuit, capture, possession, sale, barter, purchase, transport, and export of migratory birds, their eggs, parts, and nests, except when authorized by the Department of the Interior. For eagles, the BGEPA take authorization serves as authorization under MBTA per 50 CFR 22.11(b). For other MBTA-protected birds, because neither the MBTA nor its permit regulations at 50 CFR Part 21 currently provide a specific mechanism to permit "unintentional" take, it is important for project developers or operators to work proactively with the Service to avoid and minimize take of migratory birds. The Service, with assistance from a Federal Advisory Committee, developed the WEG to provide a structured system to evaluate and address potential negative impacts of wind energy projects on species of concern. Because the Service has the authority to issue a permit for non-purposeful take of eagles, our legal and procedural obligations are significantly greater, and therefore the ECPG is more focused and detailed than the WEG. We have modeled as much of the ECPG as possible after the WEG, but there are important and necessary differences.

NEPA applies to issuance of eagle take permits because issuing a permit is a federal action. While providing technical assistance to agencies conducting NEPA analyses, the Service will participate in the other agencies' NEPA to the extent feasible in order to streamline subsequent NEPA analyses related to a project. For actions that may result in applications for development of programmatic permits, the Service may participate as a cooperating agency to streamline the permitting process.

If no federal nexus exists, other than an eagle permit, or if the existing NEPA of another agency is not adequate, the Service must complete a NEPA analysis before it can issue a permit. The Service will work with the project developer or operator to conduct a complete NEPA analysis, including assisting with data needs and determining the scope of analysis. Project developers or operators may provide assistance that can expedite the NEPA process in accordance with 40 CFR §1506.5. Additionally, there are opportunities to "batch" NEPA analyses for proposed projects in the same geographic area. In these cases, project developers or operators and the Service could pool resources and data, likely increasing the quality of the product and the efficiency of the process. Developers should coordinate closely with the Service for projects with no federal nexus other than the eagle permit. Close coordination between project developers or operators and the Service regarding the data needs and scope of the analysis required for a permit will reduce delays.

Through 50 CFR 22.26 and the associated FEA, the Service defined "mitigation" as per the Service Mitigation Policy (46 FR 7644, Jan. 23, 1981), and the President's Council on Environmental Quality (40 CFR 1508.20 (a-e)), to sequentially include the following:

(1) Avoiding the impact on eagles altogether by not taking a certain action or parts of an action;
(2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
(3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
(4) Reducing or eliminating the impact over time by implementing preservation and maintenance operation during the lifetime of the action; and
(5) Compensating for the impact by replacing or providing substitute resources or environments.

Throughout this document we differentiate between mitigation, which covers all of the components listed above, and compensatory mitigation, which is a subset of (5) above and directly targets offsetting permitted disturbance and mortality to accomplish a no-net-loss objective at the scale of the eagle management unit. The Service requires compensatory mitigation (potentially in addition to other mitigation) where it has not been determined that eagle populations can sustain additional mortality. The NEPA analysis on our permits and the discussion of mitigation in this document follow this system, and in this ECPG we refer to (1) – (4) as conservation measures to avoid and minimize take, of which ACPs are a subset, and to (5) as compensatory mitigation.

Eagles are significant species in Native American culture and religion (Palmer 1988) and may be considered contributing elements to a "traditional cultural property" under Section 106 of the NHPA. Some locations where eagles would be taken have traditional religious and cultural importance to Native American tribes and thus have the potential of being regarded as traditional cultural properties under NHPA. Permitted take of one or more eagles from these areas, for any purpose, could be considered an adverse effect to the traditional cultural property. These considerations will be incorporated into any NEPA analysis associated with an eagle take permit.

Federally-recognized Indian tribes enjoy a unique government-to-government relationship with the United States. The Service recognizes Indian tribal governments as the authoritative voice regarding the management of tribal lands and resources within the framework of applicable laws. It is important to recall that many tribal traditional lands and tribal rights extend beyond reservation lands. The Service consults with Indian tribal governments under the authorities of Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments" and supporting DOI and Service policies. To this end, when it is determined that federal actions and activities may affect a tribe's resources (including cultural resources), lands, rights, or ability to provide services to its members, the Service must, to the extent practicable, seek to engage the affected tribe(s) in consultation and coordination.

3. Background and Overview of Process

Increased energy demands and the nationwide goal to increase energy production from renewable sources have intensified the development of energy facilities, including wind energy. The Service supports renewable energy development that is compatible with fish and wildlife conservation. The Service closely coordinates with state, tribal, and other federal agencies in the review and permitting of wind energy projects to address potential resource effects, including effects to bald and golden eagles. However, our knowledge of these effects and how to address them at this time is limited. Given this and the Service's regulatory mandate to only authorize actions that are "compatible with the goal of stable or increasing breeding populations" of eagles has led us to adopt an adaptive management framework predicated, in part, on the precautionary approach for consideration and issuance of programmatic eagle take permits. This framework consists of case-specific considerations applied within a national framework, and with the outcomes carefully monitored so that we maximize learning from each case. The knowledge gained through monitoring can then be used to update and refine the process for making future permitting decisions such that our ultimate conservation objectives are attained, as well as to consider operational adjustments at individual projects at regular intervals where deemed necessary and appropriate. The ECPG provides the background and information necessary for wind project developers or operators to prepare an ECP that assesses the risk of a prospective or operating project to eagles, and how siting, design, and operational modifications can mitigate that risk. Implementation of the final ECP must reduce predicted eagle take, and the population level effect of that take, to a degree compatible with regulatory standards to justify issuance of a programmatic take permit by the Service.

a. Risks to Eagles

Energy development can affect eagles in a variety of ways. First, structures such as wind turbines can cause direct mortality through collision (Hunt 2002, Nygård *et al.* 2010). This is the primary threat to eagles from wind facilities, and the monitoring and avoidance and minimization measures advocated in the ECPG primarily are aimed at this threat. Second, activities associated with pre-construction, construction, or operation and maintenance of a project might cause disturbance and result in loss of productivity at nearby nests or disturbance to nearby concentrations of eagles. Third, if disturbance or mortality effects are permanent, they could result in the permanent or long term loss of a nesting territory. All of these impacts, unless properly permitted, are violations of BGEPA (USFWS 2009a). Additionally, disturbances near important eagle use areas or migration concentration sites might stress eagles to a degree that leads to reproductive failure or mortality elsewhere; these impacts are of concern as well, and they could amount to prohibited take, though such effects are difficult to predict and quantify. Thus, the ECPG addresses both direct mortality and disturbance. Many new wind projects are located in remote areas that have few, if any, transmission lines. The Service considers new transmission lines and other infrastructure associated with renewable energy projects to be part of a project. Accordingly, assessments of project impacts should include transmission lines and other facilities, not merely wind turbines.

b. General Approach to Address Risk

Applicants for permits under 50 CFR 22.26, non-purposeful eagle take, are required to avoid and minimize the potential for take of eagles to the extent practicable. Permits for wind-energy development are programmatic as they will authorize recurring take, rather than isolated incidences of take. For programmatic take permits, the regulations at 50 CFR 22.26 require that any authorized take is unavoidable after implementation of ACPs. 50 CFR 22.3 defines "advanced conservation practices" as "scientifically supportable measures that are approved by the Service and represent the best available techniques to reduce eagle disturbance and ongoing mortalities to a level where remaining take is unavoidable."

Because the best information indicates that there are currently no available scientifically supportable measures that will reduce eagle disturbance and blade-strike mortality at wind projects, the Service has not currently approved any ACPs for wind-energy projects. The preamble to the Eagle Permit Rule envisioned the Service and industry working together to identify and evaluate possible ACPs (USFWS 2009a). The process of ACP development for wind-energy facilities has been hampered because there has been little standardized scientific study of potential ACPs, and such information can best be obtained through experimental application of ACPs at operating facilities with eagle take permits. Given this, and considering the pressing need to develop ACPs for wind-energy facilities, the Service believes that the best course of action is to work with industry to develop ACPs for wind projects as part of the programmatic take permit process.

Under this scenario, ACPs would be implemented at operating wind facilities with an eagle take permit on an "experimental" basis (the ACPs are considered experimental because they would not yet meet the definition of an ACP in the eagle permit regulation). 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.

Despite the current lack of available ACPs, the best available scientific information may demonstrate that a particular avoidance, minimization, or other mitigation action should be applied as a condition on an eagle programmatic take permit for wind-energy facilities (see 50 C.F.R. 22.6(c)(1)). A project developer or operator will still be expected to implement any reasonable avoidance and minimization measures that may reduce take of eagles at a project. However, the Service and the project developer or operator will discuss and agree on other site-specific and possibly turbine-specific factors that may pose risks to eagles and experimental ACPs that might reduce or eliminate those risks if the risks are substantiated by the best available science. Unless the Service determines that there is a reasonable scientific basis to implement experimental ACPs up front, we recommend that such measures be deferred until such time as there is eagle take at the facility or the Service determines that the circumstances and evidence surrounding instances of take or risk of take suggest the experimental ACPs might be warranted. This agreement would be specified as a condition of the programmatic eagle take permit.

Because ACPs would be considered experimental in these situations, we recommend that they be subject to a cost cap that the Service and the project developer or operator establish as part of the initial agreement before issuance of a permit, thereby providing financial certainty to the project operator or developer as to what maximum costs of such measures might be. The amount of the cap should be relevant to the theorized risk factors identified for the project, and proportional to overall risk.

If eagle take is confirmed through post-construction monitoring, developers or operators would be expected to implement the experimental ACP(s) and to monitor future eagle take relative to the ACP(s) as part of the adaptive management process specified in Appendix A, but all within the limits of the pre-determined financial cap. As the results from monitoring experimental ACPs across a number of facilities accumulates and is analyzed as part of the adaptive management process, scientific information in support of certain ACPs may accrue, whereas other ACPs may show little value in reducing take. If the Service determines that the available science demonstrates an experimental ACP is effective in reducing eagle take, the Service will approve that ACP and require its implementation up front on new projects when and where warranted.

Where take is unavoidable and when eagle populations at the scale of the eagle management unit (as defined in USFWS 2009b) are not estimated to be healthy enough to sustain additional mortality over existing levels, applicants must reduce the effect of permitted unavoidable mortality to a no-net-loss standard through compensatory mitigation for the duration of the permitted activity. No-net-loss means that unavoidable mortality caused by the permitted activities is offset by compensatory mitigation that reduces another, ongoing form of mortality by an equal or greater amount, or which leads to an increase in carrying capacity that allows the eagle population to grow by an equal or greater amount. Compensatory mitigation may also be necessary to offset substantial effects in other situations (USFWS 2009a), and mitigation designed to offset other detrimental effects of permits on eagles may be advised in addition to compensatory mitigation in some cases. The Service and the project developer or operator seeking a programmatic eagle take permit should agree on the number of eagle fatalities to mitigate and what actions will be taken if actual eagle fatalities differ from the predicted number. The compensatory mitigation requirement and trigger for adjustment should be specified in the permit. If the procedures recommended in the ECPG are followed, there should not be a need for additional compensatory mitigation. However, if other, less risk-averse models are used to estimate fatalities, underestimates might be expected and the permit should specify the threshold(s) of take that would trigger additional actions and the specific mitigation activities that would be implemented if fatalities are underestimated. The approach described in the ECPG is applicable for all land-based wind energy projects within the range of the bald and golden eagle where interactions with wind project infrastructure have been documented or are reasonably expected to occur. The ECPG is intended to provide a national framework for assessing and mitigating risk.

As part of the application process for a programmatic eagle take permit, the Service recommends that project developers or operators prepare an ECP that outlines the project development process and includes conservation and monitoring plans as recommended in this ECPG. The ECPG provides examples of ways that applicants can meet the regulatory standards in the rule, and while other approaches may be acceptable, the Service will determine their adequacy on a case-by-case basis. As noted previously, an ECP is not required, but if one is developed following the approach recommended here, it will expedite Service review of the project.

There is substantial uncertainty surrounding the risk of wind projects to eagles, and of ways to minimize that risk. For this reason, the Service strongly recommends that care be taken to protect against the consequences of underestimating eagle fatality rates at wind facilities. Overestimates, once confirmed, can be adjusted downward based on post-construction monitoring information with no consequence to eagle populations, and project developers or operators can trade or be credited for excess compensatory mitigation. However, the options for addressing underestimated fatality rates are extremely limited, and pose either potential hardships for wind developers or significant risks to eagle populations.

ASSESSING RISK AND EFFECTS

1. Considerations When Assessing Eagle Use Risk

Bald eagles and golden eagles associate with distinct geographic areas and landscape features throughout their respective ranges. The Service defines these "important eagle-use areas" as "an eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles" (USFWS 2009a; 50 CFR 22.3). Migration corridors and migration stopover sites also provide important foraging areas for eagles during migration (*e.g.*, Restani *et al.* 2001, Mojica 2008) and result in seasonal concentrations of eagles. As a result, the presence of a migration corridor or stopover site on or near a proposed wind development project could increase the probability of encounters between eagles and wind turbines. Although these sites are not specifically included within the regulatory definition of an important eagle-use area at 50 CFR 22.3, the presence of such a site on or near a proposed wind project could increase the likelihood of collisions.

Wind energy projects that overlap, or are proximate to, important eagle use areas or migration concentration sites may pose risks to the eagles for reasons described earlier. Project developers or operators should identify the location and type of all important eagle use areas or migration concentration sites that might be affected by a proposed wind project (*e.g.*, within the project area). If recent (within the previous 5 years) local data are available on the spacing of eagle nests for the project-area nesting population, those data can be used to determine an appropriate boundary for such surveys (as described in Appendix H). Otherwise, for both species we suggest initial surveys be conducted on and within 10 miles of a project's footprint to establish the project-area mean inter-nest distance. The project footprint is the minimum convex polygon (*e.g.*, Mohr 1947) that encompasses the wind project area inclusive of the hazardous area around all turbines and any associated infrastructure, including utility lines, out-buildings, roads, etc. We suggest a site-specific approach based on the spacing between nearest, simultaneously occupied nests for the species present in the area. If data on nest-spacing in the project area are lacking, project proponents or operators may wish to survey up to 10 miles, as this is ½ the largest recorded spacing observed for golden eagles in the Mojave/Sonoran deserts of western Arizona (Millsap 1981). . For subsequent monitoring (*e.g.*, post-construction monitoring of occupancy and productivity of pairs potentially disturbed by the project), the project-area mean inter-nest distance can be used to define a more relevant project-area boundary. The 10-mile perimeter may be unnecessary for bald eagles in some areas, and the Service acknowledges there needs to be flexibility in the application of this approach to accommodate specific situations.

Evaluating the spatial area described above for each wind project is a key part of the programmatic take permitting process. As described later, surveys should be conducted initially to obtain data to predict effects of wind projects on eagles. After the project begins operating, studies should again be conducted to determine the actual effects. The following sections include descriptions and criteria for identifying important eagle use areas or migration concentration sites in these assessments.

a. General Background and Rationale for Assessing Project Effects on Eagles

A synthesis of publicly available databases and technical literature are fundamental to the pre-construction assessment component of an ECP. In some instances, this work may reveal information on use of a proposed project area by eagles that is strong enough to support a decision on whether to proceed with the project. In most cases, if available information warrants further consideration of a potential wind project site, on-site surveys should be implemented to further document use of the project area by eagles. The goal of such surveys should be to quantify and describe use of the project area by breeding (territorial) and non-breeding eagles across seasons and years. A variety of survey approaches may be needed to accomplish this goal.

Although potential for presence of all types of important eagle use areas or migration concentration sites should be considered when beginning to assess a potential project site, special attention is typically given to nests and nesting pairs. An eagle territory is defined in 50 CFR 22.3 as an area that contains, or historically contained, one or more nests within the home range of a mated pair of eagles. We recognize that usage conflicts with the true biological meaning of the term territory, but we use it herein in its regulatory context. Newton (1979) considered the nesting territory of a raptor as the defended area around a pair's nest site and defined the home range as "...the area traveled by the individual in its normal activities of food gathering, mating, and caring for the young." For golden eagles at least, the extent of the home range and territory during nesting season generally are similar; the eagle defends its territory by undulating flight displays near the home range boundaries and adjoining territories barely overlap (Harmata 1982, Collopy and Edwards 1989, Marzluff *et al.* 1997).

Avoidance zones, often distinguished by specific "buffer" distances, have been prescribed to protect nests and other types of eagle use areas from disturbance. Recommendations for the size of avoidance zones for nests of bald eagles and golden eagles have sometimes been based on documented distances between nests and territory boundaries. For example, McGrady *et al.* (2002) and Watson and Davies (2009) indicated nesting territories of golden eagles extend to at least 4 miles from their nests. Garrett *et al.* (1993) found that bald eagle territories extend at least 2 miles from nests, though studies in areas of densely packed breeding territories of bald eagles suggest much smaller distances (Sherrod *et al.* 1976, Hodges and Robards 1982, Anthony 2001). A recommendation for a spatial buffer to avoid disturbance of eagle nests can hardly be applied throughout the entire range of either species due to marked variation in the size and configuration of nesting territories. As such, these avoidance prescriptions have been conservative because there are few site-specific data on spatial extent of territories in the published and unpublished literature. For bald eagles, minimum-distance buffers are prescribed by the Service to protect nests, foraging areas, and communal roosts against disturbance from a variety of activities (USFWS 2007b).

The approach we recommend in the ECPG for evaluating siting options and assessing potential mortality and disturbance effects of wind facilities on eagles is to conduct standardized surveys (*e.g.*, point counts) to estimate eagle exposure within the project footprint. We further suggest augmenting these with surveys to determine locations of important eagle use areas or migration concentration sites for the project-area eagle population. The project-area eagle population is the population of breeding, resident non-breeding, migrating, and wintering eagles within the project area. As described previously and in Appendix H, if recent data on the spacing of eagle nests in the project area are available, it may be appropriate to use the mean species-specific inter-nest distance (assuming there is no reason to suspect eagle territories in the project area are configured such that the mean inter-nest distance would be misleading) as the outer boundary of the project area. Such a choice, however, also increases the importance of having adequate eagle exposure information from the project footprint for all seasons. For example, a winter communal night roost of eagles further than one mean inter-nest distance from the project boundary could produce a large influx of eagles into the footprint in winter. Inadequate winter eagle exposure sampling (or sampling in only one year, if the night roost is not used annually) in combination with selection of a project area based on nest spacing alone, could result in a failure to detect this increased risk to eagles in winter. Unpredicted fatalities that result from such an oversight will have to be addressed by the project developers or operators eventually through increased compensatory mitigation, operational adjustments, or both to continue operating under the authority of a valid eagle permit. Thus, it is important that the combination of exposure and project-area surveys adequately capture all risks to eagles.

One-half the mean inter-nest distance has been used as a coarse approximation for the territory boundary in a number of raptor studies (*e.g.*, Thorstrom 2001, Wichmann *et al.* 2003, Soutullo *et al.* 2006). Eagle pairs at nests within ½ the mean project-area inter-nest distance of the project footprint are potentially susceptible to disturbance take and blade-strike mortality, as these pairs and offspring may use the project footprint. We recommend using this distance to delineate territories and associated breeding eagles at risk of mortality or disturbance. Exposure surveys should adequately sample the parts of the project footprint potentially used by these eagle pairs so they are captured in the fatality estimates, and these nests should be included in post-construction occupancy and productivity monitoring (see Appendix H). This information is useful in decisions on whether a wind project might meet permit requirements at 50 CFR 22.26 considering both predicted take through fatalities and likely take from disturbance; for evaluating various siting and project-configuration alternatives; and in monitoring for disturbance effects during the post-construction period. In some situations, as where nests are concentrated on linear features (such as cliffs for golden eagles or along rivers for bald eagles), ½ the mean inter-nest distance may not encompass all important parts of the territory. In these situations inferences based on nest spacing should be used cautiously. The overall effectiveness of this approach will be evaluated through post-construction monitoring and the adaptive management framework described later in this ECPG.

b. Additional Considerations for Assessing Project Effects: Migration Corridors and Stopover Sites

Bald eagles and golden eagles tend to migrate along north-south oriented cliff lines, ridges, and escarpments, where they are buoyed by uplift from deflected winds (Kerlinger 1989, Mojica *et al.* 2008). Bald eagles typically migrate during midday by soaring on thermal uplift or on winds aloft, the onset of dally movements migration being influenced by rising temperatures and favorable winds (Harmata 2002). Both species will forage during migration flights, though for bald eagles foraging often is limited to lakes, rivers, streams, and other wetland systems (Mojica *et al.* 2008). Both species use lift from heated air from open landscapes to move efficiently during migration and seasonal movements, gliding from one thermal to the next and sometimes moving in groups with other raptor species.

Passage rates and altitude of migrant eagles can be influenced by temperature, barometric pressure, winds aloft, storm systems, weather patterns at the site of origin, and wind speed (Yates *et al.* 2001). Both species avoid large water bodies during migration and funnel along the shoreline, often becoming concentrated at the tips of peninsulas or in other situations where movement requires water crossings (Newton 1979). Eagles annually use stopover sites with predictably ample food supplies (*e.g.*, Restani *et al.* 2000, Mojica *et al.* 2008), although some stopovers may be brief and infrequent, such as when optimal migration conditions suddenly become unfavorable and eagles are forced to land and seek roosts. Presence of a migration corridor or stopover site in the project area is best documented and delineated by using a standard "hawk watch" migration count as recommended in this ECPG as part of site-specific surveys or, in some cases, by simply expanding point count surveys to account for migration incidence during what normally would be the peak migration period (Appendix C).

Much eagle mortality could occur if communal night roosts or communal foraging areas of eagles are separated by strings of wind turbines from other areas used by eagles. Outside the breeding season, both bald eagles and golden eagles can roost communally. Such roosts can include individuals of all ages and residency status (Platt 1976, Craig and Craig 1984, Mojica *et al.* 2008). During the breeding season, non-breeding bald eagles also may roost communally. Large roosts of eagles tend to be associated with nearby foraging areas. Conversely, eagles also may congregate to forage at sites of unusually high prey or carcass availability; such concentrations of bald eagles may number in the hundreds (Buehler 2000). Methods for documenting concentrations of eagles, and movements to and from such areas in relation to the project footprint are provided in Appendix C.

2. Eagle Risk Factors

Factors that influence vulnerability of eagles to collisions with wind turbines are poorly known. Theoretically, two major elements are likely involved: (1) eagle abundance, and (2) the presence of features or circumstances that decrease an eagle's ability to perceive and avoid collision. However, the relative importance of these factors, and how they interrelate, remains poorly understood for eagles and birds in general (Strickland *et al.* 2011). Table 1 lists some of the factors known or postulated to be associated with turbineblade-strike risk in raptors, but evidence for or against these is equivocal, and may well vary between sites. While some of these factors are not known to affect eagles, because of the similarity of flight behavior between eagles and some other soaring raptors, we include them here because they may apply to eagles. Evidence across multiple studies suggests that in addition to eagle abundance, two main factors contribute to increased risk of collision by eagles: (1) the interaction of topographic features, season, and wind currents that create conditions for high-risk flight behavior near turbines; and (2) behavior that distracts eagles and presumably makes them less vigilant (*e.g.*, active foraging or inter- and intra-specific interactions).

Table 1. Factors potentially associated with wind turbine collision risk in raptors. Not all factors apply to eagles, and the influence of these factors may vary in association with other covariates on a case-by-case basis.

Risk Factor	Status of Knowledge from Literature	Citations
Bird Density	Mixed findings; likely some relationship but other factors have overriding influence across a range of species.	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hunt (2002), Smallwood *et al.* (2009), Ferrer *et al.* (2011)
Bird Age	Mixed findings. Higher number of fatalities among subadult and adult golden eagles in one area. Higher fatalities among adult white-tailed eagles in another.	Hunt (2002), Nygård et al (2010)

Risk Factor	Status of Knowledge from Literature	Citations
Proximity to Nests	White-tailed eagle nesting areas close to turbines have been observed to have low nest success and be abandoned over time.	Nygård et al (2010)
Bird Residency Status	Mixed findings. Higher risk to resident adults in Egyptian vultures (*Neophron percnopterus*). High number of mortalities among subadults and floating adults in golden eagles in one other study.	Barrios and Rodriguez (2004), Hunt (2002)
Season	Mixed findings. In some cases for some species, risk appears higher in seasons with greater propensity to use slope soaring (fewer thermals) or kiting flight (windy weather) while hunting.	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hoover and Morrision (2005), Smallwood *et al.* (2009)
Flight Style	Species most at risk perform more frequent flights that can be described as kiting, hovering, and diving for prey.	Smallwood *et al.* (2009)
Interaction with Other Birds	Higher risk when interactive behavior is occurring.	Smallwood *et al.* (2009)
Active Hunting/ Prey Availability	High risk when hunting close to turbines, across a range of species.	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hoover and Morrision (2005), Hunt (2002), Smallwood *et al.* (2009)
Turbine Height	Mixed, contradictory findings across a range of species.	Barclay *et al.* (2007), De Lucas *et al.* (2008)
Rotor Speed	Higher risk associated with higher blade-tip speed for golden eagles in one study, but this finding may not be generally applicable.	Chamberlain *et al.* (2006)
Rotor-swept Area	Meta-analysis found no effect, but variation among studies clouds interpretation.	Barclay *et al.* (2007)
Topography	Several studies show higher risk of collisions with turbines on ridge lines and on slopes. Also a higher risk in saddles that present low-energy ridge crossing points.	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hoover and Morrission (2005), Smallwood and Thelander (2004)
Wind Speed	Mixed findings, probably locality dependent.	Barrios and Rodriguez (2004), Hoover and Morrision (2005), Smallwood *et al.* (2009)

3. Overview of Process to Assess Risk

This ECPG, and in particular the eagle fatality prediction model described in Appendix D, relies on the assumption that there is predictable relationship between pre-construction eagle occurrence and abundance in the project footprint and subsequent fatalities. Assessing the veracity of this operating hypothesis is a key element of the adaptive management component of the ECPG. The ECPG outlines a decision-making process that gathers information at each stage of project development, with an increasing level of detail. This approach provides a framework for making decisions sequentially at three critical phases in project development: (1) siting, (2) construction, and (3) operations. The greatest potential to avoid and minimize impacts to eagles occurs if eagle risk factors are taken into account at the earliest phase of project development. If siting and construction have proceeded without consideration of risks to eagles, significant opportunities to avoid and minimize risk may have been lost. This can potentially result in greater compensatory mitigation requirements or, in the worst case, an unacceptable level of mortality for eagles.

The related, but more general, WEG advocates using a five-tiered approach for iterative decision making relative to assessing and addressing wildlife effects from wind facilities. Elements of all of those tiers apply here, but the process for eagles is more specifically defined and falls into five broadly overlapping, iterative stages that largely do not parallel the WEG's five tiers (Figures 1 and 2).

Stage 1 for eagles (Appendix B) combines Tiers 1 and 2 from the WEG, and consists of an initial **site assessment**. In this stage project developers or operators evaluate broad geographic areas to assess the relative importance of various areas to resident breeding and non-breeding eagles, and to migrant and wintering eagles. The Service is available to assist project developers or operators in beginning to identify important eagle use areas or migration concentration sites and potential eagle habitat at this stage. To increase the probability of meeting the regulatory requirements for a programmatic take permit, biological advice from the Service and other jurisdictional wildlife agencies should be requested as early as possible in the developer's planning process and should be as inclusive as possible to ensure all issues are being address at the same time and in a coordinated manner. Ideally, consultation with the Service, and state and tribal wildlife agencies is done prior to any substantial financial commitment or finalization of lease agreements. During Stage 1 the project developer or operator should gather existing information from publicly available literature, databases, and other sources, and use those data to judge the appropriateness of various potential project sites, balancing suitability for development with potential risk to eagles.

Once a site has been selected, the next stage, **Stage 2**, is **site-specific surveys and assessments** (this is the first component of Tier 3 in the WEG; Appendix C). During Stage 2 the project developer or operator should collect quantitative data through scientifically rigorous surveys designed to assess the potential risk of the proposed project to eagles. In the case of small wind projects (one or a few small turbines), the project developer or operator should apply the predictive model described in Stage 3 (below) to determine if stage 2 surveys are necessary. In many cases, the hazardous area associated with such projects will be small enough that Stage 2 surveys will not be necessary to demonstrate that the project will likely not take eagles.

In **Stage 3**, **the predicting eagle fatalities stage**, the Service and project developers or operators use data from Stage 2 in standardized models linked to the Service's adaptive management process to generate predictions of eagle risk in the form of average number of fatalities per year extrapolated to the tenure of the permit (see Appendix D). These models can be used to comparatively evaluate alternative siting, construction, and operational scenarios, a useful feature in constructing hypotheses regarding predicted effects of conservation measures and ACPs. We encourage project developers or operators to use the recommended pre-construction survey protocol in this ECPG in Stage 2 to help inform our predictive models in Stage 3. If Service-recommended survey protocols are used, this risk assessment can be greatly facilitated using model tools available from the Service. If project developers or operators use other forms of information for the Stage 2 assessment, they will need to fully describe those methods and the analysis used for the eagle risk assessment, and more time will be required for Service biologists to evaluate and review the data. For example, the Service will compare the results of the project developer or operator's eagle risk assessment with predictions from our models, and if the results differ, we will

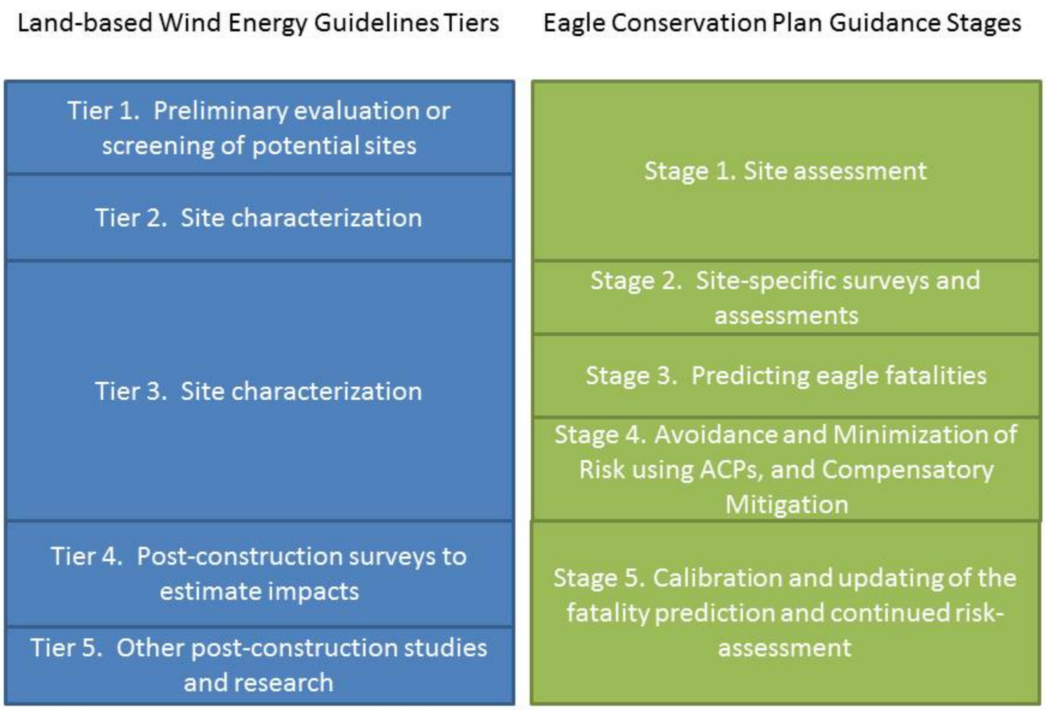

Figure 1. Chart comparing Land-based Wind Energy Guideline tiers with Eagle Conservation Plan Guidance stages.

work with the project developers or operators to determine which model results are most appropriate for the Service's eventual permitting decisions. The Service and project developers or operators also evaluate Stage 2 data to determine whether disturbance take is likely, and if so, at what level. Any loss of production that may stem from disturbance should be added to the fatality rate prediction for the project. The risk assessments at Stage 2 and Stage 3 are consistent with developing the information necessary to assess the efficacy of conservation measures, and to develop the monitoring required by the permit regulations at 50 CFR 22.26(c)(2).

Stage 4 is the avoidance and minimization of risk using conservation measures and ACPs and compensatory mitigation (if required).

Conservation measures and *ACPs*. Regardless of which approach is employed in the Stage 3 assessment, in Stage 4 the information gathered should be used by the project developer or operator and the Service to determine potential conservation measures and ACPs (if available) that can be employed to avoid and/or minimize the predicted risks at a given site (see Appendix E). The Service will compare the initial predictions of eagle mortality and disturbance for the project with predictions that take into account proposed and potential conservation measures and ACPs to determine if the project developer or operator has avoided and minimized risks to the maximum degree achievable, thereby meeting the requirements for programmatic permits in 50 CFR 22.26 that remaining take is unavoidable. Additionally, the Service will use the information provided along with other data to conduct a cumulative effects analysis to determine if the project's impacts, in combination with other permitted take and other known factors affecting the local-area and

Figure 2. General Framework of Tiered Approach in Wind Energy Guidelines Applied to Eagles

TIER 1 (See Stage 1 suggested methods in Appendix B of ECPG)

A. Eagles known to be present?

1. No..........proceed to Tier 2
2. Unknown – Insufficient or inconclusive data..........proceed to Tier 2
3. Yes..........likely Category 1 or 2 site (see ECPG Sec. 4.a or b.), abandon or proceed to Tier 2.

TIER 2 (See Stage 1 suggested methods in Appendix B of ECPG)

A. Probability of take of eagles?

1. Unknown – Insufficient or inconclusive data..........proceed to Tier 3
2. Low..........likely a Category 3 site (see ECPG 4.c.) for which an eagle take permit may not be warranted, but difficult to confirm without Tier 3 surveys.
3. Moderate..........likely a Category 2 site (ECPG 4.b), proceed to Tier 3.
4. High..........likely a Category 1 site (ECPG 4.a.), proceed to Tier 3 or abandon.

TIER 3 (See Stage 2 suggested survey methods in Appendix C of ECPG; Stage 3 and 4 suggested analysis and cumulative effects assessment methods in Appendices D and H of the ECPG; and suggested avoidance, minimization, and mitigation methods in Appendix E of the ECPG.

A. Probability of take of eagles?

1. Low..........likely a Category 3 site (see ECPG 4.c.) for which an eagle take permit may not be warranted.
2. Moderate to high but within preservation standard criteria with avoidance, minimization, and mitigation. likely a Category 2 site (see ECPG 4.b.) for which an eagle take permit is recommended. Developer/operator should apply for an eagle take permit if one is desired.
3. High, and:
   a. can be brought to within preservation standard criteria with avoidance and minimization measures..........likely a category 2 site for which an eagle take permit is recommended. Developer/operator should apply for a permit if one is desired.
   b. cannot be brought to within preservation standard criteria with avoidance and minimization measures..........likely a category 1 site that will take eagles but for which regulatory requirements for a permit could not be met; abandon or modify project.

DECISION ON ISSUANCE OF EAGLE TAKE PERMIT IF REQUESTED AND REGULATORY REQUIREMENTS ARE MET*†

A. Permit conditions:

1. Sets the total eagle take limit for period of up to 5 years.
2. Sets compensatory mitigation requirements.
3. Establishes Tier 4 (ECPG Stage 5) post-construction monitoring requirements and timeframe.
4. Establishes triggers for implementation of actions constituting experimental ACPs within cost ceilings. (see ECPG Sec. 3).
5. Establishes triggers for the need to conduct additional compensatory mitigation (if necessary).

TIER 4 (For projects for which an eagle take permit is issued and after the project is operational; see Stage 5 suggested methods in Appendix F of ECPG)

A. Post-construction monitoring in accordance with the permit conditions reveals eagle take is less than predicted range and ACP/mitigation triggers are not met..........update fatality prediction, post-construction monitoring requirements, and compensatory mitigation requirements for next permit interval; provide credit for excess compensatory mitigation and adjust regional and local area take debits to reflect revised predictions of take.

B. Post-construction monitoring in accordance with the permit conditions reveals eagle take is within predicted range and ACP/mitigation triggers are not met..........update fatality prediction, post-construction monitoring requirements, and compensatory mitigation requirements for next permit interval.

C. Post-construction monitoring in accordance with the permit conditions reveals eagle take is higher than predicted range and/or ACP/mitigation triggers are met..........update fatality prediction, implement experimental ACPs, update post-construction monitoring requirements to emphasize evaluation of experimental ACPs, revise compensatory mitigation requirements if trigger is met, and adjust regional and local area take debits to reflect revised predictions of take.

*Not an explicit element of the WEG.

† Operational wind projects seeking an eagle programmatic take permit enter the Tiered process relative to eagles at this point, between Tiers 3 and 4.

Figure 2. Figure 1 from WEG, adapted to show where and how eagles are considered in that process and which Stage and section of the ECPG are applicable at each Tier of the WEG. Note that existing, operational wind energy projects enter the process between Tiers 3 and 4.

eagle management unit population(s), are at a level that exceed established thresholds or benchmarks (see Appendix F). This final eagle risk assessment is completed at the end of Stage 4 after application of conservation measures and ACPs along with a plan for compensatory mitigation if required.

Compensatory Mitigation. Compensatory mitigation occurs in the eagle permitting process if conservation measures and ACPs do not remove the potential for take, and the projected take exceeds calculated thresholds for the species-specific eagle management unit in which the project is located. Compensatory mitigation may also be necessary in other situations as described in the preamble to 50 CFR 22.26 (USFWS 2009a), and the following guidance applies to those situations as well.

Compensatory mitigation can address any pre-existing mortality source affecting the species-specific eagle management unit impacted by the project (*e.g.* environmental lead abatement, addressing eagle electrocutions due to high risk power poles, etc.) that was in effect at the time of the FEA in 2009 (USFWS 2009b), or it can address increasing the carrying capacity of the eagle population in the affected eagle management unit. However, there needs to be a credible analysis that supports the conclusion that implementing the compensatory mitigation action will achieve the desired beneficial offset in mortality or carrying capacity. All compensatory mitigation projects will be subjected to random inspections by the Service or appointed subcontractors to examine efficacy, accuracy, and reporting rigor.

For new wind development projects, if compensatory mitigation is necessary, the compensatory mitigation action (or a verifiable, legal commitment to such mitigation) will be required up front before project operations commence because projects must meet the statutory and regulatory eagle preservation standard before the Service may issue a permit. For operating projects that may meet permitting requirements, compensatory mitigation should be applied from the start of the permit period, not retroactively from the initiation of project operations. The initial compensatory mitigation contribution effort should be sufficient to offset take at the upper 80% confidence limit (or equivalent) of the predicted number of eagle fatalities per year for a five-year period starting with the date the project becomes operational (or, for operating projects, the date the permit is signed). No later than at the end of the five year period, the predicted annual take estimate will be compared to the realized take as estimated by post-construction monitoring. If the triggers identified in the permit for adjustment of compensatory mitigation are met, those adjustments should be implemented. In the case where the realized take is less than predicted, the permittee will receive a credit for the excess compensation (the difference between the actual mean and the number compensated for) that can be applied to other take (either by the permittee or other permitted individuals at his/her discretion) within the same eagle management unit. Compensatory mitigation for future years for the project will be determined at this point, taking into account the observed levels of mortality and any reduction in that mortality that is expected based on implementation of additional experimental conservation measures and ACPs that might reduce fatalities.

To illustrate an acceptable process for calculating compensatory mitigation, the Service has prepared an example of a strategy using Resource Equivalency Analysis (REA) to quantify the number of power pole retrofits needed to offset the take of golden eagles at a wind project (see Appendix G). The Service used the example of eliminating electrocutions because: (1) high-risk power poles cause quantifiable adverse impacts to eagles; (2) the ‘per

> eagle' effects of high-risk power pole retrofitting are quantifiable and verifiable through accepted practices; (3) success of and subsequent maintenance of retrofitting can be monitored; and (4) electrocution from high-risk power poles is known to cause eagle mortality and this can be corrected. The potential for take of eagles is estimated using informed modeling, as described in Stage 3 of the ECPG (Appendix D). This fatality prediction is one of several fundamental variables that are used to populate the REA (see REA Inputs, Appendix G). The REA generates a project-area eagle impact calculation (debit), expressed in bird-years, and an estimate of the quantity of compensatory mitigation (credit) (*e.g.*, power pole retrofits) necessary to offset this impact. Compensatory mitigation would then be implemented either directly by the project developer or operator or through a formal, binding agreement with a third party to implement the required actions.
>
> Effectiveness monitoring of the resulting compensatory mitigation projects should be included within the above options using the best scientific and practicable method available. The Service will modify the compensatory mitigation process to adapt to any improvements in our knowledge base as new data become available.

At the end of Stage 4, all the materials necessary to satisfy the regulatory requirements to support a permit application should be available. While the application can be submitted at any time, it is only after completion of Stage 4 that the Service can begin the formal process to determine whether a programmatic eagle take permit can be issued or not. Ideally, NEPA and NHPA analyses and assessments will already be underway, but if not, Stage 4 should include necessary NEPA analysis, NHPA compliance, coordination with other jurisdictional agencies, and tribal consultation.

If a permit is issued and the project goes forward, Stage 5 of the process is calibration and updating of the fatality prediction and continued risk assessment, equivalent to Tier 4 and, in part, Tier 5 in the WEG. During this stage, post-construction surveys are conducted to generate empirical data for comparison with the pre-construction risk-assessment fatality and disturbance predictions. The monitoring protocol should include both validated techniques for assessing mortality, and for estimating effects of disturbance to eagles, and they must meet the permit-condition requirements at 50 CFR 22.26(c)(2). We anticipate that in most cases, intensive monitoring to estimate the true annual fatality rate and to assess possible disturbance effects will be conducted for at least the first two years after permit issuance, followed by less intense monitoring for up to three years after the expiration date of the permit, in accordance with monitoring requirements at 50 CFR 22.26(c)(2). We recommend project developers or operators use the post-construction survey protocols included or referenced in this ECPG, but we will consider other monitoring protocols provided by permit applicants. We will use the information from post-construction monitoring in a meta-analysis framework to weight and improve pre-construction predictive models. Additionally in Stage 5 the Service and project developers or operators should use the post-construction monitoring data to (1) assess whether compensatory mitigation is adequate, excessive, or deficient to offset observed mortality, and make adjustments accordingly; and (2) explore operational changes that might be warranted at a project after permitting to reduce observed mortality and ensure that permit condition requirements at 50 CFR 22.26(c)(7) are met.

Table 2 provides a summary of the roles of the project developer or operator and the Service, responsibilities, and decision points at each stage.

Table 2. Roles, responsibilities of the project developers and operators and the Service, and decision points at each stage of the ECP process.

Stage	Project developer/operator role	Service role
1	• Conduct a desktop landscape-level assessment for known or likely occurrence of eagles, including reconnaissance visits to prospective sites. • Consult with the Service on potential for any obvious negative impacts on eagles in at least general locale of prospective sites. • Decision point: select site(s) for Stage 2 study, if appropriate.	• Recommend and help provide existing data and input if requested. • Provide preliminary consultation on appropriateness of application for eagle take permits for sites considered and the likelihood permits could be issued. • Review available Stage 1 data and advise what Stage 2 data are recommended. • Decision point: none.
2	• Conduct detailed, site-specific field studies in the project area to inform eagle fatality prediction model, document important eagle use areas or migration concentration sites, and identify possible eagle disturbance issues. • Coordinate in advance with the Service and other jurisdictional agencies to ensure studies will satisfy regulatory requirements for permitting. • Decision point: choose whether to move to Stage 3.	• Consult on field study design and approach in coordination with other jurisdictional agencies. • Decision point: None.
3	• Optionally generate an estimated annual eagle fatality prediction for the site(s) and an assessment of eagle disturbance risk using data from Stage 2 and model(s) of choice. • Report on all other germane aspects of eagle use such as communal roosts and nest or territory locations. • Decision point: choose whether to move to Stage 4.	• Generate an initial eagle fatality estimate for site(s), using the Service model and survey data from Stage 2. • Assess likelihood of disturbance to eagles; quantify extent and impact of disturbance, if any likely. • Make preliminary recommendation on risk category. • Consult with developer/operator to interpret and resolve discrepancies in conclusions and risk category recommendation. • Decision point: None.
4	• Identify conservation measures and ACP s that can be used to avoid and minimize take identified in Stage 3. • Optionally generate revised fatality and disturbance estimates, taking into account conservation measures and ACPs. • Identify and develop necessary agreements for compensatory mitigation to offset take, if required.	• Re-run Service fatality model to predict fatalities with conservation measures and ACPs. • Re-assess potential for disturbance take with conservation measures and ACPs. • Coordinate with developer/operator to reach agreement on predicted take and risk category. • Coordinate with developer/operator on compensatory mitigation, if requested. • Provide revised preliminary assessment of likelihood site(s) will be permittable if requested.

Stage	Project developer/operator role	Service role
	• Decision point: choose whether to submit eagle take permit application.	• Decision point: None.
Permit Decision	• Draft ECP or equivalent, including a plan for post-construction monitoring of eagle fatality and disturbance. • Submit a permit application that meets requirements at 50 CFR 22.26 or 22.27, including ECP or equivalent information as part of application package. • Choose whether to assist Service in conducting NEPA. • Decision point: None.	• Coordinate and consult on writing of ECP or equivalent, including proposed plan for post-construction. • Convey adequacy of ECP or equivalent to developer/operator. • Evaluate permit application for regulatory sufficiency. • Draft permit conditions drawing on relevant components of ECP or equivalent. • Conduct cumulative effects analysis. • Conduct NEPA review. • Conduct NHPA evaluation. • Coordinate with other jurisdictional agencies. • Consult with Tribes. • Establish limits on future operational adjustments proportionate to risk, in coordination with applicant. • Decision point: whether permit can be issued.
5	• Implement post-construction monitoring in accordance with permit conditions, including immediate reporting of any eagle take. • Participate in scheduled reviews of post-construction monitoring results. • Effect additional compensatory mitigation if necessary. • Implement and monitor additional conservation measures and ACPS, if warranted, within scope of permit sideboards. • Decision point: choose whether to apply for permit renewal near the end of permit term.	• Monitor compliance with permit conditions. • Review post-construction monitoring data, including comparison of predicted and observed annual fatality rate and disturbance. • At no more than 5-year intervals, determine whether revision of the estimated fatality rate, adjustments to monitoring, implementation of additional experimental conservation measures and ACPs, and compensatory mitigation are warranted. • Effect any necessary adjustments by crediting back excess compensatory mitigation, or by assessing additional compensatory mitigation for fatalities in excess of predictions. • Combine monitoring data with that from other projects for meta-analysis within adaptive management framework. • Decision point: determine what adjustments need to be made to compensatory mitigation level, and whether additional conservation measures and ACPs are warranted or not.

4. Site Categorization Based on Mortality Risk to Eagles

We recommend the approach outlined below be used to categorize the likelihood that a site or operational alternative will meet standards in 50 CFR 22.26 for issuance of a programmatic eagle take permit.

a. Category 1 – High risk to eagles, potential to avoid or mitigate impacts is low

A project is in this category if it:

(1) has an important eagle-use area or migration concentration site within the project footprint; or
(2) has a species-specific uncertainty-adjusted annual fatality estimate (average number of eagles predicted to be taken annually) > 5% of the estimated species-specific local-area population size; or
(3) causes the cumulative annual take for the local-area population to exceed 5% of the estimated species-specific local-area population size.

In addition, projects that have eagle nests within ½ the mean project-area inter-nest distance of the project footprint should be carefully evaluated (see Appendix H). If it is likely eagles occupying these territories use or pass through the project footprint, category 1 designation may be appropriate.

Projects or alternatives in category 1 should be substantially redesigned if they are to at least meet the category 2 criteria. Construction of projects at sites in category 1 is not recommended because the project would likely not meet the regulatory requirements for permit issuance and may place the project developer or operator at risk of violating the BGEPA. The recommended approach for assessing the percentage of the local-area population predicted to be taken is described in Appendix F.

b. Category 2 – High or moderate risk to eagles, opportunity to mitigate impacts

A project is in this category if it:

(1) has an important eagle-use area or migration concentration site within the project area but not in the project footprint; or
(2) has a species-specific uncertainty-adjusted fatality estimate between 0.03 eagles per year and 5% of the estimated species-specific local-area population size; or
(3) causes cumulative annual take of the species-specific local-area population of less than 5% of the estimated local-area population size.

Projects in this category will potentially take eagles at a rate greater than is consistent with maintaining stable or increasing populations, but the risk might be reduced to an acceptable level through a combination of conservation measures and reasonable compensatory mitigation. These projects have a risk of ongoing take of eagles, but this risk can be minimized. For projects in this category the project developer or operator should prepare an ECP or similar plan to document meeting the regulatory requirements for a programmatic permit. For eagle management populations where take thresholds are set at zero, the conservation measures in the ECP should include compensatory mitigation and must result in no-net-loss to the breeding population to be compatible with the permit regulations. This does not apply to golden eagles east of the 100th meridian, for which no non-emergency take can presently be authorized (USFWS 2009b).

c. Category 3 – Minimal risk to eagles

A project is in this category if it:

(1) has no important eagle use areas or migration concentration sites within the project area; and
(2) has a species-specific uncertainty-adjusted annual fatality rate estimate of less than 0.03 for both species of eagle; and
(3) causes cumulative annual take of the local-area population of less than 5% of the estimated species-specific local-area population size.

Projects in category 3 pose little risk to eagles and may not require or warrant eagle take permits, but that decision should be made in coordination with the Service. Still, a project developer or operator may wish to create an ECP that documents the project's low risk to eagles, and outlines mortality monitoring for eagles and a plan of action if eagles are taken during project construction or operation. If take should occur, the developer or operator should contact the Service to discuss ways to avoid take in the future. Such an ECP would enable the Service to provide a permit to allow a *de minimis* amount of take if the project developer or operator wished to obtain such a permit.

The risk category of a project has the potential to change from one of higher risk to one of lower risk or one of lower risk to one of higher risk through additional site-specific analyses and application of measures to reduce the risk. For example, a project may appear to be in category 2 as a result of Stage 1 analyses, but after collection of site-specific information in Stage 2 it might become clear it is a category 1 project. If a project cannot practically be placed in one of these categories, the project developer or operator and the Service should work together to determine if the project can meet programmatic eagle take permitting requirements in 50 CFR 22.26 and 22.27. Projects should be placed in the highest category (with category 1 being the highest) in which one or more of the criteria are met.

5. Cumulative Effects Considerations

a. Early Planning

Regulations at 50 CFR 22.26 require the Service to consider the cumulative effects of programmatic eagle take permits. Cumulative effects are defined as: "the incremental environmental impact or effect of the proposed action, together with impacts of past, present, and reasonably foreseeable future actions" (50 CFR 22.3). Thorough cumulative effects analysis will depend on effective analysis during the NEPA process associated with an eagle permit. Scoping and other types of preliminary analyses can help identify important cumulative-effects factors and identify applicable past, present, and future actions. Comprehensive evaluation during early planning may identify measures that would avoid and minimize the effects to the degree that take of eagles is not likely to occur. In that case, there may be no permit, and thus no need for NEPA associated with an eagle take permit. When a wind project developer or operator seeks an eagle take permit, a comprehensive cumulative effects analysis at the early planning stage will serve to streamline subsequent steps, including the NEPA process.

The Service recommends that cumulative effects analyses be consistent with the principles of cumulative effects outlined in the Council on Environmental Quality (CEQ) handbook, "Considering Cumulative Effects under the National Environmental Policy Act (1997) (CEQ handbook). The Service recommends consideration of the following examples from the CEQ handbook that may apply to cumulative effects to eagles and the ecosystems they depend upon:

(1) Time crowding - frequent and repetitive effects on an environmental system;
(2) Time lags - delayed effects;
(3) Space crowding - High spatial density of effects on an environmental system;
(4) Cross- boundary - Effects occur away from the source;
(5) Fragmentation - change in landscape pattern;
(6) Compounding effects - Effects arising from multiple sources or pathways;
(7) Indirect effects - secondary effects; and
(8) Triggers and thresholds - fundamental changes in system behavior or structure.

b. Analysis Associated with Permits

The cumulative effects analysis for a wind project and a permit authorization should include whether the anticipated take of eagles is compatible with eagle preservation as required at 50 CFR 22.26, including indirect impacts associated with the take that may affect eagle populations. It should also include consideration of the cumulative effects of other permitted take and additional factors affecting eagle populations.

Whether or not a permit authorization is compatible with eagle preservation was analyzed in the FEA that established the thresholds for take (USFWS 2009b). The scale of that analysis was based upon eagle management units as defined in USFWS (2009b). However, the scale for cumulative effects analysis of wind projects and associated permits should include consideration of the effects at the local-population scale as well.

The cumulative effects analyses for programmatic permits should cover the time period over which the take will occur, not just the period the permit will cover, including the effect of the proposed action, other actions affecting eagles, predicted climate change impacts, and predicted changes in number and distribution of affected eagle populations. Effects analyses should note whether the project is located in areas where eagle populations are increasing or predicted to increase based on available data, over the lifetime of the project, even if take is not anticipated in the immediate future. In addition, conditions where populations are saturated should be considered in cumulative effects analyses. Numerous relatively minor disruptions to eagle behavior from multiple activities, even if spatially or temporally distributed, may lead to disturbance that would not have resulted from fewer or more carefully sited activities (*e.g.*, Whitfield *et al.* 2007). Additional detailed guidance for cumulative impacts analyses can be found on the Council on Environmental Quality website at *http://ceq.hss.doe.gov/nepa/ ccenepa/ ccenepa.htm*.

Specific recommendations for conducting cumulative effects analysis of the authorized take under eagle programmatic take permits is provided in Appendix F.

ADAPTIVE MANAGEMENT

Management of wind facilities to minimize eagle take, through decisions about siting, design, operation, and compensatory mitigation, is a set of recurrent decisions made in the face of uncertainty. The Department of the Interior has a long history of approaching such decisions through a process of adaptive management (Williams *et al.* 2007). The purpose of adaptive management is to improve long-term management outcomes, by recognizing where key uncertainties impede decision making, seeking to reduce those uncertainties over time, and applying that learning to subsequent decisions (Walters 1986).

In the case of managing eagle populations in the face of energy development there is considerable uncertainty to be reduced. For example, evidence shows that in some areas or specific situations, large soaring birds, specifically raptors, are vulnerable to colliding with wind turbines (Barrios and Rodriguez 2004, Kuvlesky *et al.* 2007). However, we are uncertain about the relative importance of factors that influence that risk. We are also uncertain about the best way to mitigate the effects of wind turbine developments on raptors; we suspect some strategies might be effective, others are worth trying. We also suspect that a few species, including golden eagles (USFWS 2009b), may be susceptible enough to collisions with wind turbines that populations may be negatively affected. Thus, there are uncertainties at several levels that challenge our attempts to manage eagle populations: (1) at the level of understanding factors that affect collision risk, (2) at the level that influences population trends, and (3) about the efficacy of various mitigation options. The Service, our conservation partners, and industry will never have the luxury of perfect information before needing to act to manage eagles. Our goal is to reduce that uncertainty through use of formal adaptive management, thereby improving our predictive capability over time. Applying a systematic, cohesive, nationally-consistent strategy of management and monitoring is necessary to accomplish this goal.

In the context of wind energy development and eagle management under the ECPG, there are four specific sets of decisions that will be approached through adaptive management: (1) adaptive management of wind project operations; (2) adaptive management of wind project siting and design recommendations; (3) adaptive management of compensatory mitigation; and (4) adaptive management of population-level take thresholds. These are discussed in more detail in Appendix A. The adaptive management process will depend heavily on pre- and post-construction data from individual projects, but analyses, assessment, and model evaluation will rely on data pooled over many individual wind projects. Therefore, individual project developers or operators will have limited direct responsibilities for conducting adaptive management analyses, other than to provide data through post-construction monitoring.

EAGLE CONSERVATION PLAN DEVELOPMENT PROCESS

The following sections of the ECPG, including attached appendices, provide a descriptive instructional template for developing an ECP. Throughout this section, we use the term ECP to include any other document or collection of documents that could be considered equivalent to an ECP. The ECP is an integral part of the permit process, and the following chronological step-by-step outline shows how the pieces fit together:

The ECPG provides guidance and serves as a reference for project developers or operators, the Service, and other jurisdictional agency biologists when developing and evaluating ECPs. Using the ECPG as a non-binding reference, the Service will work with project developers or operators to develop an ECP. The ECP documents how the project developer or operator intends to comply with the regulatory requirements for programmatic permits and the associated NEPA process by avoiding and minimizing the risk of taking eagles up-front, and formally evaluating possible alternatives in (ideally) siting, configuration, and operation of wind projects. The Service's ability to influence siting and configuration factors depends on the stage of development of the project at the time the project developer or operator comes to us.

The Service recommends that project developers or operators develop an ECP following the five-staged approach described earlier. During Stages 1 through 4, projects or alternatives should be placed in one of the three risk categories, with increasing certainty by Stage 4. The ECP should provide detailed information on siting, configuration, and operational alternatives that avoid and minimize eagle take to the point any remaining take is unavoidable and, if required, mitigates that remaining take to meet the statutory preservation standard. The Service will use the ECP and other application materials to either develop an eagle take permit for the project, or to determine that the project cannot be permitted because risk to eagles is too high to meet the regulatory permit requirements.

For permitted projects, the Service will use the 80% upper confidence limit or similar risk-averse estimate (*e.g.*, the upper limit of the 80% credible interval is used in the Service's predictive model described in Appendix D) of the mean annual predicted unavoidable eagle take to determine likely population-level effects of the permit and compensatory mitigation levels, if required. For predicted recurring eagle take that is in excess of calculated eagle management unit take thresholds, the Service will either (a) approve a compensatory mitigation proposal from the project developer or operator; or (b) accept, if sufficient, a commitment of funds to an appropriate independent third party that is formally obligated (via contract or other agreement with the project developer or operator) to perform the approved mitigation work. Under either (a) or (b), the compensatory mitigation cost and actions will be calibrated so as to offset the predicted unavoidable take, such that we bring the individual permit's (and cumulatively over all such permits') predicted mortality effect to a no-net-loss standard. Compensatory mitigation will initially be based on the upper 80% confidence limit of the predicted mean annual fatality rate (or similar risk-averse estimate) over a five year period, and it will be adjusted for future years based on the observed fatality rate over the initial period of intensive post-construction monitoring (no less than 2 years). Compensatory mitigation, as well as other forms of mitigation aimed at reducing other detrimental effects of permits on eagles, may also be necessary in other situations where predicted effects to eagle populations are substantial and not consistent with stable or increasing breeding populations of eagles.

Post-construction monitoring may be required as a condition of an eagle programmatic take permit and will be required for wind-energy projects that may potentially take eagles. This monitoring should be systematic and standardized to be suitable for use in a formal adaptive management framework to evaluate and improve the predictive accuracy of our models. In addition, the information will be used by the Service and the project developer or operator to determine if, after no more than five years of post-construction monitoring, the 80% upper confidence limit on the predicted mean number of annual fatalities adequately captured the observed estimated mean number of fatalities annually. If the observed and predicted estimates of annual fatalities are different, either additional compensatory mitigation will be required retroactively to offset higher-than-predicted levels of take (assuming the actual number of eagles taken was greater than the number actually compensated for), or the permittee will receive a credit for the excess compensation (the difference between the actual mean and the number compensated for) that can be applied to other take (either by the permittee or other permitted individuals at his/her discretion) within the same eagle management unit at any time in the future.

At no more than five-years from the date a permit is issued, the permittee will compile and the Service and the permittee will review fatality information for the project to determine if experimental ACPs should be implemented to potentially reduce eagle mortalities based on the observed, specific situation at each site. As discussed previously, at the time of permit issuance the Service and the project developer or operator will agree to an upper limit on the cost of such future experimental ACPs, which will only be implemented if warranted by eagle disturbance or mortality data. If these experimental ACPs are likely to reduce mortalities at the project in the future, the amount of future compensatory mitigation will be decreased accordingly (*e.g.* if ACPs are predicted to reduce the fatality rate from three to two eagles annually, compensatory mitigation would only be required to offset the future predicted take of two eagles per year). In such cases, additional post-implementation monitoring should be conducted to determine the effectiveness of the experimental ACPs. In cases where observed fatalities exceed predicted to the degree category 1 fatality-rate criteria are confirmed to have been met or exceeded by a permitted project, and for whatever reason experimental ACPs or additional conservation measures cannot be implemented to reduce fatalities to category 2 levels or below, the Service may have to rescind the permit for that project to remain in compliance with regulatory criteria.

Programmatic eagle take permits will be conditioned to require access to the areas where take is possible and where compensatory mitigation is being implemented by Service personnel, or other qualified persons designated by the Service, within reasonable hours and with reasonable notice from the Service, for purposes of monitoring the site(s). The regulations provide, and a condition of any permit issued will require, that the Service may conduct such monitoring while the permit is valid, and for up to three years after it expires (50 CFR 22.26(c)(4)). In general, verifying compliance with permit conditions is a secondary purpose of site visits; the primary purpose is to monitor the effects and effectiveness of the permitted action and mitigation measures. This may be done if a project developer or operator is unable to observe or report to the Service the information required by the annual report—or it may serve as a "quality control" measure the Service can use to verify the accuracy of reported information and/or adjust monitoring and reporting requirements to provide better information for purposes of adaptive management.

1. Contents of the Eagle Conservation Plan

This section provides a recommended outline for an ECP, with a short description of what should be contained in each section. See previous sections and referenced appendices for details on the stages and categories.

a. Stage 1

Data from Stage 1 should be presented and summarized in this section of the ECP. The project developer or operator should work with the Service to place potential wind–facility site in a category based on the Stage 1 information. For detailed recommendations on the Stage 1 process, see Appendix B.

b. Stage 2

Data from Stage 2 should be presented and summarized in this section of the ECP. For detailed recommendations on the Stage 2 methods and metrics, see Appendix C. The risk categorization should be re-assessed in this section, taking into account Stage 2 results.

c. Stage 3

In this section of the ECP, project developers or operators should work in coordination with the Service to calculate a prediction of the annual eagle fatality rate and confidence interval for the project using data generated from the Stage 2 assessment. The initial estimate of the fatality rate should not take into account possible conservation measures and ACPs; these will be factored in as part of Stage 4. For detailed recommendations on Stage 3 methods and metrics, see Appendix D. The risk categorization should be re-assessed in this section, taking into account Stage 3 results.

d. Stage 4

This section of the ECP should describe how proposed conservation measures and ACPs should reduce the fatality rate generated in stage 3, and what compensatory mitigation measures will be employed to offset unavoidable take, if required. This section facilitates demonstrating how conservation measures and ACPs have reduced the raw predicted fatality rate to the unavoidable standard. For detailed recommendations on considerations for the development of conservation measures and ACPs see Appendix E. The risk categorization should be re-assessed in this section, taking into account Stage 4 results. This should be the final pre-construction risk categorization for the proposed project. This section should also fully describe the proposed compensatory mitigation approach (if required). For detailed recommendations regarding compensatory mitigation, see Appendix G.

e. Stage 5 – Post-construction Monitoring

In this section of the ECP, the project developer or operator should describe the proposed post-construction survey methodology for the project. Detailed recommendations for post-construction monitoring are in Appendix H. The Stage 5 post-construction monitoring plan is the final section of the ECP.

INTERACTION WITH THE SERVICE

As noted throughout this ECPG, frequent and thorough coordination between project developers or operators and Service and other jurisdictional-agency employees is crucial to the development of an effective and successful ECP. Close coordination will also be necessary in the refinement of the modeling process used to predict fatalities, as well as in post-construction monitoring to evaluate those models. We anticipate the ECPG and the recommended methods and metrics will evolve rapidly as the Service and project developers or operators learn together. The Service has created a cross-program, cross-regional team of biologists who will work jointly on eagle-programmatic-take permit applications to help ensure consistency in administration and application of the Eagle Permit Rule. This close coordination and interaction is especially important as the Service processes the first few programmatic eagle take permit applications.

The Service will continue to refine this ECPG with input from all stakeholders with the objective of maintaining stable or increasing breeding populations of both bald and golden eagles while simultaneously developing science-based eagle-take regulations and procedures that are appropriate to the risk associated with each wind energy project. As the ECPG evolves, the Service will not expect project developers or operators to retroactively redo analyses or surveys using the new approaches. The adaptive approach to the ECPG should not deter project developers or operators from using it immediately.

INFORMATION COLLECTION

The Bald and Golden Eagle Protection Act authorizes us to collect information in order to issue permits for eagle take. The Eagle Conservation Plan Guidance defines and clarifies the information required for a permit application (FWS Form 3-200-71) and the associated annual report (FWS Form 3-202-15). We use the collected information to evaluate whether the take is compatible with the preservation of the eagle; to determine if take is likely and how it can be avoided and minimized; to determine if the applicant will take reasonable measures to minimize the take; and to assess how the activity actually affects eagles in order to adjust mitigation measures for that project and for future permits.

We may not conduct or sponsor, nor are you required to respond, to a collection of information unless it displays a currently valid Office of Management and Budget control number. The burden for the information collection associated with eagle permits and reports is approved under OMB Control No. 1018-0022 (Federal Fish and Wildlife Permit Applications and Reports--Migratory Birds and Eagles) and OMB Control No. 1018-0148 (Land-Based Wind Energy Guidelines).

GLOSSARY

Active nest – see occupied nest.

Adaptive resource management – an iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

Advanced conservation practices (ACP) – means scientifically supportable measures that are approved by the Service and represent the best available techniques to reduce eagle disturbance and ongoing mortalities to a level where remaining take is unavoidable. ACPs are a special subset of conservation measures that must be implemented where they are applicable.

Adult – an eagle five or more years of age.

Alternate nests – additional sites within a nesting territory that are available to be used.

Avoidance and minimization measures – conservation actions targeted to remove or reduce specific risk factors (*e.g.*, avoiding important eagle use areas and migration concentration sites, placing turbines away from ridgelines). A subset of conservation measures.

Benchmark – an eagle harvest rate at the local-area population scale that should trigger heightened scrutiny.

Breeding territory – equivalent to eagle territory.

Calculated take thresholds – annual allowable eagle take limits established in USFWS (2009b).

Collision probability (risk) – the probability that an eagle will collide with a turbine given exposure.

Compensatory mitigation – replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value. In the case of an the ECPG, an action in the eagle permitting process that offsets the predicted take of eagles if ACPs and other conservation measures do not completely remove the potential for take, and projected take exceeds calculated take thresholds for the species or the eagle management unit affected (or in some cases, under other circumstances as described in USFWS 2009a).

Conservation measures – actions that avoid (this is best achieved at the siting stage), minimize, rectify, reduce, eliminate, or mitigate an effect over time. ACPs are conservation measures that have scientific support and which must be implemented where they are applicable.

Discount rate – the interest rate used in calculating the present value of expected yearly benefits and costs.

Disturb - means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

Eagle Conservation Plans (ECP) – a document produced by the project developer or operator in coordination with the Service that supports issuance of an eagle take permit under 50 CFR 22.26 and potentially 22.27 (or demonstrates that such a permit is unnecessary).

Eagle Management Unit – regional eagle populations defined in the FEA (USFWS 2009b). For golden eagles, eagle management units follow Bird Conservation Regions (Figure 2), whereas bald eagle management units largely follow Service regional boundaries (Figure 3).

Eagle exposure rate – Eagle-minutes flying within the project footprint (in proximity to turbine hazards) per hour (hr) per kilometer^2 (km^2).

Eagle nest (or nest) – any readily identifiable structure built, maintained or used by bald eagles or golden eagles for the purposes of reproduction (as defined in 50 CFR 22.3).

Eagle territory – an area that contains, or historically contained, one or more nests within the home range of a mated pair of eagles (from the regulatory definition of "territory" at 50 CFR 22.3). "Historical" is defined here as at least the previous 5 years.

Experimental ACPs – prospective conservation measures identified at the start of a programmatic eagle take permit that are not implemented immediately, but are deferred pending the results of post-construction monitoring. If such monitoring indicates the measures might reduce observed eagle fatalities, they should be implemented and monitored for a sufficient period of time to determine their effectiveness.

Fatality monitoring – searching for eagle carcasses beneath turbines and other facilities to estimate the number of fatalities.

Fatality rate – (1) in fatality prediction models, the fatality rate is the number of eagle fatalities per hr per km^2; (2) elsewhere in the ECPG it is the number of eagles taken or predicted to be taken per year.

Floater (floating adult) – an adult eagle that has not settled on a breeding territory.

Hazardous area – Rotor-swept area around a turbine or proposed turbine (km^2).

Home range – the area traveled by and eagle in its normal activities of food gathering, mating, and caring for young. Breeding home range is the home range during the breeding season, and the non-breeding home range is the home range outside the breeding season.

Important eagle-use area – an eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles (as defined at 50 CFR 22.26).

Inactive nest – a bald eagle or golden eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive days immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Eagle Act.

Inventory – systematic observations of the numbers, locations, and distribution of eagles and eagle resources such as suitable habitat and prey in an area.

Jurisdictional agency – a government agency with jurisdictional authority to regulate an activity (*e.g.*, a state or tribal fish and wildlife agency, a state or federal natural resource agency, etc.).

Juvenile – an eagle less than one year old.

Kiting – stationary or near-stationary hovering by a raptor, usually while searching for prey.

Local-area population – is as defined in USFWS (2009b), and refers to the eagle population within a distance from the project footprint equal to the species median natal-dispersal distance (43 miles for bald eagles and 140 miles for golden eagles).

Mean inter-nest distance – the mean nearest-neighbor distance between simultaneously occupied eagle nests.

Meteorological towers (met towers) – towers erected to measure meteorological events such as wind speed, direction, air temperature, etc.

Migration concentration sites – places where geographic features (*e.g.,* north-south oriented ridgelines, peninsulas) funnel migrating eagles, resulting in concentrated use during migration periods.

Migration corridors – the routes or areas where eagles may concentrate during migration (*e.g.*, funneling areas along ridgetops, at tips of peninsulas) as a result of the interplay between weather variables and topography.

Migration counts – standardized counts that can be used to determine relative numbers of diurnal raptors passing over an established point during fall or spring migration.

Mitigation – avoidance, minimization, rectification, reduction over time, and compensation for negative impacts to bald eagles and golden eagles from the permitted actions. In the ECPG, we use the term compensatory mitigation to describe the subset of mitigation actions designed to offset take to achieve the no-net-loss standard.

Monitoring – (1) a process of project oversight such as checking to see if activities were conducted as agreed or required; (2) making measurements of uncontrolled events at one or more points in space or time with space and time being the only experimental variable or treatment; (3) making measurements and evaluations through time that are done for a specific purpose, such as to check status and/or trends or the progress towards a management objective.

No-net-loss – no net change in the overall eagle population mortality or natality rate after issuance of a permit that authorizes take, because compensatory mitigation reduces another form of mortality, or increases natality, by a comparable amount.

Occupied nest – a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied.

Occupied territory – an area that encompasses a nest or nests or potential nest sites and is defended by a mated pair of eagles.

Operational adjustments – modifications made to an existing wind project that changes how that project operates (*e.g.*, increasing turbine cut in speeds, implementing curtailment of turbines during periods of high eagle use).

Posterior distribution (Bayesian) – a distribution that quantifies the uncertainty in the model parameters after incorporating the observed data. The distributions are usually summarized by intervals around the median.

Present value – within the context of a Resource Equivalency Analysis (REA), refers to the value of debits and credits based on an assumed annual discount rate (3%). This term is commonly used in economics and implies that resources lost or gained in the future are of less value to us today.

Prior distribution (Bayesian) – a distribution that quantifies the uncertainty in the model parameters from previous data or past knowledge. A non-informative prior can be used to imply that little or nothing is known about the parameters.

Programmatic take – take that is recurring, is not caused solely by indirect effects, and that occurs over the long term or in a location or locations that cannot be specifically identified (as defined in 50 CFR 22.3).

Project area – the area that includes the project footprint as well as contiguous land that shares relevant characteristics. For eagle-take considerations, the Service recommends the project area be either project footprint and a surrounding perimeter equal to the mean species-specific inter-nest distance for eagles locally, or the project footprint and a 10-mile perimeter.

Project-area inter-nest distance – the mean nearest-neighbor distance between simultaneously occupied eagle nests of a species (including occupied nests in years where no eggs are laid). We recommend calculating this metric from the nesting territory survey in Stage 2, using all nesting territories within the project area, ideally over multiple years.

Project-area nesting population – number of pairs of eagles nesting within the project area.

Project-area eagle population – the population of eagles, considering breeding, migrating, and wintering eagles, within the project area.

Project footprint – the minimum-convex polygon that encompasses the wind-project area inclusive of the hazardous area around all turbines and any associated utility infrastructure, roads, etc.

Project developer or operator – any developer or operator that proposes to construct a wind project.

Productivity — the number of juveniles fledged from an occupied nest, often reported as a mean over a sample of nests.

Renewable energy – energy produced by solar, wind, geothermal or any other methods that do not require fossil fuels.

Resource Equivalency Analysis (REA) – in the context of the ECPG, a methodology used to compare the injury to or loss of eagles caused by wind facilities (debit) to the benefits from projects designed to improve eagle survival or increase productivity (credits). Compensation is evaluated in terms of eagles and their associated services instead of by monetary valuation methods.

Retrofit – any activity that results in the modification of an existing power line structure to make it bird safe.

Risk-averse – a conservative estimate in the face of considerable uncertainty. For example, the Service typically will use the upper 80% credible interval of the median estimated number of annual eagle fatalities for permit decisions in an effort to avoid underestimating fatality rates at wind projects.

Risk validation – as part of Stage 5 assessment, where post-construction surveys are conducted to generate empirical data for comparison with the pre-construction risk assessment predictions to validate if the initial assumptions were correct.

Roosting – activity where eagles seek cover, usually during night or periods of severe weather (*e.g.*, cold, wind, snow). Roosts are usually found in protected areas, typically tree rows or trees along a river corridor.

Seasonal concentration areas – areas used by concentrations of eagles seasonally, usually proximate to a rich prey source.

Site categorization – a standardized approach to categorize the likelihood that a site or operational alternative will meet standards in 50 CFR 22.26 for issuance of a programmatic eagle take permit.

Stopover sites – areas temporarily used by eagles to rest, seek forage, or cover on their migration routes.

Subadult – an eagle between 1 and 4 years old, typically not of reproductive age.

Survey –combined inventory and monitoring.

Take threshold – an upper limit on the annual eagle harvest rate for each species-specific eagle management unit. Thresholds were set in the Final Environmental Assessment on the Eagle Permit Rule (USFWS 2009b).

Territory – area that contains, or historically contained, one or more nests within the home range of a mated pair of eagles (from 50 CFR 22.3).

Unoccupied nest – those nests not selected by raptors for use in the current nesting season. See also inactive nest.

U.S. Fish and Wildlife Service Draft Land-based Wind Energy Guidelines (WEG) – a document that describes a multi-tiered process to site, construct, operate and monitor wind facilities in ways that avoid, minimize, and mitigate impacts to wildlife.

Wind facilities – developments for the generation of electricity from wind turbines.

Wind project – developments for the generation of electricity from wind turbines.

Wind turbine – a machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity.

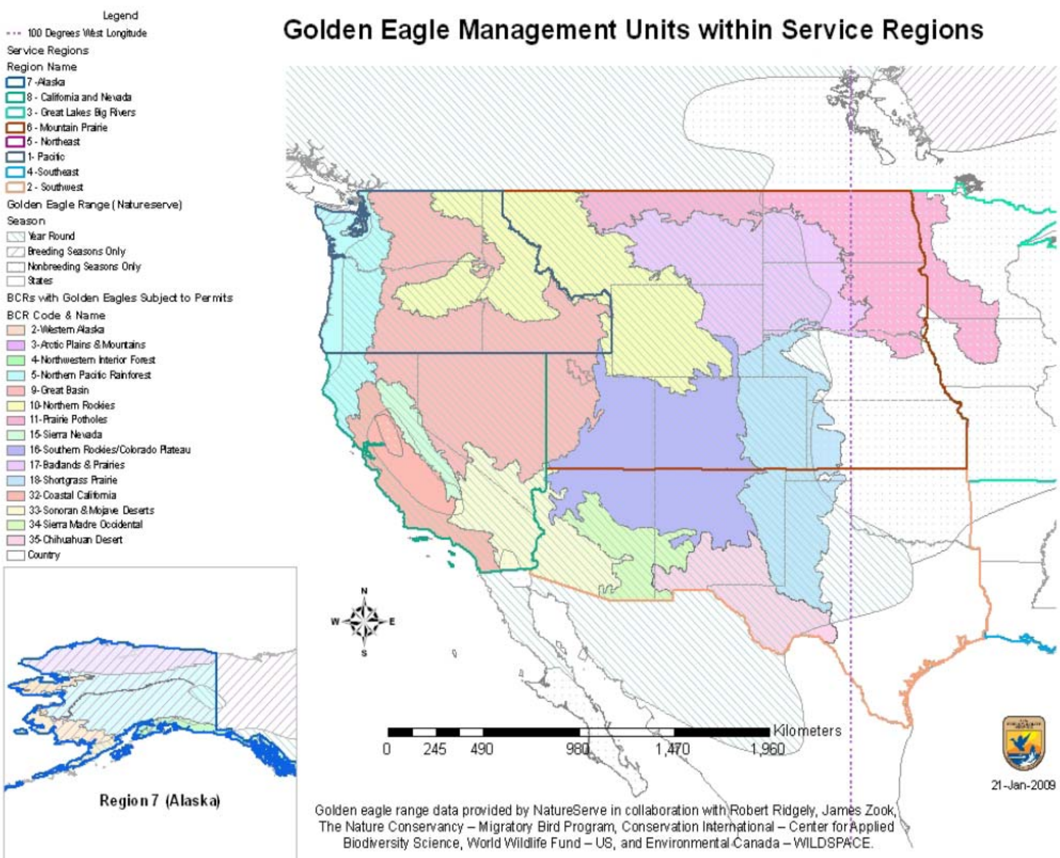

Figure 2. Map of golden eagle management units, from USFWS (2009b).

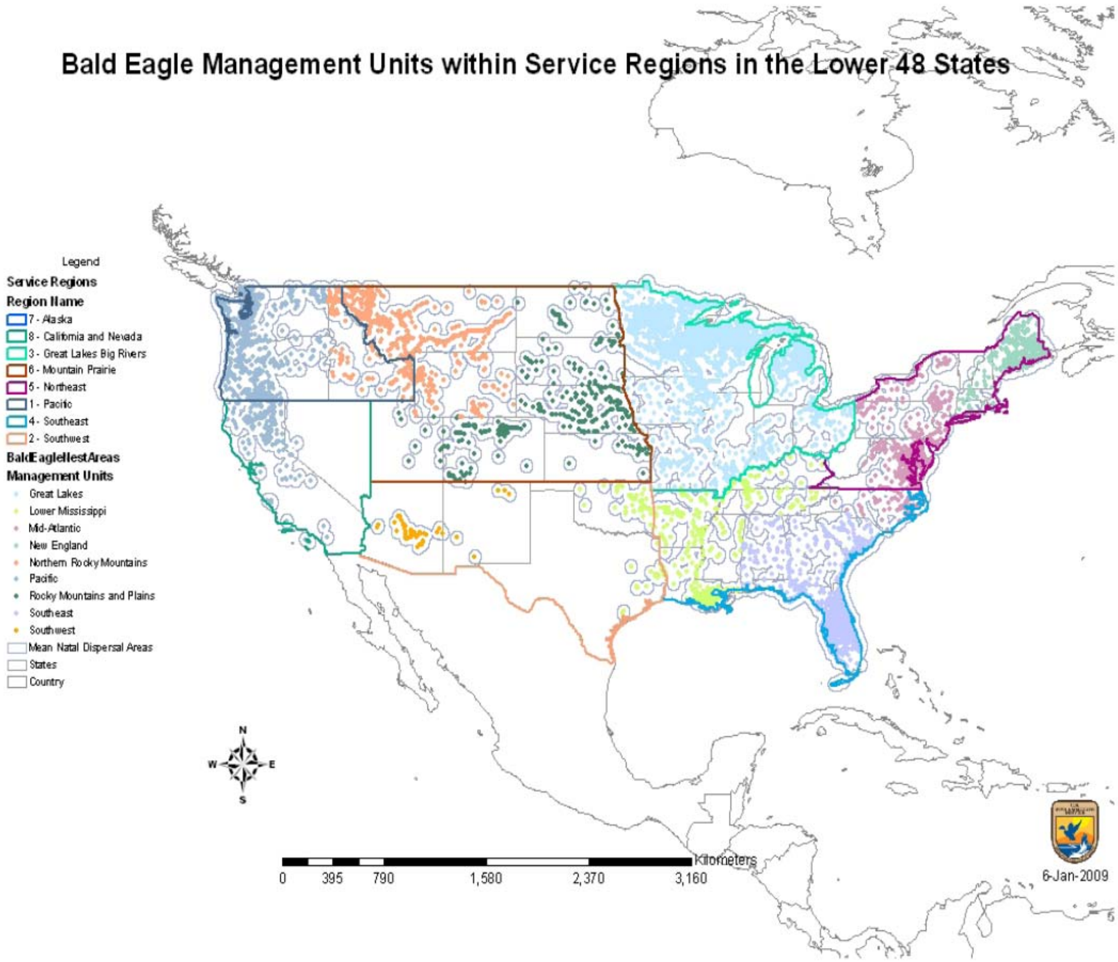

Figure 3. Map of bald eagle management units, from USFWS (2009b).

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APPENDIX A: ADAPTIVE MANAGEMENT

Management of wind facilities to minimize eagle take through decisions about siting, design, operation, and compensatory mitigation, is a set of recurrent decisions made in the face of uncertainty. The Department of the Interior has a long history of approaching such decisions through a process of adaptive management (Williams *et al.* 2007). The purpose of adaptive management is to improve long-term management outcomes, by recognizing where key uncertainties impede decision making, seeking to reduce those uncertainties over time, and applying that learning to subsequent decisions (Walters 1986).

Adaptive management is a special case of decision analysis applied to recurrent decisions (Lyons *et al.* 2008). Like all formal decision analysis, it begins with the identification of fundamental objectives—the long-term ends sought through the decision (step 2, Fig. A-1). These objectives are the primary concern, and all the other elements are designed around them. With these objectives in mind, alternative actions are considered, and the consequences of these alternatives are evaluated with regard to how well they might achieve the objectives. But in many decisions, there is critical uncertainty that impedes the decision (step 6, Fig. A-1), that is, the decision-maker is missing knowledge that affects which alternative might be best. In recurrent decisions, there exists the opportunity to reduce that uncertainty, by monitoring the outcomes of early actions, and apply that learning to later actions. It is valuable to note that learning is not pursued for its own sake, but only insofar as it helps improve long-term management by reducing these uncertainties.

There are two hallmarks of a formal interpretation of adaptive management, like that described above. The first hallmark is the *a priori* identification of the critical uncertainty. In this way, adaptive management is not a blind search for some unspecified new insights, but a focused effort to reduce the uncertainty that stands in the way of better decision-making. The second hallmark is that the means of adaptation is clear, that is, the way in which new information will be applied to subsequent decisions is articulated.

There is, however, recognition that unanticipated learning does occur in any real system, and this learning can sometimes lead to valuable insights. In so-called “double-loop learning” (Argyris and Shon 1978), the learning might even lead to a re-framing of the decision, a re-examination of the objectives, or consideration of new alternatives (this could be represented by a loop from step 7 to step 1 in Fig. A-1). In the context of eagle management at wind facilities, the Service’s focus is on the inner-loop learning (represented by the feedback from step 7 to 8 to 4 in Fig. A-1), but unanticipated learning will not be ignored.

In the case of managing eagle populations in the face of energy development, there is considerable uncertainty to be reduced. For example, we believe that in some areas or specific situations, large soaring birds, specifically raptors, might be especially vulnerable to colliding with wind turbines (Barrios and Rodriguez 2004, Kuvlesky *et al.* 2007), but we are uncertain about the relative importance of factors that influence that risk. We are also uncertain about the best way to mitigate the effects of wind turbine developments on raptors; we suspect some strategies might be effective, others are worth trying. We also suspect that a few species, including golden eagles (USFWS 2009), may be susceptible enough to collisions with wind turbines that populations may be negatively affected. Thus, there are uncertainties at several levels that challenge our attempts to manage eagle populations: (1) at the level of understanding factors that affect collision risk, (2) at the level that influences population trends, and (3) about the efficacy of various mitigation options. The Service, our conservation partners, and industry will never have the luxury of perfect information before needing to act to manage eagles. We are therefore left to make management decisions based on the best available information with some inherent degree of uncertainty about the outcomes of those decisions. Our goal is to reduce that uncertainty through use of formal adaptive management, thereby improving our predictive capability over time. Applying a systematic, cohesive, nationally-consistent strategy of management and monitoring is necessary to accomplish this goal.

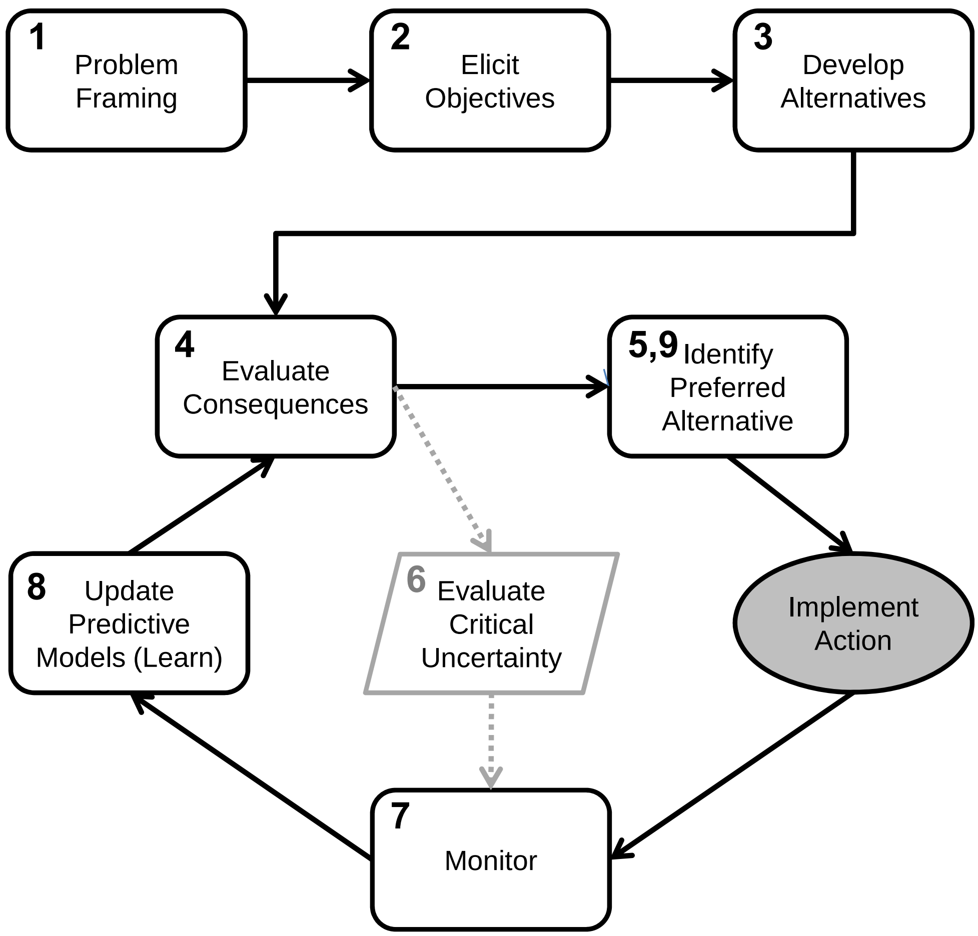

Figure A-1: A framework for adaptive resource management (ARM). At the core of adaptive management is critical uncertainty that impedes the identification of a preferred alternative. When decisions are recurrent, implementation coupled with monitoring can resolve uncertainty, and allow future decisions to reflect that learning. (Figure from Runge 2011).

1. Adaptive Management as a Tool

Using adaptive management as a tool to manage wildlife populations is not new to the Service. We and other agencies are increasingly using the principles of adaptive management across a range of programs, including waterfowl harvest management (Johnson *et al.* 1997), endangered species (Runge 2011), and habitat management at local and landscape scales (Lyons *et al.* 2008). Applying adaptive management to complex resource management issues is promoted throughout the Department of the Interior (Williams *et al.* 2007).

Waterfowl harvest management is the classic example of adaptive resource management. Hunting regulations are reset each year in the United States and Canada through the application of adaptive management principles (Johnson *et al.* 1997). A key uncertainty in waterfowl management is the extent to which harvest mortality is compensated by reductions in non-harvest mortality or by increases in productivity (Williams *et al.* 1996). Various population models have been built based on competing hypotheses to answer this question; these competing models make different predictions about how the population will respond to hunting. Every year the Service and the Canadian Wildlife Service monitor waterfowl and environmental conditions to estimate population size, survival rates, productivity, and hunting rates. These data feed into the various competing models, and the models are evaluated annually based on how well they predict changes in waterfowl populations. Models that perform best year-after-year accrue increasing weight (*i.e.*, evidence in support of the underlying hypothesis). Weighted model outputs directly lead to recommended sets of hunting regulations (*e.g.*, bag limits and season lengths) for the subsequent year. Over time, by monitoring the population effects of various harvest rates on survivorship, and environmental conditions on productivity, our uncertainty about the degree to which harvest is compensated by other factors has been reduced, allowing for the setting of harvest rates with greater confidence every year. The application of adaptive management principles to waterfowl harvest regulation has helped the Service and its partners achieve or exceed population goals for most species of waterfowl (NAWMP 2004).

Adaptive management is a central component of the Service's approach to collaborative management at the landscape scale, through strategic habitat conservation (NEAT 2006). The principles of adaptive management are also embedded in endangered species management (Ruhl 2004, Runge 2011), including in recovery planning (Smith 2011) and habitat conservation planning (Wilhere 2002). Indeed, the Service recognizes that adaptive management is a normative concept in modern ecological decision-making (Callicott *et al.* 1999), and embraces it as a fundamental tool.

2. Applying Adaptive Management to Eagle Take Permitting

In the context of wind energy development and eagle management under the ECPG, there are four specific sets of decisions that are suitable for an adaptive management approach.

a. Adaptive Management of Wind Project Operations

The most immediate and direct opportunity for adaptive management is at the site-level for wind facilities after construction. The relevant uncertainty is in the predictions of eagle take at the project, and the operational factors that influence the level of take. The role of adaptive management at this scale will be analyzed and evaluated in the NEPA associated with each permit. Under the ECPG, a wind project would initially work with the Service to generate predictions of take, given the siting, design, and operational parameters of the project. These predictions are made under uncertainty, and the risk to eagles associated with this uncertainty is factored into the compensatory mitigation terms of the permit under BGEPA. After a site becomes operational, ongoing surveys of realized take can be compared to the predictions of take. At the review points of the permit (typically, every five years), the Service and the operator will review the observed take. If the observed take exceeds the predicted and permitted take, the Service will work with the operator to identify measures that could be taken to reduce the take below the permitted threshold (within the limits jointly agreed to at the outset of the permit period). The monitoring data may provide clues about how this could be done, for example, by identifying where and when most of the take is occurring. On the other hand, if the observed take is significantly less than the predicted take, the Service can work with the operator to update the predictions of take for the next review period, adjust the conditions for compensatory mitigation, and return credits to the operator for any excess compensatory mitigation.

In a related manner, for both new and existing facilities, ongoing monitoring can provide information to reduce uncertainty about the effectiveness of conservation measures and ACPs. In particular, experimental conservation measures and ACPs are actions taken by the operator that are thought to reduce mortality risk, but there is uncertainty about how effective some of these measures can be. In the end, the purpose of adaptive management of operations is to reduce mortality of eagles while also reducing the impact of conservation measures and ACPs on power generation at wind facilities.

b. Adaptive Management of Wind Project Siting and Design Recommendations

Through the ECPG and the permit review process, the Service makes recommendations to operators about how to site and design wind facilities to reduce eagle disturbance and mortality. These recommendations are based on the best available science, but acknowledge that our understanding of the interaction between eagles and wind facilities is incomplete. Adaptive management provides the opportunity to respond to increasing understanding about this interaction.

The particular focus of this layer of adaptive management is the predictions of take that are made by considering pre-construction surveys and risk factors (see APPENDIX D). The proposed models are initially quite coarse in their ability to make predictions, but the Service, in partnership with the U.S. Geological Survey (USGS), plans to refine these models. The key uncertainties concern the risk factors that are important in predicting eagle take. For example, how important is the proximity to nesting sites, prey concentrations, or ridgelines in determining the risk posed by any wind turbine? Multiple models will be developed to express uncertainty in these risk factors, and the predictions from these multiple models will be compared to the patterns of observed take at existing facilities. Using multiple models to express uncertainty allows inclusion and evaluation of alternative models from different sources. The learning that emerges will be used to improve the predictions from the models, which in turn, will allow future recommendations about siting and design to be enhanced. In this case, the benefit of the monitoring at individual sites accrues to the wind industry as a whole.

c. Adaptive Management of Compensatory Mitigation

The determination of appropriate levels of compensatory mitigation, such as through a resource equivalency analysis (REA, see APPENDIX F), is based on two predictions: the level of take expected at a project; and the amount of mitigation required to offset that take. As noted above, site-level learning, through observation of realized take, can be used to update predictions of take, and compensatory mitigation can be adjusted accordingly. In addition, the accrued experience across sites, through monitoring of the effectiveness of compensatory mitigation projects and eagle population responses, can be used to update the methods and parameters in the REA methods used to determine the appropriate level of compensatory mitigation.

d. Adaptive Management of Population-Level Take Thresholds

Healthy, robust populations of animals can sustain some degree of incidental take, without long-term adverse impacts to the population or the ecosystem. The amount of take that is sustainable and that can be authorized is a function of both scientific factors (*e.g.*, the intrinsic growth rate and carrying capacity of the population) and policy interpretation (*e.g.*, the amount of potential growth that can be allocated to take, and the risk tolerance for excessive take) (Runge *et al.* 2009). The capacity to sustain incidental take arises from the resilience in populations due to the ability to compensate for that take by increasing survival or reproductive rates.

At the scale of regional populations (*e.g.*, bird conservation regions for golden eagles), the central question for eagles is not altogether different than it is for waterfowl: to what extent is mortality from energy development, or any other anthropogenic source, compensated by reductions in mortality from other sources, or by increases in productivity? These questions are best answered by building population models founded on competing hypotheses that incorporate estimates of mortality, productivity, and the variation around those vital rates. What is needed is a systematic effort to collect information on mortality, breeding, and population status to feed those models. Similar to waterfowl management, reducing uncertainty in population-level models for eagle management will require rolling up the results of local monitoring and research across the distribution of eagles. The results will allow the Service to make more informed management recommendations to reach the Service's population goal of stable or increasing breeding populations for both eagle species.

At present, the Service's regulations call for no increase in net take of golden eagles, under a protective concern that the current level of take exceeds a sustainable threshold. As our understanding of golden eagle population size and status increases, and our knowledge of vital rates and potential resilience improves, the Service and USGS will reanalyze the potential for instituting take thresholds for golden eagles. Take thresholds for bald eagles will also be re-assed no less frequently than every five years (USFWS 2009). If thresholds for either species are increased and additional take is authorized, continued population monitoring will be critical in providing feedback on population response (*i.e.*, step 4 to 8 in Fig. A-1).

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APPENDIX B: STAGE 1 – SITE ASSESSMENT

Occurrence of eagles and their use of landscapes vary across broad spatial scales. The first step in project development is to conduct a landscape-scale assessment, based mainly on publicly available information, to identify sites within a large geographic area that have both high potential for wind energy and low potential for negative impacts on eagles if a project is developed. Stage 1 corresponds to Tiers 1 and 2 of the WEG and, along with Stage 2 herein and Tier 3 in the WEG, comprise the pre-construction evaluation of wind energy projects. Depending on the outcome of Stage 1, developers decide whether to proceed to the next stage, "... requiring a greater investment in data collection to answer certain questions" (referring to Tier 3, in the WEG; see also Table B-1). The WEG should be examined for general considerations relevant to Stage 1; this appendix and the following APPENDIX C focus on considerations specific to eagles.

The Stage 1 assessment should evaluate wind energy potential within the ecological context of eagles, including considerations for the eagle's annual life-cycle, *i.e.*, breeding, dispersal, migration, and wintering. The goal at this stage is to determine whether prospective wind project sites are within areas known or likely to be used by eagles and, if so, begin to determine the relative spatiotemporal extent and type of eagle use of the sites. Areas used heavily by eagles are likely to fall into category 1; development in these areas should be avoided because the Service probably could not issue project developers or operators a programmatic permit for take that complies with all regulatory requirements. Stage 1 assessment is a relatively straightforward "desktop" process that probably should conduct before significant financial resources have been committed to developing a particular project.

Multiple data sources can be consulted when evaluating a prospective site's value to eagles. Wildlife biologists and other natural resource professionals from federal agencies including the Service, and tribal, state, and county agencies should be consulted early in the Stage 1 process to help ensure all relevant information is being considered. Information mainly encompasses physiographic and biological factors that could affect eagle risk associated with wind energy development. Questions generally focus on: (1) recent or historical nesting and seasonal occurrence data for eagles at the prospective area; (2) migration or other regular movement by eagles through the area or surrounding landscape; (3) seasonal concentration areas such as a communal roost site in a mature riparian woodland or a prairie dog (*Cynomys* spp.) town serving as a major forage base; and (4) physical features of the landscape, especially topography, that may attract or concentrate eagles. "Historical" is defined here as 5 or more years; a search for historical data should encompass at least the previous 5 years. Data from far longer time periods may be available but should be cautiously scrutinized for confounding factors such as land use change that diminish the data's relevance.

Preliminary site evaluation could begin with a review of publically available information, including resource databases such as NatureServe (*http://www.natureserve.org/*) and the American Wind Wildlife Institute's Landscape Assessment Tool (LAT; *http://www.awwi.org/initiatives/ landscape.aspx*); information from relevant tribal, state, and federal agencies, including the Service; state natural heritage databases; state Wildlife Action Plans; raptor migration databases such as those available through Hawk Migration Association of North America (*http://www.hmana.org*) or HawkWatch International (*http://www.hawkwatch.org*); peer-reviewed literature and published technical reports; and geodatabases of land cover, land use, and topography (*e.g.*, the LAT integrates several key geodatabases). Additional information on a site's known or potential value to eagles can be garnered by directly contacting persons with eagle expertise from universities, conservation organizations, and professional or state ornithological or natural history societies.

Some of this wide assortment of desktop information and certain knowledge gaps identified probably will necessitate validation through site-level reconnaissance, as suggested in the WEG.

Using these and other data sources, a series of questions should be considered to help place the prospective project site or alternate sites into an appropriate risk category. Relevant questions include (modified from the WEG):

1. Does existing or historical information indicate that eagles or eagle habitat (including breeding, migration, dispersal, and wintering habitats) may be present within the geographic region under development consideration?
2. Within a prospective project site, are there areas of habitat known to be or potentially valuable to eagles that would be destroyed or degraded due to the project?
3. Are there important eagle use areas or migration concentration sites documented or thought to occur in the project area?
4. Does existing or historical information indicate that habitat supporting abundant prey for eagles may be present within the geographic region under development consideration (acknowledging, wherever appropriate, that population levels of some prey species such as black-tailed jackrabbits (*Lepus californicus*) cycle dramatically [Gross *et al.* 1974] such that they are abundant and attract eagles only in certain years [*e.g.*, Craig *et al.* 1984])?
5. For a given prospective site, is there potential for significant adverse impacts to eagles based on answers to above questions and considering the design of the proposed project?

We recommend development of a map that, based on answers to the above questions, indicates areas that fall under site category 1, *i.e.*, areas where wind energy development would pose obvious, substantially high risks to eagle populations. Remaining areas could be tentatively categorized as either moderate to high but mitigable risk or minimal risk to eagle populations (category 2 or category 3). Prospective sites that fall into category 1 at this point are unlikely candidates for a programmatic permit for take of eagles, although classification of a site at Stage 1 might be regarded as tentative (see "Assessing Risk and Effects; 4. Site Categorization Based on Mortality Risk to Eagles" in the ECPG. If a site appears to be a category 1 site based on the outcome of Stage 1, the developer can decide whether information at that stage adequately supports a category decision or whether to invest in Stage 2 assessment to clarify preliminary indications of Stage 1 (Table B-1). Sites that tentatively fall into categories 2 or 3 at Stage 1 can move on to Stage 2 assessment, but could ultimately be excluded as permit candidates after more site-specific data are collected in Stage 2.

Again, the goal of Stage 1 site assessment in this ECPG is to determine whether prospective wind project sites are within areas known or likely to be used by eagles and, if so, begin to assess the spatiotemporal extent and type of eagle use the sites receive or are likely to receive. Thus, the ultimate goal of Stage 1 is to determine whether sites exhibit any obvious substantial risk for eagles. For those that do not, the Stage 1 site assessment will provide fundamental support for the design of detailed surveys in Stage 2, decisions which influence optimal allocation of the financial investment in surveys and quality of data collected. In some situations, the Stage 1 site assessment may provide enough information to adequately estimate impacts and support decisions on site categorization (and, where relevant, potential conservation measures and appropriate levels of compensatory mitigation), rendering Stage 2 assessment unnecessary (Table B-1).

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Craig, T. H., E. H. Craig, and L. R. Powers. 1984. Recent changes in eagle and buteo abundance in southeastern Idaho. Murrelet 65:91-93.

Gross, J. E., L. C. Stoddart, and F. H. Wagner. 1974. Demographic analysis of a northern Utah jackrabbit population. Wildlife Monograph 40.

Table B-1. Framework for decisions on investment at Stage 2 level to address chief information needs. A bidirectional arrow represents a continuum of conditions.

	Strength of Stage 1 Information Base for Assessing Risk to Eagles		
Area of Information Need	**Robust:** well investigated and supported, at least semi-quantitative documentation from most recent 2-5 years, encompassing potential site(s) or adjoining areas from which reliable inferences can be made	↔	**Weak:** characterized by little supportive information and marginal certainty overall, at best only general descriptions, conjecture, or limited inferences from other areas or regions
Seasonal abundance		↔	
Nesting records		↔	
Migration corridors		↔	
Communal roosts		↔	
Prey availability or foraging hotspots		↔	
Outcome and implications for additional assessment needs at Stage 2 level:	Relevant areas of information need are well-addressed and risk level is clearly low – Stage 2 may not be warranted or else modest or limited-focus survey effort at Stage 2 level recommended Relevant areas of information need are well-addressed and risk level is moderate or high – strong effort at Stage 2 level advised	↔	Uncertain risk level – strong survey effort at Stage 2 level advised

APPENDIX C: STAGE 2 – SITE-SPECIFIC SURVEYS AND ASSESSMENT

1. Surveys of Eagle Use

Information collected in Stage 2 is used mainly to generate predictions of the mean annual number of eagle fatalities for a prospective wind energy project and to identify important eagle use areas or migration concentration sites that could be affected by the project. Information from Stage 2 is also used to assess the likelihood of disturbance take of eagles. An array of survey types could be used to quantify use by eagles of a proposed project area. This section focuses on four types of surveys recommended for assessing risk to eagles at proposed wind projects. The first three are surveys of eagle use within the proposed project footprint. These include: (1) point count surveys, which mainly generate occurrence data that form underpinnings of the risk assessment model recommended herein; (2) migration ("hawk watch") counts, documenting hourly passage rates of eagles; and (3) utilization distribution (UD) assessment, an accounting of the intensity of use of various parts of the home range within the project footprint; and (4) surveys of nesting territory occupancy in the project area. Where uncertainties exist regarding survey methods, our recommendations tend to be conservative such that biases in survey data, if any, are more likely to favor greater rather than lower estimates of use and ultimately more rather than less protection for eagles. This approach is consistent with the Service's policy of taking a risk-averse stance in the face of existing uncertainty with respect to eagle programmatic take permits.

In addition to fatality estimation and informing a site categorization decision, Stage 2 studies of eagles should help answer the following questions (modified from the WEG):

1. What is the distribution, relative abundance, behavior, and site use of eagles and to what extent do these factors expose eagles to risk from the proposed wind energy project?
2. What are the potential risks of adverse impacts of the proposed wind energy project to individual and local populations of eagles and their habitats?
3. How can developers avoid, minimize, and mitigate identified adverse impacts?
4. Are there studies that should be initiated at this stage that would be continued in post-construction?

a. Point Count Surveys

Point counts (*i.e.*, circular-plot surveys) often are used to assess relative abundance, population trends, and habitat preferences of birds (Johnson 1995). The Service advocates use of point count surveys as the means of providing primary input for models predicting fatality rate of eagles associated with wind turbines. However, we acknowledge the term point count survey does not accurately describe the approach we advocate for collecting data to support fatality rate estimation at wind energy projects. The Service's approach in this regard is point-based recording of activity duration (minutes of flight) within a three-dimensional plot. In contrast, point count surveys, as typically conducted, yield indices of relative abundance or frequency of occurrence (in addition to trend, density estimation, and habitat association, depending on how data are collected; Ralph *et al.* 1993). With that said, most records of eagle flight duration are likely to be classified as 1 minute, per the approach recommended in this section, and as such resemble records of occurrence for data from point count surveys. Although a bit of a misnomer in this regard, "point count survey" is applied broadly herein to include both point-based records of flight time and traditional point count surveys because sampling frameworks for each so closely overlap and both data types can be gathered simultaneously, along with other information described in this appendix. There may be other means of generating count data to support the fatality model described in this document. Consideration of alternative approaches for predicting fatality at such projects may require greater time and additional reviews.

The general approach for conducting a fixed-radius point count survey is to travel to a pre-determined point on the landscape and record individual birds detected – whether observed, only heard, or both observed and heard – within a circular plot, the boundary of which is at a fixed distance from the point and is marked in the field in several places (Hutto *et al.* 1986, Ralph *et al.* 1993). In addition to plot radius, the survey is standardized by count duration. Sometimes a variable-radius plot method (Reynolds *et al.* 1980) is used, yielding species-by-species detectability coefficients to appropriately bound the plot radius (*i.e.*, sampling area) for each species. A variety of point count survey methods have been used specifically for raptors (reviewed in Anderson [2007]; the North American Breeding Bird Survey [Sauer *et al.* 2009] is a random-systematic, continent-wide point count survey of bird population trends, including those of many raptor species). However, a fixed-radius approach with circular plots of 800-m radius typically is used for surveying eagles and other large (greater than crow [*Corvus* spp.]-size) diurnal species of raptors at proposed wind energy projects in the United States (Strickland *et al.* 2011).

The optimal duration of point count survey for eagles is a focus of current research. For now, for point count surveys of eagles at proposed wind energy projects, the Service recommends counts of 1, 2, or more hours duration instead of 20- to 40-minute counts typically used (Strickland *et al.* 2011). Longer counts also facilitate integration of other survey types (*e.g.,* development of utilization distribution profiles). Many raptor biologists have suggested that the likelihood of detecting an eagle during a 20- to 40-minute point count survey is extremely low in all but locales of greatest eagle activity and datasets generated by pre-construction point count surveys of this duration typically are replete with counts of zero eagles, resulting in unwieldy confidence intervals and much uncertainty. Moreover, time spent traveling to and accessing points for 20-minute surveys may exceed time spent conducting the observations. For example, 250 1-hour surveys conducted annually at a project of average size (*e.g.*, 15 sampling points, 1 to 3 km apart) and travel conditions require roughly the same total field time as needed for 500 20-minute surveys, yet yield 50% more observation hours (250 versus 167), with correspondingly greater probability of detecting eagles. Another advantage of longer counts is that they reduce biases created if some eagles avoid conspicuous observers as they approach their points and begin surveys, although some observers may become fatigued and overlook eagles during longer counts. A potential trade off of fewer visits, of course, is diminished accounting of temporal variation (*e.g.*, variable weather conditions or an abrupt migration event). While counting at fewer points for longer periods might also reduce the ability to sample more area, we advocate maintain the minimum spatial coverage of at least 30% of the project footprint. Until there is more evidence that shorter count intervals are adequate to estimate eagle exposure, we believe that a sampling strategy including counts of longer duration, albeit fewer total counts, may in the end improve sampling efficiency and data quality.

A key assumption of fatality prediction models based on data from point count surveys is that occurrence of eagles at a proposed project footprint before construction bears a positive relationship with turbine-collision mortality after the project becomes operational (Strickland *et al.* 2011). Support for this assumption from published literature is limited for eagles and other diurnal raptors at this time, however. In a recent study of raptors at 20 projects in Europe, no overall relationship was evident between either of two pre-construction risk indices and post-construction mortality (Ferrer *et al.* 2011). However, the authors based risk indices only in part on data from pre-construction point counts; factors incorporated into risk indices included a somewhat subjective decision on species-specific sensitivity to collision and conservation status. Despite this, a weak relationship between pre-construction flight activity and post-construction mortality was suggested for the most common species, griffon vulture (*Gyps fulvus*) and kestrels (*Falco* spp.). Neither *Aquila* nor *Haliaeetus* eagles occurred in the study. On coastal Norway, however, a high density, local population of the white-tailed eagle, a species closely related and ecologically similar to the bald eagle, experienced substantial turbine-collision fatality and loss of nesting territories after development of a wind energy project (Nygård *et al.* 2010). The relationship between pre-construction occurrence and post-construction mortality might be less clear if eagles and other raptor species avoided areas after wind energy projects were constructed (*e.g.*, Garvin *et al.* 2011), but in general such displacement seems negligible (Madders and Whitfield 2006).

Precision, consistency, and utility of data derived from point count surveys depend greatly on the sampling framework and field approach for conducting the counts, which in turn depend somewhat on study objectives and the array of species under consideration. Precision and reliability of data from point count surveys for eagles can be much improved upon – and need for a risk-averse approach lessened – by incorporating some basic, common-sense sideboards into the survey design. One of these, longer count duration, is discussed above. Below are examples of ideal design features for point count surveys of eagle use of proposed wind energy projects, particularly when fatality rate prediction is a primary objective. Some of these extend from Strickland *et al.* (2011) and references therein, although the first is not in accord with corresponding guidance in that document.

- Surveys of eagles and other large birds are exclusive of those for small birds, to avoid overlooking large birds while searching at a much smaller scale for a much different suite of birds. The relatively brief (*e.g.*, 10-minute) point counts for small birds could be conducted during the same visit, but before or after the count of large birds.
- In open areas where observers may be conspicuous, counts are conducted from a portable blind or from a blind incorporated into a vehicle to reduce the possibility that some individual eagles avoid observers, ,thus reducing likelihood of detection. Blinds are designed to mask conspicuous observer movement while not impeding views of surroundings.
- Point locations may be shifted slightly to capitalize on whatever vantage points may be available to enhance the observer's view of surroundings.
- Elevated platforms (*e.g.*, blinds on scaffolding or high in trees, truck-mounted lifts) are used to facilitate observation in vistas obstructed by tall vegetation, topographic features, or anthropogenic structures.
- The observer's visual field at a point count plot, if less than 800 m (*e.g.*, due to obstruction by forest cover), is mapped. The percentage of the plot area that is visible is factored into the calculation of area surveyed.
- Observers use the most efficient, logical route to move among points, changing the starting point with the beginning of each survey cycle such that each point is surveyed during a range of daylight hours.
- Systematic scans of the point count plot using binoculars alternating with scans via the unaided eye to detect close and distant eagles, and with overhead checks for

eagles that may have been overlooked during peripheral scanning (Bildstein *et al.* 2007).

- Observers are trained and their skills are tested, including accurate identification and distance estimation (both horizontal and vertical; *e.g.*, eagles greater than 600 m horizontal distance may not be detected by some observers and correction for differences among individual observers may be warranted).
- The boundary of each point count plot is identified via distinct natural or anthropogenic features or marked conspicuously (*e.g.*, flagging on poles) at several points for distance reference. Distance intervals within the plot also are marked if observations are to be categorized accordingly; rangefinder instruments are useful in this regard.
- Surveys are distributed across daylight hours (*e.g.*, morning – sunrise to 1100 hours; midday – 1101-1600; evening 1601 to sunset). In areas or during seasons where eagle flight is more likely during midday than in early morning or evening (*e.g.*, migration [Heintzelman 1986]), sampling efficiency could be increased by temporally stratifying surveys to more intensively cover the midday period.
- A map (*e.g.*, 1:24,000 scale topographic quadrangle) or aerial photographs indicating topographic and other reference features plus locations of point count plots is used as the primary recording instrument in the field. A GPS with GIS interface may serve in this regard.
- Time and position of each individual eagle is recorded on the map, *e.g.*, at the beginning of each minute of observation, if not more frequently.

The following examples of suggested sideboards pertain especially to point count surveys supplying data for the fatality prediction method recommended in this document:

- Following a point count survey, the duration of observation of each eagle flying within the plot is summarized in number of minutes, rounded to the next highest integer (*e.g.*, an eagle observed flying within the plot for about 15 seconds is 1 eagle-minute, another observed within for about 1 minute 10 seconds is 2 eagle-minutes, and so on; most observations likely will equal 1 eagle-minute).
- Eagles are mapped when perched or when otherwise not flying, but the summary of eagle-minutes for a count excludes these observations and includes only eagles in flight.
- Horizontal distance of each eagle-minute is estimated and recorded as ≤ 800 m or > 800 m. Vertical distance of each eagle-minute is estimated and recorded as ≤ 200 m (at or below conservative approximation of maximum height of blade tip of tallest turbine) or > 200 m. Thus, the point count "plot" is a 200-m high cylinder with a radius of 800 m.
- Surveys are done under all weather conditions except that surveys are not conducted when visibility is less than 800 m horizontally and 200 m vertically.
- Data from point count surveys are archived in their rawest form to be available when fatality is estimated as detailed in this document (APPENDIX D).

Other information recorded during point counts may prove useful in project assessment and planning, or in additional data analyses (some requiring data pooled from many projects), *e.g.*:

- Flight paths of eagles, including those outside the plot, are recorded on reference maps, using topographic features or markers placed in the field as location references. Eagle flight paths are recorded also before and after point count surveys and incidental to other field work. Flight paths are summarized on a final map, with those recorded during point count surveys distinguished from others to roughly account for spatial coverage bias. Documentation of flight paths can aid planning to avoid areas of high use (Strickland *et al.* 2011).
- Behavior and activity prevalent during each 1-minute interval is recorded as (*e.g.*) soaring flight (circling broadly with wings outstretched); unidirectional flapping-gliding; kiting-hovering; stooping or diving at prey; stooping or diving in an agonistic context with other eagles or other bird species; undulating/territorial flight; perched; or other (specified).
- Age class of individual eagles is recorded, *e.g.*, juvenile (first year), immature or subadult (second to fourth year), adult (fifth year or greater), or unknown.
- Weather data are recorded, including wind direction and speed, extent of cloud cover, precipitation (if any), and temperature (Strickland *et al.* 2011).
- Distance measures are used to estimate detectability for improving estimates from counts (Buckland *et al.* 2001) and could be used to assess whether eagles avoid observers. Horizontal distance of each eagle-minute is estimated and categorized, *e.g.*, in 100-m intervals to > 800 m.

The key consideration for planning point count surveys at proposed wind energy projects is sampling effort. We advise that project developers or operators coordinate closely with the Service regarding the appropriate seasonal sampling effort, as sampling considerations are complex and depend in part on case-specific objectives. We also reiterate that these (and most other) surveys should be conducted for at least 2 years before project construction and, in most cases, across all seasons. In general, sampling effort should be commensurate with the relative level of risk at a proposed project footprint if this can be surmised reliably from the Stage 1 assessment. If Stage 1 information cannot support reasonably certain risk categorization, Stage 2 surveys should be conducted as described here to clearly ascertain whether eagles are known or likely to use the area. If a project is determined to be category 2, products of point count surveys should include data for the fatality model detailed in this document (APPENDIX D). If there is compelling Stage 1 evidence indicating no use in a given season, zero use could be assumed and point count surveys in that season might be unnecessary.

In general, goals for the Stage 2 surveys are either to: (1) confirm category-3 status for a project, or (2) to generate a fatality rate estimate. Regardless of which of these survey goals apply to a particular project, we recommend first identifying potential sites for wind turbines, including alternate sites, then calculating the total area (km^2) encompassing a 1-km buffer around all the sites. We suggest 1 km because this approximates optimal spacing of a generic 2.5-MW turbine (Denholm *et al.* 2009), and the area outside this may not be representative of topographic features and vegetation types that characterize turbine strings within the project footprint. This approach assures close association between sampling sites and likely turbine locations, as recommended by Strickland *et al.* (2011). Next, we recommend that at least 30% of the area within 1 km of turbines be considered as the total km^2 area to be covered by 800-m radius point count plots (with a sample area for each plot of 2 km^2). Our recommended 30% minimum is based on the actual minimum coverage at eight wind facilities under review by the Service at the time version 2 of the ECPG was being developed.

The first case (i.e., (1) above) is the use of point count data to validate whether a proposed project meets category 3 criteria when Stage 1 information is inadequate. Based on experience with current parameters of the "prior term" in our predictive model (see APPENDIX D), we calculate an average of 20 hours per turbine as an optimal level of annual sampling via point count survey (*e.g.,* equivalent of ten 4-hour point count surveys at each of 20 sample points for a 40-turbine project; our 20-hour recommendation considers the hazardous area created by a generic 2.5-MW turbine with a rotor diameter of about100 m; sample effort for turbines with smaller rotor diameters would be less). As sampling effort falls from this level, uncertainty regarding fatality risk rises sharply, calling for an increasingly risk averse basis for risk categorization. Although 20 sample hours per turbine may be necessary initially for validating category 3 determination where little Stage 1 information exists, we expect this will decrease as more projects are incorporated into the adaptive management meta-analyses that will refine the prior term.

The second case (i.e., (2) above) is where Stage 1 evidence is strong enough to support the decision that a project is category 2 (or category 3 with potential for re-evaluation as category 2). Fatality rate estimation becomes the main objective of point count surveys and demands for sampling effort can be reduced. We recommend a minimum of 1 hour of observation per point count plot per month but at least 2 hours of observation per point count is warranted for a season for which Stage 1 evidence is ambiguous or suggests high use.

These ideas on minimum observation hours stem from the Service's initial experience in fatality estimation (see APPENDIX D: Stage 3 – Predicting Eagle Fatalities). However, as noted above, with more field applications of our fatality prediction model we should be able to refine our ability to characterize uncertainty based in part on site-specific characteristics, something the Service's current model does not do. Again, to develop a reasonable, informed sampling approach, we urge project developers to engage early with the Service in discussions about sampling design and strategies.

The example below includes determination of the number of point count plots for a project.

Example

The site for a 100-MW, 40-turbine project proposed in open foothills of central New Mexico encompasses 40 km^2 (16 mi^2). During the Stage 1 assessment, data from a hawk watch organization indicates the area is 25 miles east of a north-south mountain ridge that sustains a moderate level of migration by golden eagles each fall but receives little use in spring. According to the state ornithological society, the region also is thought to attract golden eagles during winter, but this is based on sparse anecdotal accounts. Aerial nesting surveys by the Service 5 years ago yielded no evidence of eagle nests within 10 miles of the proposed project, although use of the area by non-breeding resident eagles during spring and summer cannot be ruled out. Reconnaissance visits and review of land cover and other habitat layers in geodatabases support the general indication that the area is important to golden eagles during at least part of the year.

Stage 1 Summary: Of primary concern at the prospective project site is potential for risk to golden eagles during fall migration. Evidence of this at the Stage 1 level is somewhat equivocal, however, because the known migration pathway is outside the project area. Further examination of use in spring, summer, and especially winter also seems warranted. Questions include temporal (seasonal) and spatial (distribution within project) use. The overarching goal is to quantify risk to eagles posed by the proposed project, mainly by estimating fatality rate. If fatality is anticipated, a secondary goal is to determine whether the predicted level is acceptable and, if not, whether fatality can be avoided and minimized through specified project design and operation features.

The primary tool for predicting fatality is the point count survey. However, if the pre-construction assessment is robust and optimally designed, point count surveys will provide insight on distribution of use within the project footprint especially near proposed turbine sites, and on migration timing and movement pathways.

Sampling Effort

A. Number of points, *i.e.*, point count plots, and spatial allocation:
  1. 40 turbines are proposed for project
  2. potential sites for turbines have been selected
  3. area within 1 km of turbines covers total of 100 km^2
  4. 30% of total area = 30 km^2
  5. number of 800-m radius (area of each, 2-km^2) point count plots recommended = 30/2 = 15 plots
  6. survey points are distributed among turbine strings via random-systematic allocation, with each point no more than 1 km from a prospective turbine site

B. Number of counts per point per season and duration of each point count survey:
  1. Based on some Stage 1 evidence of low use in this example, 1 hour of observation per point count plot per month seems appropriate during each of winter (*e.g.*, mid-December through mid-March), spring (mid-March through mid-June), and summer (mid-June through mid-September) seasons. A count duration of 1 hour is selected to maximize efficiency in the field
  2. Survey effort is doubled during the mid-September through mid-December fall migration season for golden eagles, based on Stage 1 evidence of fall migration nearby and need for more definitive data on eagle occurrence, timing, and distribution within the footprint. This could be done by using either two 1-hour counts or a 2-hour count per point per month; the latter is chosen to maximize field efficiency and better emulate migration count methods. The 1-hour counts may lend better insight on temporal variation, but in this example each monthly session of 15 2-hour counts requires an observer 3-4 days to complete, affording some accounting of day-to-day variation.
  3. The total yearly effort in this example is nine 1-hour counts and three 2-hour counts at each of 15 points, yielding 225 total observation hours.

The raw data, in number of eagle-minutes, appear as follows (*e.g.*, for the first fall season sampled, with one 2-hour count per point per month):

Point no.	Point count visit number – Fall Season, Year 1		
	1 (early fall)	2 (mid-fall)	3 (late fall)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	1	1	0
8	0	0	0
9	0	0	0
10	0	2	1
11	0	0	0
12	0	2	0
13	0	0	0
14	0	1	0
15	0	0	0

The first year's fall point count survey totals 90 observation hours, the equivalent of nine 10-hour migration counts. Thus, the fall point count surveys could yield much insight on eagle migration – perhaps even substituting for focused migration counts – especially if the sample is stratified so point count surveys mainly cover the midday period when eagles are most likely to be moving. (see b. Migration Counts and Concentration Surveys, below). Observations made during point count surveys in all seasons also could support a map of flight paths to roughly indicate the distribution of use of the area by eagles relative to turbine sites (see c. Utilization Distribution (UD) Assessment, below).

Fatality estimation should be adequately supported by the data, although multiple survey years are likely needed to account for annual variation. Data for fatality estimation should be made available to the Service in the rawest form, as in the above example.

b. Migration Counts and Concentration Surveys

Wherever potential for eagle migration exists, migration counts should be conducted unless the Stage 1 assessment presents compelling evidence that the project area does not include or is not part of a migration corridor or a migration stopover site. Migration counts convey relative numbers of diurnal raptors passing over an established point per unit time (Bildstein *et al.* 2007, Dunn *et al.* 2008), usually a migration concentration site. Examples of sites include north-south oriented ridges, cliff lines, or deeply incised river valleys; terminal points or coast lines of large water bodies; or peninsulas extending into large water bodies (Kerlinger 1989, Bildstein 2006, Mojica *et al.* 2008). Migration counts could be considered a specialized type of point count, one for which the plot radius is unlimited (Reynolds *et al.* 1980) and the count period is quite long, from 6 hours to a full day.

In contrast to the allocation of sample points for point count surveys at proposed wind energy projects, migration counts typically are conducted from one to a few points within or adjacent to a proposed project footprint. Points are widely spaced, located primarily at places that collectively provide greatest visual coverage especially of topographic features likely to attract or funnel migrating raptors. At many proposed projects, however, survey points for migration counts could be the same as or a subset of those used for point count surveys, *e.g.*, per the above example (under 1a. Point Count Surveys), such that migration counts at a given point simultaneously contribute point count data. Consideration should be given to restructuring point count surveys to this end, including temporal stratification to more effectively account for potential eagle migration and improve precision of exposure estimates. As another example, during an anticipated 6-week peak of eagle migration in fall, point count duration could be extended to 6 hours. If the surveys were to cover either the first 6 hours or the last 6 hours of the day, the two survey periods would overlap by several hours in midday, better covering the time of day when eagles are most likely moving (Heintzelman 1986). The data may have to be adjusted slightly when used for fatality estimation, however.

Strickland *et al.* (2011) summarize some important details for conducting raptor migration counts at proposed wind energy sites. Counts should be conducted using standard techniques (Bildstein *et al.* 2007, Dunn *et al.* 2008) during at least peak periods of passage (see the Hawk Migration Association of North America's [HMANA] website for information on seasonal passage periods for eagles at various migration survey sites: *http://www.hmana.org*). Migration counts may involve staffing survey points up to 75% of days during peak passage (Dunn *et al.* 2008). If at least a modest eagle migration is evidenced (*i.e.*, multiple individuals observed passing unidirectionally during each of multiple days), surveys should be continued for at least 2 years and into the operational phase to validate initial observations and help assess evidence of collision and influence of turbines on migration behavior. Migration count data should be provided to the Service as an appendix to the ECP, using a reporting format similar to that used by HMANA. As with point count surveys, training of migration survey staff should include assessment of raptor identification skills and of ability of individuals to detect eagles in flight under a broad range of distances and weather conditions.

Potential for non-breeding (either winter or summer) season concentrations of eagles in or near the project footprint should begin to be evaluated in Stage 1, including close scrutiny of potential habitat via geospatial imagery and follow up reconnaissance visits (see APPENDIX B). Non-breeding bald eagles often use communal roosts and forage communally (Platt 1976, Mojica *et al.* 2008). Golden eagles may do so on occasion, with other golden eagles and/or with bald eagles (Craig and Craig 1984). Both species can become concentrated on spring and fall migration under particular combinations of weather and topographic conditions, or may annually use traditional stopover sites during migration. The Stage 1 assessment may suggests that seasonal concentrations of eagles regularly occur within the project area, either because of favorable conditions (*e.g.*, clusters of large trees along rivers offering potential roost sites, stopover concentrations of migrating waterfowl) or because of indications from prior anecdotal or systematically collected records. The Stage 2 assessment should include surveys designed to further explore evidence of any such occurrences. If, based on the outcome of Stage 1, there is no compelling reason to believe concentration areas are lacking, an efficient way to begin to probe for concentration areas is simply to extend the duration of point count surveys and perhaps conduct them more frequently. Expanded point count surveys, distributed evenly across the day during the first year of Stage 2, should provide at least a preliminary indication of regular movements to and from what may be roosts or prey hotspots within or outside the project footprint. Moreover, expanded point count surveys conducted near potential turbine sites (see design recommendations in a. Point Count Surveys, above) can better inform turbine siting decisions in relation to eagle use of concentration areas, if such areas exist. The increased survey effort also could contribute towards a more precise indication of eagle exposure in a fatality estimate for the proposed project (APPENDIX D).

Early in Stage 2, evidence from Stage 1 of concentration areas in the project area may be corroborated or new evidence of concentrations may surface. In either case, focused surveys (*e.g.*, via direct observation or by aircraft) can be implemented to document their locations and daily timing and spatial patterns of their use by eagles in relation to the proposed project footprint throughout the season(s). For example, surveys for wintering concentrations of bald eagles could be conducted, following USFWS (1983) guidance. Direct, systematic observation from vantage points in early morning and evening is the most practical means of documenting roost locations and movements of eagles to and from roosts on a local scale (Steenhof *et al.* 1980, Crenshaw and McClelland 1989). Aerial surveys may be needed for repeated surveys of eagles at extensive roosts (Chandler *et al.* 1995). Direct observation can be used to compare occurrence and activity of eagles before and after construction and operation of a project (Becker 2002) and may be a valid means to identify disturbance effects on roosting concentrations.

c. Utilization Distribution (UD) Assessment

UD can be thought of as animal's spatial distribution or intensity of use of various parts of a given area, such as its home range. A basic though perhaps labor-intensive approach for documenting spatial distribution of use across all or part of a proposed project footprint by eagles is to systematically observe and record eagle movements and activities (*e.g.*, territorial display, prey delivery flight) on maps in the field then convert the data into GIS formats for standard analyses (*e.g.*, Walker *et al.* 2005). For example, a grid of square cells, each 0.5 x 0.5 km, can be framed by the Universal Transverse Mercator (UTM) system across a map of the area of interest to record eagle observations in each 0.25 km^2 cell. The area of interest is divided into non-overlapping observation sectors, each with a vantage point that affords unobstructed viewing of grid cells to more than 1 km in all directions. Observation periods last at least 4 hours and include all daylight hours and account for roost sites. If necessary, two (or more) observers working from separate vantage points can pinpoint locations of eagles through triangulation.

The data can be analyzed by simply counting the number of flights intersecting each cell. An eagle's distribution of use can then be estimated by using standard kernel analyses (Worton 1989, 1995, Seaman and Powell 1996, Kenward 2001) or other probabilistic approaches, comparable to Moorcroft *et al.* (1999), McGrady *et al.* (2002), and McLeod *et al.* (2002). Having concern over potential autocorrelation, Walker *et al.* (2005) randomly selected independent locations of golden eagles along flight paths to establish a point database for standard UD analyses. They determined that locations would be independent if separated by at least 45 minutes. McGrady *et al.* (2002) conservatively used a 1-hour minimum to separate points, even though their data indicated a 20-minute interval would suffice. Concerns with autocorrelation in UD analyses have recently diminished, however (Feiberg *et al.* 2010). Most study of eagle UD has focused on resident birds especially breeding adults on their nesting territories. Size and shape of use areas can vary seasonally (Newton

1979), so documentation of spatial use by resident eagles should encompass all seasons in addition to accounting for annual variation.

A substantial advantage of a direct observation approach compared to telemetry techniques, which typically target only one or two resident eagles at a proposed project, is that it disregards age and breeding and residency status. Included are overwintering individuals; dispersing juveniles; post-fledging young from nearby territories and juveniles dispersing from other areas or regions; and adults from adjoining territories plus non-breeding adults (*i.e.*, "floaters," Hunt 1998) and subadults that may occur along boundaries of breeding territories. In many instances, identification of individual eagles may not be important and final results of a generalized UD analysis may be based on data pooled from multiple birds, some of which were indistinguishable from each other in the field. A disadvantage of this approach is that position accuracy based on direct observation across expansive landscapes is coarse compared to using telemetry with GPS capability, and generally declines with distance, increasing topographic and forest cover, and during early morning and late evening hours. This can be resolved to some extent by limiting the size and increasing the number of observation sectors (in addition to using multiple observers), but for most pre-construction information needs, a high degree of accuracy is unessential for UD data. Last, it is unlikely that UD needs to be assessed across entire project footprints. Instead, it is more likely used to target specific areas of concern, such as areas where eagles nest or frequently forage, and to refine knowledge of use of particular areas to better inform turbine siting decisions. The method obviously has little utility in areas of low eagle occurrence.

Although we acknowledge telemetry offers some distinct benefits for assessing risks and impacts of wind projects, use of the method for eagles has other drawbacks. Specific individual eagles must be targeted for capture and not all eagles using a given project footprint are equally likely to be captured or provide useful data (*e.g.*, migrants may be readily captured but leave the area before providing much data). More importantly, capturing and radio-marking eagles can have negative effects on behavior, productivity, and re-use of nest sites (*e.g.*, Marzluff *et al.* 1997, Gregory *et al.* 2002), and recent information suggests a negative effect in some cases on survival, especially of golden eagles captured as adults and released with large (70- to 100-g), solar-charged transmitters (USFWS, unpublished information). These effects must be better understood before routine use of telemetry techniques can be recommended as components of wind-facility assessments. Until then, the Service discourages the use of telemetry in assessments of eagle use associated with wind energy projects; survey approaches suggested herein do not require telemetry.

d. Summary

The Service encourages development of cost-effective sampling designs that simultaneously address multiple aspects of use of proposed wind energy projects by eagles, though emphasizes that high-quality point count data to support fatality rate estimation should be considered the highest priority. In many cases, the sampling framework for point count surveys likely can be extended to reasonably assess migration incidence, UD, and other objectives. Although field-based data that directly support fatality estimation are most important, development of methods for addressing other objectives is encouraged, such as the use of digital trail cameras to document eagle occurrence at carcass stations. Regardless, we recommend that pre-construction surveys at proposed wind energy sites encompass a minimum of 2 years, including at least 1 year characterized by robust sampling that integrates multiple survey types.

2. Survey of the Project-area Nesting Population: Number and Locations of Occupied Nests of Eagles

To evaluate project siting options and help assess potential effects of wind energy projects on breeding eagles, we recommend determining locations of occupied nests of eagles within the project area for no less than two breeding seasons prior to construction. The primary objective of a survey of the project-area nesting population is to determine the number and locations of occupied nests and the approximate centers of occupied nesting territories of eagles within the project area. If recent (*i.e.*, within the past 5 years) data are available on spacing of occupied eagle nests for the project-area nesting population, the data can be used to delineate an appropriate boundary for the project area as described in APPENDIX H. Otherwise, we suggest that project area be defined as the project footprint and all area within 10 miles.

In this ECPG document we use raptor breeding terminology originally proposed by Postupalsky (1974) and largely followed today (Steenhof and Newton 2007). An occupied nest is a nest structure at which any of the following is observed: (1) an adult eagle in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of a pair of adult eagles (or, sometimes subadults, *e.g.*, Steenhof *et al.* [1983]) at or near a nest through at least the time incubation normally occurs, (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed early in the breeding season, or (6) "A recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath" (Postupalsky 1974).

A nest that is not occupied is termed unoccupied. An occupied nesting territory includes one occupied nest and may include alternate nests, *i.e.*, any of several other nest structures within the nesting territory. Sometimes "active nest" is used to encompass occupied nests in which eggs were laid plus those at which no eggs were laid. Here, as elsewhere in the ECPG and in Postupalsky (1974), an active nest is considered one in which an egg or eggs have been laid. A nest that is active is also, by default, occupied. A nest that is not active is inactive, and there is a regulatory definition for the term inactive nest (50 CFR 22.3. Not all pairs of bald eagles and golden eagles attempt to nest or nest successfully every year (Buehler 2000, Kochert *et al.* 2002), and nesting territories where pairs are present but do not attempt to nest could in some cases be misclassified as unoccupied. Accurate comprehension of territory distribution and determination of occupancy status is the crux of determining the project-area nesting population.

The project-area nesting population survey should include all potential eagle nesting habitat within the project area. At least two checks via aircraft or two ground-based observations are recommended to designate a nest or territory as unoccupied, as long as all potential nest sites and alternate nests are visible and monitored (*i.e.*, alternate nests may be widely separated such that a full-length, ground-based observation should be devoted to each). Ground-based observations should be conducted for at least 4 hours each (occupancy may be verified in less time), aided by spotting scopes, from at least 0.8 km from the nest(s), during weather conducive to eagle activity and good visibility. Surveys of occupancy should be conducted at least 30 days apart, ideally during the normal courtship and mid-incubation periods, respectively. Surveys later in the breeding season are likely to overlook some territorial pairs that that did not lay eggs or failed early in the nesting season. Timing of surveys should be based on local nesting chronologies; Service staff can provide recommendations. If an occupied nest or a pair of eagles is located, the territory should continue to be searched for alternate nest sites. This information can help determine the relative value of individual nests to a territory if ever there are applications for permits to take inactive nests, and when determining whether abandonment of a particular nest may result in loss of a territory.

Use of aerial surveys followed by ground-based surveys at targeted sites can be an ideal approach to determine nest and territory occupancy. Helicopters are an accepted and efficient means for inventory of extensive areas of potential nesting habitat for eagles, although fixed-wing aircraft can be used where potential nest sites are widely scattered and conspicuous. Aerial surveys for eagle nests in woodland habitat may require two to three times as much time as aerial surveys for nests on cliffs. When surveying rugged terrain by helicopter, cliffs should be approached from the front, rather than flying over from behind or suddenly appearing from around corners or buttresses. Inventories by helicopter should be flown at slow speeds, about 30 to 40 knots. All potentially suitable nest sites should be scrutinized; multiple passes at several elevation bands may be necessary to provide complete coverage of nest site habitat on large cliff complexes. Hovering for up to 15 seconds no closer than 50 m from a nest may be necessary to verify the nesting species, photograph the nest site, and, if late in the nesting season, allow the observer to count and estimate age of young in the nest. Aerial surveys may not be appropriate in some areas such as bighorn sheep lambing areas; to avoid such sensitive areas, state resource agencies should be consulted when planning surveys. Additional guidelines for aerial surveys for eagles and other raptors are reviewed in Anderson (2007).

Surveys should be conducted only by biologists with extensive experience in surveys of raptors and appropriate training in aerial surveys (see review in Anderson 2007). Whether inventories are conducted on the ground or aerially, metrics of primary interest to the Service for the project-area nesting population include:

1. number and locations of nest structures that are verified or likely to be eagle nests
2. number and locations of eagle nests currently or recently occupied based on criteria outlined herein
3. estimated number and approximate boundaries and centers of eagle breeding territories, based on records of nest site occupancy and clustering of nests.

Additionally, productivity (*i.e.*, reproductive success, defined here as the mean number of nestlings surviving to $\geq$ 56 and $\geq$ 67 days of age per occupied nest for golden eagles and bald eagles, respectively) may be of interest for assessing disturbance effects, although utility of productivity data at a given project likely will be limited due to small sample size and factors confounding the interpretation of results. A meta-analysis approach based on productivity data from many projects is contemplated as part of the adaptive management process accompanying the ECPG, and may contribute to understanding of disturbance effects on this aspect of eagle breeding biology. Moreover, abandonment of territories – the gravest manifestation and clearest evidence of disturbance effects – could be documented through the occupancy surveys recommended herein, if these surveys are repeated after project construction. We reiterate that accurate comprehension of territory distribution and determination of occupancy status should be the primary goal of nesting surveys.

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APPENDIX D: STAGE 3 – PREDICTING EAGLE FATALITIES

The Service uses a Bayesian method (see Gelman *et al.* 2003) to predict the annual fatality rate for a wind-energy facility, using explicit models to define the relationship between eagle exposure (resulting from the Stage 2 assessment, APPENDIX C), collision probability, and fatalities (verified during post-construction monitoring in Stage 5, APPENDIX H), and to account for uncertainty. 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 (see Assessing Risk and Effects; 2. Eagle Risk Factors in the ECPG). The baseline model presented below is a foundation for modeling fatality predictions from eagle exposure to wind turbine hazards. In addition to generating the fatality estimate that will be a component of the Service's analysis of the permit application, the model also serves as a basis for learning and the exploration of other candidate models that attempt to better incorporate specific factors and complexity. The Service encourages project developers or operators to develop additional candidate models (both *a priori* and *post hoc*) for direct comparison with, and evaluation of, the baseline model and modeling approach. Our ability to learn over time and reduce uncertainty by incorporating new information into our modeling approach through an adaptive management framework (see APPENDIX A) enables us to improve site-specific estimation of eagle fatalities, reduce uncertainty in predictions, and, ultimately, improve management decisions relating to eagles and wind energy in a responsible and informed way. Rigorous post-construction monitoring is a critical component of evaluating model performance over time (see APPENDIX H).

Variables used in the formulas below are summarized in Table D-1 for ease of reference. The total annual eagle fatalities (F) as the result of collisions with wind turbines can be represented as the product of the rate of eagle exposure (λ) to turbine hazards, the probability that eagle exposure will result in a collision with a turbine (C), and an expansion factor (ε) that scales the resulting fatality rate to the parameter of interest, the annual predicted fatalities for the project:

$$F = \varepsilon \lambda C.$$

Using the Bayesian estimation framework, we define prior distributions for exposure rate and collision probability; the expansion factor is a constant and therefore does not require a prior distribution. Next, we calculate the exposure posterior distribution from its prior distribution and observed data. The expanded product of the posterior exposure distribution and collision probability prior yields the predicted annual fatalities.

Table D-1. Abbreviations and descriptions of variables used in the Service method for predicting annual eagle fatalities.

Abbreviation	Variable	Description
F	Annual fatalities	Annual eagle fatalities from turbine collisions
λ	Exposure rate	Eagle-minutes flying below 200 m in height within the project footprint (in proximity to turbine hazards) per hr per km^2
C	Collision probability	The probability of an eagle colliding with a turbine given exposure
ε	Expansion factor	Product of daylight hours and total hazardous area (hr·km^2)
k	Eagle-minutes	Number of minutes that eagles were observed flying below 200 m during survey counts
δ	Turbine hazardous area	Rotor-swept area around a turbine or proposed turbine from 0 to 200 m (km^2)
n	Trials	Number of trials for which events could have been observed (the number of hr·km^2 observed)
τ	Daylight hours	Total daylight hours (*e.g.* 4383 hr per year)
n_t	Number of turbines	Number of turbines (or proposed turbines) for the project

1. Exposure

The exposure rate λ is the expected number of exposure events (eagle-minutes) per daylight hour per square kilometer (hr· km^2). We defined the prior distribution for exposure rate based on information from a range of projects under Service review and others described with sufficient detail in Whitfield (2009). The exposure prior predicts an exposure rate from a mixture distribution of project-specific Gamma distributions (Figure D-1). We used the Gamma distribution because all values are positive and real (see Gelman et al., 1995, p. 474–475). The mixture distribution is summarized by a new Gamma distribution (our prior distribution for exposure) with a mean (0.352) and standard deviation (0.357) derived from the conditional distributions (Gelman et al, 1995, equation 1.7 p. 20). The resulting prior distribution for exposure rate is:

$Prior\ \lambda \sim Gamma(\propto, \beta)$, with shape and rate parameters of α = 0.97 and β = 2.76.

Simulation trials produced consistent results. The prior distribution is meant to include the range of possible exposure rates for any project considered.

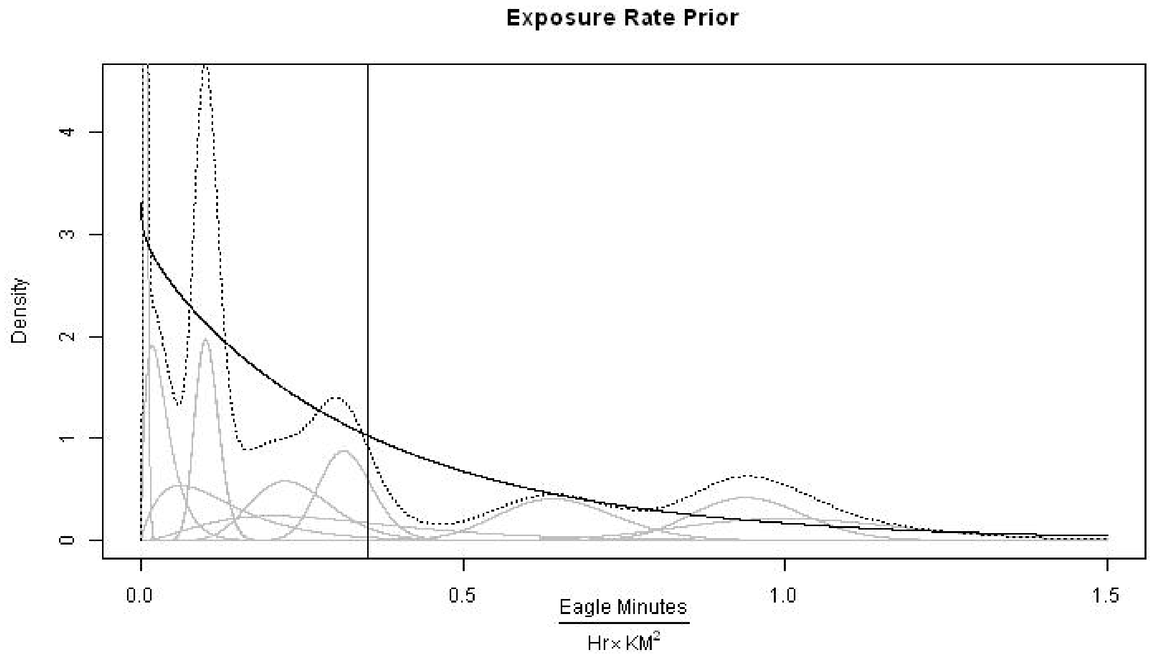

Figure D-1. The prior probability distribution Gamma (0.97, 2.76), for exposure rate, λ, with a mean of 0.352 (indicated by the reference line) and standard deviation of 0.357. The distribution is positively skewed such that exposure is generally at or near 0 with fewer higher values shown by the black curve. The project-specific distributions (gray curves) were used to determine the mixture distribution (dashed curve) which determined the prior distribution parameters.

Eagle exposure data collected during the pre-construction phase surveys (see APPENDIX C) can be used to update this prior and determine the posterior distribution that will be used to estimate the predicted fatalities. The Service may also be able to work with a project developer or operator on a case-by-case basis to use the prior λ distribution to generate a risk-averse fatality prediction for projects where no pre-construction survey data are available. Assuming the observed exposure minutes follow a Poisson distribution with rate λ, the resulting posterior λ distribution is:

$$Posterior\ \lambda \sim Gamma(\propto + \textstyle\sum_{i=1}^{n} k_i\,, \beta + n).$$

The new posterior λ parameters are the sum of α from the prior and the events observed (eagle minutes, k_i), and the sum of β from the prior and the number of trials, *n*, for which events could have been observed (the number of "trials" is the number of hr·km² that were observed). Note that by including realistic time and area data from the pre-construction surveys, the relative influence of the prior λ distribution on the resulting posterior λ distribution for exposure rate becomes negligible. In other words, with adequate sampling, the data will determine the posterior distribution, not the prior. The posterior λ distribution can then be used to estimate the annual fatality distribution.

In addition, this posterior λ distribution can now serve as a prior distribution for the next iteration of the predictive model in an adaptive framework (see APPENDIX A), at least for the project under consideration and potentially in a more general way as the posteriors from multiple sites are considered; in this way, we build ongoing information directly into the predictive process.

2. Collision Probability

Collision probability C is the probability, given exposure (1 minute of flight in the hazardous area, δ), of an eagle colliding with a turbine; for the purposes of the model, all collisions are considered fatal. We based the prior distribution on a Whitfield (2009) study of avoidance rates from four independent sites. Averaging avoidance from those sites yielded a mean and standard deviation for collision probability of 0.0058, 0.0038, respectively (note this is consistent with eagle avoidance rates in other risk assessment approaches, *e.g.* 99%). This in turn defined the prior C distribution as:

$Prior\ C \sim Beta(\nu, \nu')$, with parameters ν and ν´ of 2.31 and 396.69 (Figure D-2).

The Beta distribution is used to describe values between 0 and 1 (Gelman et al.,1995, p. 476–477). The prior C distribution attempts to include the range of possible collision probabilities across the set of potential sites to be considered.

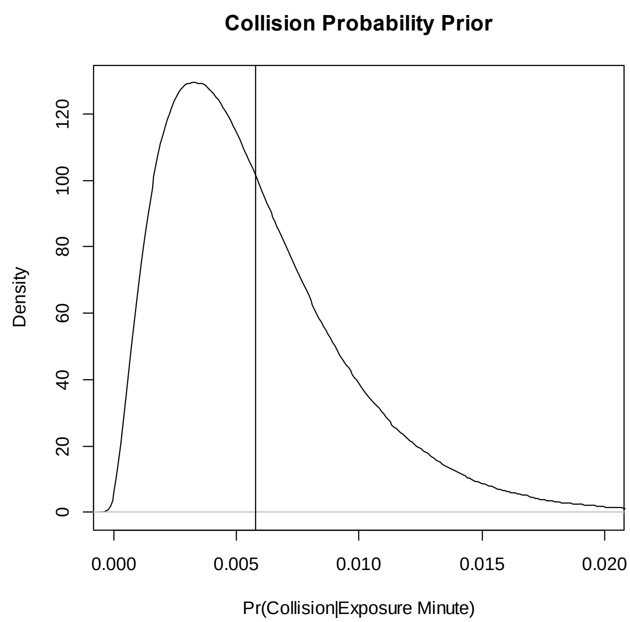

Figure D-2. The probability distribution for the collision probability prior, a Beta(2.31, 396.69) distribution with a mean of 0.0058 (indicated by the reference line) and a standard deviation of 0.0038. The distribution is positively skewed such that most collision probabilities will be small.

At the time of pre-construction permitting, the prior C distribution will be used to estimate the annual predicted fatalities. After construction, post-construction monitoring can be used to determine the posterior C distribution by updating the prior C distribution.

Assuming the observations of fatalities follow a binomial distribution with rate C, the posterior distribution of the rate C will be a beta distribution (the beta distribution and the binomial distribution are a conjugate pair):

$$Posterior\ C \sim Beta(\nu + f, \nu' + g),$$

where f is the number of fatalities estimated from the Stage 5 post-construction monitoring, and g is the estimated number of exposure events that did *not* result in a fatality. The posterior distribution for C cannot be calculated until a project has been built, has started operations, and at least one season of post-construction monitoring has been completed. Once determined, the posterior C distribution can then be used to generate a prediction for annual fatalities and can serve as a prior C for the next iteration of the predictive model (see APPENDIX A).

3. Expansion

The expansion factor (ε) scales the resulting per unit fatality rate (fatalities per hr per km^2) to the daylight hours, τ, in 1 year (or other time period if calculating and combining fatalities for seasons or stratified areas) and total hazardous area (km^2) within the project footprint:

$$\varepsilon = \tau \sum_{i=1}^{n_t} \delta_i,$$

where n_t is the number of turbines, and δ is the circular area centered at the base of a turbine with a radius equal to the rotor-swept radius of the turbine; we define this as the hazardous area surrounding a turbine. In this model, to simplify data requirements and assumptions, we consider both eagle use and hazardous area as 2-dimensional areas, since the height of the sampled and hazardous areas are the same (200 m) and will cancel out in the calculations. Alternative models that consider 3-dimensional space could also be considered, though the expansion factor should be adjusted accordingly. The units for ε are hr$\cdot$ km^2 per year (or time period of interest).

4. Fatalities

Now we can generate the distribution of predicted annual fatalities as the expanded product of the posterior exposure rate and the prior collision probability (once post-construction data is available, the posterior collision probability would be used to update our fatality distribution):

$$F = \varepsilon \cdot posterior\ \lambda \cdot prior\ C.$$

We can then determine the mean, median, standard deviation, and 80% quantile (this will be the upper credible limit) directly from the distribution of predicted fatalities.

5. Putting it all together: an example

The Patuxent Power Company example below illustrates the calculation of predicted fatalities from exposure data from a hypothetical project site. This data will normally come from the field surveys in Stage 2, but for the purposes of this example, we have generated fabricated observation data. The advantage of simulating data in such an exercise is that we can manipulate model inputs to critically evaluate the performance of the model. Additional examples are provided at the end of this document to illustrate the general approach and clarify specific considerations that may apply to certain projects.

a. Patuxent Power Company Example

Patuxent Power Company conducted surveys for eagles at a proposed location for a small- to medium-sized wind facility (18 turbines, each with a 50 meter rotor diameter) following the recommended methods in the ECPG (see Table D-2). They conducted 168 counts at 7 points and 60 eagle-min of exposure were observed. Each count was 2-hr in duration, and covered a circular area of radius 0.8 km. Thus, 675.6 km^2·hr were observed in total.

Table D-2. Exposure data for Patuxent Power Company example. In this hypothetical example, 168 counts were performed. Each count was 2-hr in duration and covered a 0.8 km radius circle. Thus, the total time and area sampled was 675.6 km^2·hr. In that time, 60 exposure events (eagle-min) were observed.

Visit	P1	P2	P3	P4	P5	P6	P7	Total
1	0	0	2	0	2	0	1	5
2	0	0	1	0	0	0	1	2
3	0	1	2	0	0	0	1	4
4	0	1	0	0	0	1	1	3
5	0	1	0	1	0	1	1	4
6	0	0	1	1	0	0	1	3
7	0	1	0	0	0	1	1	3
8	0	0	0	0	0	1	0	1
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	1	0	1	1	0	0	0	3
12	0	1	0	0	1	0	0	2
13	0	0	1	0	0	0	1	2
14	2	0	0	0	0	0	2	4
15	0	0	0	2	2	0	1	5
16	0	0	0	1	0	0	0	1
17	0	0	0	2	0	0	0	2
18	1	0	1	1	0	0	0	3
19	0	0	0	1	0	2	0	3
20	0	0	2	0	1	0	0	3
21	0	0	0	0	1	0	0	1
22	1	0	0	0	0	0	1	2
23	1	0	0	3	0	0	0	4
24	0	0	0	0	0	0	0	0
Total	6	5	11	13	7	6	12	60

b. Exposure

The posterior distribution for the exposure rate is:

$$Posterior\ \lambda \sim Gamma(\tilde{\alpha}, \tilde{\beta}), \text{ remember,}$$
$$Prior\ \lambda \sim Gamma(0.97, 2.76), \text{ Figure D1; where,}$$

$$\tilde{\alpha} = \alpha + \sum_{i=1}^{n} k_i = 0.97 + 60\ eagle\ minutes = 60.97\ eagle\ minutes$$

$$\tilde{\beta} = \beta + n = 2.76 + (168\ counts \times 2\ hr \times \pi(0.8\ km)^2) = 678.31\ km^2 \cdot hr$$

Thus,

$$Posterior\ \lambda \sim Gamma(60.97, 678.31); \text{ the units for } \lambda \text{ are per hr per km}^2.$$

The posterior distribution is shown in Figure D-3. The mean and standard deviation of exposure rate are 0.09 and 0.01, respectively. Note that there is little influence of the prior on this posterior, because the sampling effort was substantial.

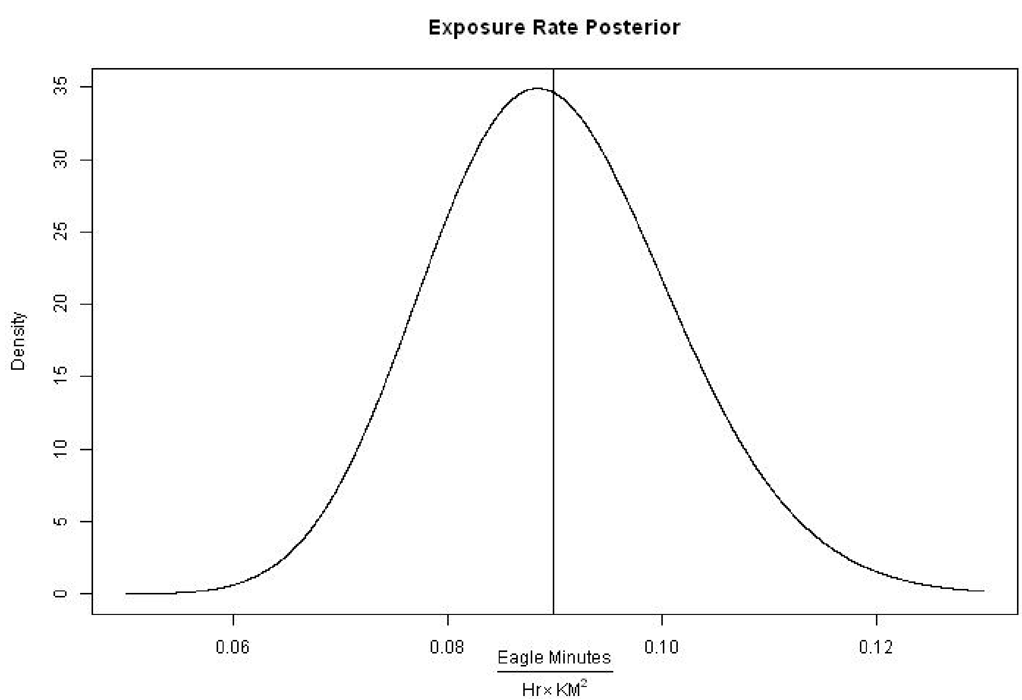

Figure D-3. The posterior distribution for exposure rate for the example project, "Patuxent Power Company." This gamma distribution has a mean (indicated by the reference line) of 0.09 and a standard deviation of 0.01.

b. Collision Probability

We do not have any additional information about collision probability, C, so we will use the prior distribution, which has a mean of 0.0058 and a standard deviation of 0.0038:

$$Prior\ C \sim Beta(2.31{,}396.69);\ \text{see Figure D-2.}$$

c. Expansion

The expansion rate, ε, is the number of daylight hours in a year (τ) multiplied by the hazardous area (δ) around the 18 turbines proposed for the project:

$$\varepsilon = 4{,}383\ hr \cdot \pi(0.025\ km)^2 \cdot 18\ = 154.9\ hr \cdot km^2.$$

d. Fatalities

To determine the distribution for the predicted annual fatalities, the exposure and collision risk distributions need to be multiplied by each other and expanded. The resulting distribution cannot be calculated in closed form; it is easiest to generate it through simulations. In this example, after running 100,000 simulations, the predicted distribution for annual fatalities (Figure D-4) has a mean of 0.082 and a standard deviation of 0.055. The 80% quantile is 0.12 eagle fatalities per year.

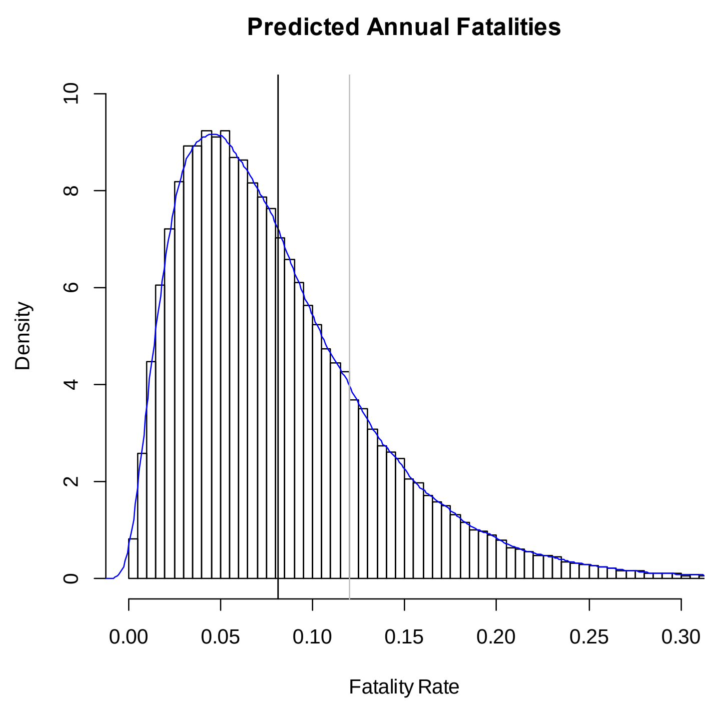

Figure D-4. The probability distribution for predicted annual fatalities. The histogram shows the simulation results. The mean (0.082) and 80% quantile (0.12) are represented by the reference lines (black and gray, respectively). The standard deviation is 0.055.

The Service's baseline model for the proposed Patuxent wind facility predicts that 80% of the time that annual fatalities would be 0.12 eagles or fewer, suggesting that an eagle collision fatality would be predicted to occur at the project site every 8-9 years on average. The facility had a medium amount of eagle activity at the site, but the small size of the project kept the predicted fatality numbers lower than they would have been for a larger project in the same location. Ideally, we would consider other candidate models alongside the baseline model presented here and compare their relative performance using data collected in Stage 5.

6. Additional Considerations

This initial estimate of fatality rate should not take into account possible conservation measures and ACPs (*e.g.* changes in turbine siting or seasonal curtailments); these will be factored in as part of Stage 4 (APPENDIX E). Additionally, any loss of production that may stem from disturbance is not considered in these calculations, but should be added to these estimates and later adjusted based on post-construction monitoring as described in Stage 5. This stage and Stage 5 of the ECP will require close coordination between the project developer or operator and the Service.

a. Small-scale Projects

Small-scale projects (generally these will be residential or small-business projects) may pose a low enough risk that Stage 2 surveys are unnecessary to demonstrate that the project is not likely not take eagles. This presumes that Stage 1 surveys are conducted and show no important eagle use areas or migration concentration sites in the project area. In such cases, the fatalities predicted by the collision fatality model are the expanded product of the exposure prior and the collision probability prior; the exposure prior is not updated to create a posterior as it would be for projects with survey data (Figure D-5). With the prior distributions currently used for exposure rate and collision probability (note that the parameters for the priors distributions are part of the adaptive management framework and will change as new information becomes available), the 80 percent quantile of the predicted fatality distribution for projects with less than approximately 2.4×10^{-3} km^2 of hazardous area predicts fatalities at a rate less than 1 eagle in 30 years (not likely to take eagles). This is equivalent to a single turbine with a rotor diameter of approximately 55 m, or more than 45 turbines with 8 m rotor diameter (each of which has the capacity to exceed typical home energy needs). The calculation of hazardous area is presented in this Appendix under 'Expansion'. If the collision model prediction based on the exposure prior predicts that take of eagles will occur (*e.g.,* if the hazardous area is greater than 2.4×10^{-3} km^2), Stage 2 preconstruction sampling for eagle use of the project area is recommended (see APPENDIX C). The data from Stage 2 surveys will be used to update the exposure prior distribution and produce a project-specific fatality prediction. Projects are encouraged to consult with the Service early in the planning process as components of the fatality prediction model will continue to evolve and may change over time.

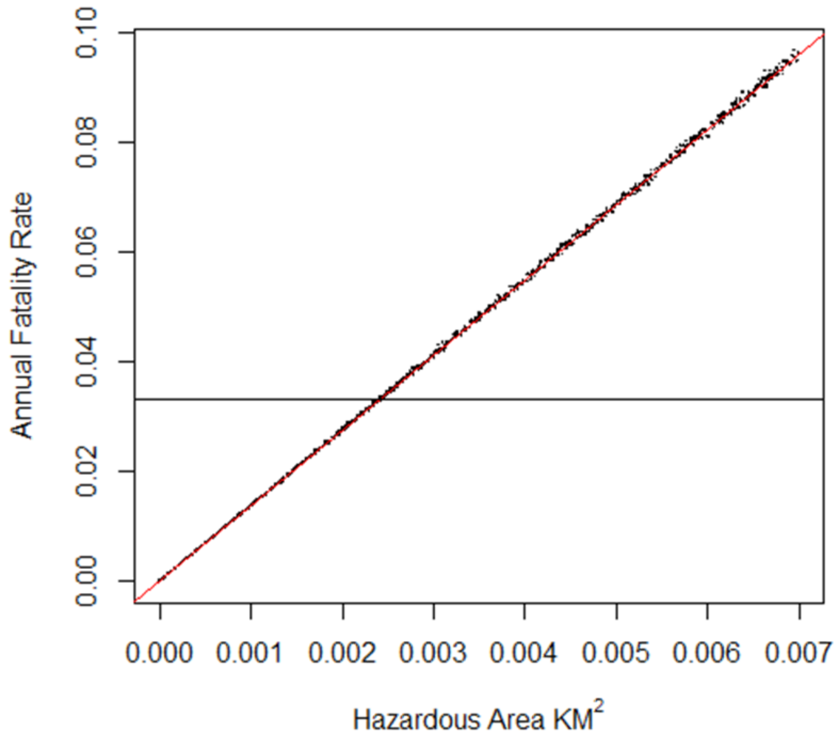

Figure D-5. Predicted fatalities for projects with small hazardous areas based on the prior-only collision fatality model; projects with less than 2.4×10^{-3} km^2 hazardous area are predicted to take less than 1 eagle in 30 years.

The Service is working on the development of additional tools to assist project developers or operators with estimating predicted fatalities given different inputs and allowing for the flexibility to incorporate other factors into additional candidate models. We encourage project developers or operators to begin coordinating with the Service early in the process (Stage 1 or Stage 2) so that we can collaboratively develop a suite of candidate models to consider.

Literature Cited

Gelman, A., Carlin, J. B., Stern, H. S., and D. B. Rubin. 2003. Bayesian Data Analysis, 2nd ed. London, Chapman & Hall.

Whitfield, D. P. 2009. Collision avoidance of golden eagles at wind farms under the 'Band' collision risk model. Report from Natural Research to Scottish Natural Heritage, Banchory, UK.

APPENDIX E: STAGE 4 – AVOIDANCE AND MINIMIZATION OF RISK USING ACPS AND OTHER CONSERVATION MEASURES, AND COMPENSATORY MITIGATION

The most important factor when considering potential effects to eagles is the siting of a wind project. Based on information gathered in Stage 2 and analyzed in Stage 3, the project developer or operator should revisit the site categorization from the Stage 1 assessment to determine if the site(s) still falls into an acceptable category of risk (at this stage, acceptable categories are 2 and 3, and very rarely 1). When information suggests that a proposed wind project has a high eagle exposure rate and presents multiple risk factors (*e.g.*, is proximate to an important eagle-use area or migration concentration site and Stage 2 data suggest eagles frequently use the proposed wind-project footprint), it should be considered a category 1 site; we recommend relocating the project to another area because a location at that site would be unlikely to meet the regulatory requirements for a programmatic permit. If the site falls into categories 2 or 3, or rarely some category 1 sites where there is potential to adequately abate risk, the ECP should next address conservation measures and ACPs that might be employed to minimize or, ideally, avoid eagle mortality and disturbance. To meet regulatory requirements, ACPs, if available, must be employed such that any remaining eagle take is unavoidable.

In this section of the ECP, we recommend project developers or operators re-run models predicting eagle fatality rates after implementing conservation measures and available ACPs for all the plausible alternatives. This re-analysis serves two purposes: (1) it demonstrates the degree to which minimization and avoidance measures might reduce effects to eagle populations compared to the baseline project configuration, and (2) it provides a prediction of unavoidable eagle mortality. Conservation measures and ACPs should be tailored to specifically address the risk factors identified in Stage 3 of the ECP. This section of the ECP should describe in detail the measures proposed to be implemented and their expected results.

The Service does not advocate the use of any particular conservation measures and merely provides the below list as examples. Moreover, at this time none of these measures have been approved as ACPs for wind projects. Ultimately, project developers or operators will propose and implement site specific conservation measures and ACPs (as they become available) in cooperation with local Service representatives in order to meet the regulatory standard of reducing any remaining take to a level that is unavoidable.

Examples of conservation measures that could be considered before and during project construction, depending on the specific risk factors involved, include:

1. Minimize the area and intensity of disturbances during pre-construction and construction periods.
2. Prioritize locating development on lands that provide minimal eagle use potential including highly developed and degraded sites.
3. Utilize existing transmission corridors and roads.
4. Set turbines back from ridge edges.
5. Site structures away from high eagle use areas and the flight zones between them.
6. Dismantle nonoperational meteorological towers.
7. Bury power lines to reduce avian collision and electrocution.
8. Follow the Avian Power Line Interaction Committee (APLIC) guidance on power line construction and design (APLIC 2006).
9. Minimize the extent of the road network.

10. Avoid the use of structures, or remove existing structures, that are attractive to eagles for perching.
11. Avoid construction designs (including structures such as meteorological towers) that increase the risk of collision, such as guy wires. If guy wires are used, mark them with bird flight diverters (according to the manufacturer's recommendation).
12. Avoid siting turbines in areas where eagle prey are abundant.
13. Avoid areas with high concentrations of ponds, streams, or wetlands.

Examples of avoidance and minimization measures that could be considered during project operation, depending on the specific risk factors involved, include:

1. Maintain facilities and grounds in a manner that minimizes any potential impacts to eagles (*e.g.* minimize storage of equipment near turbines that may attract prey, avoid seeding forbs below turbines that may attract prey, etc.).
2. Avoid practices that attract/enhance prey populations and opportunities for scavenging within the project area.
3. Take actions to reduce vehicle collision risk to wildlife and remove carcasses from the project area (*e.g.* deer, elk, livestock, etc.).
4. Instruct project personnel and visitors to drive at low speeds (< 25 mph) and be alert for wildlife, especially in low visibility conditions.

When post-construction fatality information becomes available, the project developer or operator and the Service should consider implementing all or a subset of the additional conservation measures and experimental ACPs that were considered at the time the permit was issued (see ASSESSING RISK AND EFFECTS, 3b. General Approach to Address Risks in the ECPG).

Examples of experimental ACPs that could be identified initially or after evaluation of post-construction fatality monitoring data, depending on the specific risk factors involved, include:

1. Seasonal, daily, or mid-day shut-downs (particularly relevant in situations where eagle strikes are seasonal in nature and limited to a few turbines, or occur at a particular time of day).
2. Turbine removal or relocation.
3. Adjusting turbine cut-in speeds.
4. Use of automated detection devices (*e.g.* radar, etc.) to control the operation of turbines.

Literature Cited

Avian Power Line Interaction Committee (APLIC). 2006. Suggested practices for avian protection on power lines: the state of the art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington D.C. and Sacramento, CA, USA. *http://www.aplic.org/SuggestedPractices2006(LR-2watermark).pdf.*

APPENDIX F: ASSESSING PROJECT-LEVEL TAKE AND CUMULATIVE EFFECTS ANALYSES

The Service is required to evaluate and consider the effects of programmatic take permits on eagles at the eagle management unit, local-area, and project-area population scales, including cumulative effects, as part of its permit application review process (50 CFR 22.26 (f)(1) and USFWS 2009). The Service will rely on information a developer provides from the Stage 1 and Stage 2 assessments, as well as all other available information on mortality and other population-limiting effects at the various population scales, when preparing its cumulative impact assessment. The Service's NEPA on the Eagle Permit Rule evaluated and set sustainable take levels at the eagle management unit scale (USFWS 2009). However, that NEPA analysis did not assess impacts at other population scales. A significant part of the cumulative effects evaluation is assessing the effect of the proposed take in combination with take caused by previously authorized actions and reasonably foreseeable future actions on the local-area eagle population(s), and it is this analysis that is the focus of this appendix.

The purpose of this part of the cumulative effects evaluation is to identify situations where take, either at the individual project level or in combination with other authorized or foreseeable future actions and other limiting factors at the local-area population scale, may be approaching levels that are biologically problematic or which cannot reasonably be offset through compensatory mitigation. In previous assessments of the effect of falconry take on raptor populations (Millsap and Allen 2006), the Service identified annual take levels of 5% of annual production to be sustainable for a range of healthy raptor populations, and annual take levels of 1% of annual production as a relatively benign harvest rate over at least short intervals when population status was uncertain. This approach was used to establish take thresholds at the eagle management unit scale (USFWS 2009). The Service considered several alternatives for benchmark harvest rates at the local-area population scale, and after comparative evaluation identified take rates of between 1% and 5% of the estimated total eagle population size at this scale as significant, with 5% being at the upper end of what might be appropriate under the BGEPA preservation standard, whether offset by compensatory mitigation or not. These local-area harvest rate benchmarks are overlain by the more conservative take thresholds for the eagle management units, so the overall harvest rate at the eagle management unit scale should not exceed levels established in the Final Environmental Assessment (USFWS 2009).

The Service recommends a top-down approach for this assessment: (1) identify numbers of eagles that may be taken safely at the national level (*i.e.*, a national-level benchmarks); (2) allocate take opportunities among regional eagle management units (USFWS 2009) as a function of the proportion of eagles in each unit (*i.e.*, regional-level benchmarks); (3) further allocate take opportunities to the local-area population scale as a function of inferred eagle population size at that scale (assuming, in the absence of better data on eagle distribution at the scale of the eagle management unit, a uniform distribution of that population); and (4) incorporating benchmarks that can be used to assess the likely sustainability of predicted levels of take at the local-area scale. Through a spatial accounting system, permitted take is managed to ensure that the benchmarks also consider cumulative effects at the local-area eagle population scale as a guard against authorizing excessive take at this scale.

In Table F-1, we work through this approach using the hypothetical example of eight individual yet identical projects, one in each bald eagle management unit. Each of these projects has a 314 mi^2 footprint, and affects a local-area bald eagle population over 8824 square mile (mi^2) area. For this example, we use a take rate of 5% of the local-area bald eagle population per year as the maximum acceptable take rate. In this example, the 5% benchmark take rate over the eight projects is 150 individual bald eagles per year, and the range of allowable take rates at this scale varies across management units from <1 bald eagle per year in the southwest to 67 per year in Alaska. Table F-2 provides population and eagle management unit area statistics for golden eagles to aid in performing these calculations for that species.

As noted above, in cases where the local-area eagle populations of proximate projects overlap, the overlap should be taken into account in a cumulative effects analysis so that the cumulative take on the local-area population scale can be considered against population benchmarks. Figure F-1 illustrates one method to do this, and Table F-3 provides the calculations for this example. These examples use bald eagles, but the same concept and approach can be used for golden eagles, with Bird Conservation Regions (BCRs) defining the eagle management units. The example in Figure F-1 involves bald eagles in Region 3. Project 1 (in green) has a footprint of 41 $miles^2$ (mi^2), and affects a local-area bald eagle population over 6854 mi^2 (light green buffer around the project footprint). Following the approach in Table F-1, project 1 was issued a programmatic take permit with a maximum annual project-level take of 21 bald eagles per year (see Table F-3). Project 2 (in red, the same size as project 1) applied for a programmatic eagle take permit 5 years later. The calculated project-level bald eagle take for project 2 is 20 bald eagles per year, but under the 5% benchmark, maximum take for 1563 mi^2 of project 2's local-area bald eagle population (totaling 5 bald eagles per year) was already allocated to project 1 (the hatched-marked area of overlap between the local areas of project 1 and project 2). Therefore, the calculated local-area bald eagle take for project 2 exceeds the 5% benchmark. Thus, the decision-maker for the permit for project 2 should carefully consider whether this project can be permitted as designed under the requirements of our regulations at 50 CFR 22.26.

The examples assume acceptable compensatory mitigation opportunities, when they are required, are limitless. They are not, and where compensatory mitigation is necessary to offset the permitted take, the availability of compensatory mitigation can become the proximate factor limiting take opportunities.

A critical assumption of this approach is that eagle density is uniform across eagle regions. The potential consequence of this assumption is to over protect eagles in areas of high density and under protect them in areas of low density. As the Service and others develop more reliable models for predicting the distribution of eagles within regional management populations at finer scales, these approaches should be used in place of an assumption of uniform distribution in the analyses suggested here.

Table F-1. Example of the proposed method to calculate local-area annual eagle take benchmarks. The example uses bald eagles (BAEA), and is based on a hypothetical scenario where a single project with a circular footprint of 10-mile radius is proposed in each BAEA region. See Figure F-1 for an example of how to assess the cumulative effects of such permitted take over the local-area population.

BAEA Management Unit	Estimated Population Size[a]	Region Size (mi^2)	Maximum Take Rate (% local-area population per year)[b]	Management Unit Eagle Density (BAEA/ mi^2)[c]	Local Area (mi^2)[d]	Local-area 5% Benchmark (eagles per year)[e]
R1	7105	245336	5.0	0.029	8824	13
R2	797	565600	5.0	0.001	8824	>1
R3	27617	447929	5.0	0.062	8824	27
R4	13111	464981	5.0	0.028	8824	12
R5	14021	237687	5.0	0.059	8824	26
R6	5385	732395	5.0	0.007	8824	3
R7	86550	570374	5.0	0.152	8824	67
R8	889	265779	5.0	0.003	8824	1
Sum	155474					150

[a] Taken directly from USFWS (2009).
[b] A take rate of 5% is the Service's upper benchmark for take at the local-area population scale.
[c] Management unit eagle density = population size / management unit size.
[d] The local-area for this example is the project footprint (in this case, a circle with radius of 10 miles) plus a buffer of 43 additional miles (43 miles is the average natal dispersal distance for the BAEA) = $3.142 * 53^2$.
[e] The local-area 5% benchmark = (Local-area*Regional Eagle Density)*0.05.

Table F-2. Background information necessary to estimate the local-area take benchmarks for golden eagles (GOEA). Columns are as in Table F-1. The local-area for golden eagles, which is not used in this table, is calculated using the median natal dispersal distance of 140 miles (USFWS 2009).

GOEA Management Unit	BCR Number	Estimated Population Size[a]	BCR Size (mi^2)[b]	Management Unit Eagle Density (GOEA per mi^2)
Alaska		2400	557007	0.0043
Northern Pacific Rainforest	5	108	68777	0.0016
Prairie Potholes	11	1680	160794	0.0104
Sierra Nevada	15	84	20414	0.0041
Shortgrass Prairie	18	1080	148540	0.0073
Coastal California	32	960	63919	0.0150
Sonoran and Mojave Desert	33	600	95593	0.0063
Sierra Madre Occidental	34	360	47905	0.0075
Chihuahuan Desert	35	720	72455	0.0099
Great Basin	9	6859	269281	0.0255
Northern Rockies	10	6172	199666	0.0309
Southern Rockies and Colorado Plateau	16	3770	199522	0.0189
Badlands and Prairies	17	7800	141960	0.0549
	Sum	32593		

[a] Taken directly from USFWS 2009.
[b] BCR area values are from the North American Bird Conservation Region website at: *http://www.bsc-eoc.org/international/bcrmain.html* (last visited 8 December 2011).

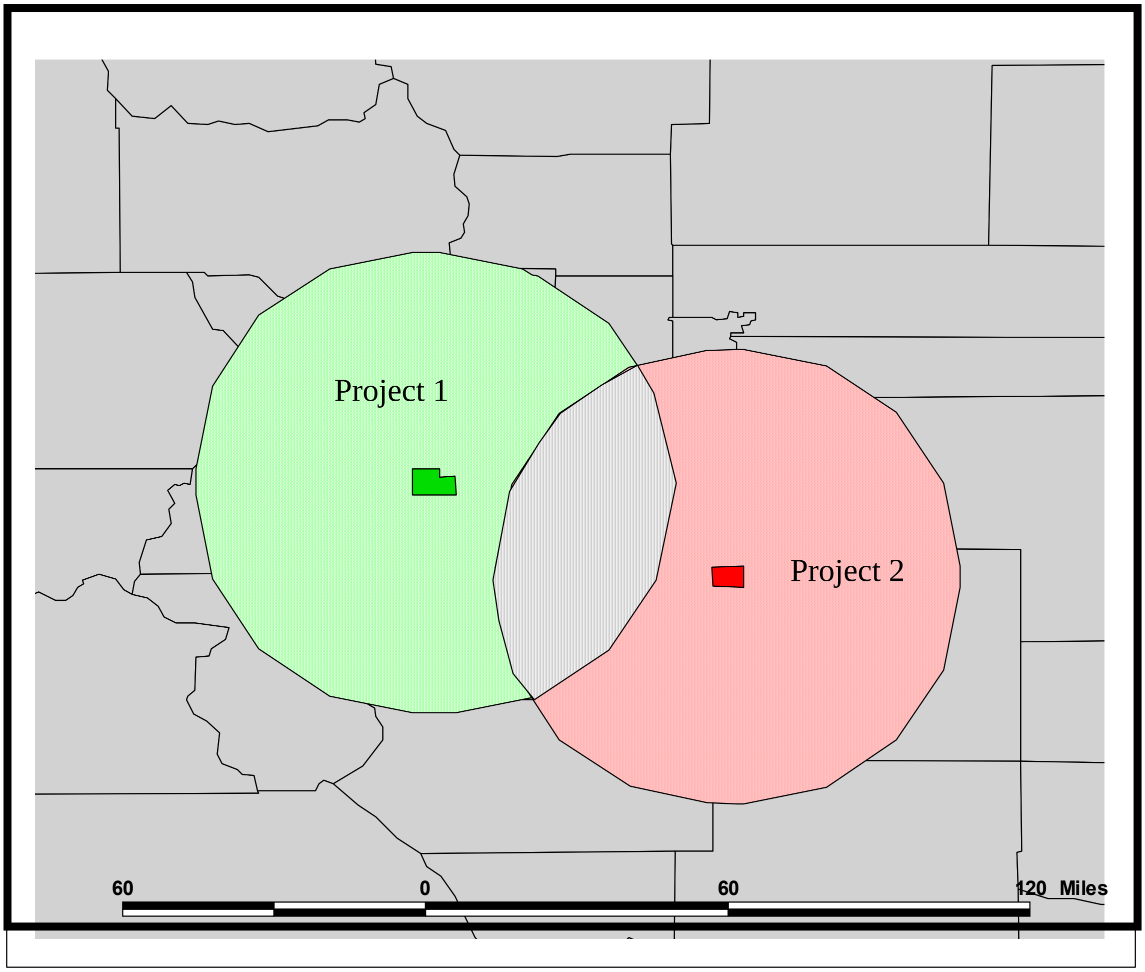

Figure F-1. Example of the proposed method for ensuring local-area take benchmarks are not exceeded through the cumulative take authorized over multiple projects. Project 1 is in green, project 2 is in red, and the overlap in their local-area eagle bald eagle populations is the hatched-marked area (see text). This same approach could be used to assess the cumulative effects of other forms of take and anthropomorphic impacts for which data on population effects are available.

Table F-3. Calculations used to determine local-area bald eagle take for the example in Fig. F-1, where project 1 is first-in-time, and the local-area bald eagle (BAEA) populations for the two projects overlap. Calculations are as described in the footnotes to table F-1.

Project	Region 3 BAEA Population Size	Region Size (mi^2)	Maximum Take Rate (% local-area population per year)[b]	Regional Eagle Density (BAEA per mi^2)	Local-area (mi^2)	Local-area 5% Benchmark (eagles per year)[e]
Project 1 (first-in-time)	27617	447929	5.0	0.062	6854	21
Project 2, unadjusted	27617	447929	5.0	0.062	6550	20
Overlap Area	27617	447929	5.0	0.062	1562	5
Project 2, adjusted	27617	447929	5.0	0.062	13404	15

Literature Cited

USFWS. 2007. Final environmental assessment, take of raptors from the wild under the falconry regulations and the raptor propagation regulations. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C.

USFWS. 2008. Final environmental assessment and management plan, take of migrant peregrine falcons from the wild for use in falconry, and reallocation of nestling/fledgling take. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C.

USFWS. 2009. Final environmental assessment, proposal to permit take as provided under the Bald and Golden Eagle Protection Act. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C.

USFWS. 2011. Draft eagle conservation plan guidance. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C.

APPENDIX G: EXAMPLES USING RESOURCE EQUIVALENCY ANALYSIS TO ESTIMATE THE COMPENSATORY MITIGATION FOR THE TAKE OF GOLDEN AND BALD EAGLES FROM WIND ENERGY DEVELOPMENT

1. Introduction

This appendix provides Resource Equivalency Analysis (REA) examples developed by the Service to illustrate the calculation of compensatory mitigation for the annual loss of golden (GOEA) eagles and bald (BAEA) eagles caused by wind power if conservation measures and ACPs do not remove the potential for take, and the projected take exceeds calculated thresholds for the species or management population affected. These examples result in estimates of the number of high-risk electric power poles that would need to be retrofitted *per* eagle taken based on the inputs provided below. Detailed explanatory documentation, literature, and supporting REA spreadsheets are now located at: www.fws.gov/windenergy/index.html

As a *framework* for compensatory mitigation, it needs to be clear that the results provided below are an illustration of how REA works given the *current* understanding of GOEA and BAEA life history inputs, effectiveness of retrofitting high-risk electric power poles, the expected annual take, and the timing of both the eagle take permit and implementation of compensatory mitigation. As would be expected, the estimated number of eagle fatalities and the permit renewal period affect the number of poles to be retrofitted. Delays in retrofitting would lead to more retrofitted poles owed. New information on changes in the level of take, understanding of the eagle life history, or effectiveness of retrofitting could be used to change the number of retrofitted poles needed for compensation. Finally, while only electric pole retrofitting is presented here in detail, the REA metric of bird-years lends itself to consideration of other compensatory mitigation options to achieve the no-net-loss standard in the future. With enough reliable information, any compensatory mitigation that directly leads to an increased number of GOEA and BAEA (*e.g.*, habitat restoration) or the avoided loss of these eagles (*e.g.*, reducing vehicle/eagle collisions, making livestock water tanks 'eagle-safe', lead ammunition abatement, etc.) could be considered for compensation within the context of the REA.

2. REA Inputs

The best available peer-reviewed, published data are provided in Tables G-1 and G-2. It should be noted that additional modeling work within the REA may be needed, particularly on issues related to migration, adult female survivorship, natal dispersal, age at first breeding, and population sex ratio.

Table G-1. *EXAMPLE INPUTS*. REA Inputs to Develop a Framework of Compensatory Mitigation for Potential Take of GOEA from Wind Energy Development

Parameter	REA Input		Reference
Start year of permit	2012		***Example.***
Length of permit renewal period	5 years		***Example.***
Estimated take	1 eagle/year		***Example.***
Average maximum lifespan	30 years		28 years, 3 months, USGS Bird Banding Lab. Consistent with Cole (2010) approach.
Age distribution of birds killed at wind facilities (based on age distribution of GOEA population)	(0-1) (1-4) (4-30)	20% 35% 45%	• 20% juveniles (age class (0-1)) • 35% sub-adults (11.67% for each age class from age class (1-2) through age class (3-4)) • 45% adults (1.73% for each age class from age class (4-5) through age class (29-30)) Assume age class is distributed evenly over time. Age distribution derived from models presented in USFWS 2009.
Age start reproducing	Age 5 [age class (5-6)]		Steenhof *et al.* 1984; Kochert *et al.* 2002
Expected years of reproduction	25 years		= (Maximum Lifespan) – (Age Start Reproducing) (Harmata 2002)
% of adult females that reproduce annually	80%		Steenhof *et al.* 1997
Productivity (mean number of individuals fledged per occupied nest annually)	0.61		USFWS 2009
year 0-1 survival	61%		USFWS 2009
year 1-2 survival	79%		
year 2-3 survival	79%		
year 3-4 survival	79%		
year 4+ survival	90.9%		
Relative productivity of mitigation option	0.0036 eagle electrocutions/pole/year		***Example.*** Compensatory mitigation involves retrofitting high-risk electric power poles, thus avoiding the loss of GOEA from electrocution (Lehman *et al.* 2010).
Discount rate	3%		A 3% discount rate is commonly used for valuing lost natural resource services (Freeman 1993, Lind 1982, NOAA 1999; and court decisions on damage assessment cases)

Table G-2. ***EXAMPLE INPUTS.*** REA Inputs to Develop a Framework of Compensatory Mitigation for Potential Take of BAEA from Wind Energy Development

Parameter	**REA Input**		**Reference**
Start year of permit	2011		***Example.***
Length of permit renewal period	5 years		***Example.***
Estimated take	1 eagle/year		***Example.***
Average maximum lifespan	30 years		32 years 10 months; Longevity record from USGS Bird Banding Lab. Consistent with Cole (2010) approach.
Age distribution of birds killed at wind facilities (based on age distribution of BAEA population)	(0-1) (1-4) (4-30)	15.4% 30% 54.6%	• 15.4% juveniles (age class (0-1)) • 30% sub-adults (10% for each age class from age class (1-2) through age class (3-4)) • 54.6% adults (2.1% for each age class from age class (4-5) through age class (29-30)) Assume age class is distributed evenly over time. Age distribution derived from models presented in USFWS 2009.
Age start reproducing	Age 5 [age class (5-6)]		Buehler 2000
Expected years of reproduction	25 years		= (Maximum Lifespan) – (Age Start Reproducing)
% of adult females that reproduce annually	42%		Hunt 1998, per. comm. Millsap
Productivity	1.3		Millsap *et al.* 2004
year 0-1 survival	77%		Millsap *et al.* 2004
year 1-2 survival	88%		
year 2-3 survival	88%		
year 3-4 survival	88%		
year 4+ survival	83%		
Relative productivity of mitigation option	0.0036 eagle electrocutions/pole/year		***Example.*** Mitigation involves retrofitting high-risk electric power poles, thus avoiding the loss of BAEA from electrocution (Lehman *et. al* 2010).
Discount rate	3%		A 3% discount rate is commonly used for valuing lost natural resource services (Freeman 1993; Lind 1982; NOAA 1999; and court decisions on damage assessment cases).

3. REA Example – WindCoA

The Service developed the following hypothetical scenario for permitting and compensatory mitigation to be applied to the take of GOEA[1] from wind power operations:

WindCoA conducted three years of pre-construction surveys to determine relative abundance of GOEA at their proposed wind project in Texas. The survey data was then used to populate a risk assessment model to generate an eagle fatality estimate. The initial fatality estimate of two eagles per year was further reduced after WindCoA implemented a few mutually agreed upon ACPs. The final fatality estimate generated from the risk assessment model, after consideration of the advanced conservation practices, was an annual take of one GOEA per year over the life of the permit starting in 2012.

WindCoA decided to conduct an REA to determine the number of high-risk power poles that would need to be retrofitted to get to no-net-loss. The company used the Service's GOEA REA inputs and assumed the power pole retrofit would occur in calendar year 2012, thus offsetting the potential loss of eagles at the newly operating wind project with avoidance of electrocution of an equal number of GOEA. Through proper operation and maintenance (O&M), the retrofitted poles are assumed to be effective in avoiding the loss of eagles for 10 years. The results of the model are expressed in the total number of electric power poles to be retrofitted to equate to no-net-loss of 5 eagles for the 5-year permit renewal period (1 eagle annually over five years). These results are extrapolated over the expected operating life of the wind project, which is assumed to be 30 years, for a total take of 30 eagles.

The results of the REA indicated that WindCoA needed to retrofit approximately 149 power poles for the first 5-year permit period (see Table G-3). Using an estimated cost of $7500/pole, the Service estimated that WindCoA could contribute $1,117,500 to a third-party mitigation account or contract the retrofits directly. After determining that they could fund the retrofits directly at a lower cost, WindCoA decided to partner with UtilityCoB to get the required number of poles retrofitted. UtilityCoB had previously conducted a risk assessment of their equipment and had identified high-risk poles that were likely to take golden eagles. Through a written agreement, WindCoA provided funding to UtilityCoB to retrofit the required number of power poles and maintain the retrofits for 10 years. In addition, WindCoA contracted with ConsultCoC to perform effectiveness monitoring of the retrofitted power poles for 2 years. The contract required that ConsultCoC visit each retrofitted power pole every 4 months (quarterly) to perform fatality searches and check for proper operation and maintenance of the equipment. The Service reviewed the compensatory mitigation project proposed by WindCoA and found it to be consistent with requirements at 50 CFR 22.26. After reviewing the signed contract between WindCoA, UtilityCoB, and ConsultCoC, the Service issued a programmatic eagle take permit to WindCoA.

a. REA Language and Methods

As discussed in greater detail in documents on the supporting website, this REA includes:

- The **direct loss** of GOEA/BAEA eagles from the take (*debit* in bird-years);
- The **relative productivity** of retrofitting high-risk power poles, which is the effectiveness in avoiding the loss of GOEA/BAEA by electrocution as a mitigation offset (measured in total bird-years per pole); and

[1] Using the inputs provided in Table G-2, this scenario may also be applied to BAEA.

- The **mitigation owed**, which is the total debit divided by the relative productivity (*scaling*) to identify the number of high-risk power poles that need retrofitting to completely offset the take of GOEA/BAEA eagles (credit).

There are up to 16 steps when conducting a REA. Depending on whether foregone future reproduction (part of the debit) is included, there are up to 13 total steps involved in calculating the injury side (debit) of a REA, and three additional steps involved in estimating compensatory mitigation owed (credit). Please refer to the technical note "Scaling Directly Proportional Avoided Loss Mitigation/Restoration Projects" on the supporting website (*www.fws.gov/windenergy*) for further information on the development of REA inputs and the inclusion of lost reproduction. Notably, in the case of an avoided loss project where the estimated prevented loss of bird-years (*e.g.*, through mitigation) is *directly proportional* to the loss of bird-years (*e.g.*, from "take"), the life history inputs (*e.g.*, longevity, age distribution, survival rates, reproduction) do not affect the final results of the credit owed. That is, the retrofitting of high-risk power poles is a directly proportional avoided loss, so only the level of take (number of eagles annually), the avoided loss of eagles per mitigated electric pole, the number of years the mitigated pole is effective in avoiding the loss of eagles, and the timing of the mitigation relative to the take affect the final credit owed. It should also be noted that the annual take of one eagle is used in the example because the lost bird-years associated with one eagle can be easily multiplied by the actual take to estimate the total debit in bird-years.

The following is a brief discussion of REA variables used in the Service's WindCoA example that affect the outcome of the compensatory mitigation calculation:

- **Relative Productivity of Mitigation (0.0036 electrocutions/pole/year**) – This rate is taken directly from published literature on eagle electrocution rates in northeastern Utah and northwestern Colorado and is specific to eagles (Lehman *et al.* 2010). Although the referenced study also lists a higher rate (0.0066) that includes all known eagle mortalities, this rate included eagles that may have died from causes unrelated to electrocution.
- **Years of Avoided Loss Per Retrofitted Pole (10 Years) –** The Service uses a period of 10 years for crediting the project developer or operator for the avoided loss of eagles from power pole retrofits. This is a reasonable amount of time to assume that power pole retrofits will remain effective. However, project developers or operators should consider entering into agreements with utility companies or contractors for the long-term maintenance of retrofits. Evidence of this type of agreement could increase the amount of credit received by the project developer or operator and, as a result, decrease the amount of compensatory mitigation required.
- **Permit Renewal Period (5 Years**) – This will be the review period that is used by the Service for adaptive management purposes and re-calculation of compensatory mitigation. The Service believes that this length of time will enable the project developer or operator to continue to meet the statutory and regulatory eagle preservation standard. This permit review tenure will remain the same regardless of the overall tenure of the permit.
- **Retrofit Cost/Payment ($7,500/pole**) – The Service received input directly from the industry regarding the actual costs to retrofit power poles. Estimates ranged from a low of approximately $400 to over $11,000 given that costs vary according to many factors. The Service believes that $7,500 represents a reasonable estimate for the current cost to retrofit power poles in the United States. Project developers or

operators are encouraged to contract directly for retrofits as this will likely not be as costly as contributing $7,500/pole to an eagle compensatory mitigation account.

b. REA Results for WindCoA

Using the WindCoA example described above, along with the REA inputs provided in Table G-1, Table G-3 provides a summary of the results:

Table G-3. WindCoA Example: Compensatory Mitigation Owed for a 5-Year Permitted Take of 5 GOEA Extrapolated to the 30-Year Expected Operating Life of the Wind Project (30 GOEA in Total).

Total Debit for Take of 1 GOEA	28.485	PV* bird-years for 5 years of GOEA take
÷Relative Productivity of High-Risk Electric Pole Retrofitting	÷0.191	Avoided loss of PV bird-years per retrofitted pole (assumes 10 years of avoided loss per pole based on the commitment from UtilityCoB)
= Mitigation Owed for 5-Year Permitted Take	=149.136	Poles to be retrofitted to achieve no-net-loss
x # Cycles of 5-Year Permit Reviews =Total Mitigation Owed	x 6 = 894.818	Poles to be retrofitted to achieve no-net-loss for the 30-year expected operating life of the wind project

*PV=Present Value

If *all* of the REA inputs remain the same after the initial five years, then the estimated 149.14 poles may be multiplied by the expected number of permit reviews to provide an estimate of the total number of poles that would eventually be retrofitted. For example, for the 30-year life cycle of the WindCoA wind project, 149.14 poles would be multiplied by 6 permit renewals to equal approximately 895 high-risk power poles in total to be retrofitted as compensatory mitigation for the take of 30 GOEA over 30 years (1 eagle annually). While this example shows the effectiveness of the mitigation method as lasting for 10 years, it may be the case that the method selected is more or less effective at avoiding the loss of eagles (*e.g.*, 5 years, more than 10 years). The REA can be adjusted for the expected effectiveness of mitigation, and more or fewer high-risk power poles would need to be mitigated. All estimates of compensatory mitigation are contingent on proper operation and maintenance being conducted by UtilityCoB or a contractor to ensure that the expected effectiveness is achieved.

For purposes of illustration, should WindCoA choose to use the GOEA inputs provided in Table G-1 and their fatality estimate is that 5 GOEA will be taken annually, the results may be easily adjusted as shown in Table G-4:

Table G-4. WindCoA Example: Compensatory Mitigation Owed for a 5-Year Permitted Take of 25 GOEA Extrapolated to the 30-Year Expected Operating Life of the Wind Project (150 GOEA in Total).

Total Debit for Take of 1 GOEA	28.485	PV bird-years for 5 years of GOEA take from Table F-3
x Actual Annual Take of GOEA	x 5 =142.425	PV bird-years for 5 years of GOEA take
÷ Relative Productivity of High-Risk Electric Pole Retrofitting	÷0.191	Avoided loss of PV bird-years per retrofitted pole (assumes 10 years of avoided loss per pole based on the commitment from UtilityCoB)
= Mitigation Owed for 5-Year Permitted Take	=**745.681**	Poles to be retrofitted to achieve no-net-loss
x # Cycles of 5-Year Permit Reviews = Total Mitigation Owed	x 6 =**4474.086**	Poles to be retrofitted to achieve no-net-loss for the 30-year expected operating life of the wind project

PV=Present Value

c. Summary of Bald Eagle REA Results

Following the same process described above for GOEA (*i.e.*, using the WindCoA example and the BAEA REA inputs provided in Table G-2), Table G-5 provides a summary of the results for bald eagles:

Table G-5. Example of Compensatory Mitigation Owed for a 5-Year Permitted Take of 5 BAEA Extrapolated to the 30-Year Expected Operating Life of the Wind Project (30 BAEA in Total).

Total Debit for Take of 1 BAEA	20.229	PV bird-years for 5 years of BAEA take
÷ Relative Productivity of High-Risk Electric Pole Retrofitting	÷0.136	Avoided loss of PV bird-years per retrofitted pole
= Mitigation Owed for 5-Year Permitted Take	=**149.136**	Poles to be retrofitted to achieve no-net-loss
x # Cycles of 5-Year Permit Reviews = Total Mitigation Owed	x 6 =**894.818**	Poles to be retrofitted to achieve no-net-loss for the 30-year expected operating life of the wind project

PV=Present Value

Although there are differences between GOEA and BAEA life history inputs (*e.g.*, longevity, age distribution, survival rates, reproduction), the estimated avoided loss of bird-years through mitigation is *directly proportional* to the loss of bird-years from the take, so the life history inputs do not affect the final results of the credit owed. Because there was no change in the level of take (number of eagles annually), the avoided loss of eagles per mitigated electric pole, the number of years the mitigated pole is effective in avoiding the loss of eagles, or the timing of the mitigation relative to the take, there is no change in the credit owed. To help illustrate, when comparing the results of BAEA to GOEA, both the debit (20.23÷28.49) and the relative productivity of electric pole retrofitting (0.14÷0.19) for BAEA are approximately 70% of GOEA, so the amount of retrofitting owed is the same. That is, both the numerator of the scaling equation (total debit) and the denominator (relative productivity of mitigation) were changed proportionally (approximately 70%), so there is no change in the mitigation owed.

d. Discussion on Using REA

The ECPG does not mandate the use of REA. Rather, the Service recognized the need for a reliable, transparent, reproducible, and cost-effective tool to expedite wind power permits, while ensuring sufficient compensatory mitigation for the take of golden eagles and bald eagles from operations to meet regulatory permitting requirements. Although there is a learning curve, REA meets these basic needs. This appendix and materials on the supporting website explain the methods, share the tools to run REAs, and discuss how changes in the different inputs can affect the results. Should project developers or operators/applicants choose to use the provided inputs, methods, and tools, the Service will be able to appropriately focus on the expected take of eagles. Project developers or operators/applicants have the discretion to offer alternative REA inputs or use different compensatory mitigation modeling methods. However, they will need to provide sufficient evidence and tools (if necessary) to ensure that the Service can provide appropriate review of the results, and should expect that such an effort will likely take additional time.

e. Additional Compensatory Mitigation Example

In the United States, another known cause of mortality to eagles, both bald and golden, is vehicle collisions. Eagles are susceptible to being struck by vehicles as they feed on carcasses along roadsides, particularly in areas of the United States where large numbers of ungulates concentrate seasonally (*e.g.* winter, breeding season, etc.). As a compensatory mitigation strategy, a project developer or operator may decide to collect data (or use existing data if it is available) on the annual number of eagle mortalities that result from vehicle collisions in a specified geographic area or along a specific stretch of roadway. This data could then be used to generate an estimate of the number of eagle mortalities that could be prevented in the same area by removing carcasses from roadsides. If there was sufficient evidence that this was a valid project (*e.g.* quantifiable and verifiable), the project developer or operator could contract to have these roadsides 'cleaned' of carcasses during the time of year that ungulates concentrate and eagles are known to be struck. The credible estimate of eagle mortalities that would be avoided through carcass removal would be the value of the compensatory mitigation achieved.

f. Take from Disturbance

Project developers or operators should work with the Service to determine if take from disturbance is likely to occur. This should be predicted in advance based on Stage 3 data, and verified through post-construction monitoring in Stage 5. The following are recommended take calculations based on information contained within the FEA (USFWS 2009):

For the standard bald eagle population:

- Take resulting from disturbance at one nest on only one occasion = take of 1.3 individuals
- One nest take resulting in the permanent abandonment of a territory = take of 1.3 individuals for the first year, then take of 8 individuals annually until data show the number of breeding pairs has returned to or exceeded the original estimated number for the eagle management unit.

For the standard golden eagle population:

- Take resulting from disturbance at one nest on only one occasion = take of 0.8 individuals
- One nest take resulting in the permanent abandonment of a territory = take of 0.8 individuals for the first year, then take of 4 individuals annually until data show the number of breeding pairs has returned to or exceeded the original estimated number for the eagle management unit.

Using the data presented in the above WindCoA example, the compensatory mitigation required for disturbance resulting in the loss of productivity from one GOEA nest for one year would result in the following:

1. Disturbance take of one GOEA nest on one occasion = 0.8 GOEA,
2. From the REA, the take of one GOEA for one year = 6 PV bird-years,
3. Six PV bird-years/GOEA * 0.8 GOEA = 4.8 PV bird-years, and
4. From the REA, 4.8 PV bird-years ÷ 0.191 PV bird-years/pole retrofitted (for 10 year maintenance of poles) = 25.1 poles retrofitted.

WindCoA would be required to retrofit a total of 174.24 poles (149.14 poles for the lethal take of 5 GOEA (see Table G-3) + 24.5 poles for the disturbance take of one GOEA nest) to cover the initial five year permitted take.

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APPENDIX H: STAGE 5 – CALIBRATING AND UPDATING OF THE FATALITY PREDICTION AND CONTINUED RISK-ASSESSMENT

Given the degree of uncertainty that currently exists surrounding the risk of wind facilities to eagles and the factors that contribute to that risk, post-construction monitoring is one of the most significant activities that will be undertaken by eagle programmatic take permit holders. Post-construction monitoring has two basic components when applied to eagle take: (1) estimating the mean annual fatality rate, and (2) assessing possible disturbance effects on neighboring nests and communal roosts. Provided that assessments conducted during Stages 1-4 are consistent, robust, and reliably performed as suggested in this ECPG, the pre-construction data should provide a solid platform for development of the Stage 5 monitoring and assessment studies.

1. Fatality Monitoring

All wind facilities that are permitted to take eagles will need to conduct fatality monitoring to ensure compliance with regulatory requirements. Fatality monitoring must be conducted at all wind facilities that are permitted to take eagles. We anticipate that in most cases, intensive monitoring to estimate the true annual fatality rate and to assess possible disturbance effects will be conducted for at least the first two years after permit issuance, followed by less intense monitoring for up to three years after the expiration date of the permit, in accordance with monitoring requirements at 50 CFR 22.26(c)(2). However, additional intensive, targeted monitoring may be necessary to determine the effectiveness of additional conservation measures and ACPs implemented to reduce observed fatalities. Such monitoring should be rigorous and sufficient to yield a reasonable estimate of the mean annual eagle fatality rate for the project. General considerations for designing fatality monitoring programs can be found in Strickland *et al.* (2011) and the WEG, and these sources should be consulted in the development of a post-construction study design. Because the post-construction monitoring protocol will be included as a condition of the programmatic take permit, the design of such monitoring will be determined jointly by the permittee and the Service. Additionally, the Service and USGS are investing significant resources into research to test and assess post-construction monitoring approaches for eagles, thus we expect to be able to offer useful input in the design of such monitoring programs. Fatality monitoring for eagles can be combined with monitoring mortality of other wildlife so long as sampling intensity takes into account the relative infrequency of eagle mortality events.

Fatality-monitoring efforts involve searching for eagle carcasses beneath turbines and other facilities to estimate the number of fatalities. The primary objectives of these efforts are to: (1) estimate eagle fatality rates for comparison with the model-based predictions prior to construction, and (2) to determine whether individual turbines or strings of turbines are responsible for the majority of eagle fatalities, and if so, the factors associated with those turbines that might account for the fatalities and which might be addressed via conservation measures and ACPs.

Fatality monitoring results should be of sufficient statistical validity to provide a reasonably precise estimate of the eagle mortality rate at a project to allow meaningful comparisons with pre-construction predictions, and to provide a sound basis for determining if, and if so which, conservation measures and ACPs might be appropriate. The basic method of measuring fatality rates is the carcass search. All fatality monitoring should include estimates of carcass removal and carcass detection bias (scavenger removal and searcher efficiency) likely to influence those rates, using the currently accepted methods. Fatality and bias correction efforts should occur across all seasons to assess potential temporal variation. Where seasonal eagle concentrations were identified in the Stage 2 assessment, sampling protocols should take these periodic pulses in abundance into account in the sample design.

Carcass searches underestimate actual mortalities at wind turbines, but with appropriate sampling, carcass counts can be adjusted to account for biases in detection (Kunz *et al.* 2007, Arnett *et al.* 2007, NRC 2007, Huso 2010). Important sources of bias and error include: (1) low or highly variable fatality rates; (2) carcass removal by scavengers; (3) differences in searcher efficiency; (4) failure to account for the influence of site (*e.g.*, vegetative) conditions in relation to carcass removal and searcher efficiency; and (5) fatalities or injured birds that may land or move outside search plots. Strickland et al (2011) provide a concise overview of fatality prediction models and considerations in the selection of a model. In the case of eagles, a primary consideration in the selection of a model and in the sampling design is the relative rarity of collisions, even at sites where fatality rates are comparatively high.

Regardless of the approach selected, we recommend the following data be collected for each search:

1. Date.
2. Start time.
3. End time.
4. Interval since last search.
5. Observer.
6. Which turbine area was searched (including decimal-degree latitude longitude or UTM coordinates and datum).
7. Weather data for each search, including the weather for the interval since the last search.
8. GPS track of the search path.

When a dead eagle is found, the following information should be recorded on a fatality data sheet:

1. Date.
2. Species.
3. Age and sex (following criteria in Pyle 2008) when possible.
4. Band number and notation if wearing a radio-transmitter or auxiliary marker.
5. Observer name.
6. Turbine or pole number or other identifying character.
7. Distance of the carcass from the turbine or pole.
8. Azimuth of the carcass from the turbine or pole.
9. Decimal-degree latitude longitude or UTM coordinates of the turbine or pole and carcass.
10. Habitat surrounding the carcass.
11. Condition of the carcass (entire, partial, scavenged).
12. Description of the carcass (*e.g.*, intact, wing sheared, in multiple pieces).
13. A rough estimate of the time since death (*e.g.*, $\leq$1 day, > a week), and how estimated.
14. A digital photograph of the carcass.
15. Information on carcass disposition.

In some cases, eagle take permits may specify other biological materials or data that should be collected from eagle carcasses (*e.g.*, feathers, tissue samples). Rubber gloves should be used to handle all carcasses to eliminate possible disease transmission. All eagle fatalities (not just those found on post-construction surveys) and associated information should be immediately reported to the Service's Office of Law Enforcement and to the Service's migratory bird permit issuing office if the facility is operating under an eagle take permit. Eagle carcasses should not be moved until such notification occurs, after which carcass disposition should be in accordance with permit conditions or Service direction.

2. Disturbance Monitoring

Project developers or operators may also be required to monitor many of the eagle nesting territories and communal roost sites identified in the Stage 2 assessments as stated in the permit regulations at 50 CFR 22.26(c)(2)for at least two years after project construction and for up to three years after the cessation of the activity. The objective of such monitoring will be to determine post-construction (1) territory or roost occupancy rates, (2) nest success rates, and (3) productivity. On a project-by-project basis, changes in any of these reproductive measures may not be indicative of disturbance. However, patterns may become apparent when the Service and USGS pool data appropriately and analyze findings from many projects in the context of a meta-analysis within the adaptive management framework.

Eagle nesting territories most likely to be affected by disturbance from a wind project are those that have use areas within or adjacent to the project footprint. The Service will accept an assumption that all eagle pairs at or within the mean project-area inter-nest distance (as determined from the Stage 2 assessment) of the project boundary are territories that may be at risk of disturbance (*e.g.*, if the mean nearest-neighbor distance between simultaneously occupied eagle territories in the Stage 2 assessment is 2 miles, we would expect disturbance to most likely affect eagles within 2 miles of the project boundary; Figures H-1 though H-4). Eagle pairs nesting within ½ the project-area mean intern-nest distance are the highest candidates for disturbance effects, and should receive special attention and consideration.

Where nesting habitat is patchy or eagle nesting density is low such that nearest-neighbors are outside a 10-mile wide perimeter of the project footprint, we recommend either: (1) extending the project-area survey outward to include the nearest-neighbors for the purposes of estimating the mean inter-nest distance value, or (2) undertaking detailed observational studies of the eagles occupying territories within the typical project-area to assess use patterns and ranging behavior relative to the project footprint. We recognize that selecting option (1) for golden eagles would extend the project area beyond the maximum of 10 miles advocated in the ECPG, but in some areas it is possible golden eagles using nests further than 10 miles from the project footprint may occur there. Regardless of which approach is used, territories that meet this distance criterion should be re-sampled annually for no less than two years after the project is operational following identical survey and reporting procedures as were used in the Stage 2 assessment.

If such monitoring shows strong evidence of direct disturbance from a project, project developers or operators and the Service will consider additional conservation measures and ACPs that might be effective in reducing the effect. Such measures would be within the sideboards established at the time of permit issuance. Alternatively, the project developer or operator may be required to provide compensatory mitigation to offset the estimated decreases in productivity to the extent necessary to meet the statutory requirement to preserve eagles.

The Service and the project developer or operator should agree on a site-specific, post-construction survey protocol for eagle concentration areas identified in Stage 2 and make an a priori decision on how to interpret and act on potential outcomes. Mortalities of eagles using proximate communal roosts will be accounted for through the protocol for monitoring post-construction fatalities. However, if communal roosts are no longer used by eagles because of disturbance, that effect should be determined, evaluated, and where population-level effects are indicated, mitigated.

3. Comparison of Post-Construction Eagle Use with Pre-Construction Use

As noted elsewhere, Service fatality models assume eagle use of the project footprint does not change as a result of project development. However, there is little information to support this assumption, and the ability to accurately predict fatality rates could be greatly improved by comparative information on post-construction eagle use. The Service encourages project developers or operators to consider conducting exposure surveys similar in design and intensity to pre-construction survey work to test this assumption where and when feasible.

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Figures H-1 to H-4 (following pages). Suggested approach for determining project-area and identifying eagle nesting territories to monitor for disturbance effects during Stage 5.

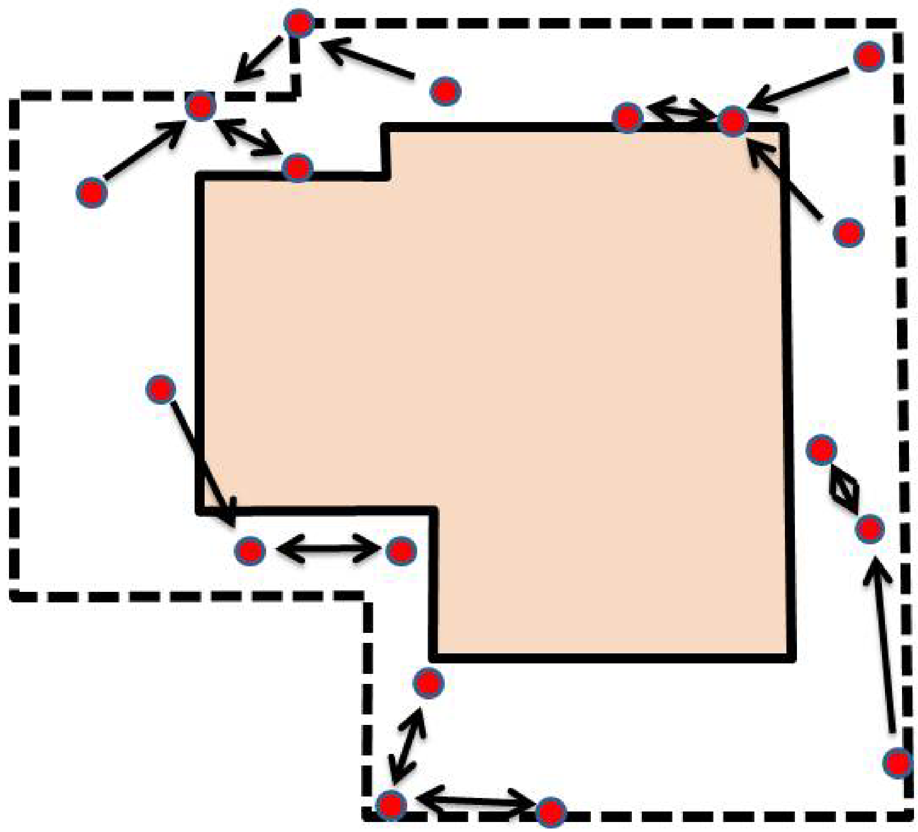

Figure H-1. Map showing hypothetical wind-facility project footprint (area inside the solid-black line, shaded peach), and the recommended project-area for eagle use area surveys in Stage 2 (inside the dotted line). Red dots denote occupied eagle nests. Arrows represent nearest-neighbor distance measurements that would be collected and used in the calculation of the project-area mean inter-nest distance. In some cases, nests are reciprocal nearest neighbors (double arrows); in these cases the inter-nest distance is the same for both nests. In other cases, the relationship is not reciprocal (e.g., a nest's nearest neighbor may be closer to another nest; one-way arrows), in which case the two have different inter-nest distance values. Ideally, this process would be completed over two or more breeding seasons to account for annual variation in nest occupancy and spacing.

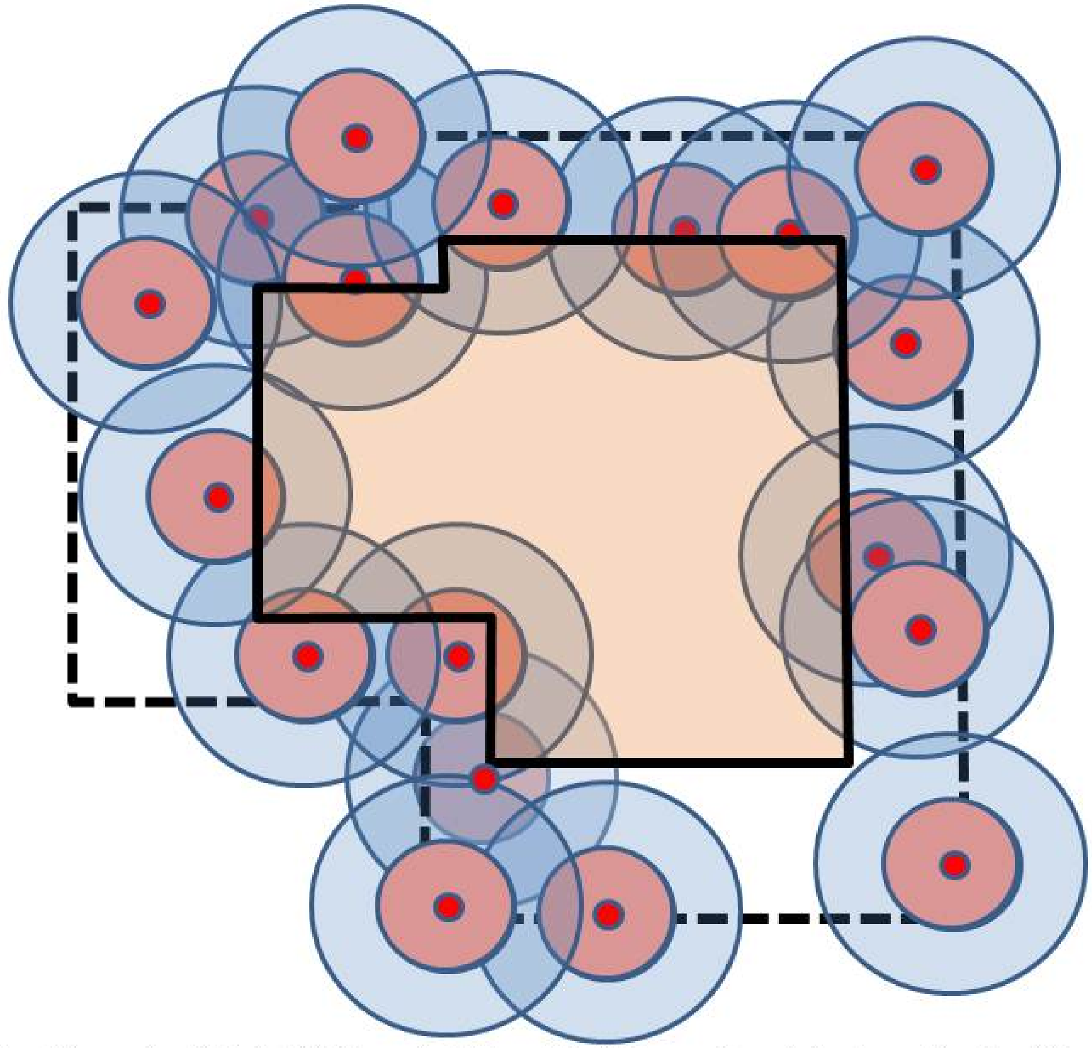

Figure H-2. Map of the same hypothetical wind-facility project in Figure H-1. Circles around occupied nests are at the radius of the project-area mean inter-nest distance (blue rings), and ½ the project-area mean inter-nest distance (pink rings), both calculated from the distance measurements collected as described in Figure H-1.

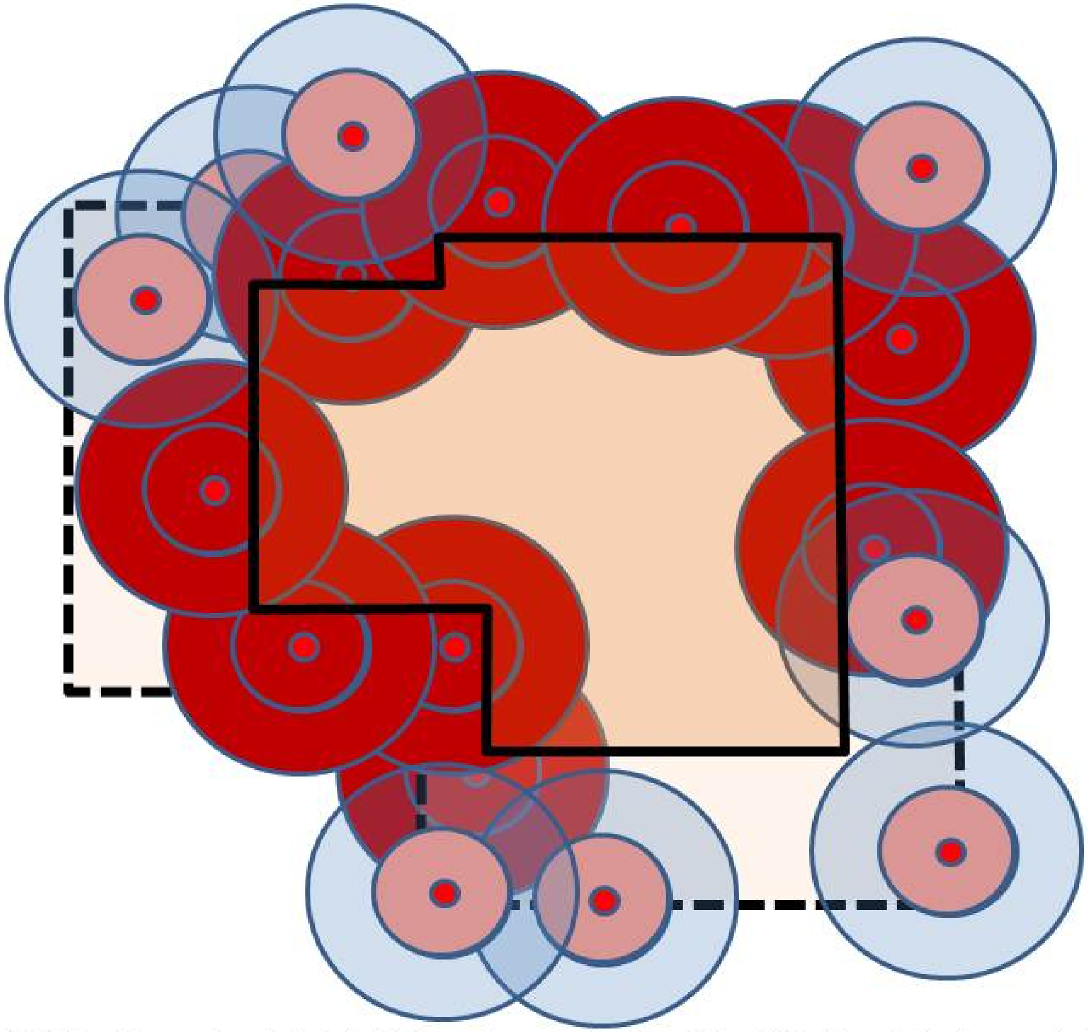

Figure H-3. Map of the same hypothetical wind-facility project area as in Figures H-1 and H-2, after applying site categorization criteria from the Guidelines. The site is currently borderline category 1 because the project footprint includes or approaches several eagle nests, and includes the area within ½ the local area inter-nest distance of those nests now highlighted in red.

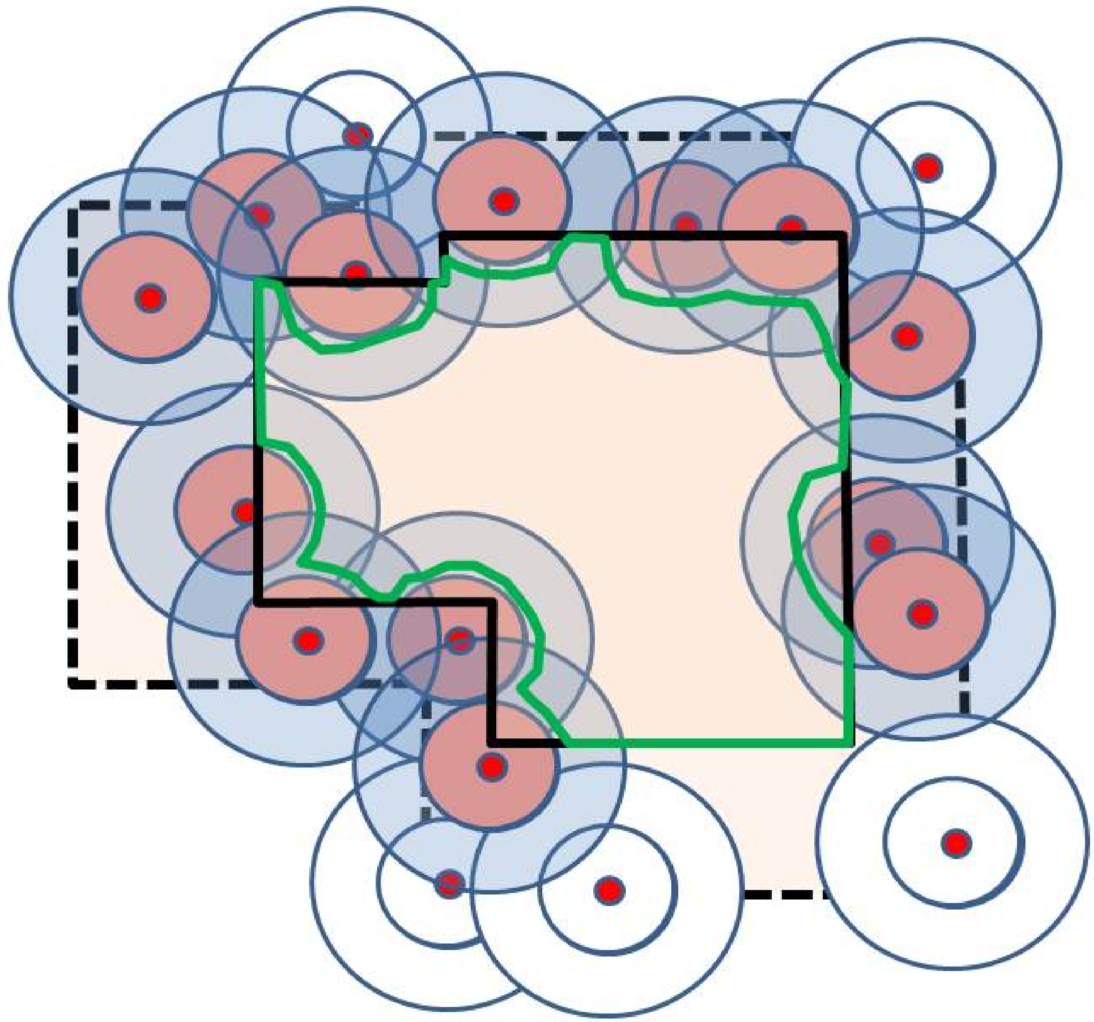

Figure H-4. The same hypothetical wind-facility project as in Figures H-1 – H-3, but re-designed such that the green line now delineates the project footprint. The re-design lessens the likelihood of negative effects on nesting eagles in the project area, and the project is now in category 2. If the project moves forward and the project developer or operator receives a programmatic eagle-take permit, those territories that are shaded should be monitored for disturbance-effects following Stage 5 recommendations because they are at or within one project-area mean inter-nest distance of the project footprint.

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