related mortality or habitat impacts and the very highest importance bottleneck areas for migrant birds.

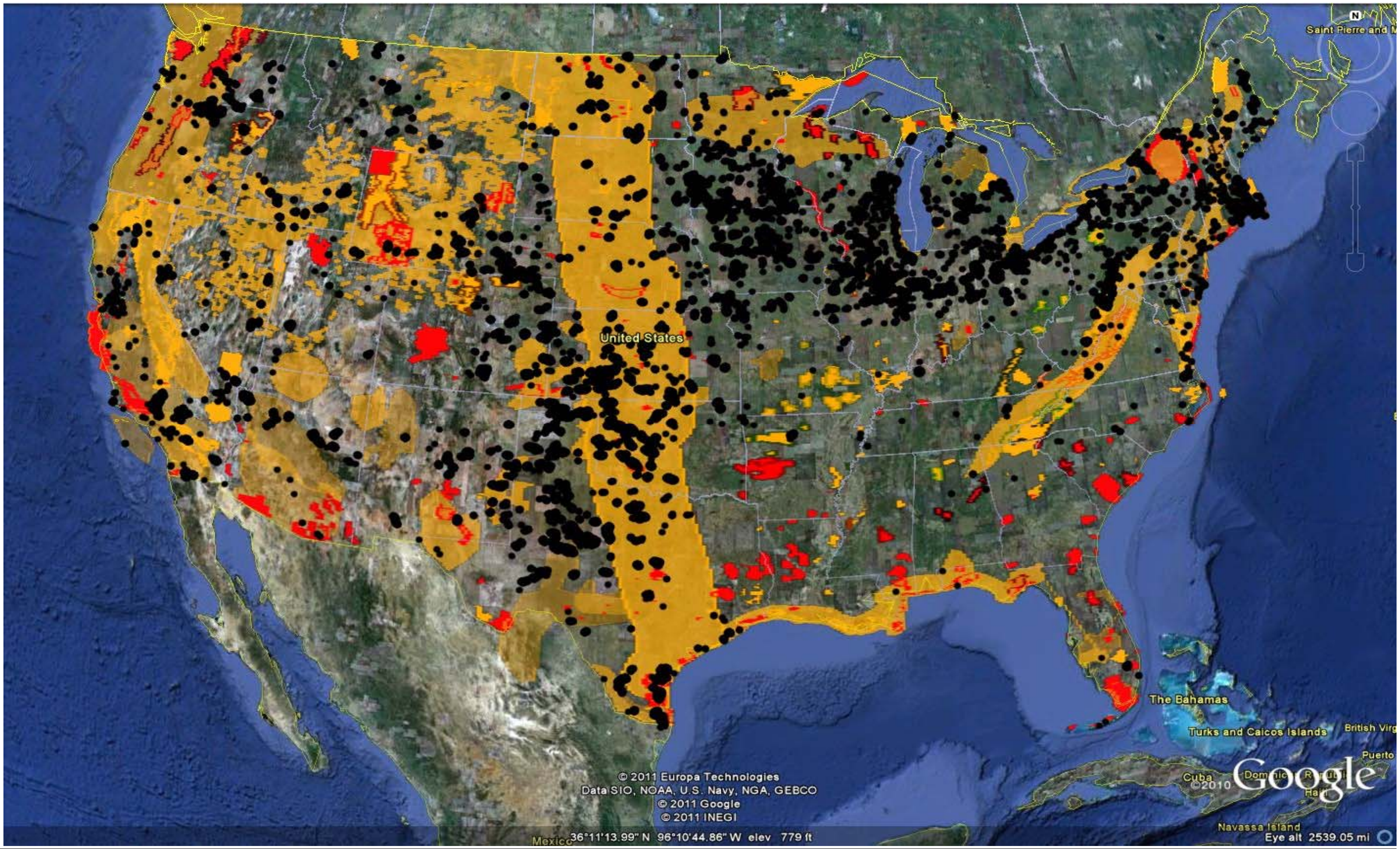
Orange indicates areas that are highly important to birds. Wind development might sometimes be possible in orange locations but will require especially careful siting and operation. Wind power should also only be developed after thorough pre-construction assessments can prove there is not a significant bird problem for a particular planned turbine configuration, or can identify ways that micro-siting or operational mitigation can effectively address any identified problem. Such areas include: Globally Important Bird Areas, important habitat for high-priority WatchList birds, and areas where migratory birds can be expected to be significantly affected. Monitoring and compensatory mitigation will be needed to redress the loss of any birds or habitat unavoidably harmed.

Areas shown in a tint of orange are either (a) Key Migration Corridors where risk to birds will differ from season to season, and may also differ from year to year between specific locations within the corridor, or (b) Key Habitat Areas for specific at-risk species where the species may not be present all year round, and birds are likely to be most at risk from wind development where their optimal habitat is found within the tinted area.

Areas that are not colored orange or red can generally be developed for wind energy if well-conducted pre-construction assessments do not indicate an unexpected or previously unknown bird impact or habitat problem, and so long as appropriate construction and operational mitigation, monitoring, and compensatory mitigation are implemented.

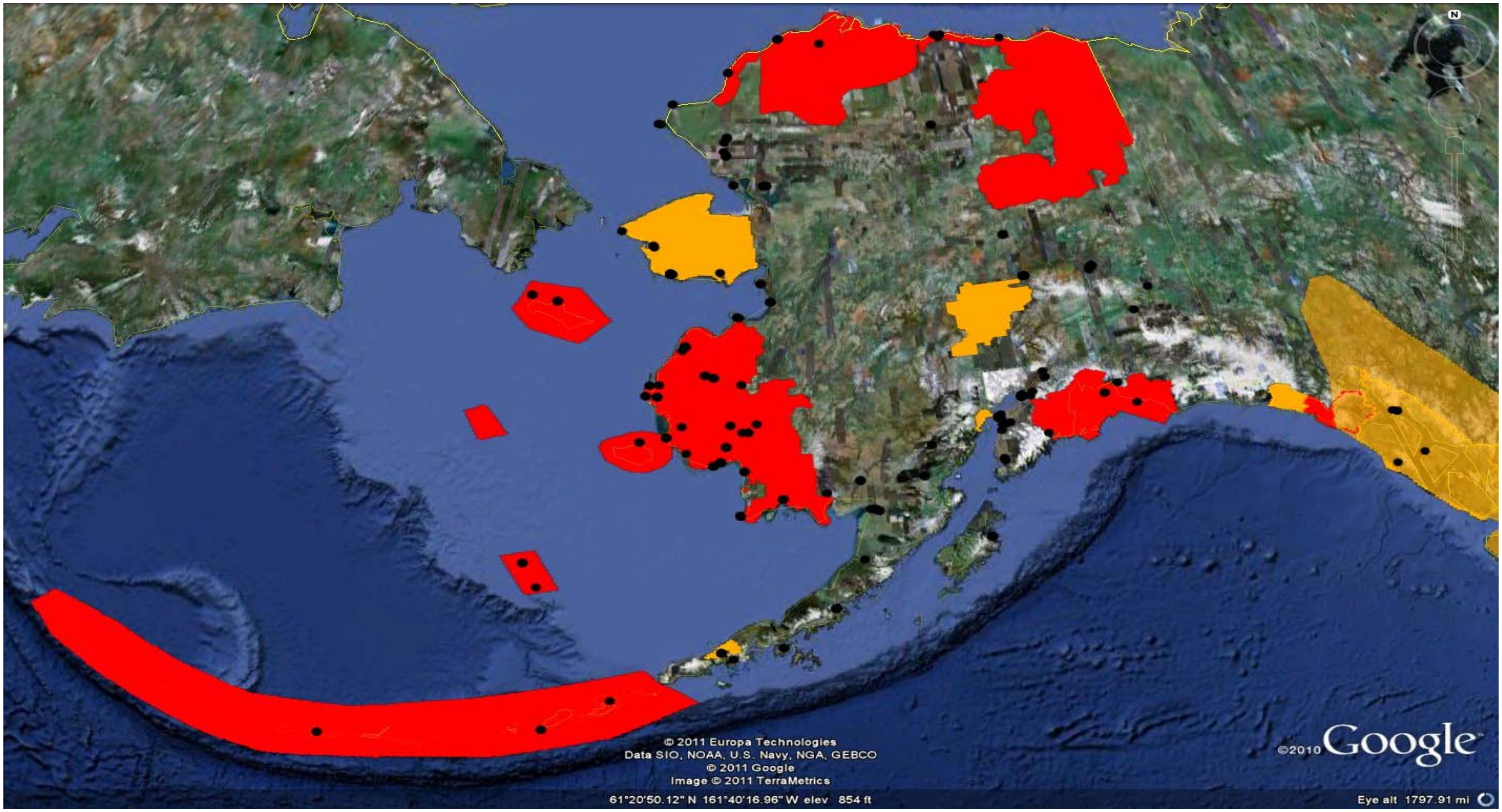
The maps are based on the best data available to ABC as of early December 2011 and ABC will update the maps over time.

MAP 3.1: Key Bird Use Areas and Estimated Wind Turbines in the Lower 48 States (2003-2011)[101]



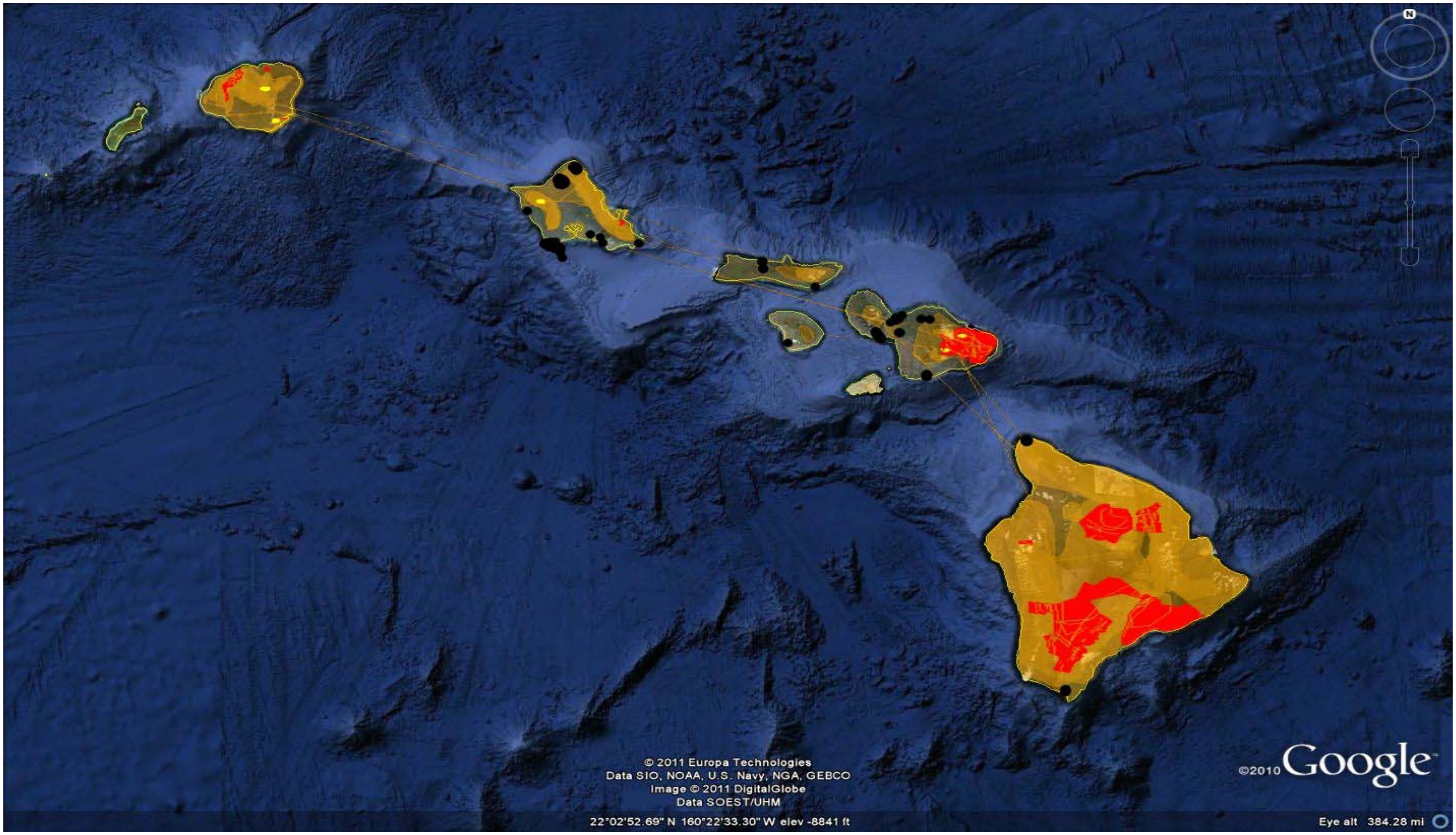
[101] Black represents proposed wind turbines and meteorological towers logged with the FAA between 2003 and 2011 in 48 states in the United States. Red indicates critically important areas for birds where wind energy should not be developed. Wind development might sometimes be possible in orange locations but will require especially careful siting and operation. All maps provided in this Petition are based on data available on the FAA website.

MAP 3.2: Key Bird Use Areas and Estimated Wind Turbines in Alaska (2003-2011)[102]



[102] Black represents proposed wind turbines and meteorological towers logged with the FAA between 2003 and 2011 in Alaska. Red indicates critically important areas for birds where wind energy should not be developed. Wind development might sometimes be possible in orange locations but will require especially careful siting and operation. All maps provided in this Petition are based on data available on the FAA website.

MAP 3.3: Key Bird Use Areas and Estimated Wind Turbines in Hawaii (2003-2011)[103]



[103] Black represents proposed wind turbines and meteorological towers logged with the FAA between 2003 and 2011 in Hawaii. Red indicates critically important areas for birds where wind energy should not be developed. Wind development might sometimes be possible in orange locations but will require especially careful siting and operation. All maps provided in this Petition are based on data available on the FAA website.

Cumulative impacts

Finally, wind energy development can harm birds through its addition to the cumulative impacts of all the threats that birds face. According to the GAO:

> Scientists, in particular, are concerned about the potential cumulative impacts of wind power on species populations if the industry expands as expected. Such concerns may be well-founded because significant development is proposed in areas that contain large numbers of species or are believed to be migratory flyways. Concerns are compounded by the fact that the regulation of wind power varies from location-to-location and some state and local regulatory agencies we reviewed generally had little experience or expertise in addressing the environmental and wildlife impacts from wind power. In addition, given the relatively narrow regulatory scope of state and local agencies, it appears that when new wind power facilities are permitted, no one is considering the impacts of wind power on a regional or "ecosystem" scale—a scale that often spans governmental jurisdictions. FWS, in its responsibility for protecting wildlife, is the appropriate agency for such a task and in fact does monitor the status of species populations, to the extent possible.

GAO Wind Power Report at 43 (emphases added). FWS has also stated that cumulative impacts are important: "Declining bird populations are probably most often the result of combined or cumulative impacts of all mortality, thus addressing each of the contributing factors is a priority." FWS, Migratory Bird Mortality: Many Human-Caused Threats Afflict our Bird Populations 2 (2002).[104]

All of the impacts of wind energy projects, described above, pose a serious threat to migratory birds. This is particularly so because at present FWS does not have any mandatory standards and regulations in place for development of wind energy projects in a manner that is protective of migratory birds.

C.3. At present, for land-based wind energy projects, FWS is relying on a system of voluntary compliance with the MBTA that is empirically ineffective in protecting migratory birds and will lead to rampant violations of federal law.

The MBTA, ESA, and BGEPA, prohibit "take" of migratory birds, endangered and threatened species, and Bald and Golden Eagles. Both the ESA and the implementing regulations of BGEPA provide mechanisms for FWS to regulate take of endangered and threatened species and Bald and Golden Eagles by individual wind energy projects (typically by issuing incidental take

[104] Available at http://www.fws.gov/birds/mortality-fact-sheet.pdf (last visited Nov. 15, 2011).

permits subject to various terms and conditions). However, at present no such comparable mechanism exists under the MBTA.

In lieu of mandatory standards and obligations for avoiding and minimizing the wildlife impacts of wind energy projects, FWS has long elected to merely provide non-binding “recommendations” to the wind industry that developers may “voluntarily” choose to follow or reject.

While such recommendations are wholly inadequate, as described further below, it should be noted that such recommendations recognize the need for a federal (and not a state) system to protect migratory birds from the threats posed by wind energy projects. For instance, state public service commissions, which are typically the state authorities that are involved in the approval of wind energy projects on non-federal lands, unlike FWS, are not equipped to address the cumulative migratory bird impacts of wind energy projects. Indeed, the MBTA itself is premised on the recognition that migratory birds constitute a unique federal trust resource that ought to be protected under a federalized system rather than in an ad hoc manner by individual states.[105] In State of Missouri v. Holland, 252 U.S. 416 (1920), the U.S. Supreme Court upheld the constitutionality and validity of the MBTA and particularly recognized the need for “national action” in lieu of potentially inconsistent state actions to protect and regulate take of migratory birds. The Court observed as follows:

> No doubt it is true that as between a State and its inhabitants the State may regulate the killing and sale of such birds, but it does not follow that its authority is exclusive of paramount powers…. The whole foundation of the State’s rights is the presence within their jurisdiction of birds that yesterday had not arrived, tomorrow may be in another State and in a week a thousand miles away…. Here a national interest of very nearly the first magnitude is involved. It can be protected only by national action in concert with that of another power. The subject matter is only transitorily within the State and has no permanent habitat therein. But for the treaty and the statute there soon might be no birds for any powers to deal with. We see nothing in the Constitution that compels the Government to sit by while a food supply is cut off and the protectors of our forests and our crops are destroyed. It is not

[105] Further, under international law, migratory species that migrate between two or more nations constitute “shared natural resources” over which a single nation cannot assume unilateral control such that it deprives the other concerned nations of their right to an equitable and reasonable share of the resource. See, e.g., U.S.-Import Prohibition of Certain Shrimp and Shrimp Products, 12 October 1998, 38 ILM 118 ¶133 (observing that sea turtles are highly migratory animals, passing in and out of the waters of various coastal states and that each of such states can claim an interest in the species conservation); see also Philippe Sands, Principles of International Environmental Law 238 (2d ed. 2003); U. N. Env’t Prog., Principles of Conduct in the field of the Environment for the Guidance of States in the Conservation and Harmonious Utilization of Natural Resources Shared by Two or More States, 17 ILM 1097 (1978), Principle 3(3).

> sufficient to rely upon the States. The reliance is vain, and were it otherwise, the question is whether the United States is forbidden to act. We are of opinion that the treaty and statute must be upheld.

252 U.S. at 434-435.

In recognition of its federal trust responsibility to protect migratory birds, in 2003, FWS issued "Interim Guidance" designed to address impacts of wind energy projects on migratory birds and other wildlife. See FWS, Interim Guidance on Avoiding and Minimizing Wildlife Impacts From Wind Turbines (May 13, 2003) ("2003 Interim Guidance").[106] FWS indicated its intent to evaluate the guidance over a two-year period. The guidance contained "voluntary" guidelines for the wind industry and did not impose any mandatory requirements to avoid or minimize wildlife impacts. In fact, in 2004, FWS issued a memo which reiterated "the voluntary and flexible nature" of the 2003 Interim Guidance and went so far as to state that, "[t]he Interim Guidelines are not to be construed as rigid requirements, which are applicable to every situation, nor should they be read literally." Memo from Steven Williams, FWS Director to FWS Regional Directors, Implementation of Service Voluntary Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines (Apr. 26, 2004).[107]

Subsequently, DOI announced the formation of a Wind Turbine Guidelines Federal Advisory Committee ("Wind FAC") to provide recommendations and advice to DOI and FWS "on developing effective measures to protect wildlife resources and enhance potential benefits to wildlife that may be identified." DOI, Establishment of Wind Turbine Guidelines Advisory Committee, 72 Fed. Reg. 11373 (Mar. 13, 2007). On October 26, 2007, the Secretary of the Interior announced in a press release that 22 individuals had been named to serve on the Wind FAC. Thereafter, several wildlife conservation groups raised objections about the skewed composition of the Wind FAC which was dominated by representatives of the wind power industry. Many members of the wildlife conservation community argued that the Committee violated the requirements of the Federal Advisory Committee Act ("FACA"), 5 U.S.C. App. 2 §§1-16, that all chartered advisory committees must be "fairly balanced in terms of the points of view represented and the functions to be performed by the advisory committee," and "will not be inappropriately influenced by … any special interest." Id. §§ 5(b)(2)-(3). In response to these objections, although DOI made some limited changes to the composition of the Committee, the members representing the wildlife protection interests continue to be clearly outweighed by industry advocates and do not represent the full spectrum of viewpoints on the issue that exist within the wildlife protection community.[108]

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[106] Available at http://www.fws.gov/midwest/wind/guidance/Serviceinterimguide.pdf (last visited Nov. 17, 2011).

[107] Available at http://www.fws.gov/habitatconservation/wind_guidelines.pdf (last visited Nov. 17, 2011).

[108] Indeed, by far the largest single voting bloc on the Committee is constituted by the wind industry representatives. Excluding the FWS official who works for the agency receiving the recommendations, there

On April 13, 2010, the Wind FAC submitted its final recommendations to FWS and DOI. See Wind Turbine Guidelines Advisory Committee Recommendations (2010) ("Committee Recommendations").[109] Instead of merely rubber-stamping the Committee Recommendations, FWS's wildlife biologists recognized that those Recommendations suffered from certain shortcomings and would not accomplish their stated conservation objectives, at least without substantial revision. See FWS, Comparison of FAC Recommendations to FWS Draft Voluntary Guidelines (Feb. 2011).[110] Thus, FWS convened a team of its wind-wildlife experts during late spring 2010 to prepare new guidelines for wind energy projects, which were finally published for public comment by FWS on February 8, 2011, i.e., the Draft Voluntary Land-Based Wind Energy Guidelines ("Wind Guidelines First Draft") and the Draft Eagle Conservation Plan Guidance ("Eagle Guidance"). See FWS 2011 MBTA Conference Presentation at 13. Both documents provided agency recommendations for industry to avoid and minimize wildlife impacts.

The Wind Guidelines First Draft was commended by many in the conservation community as an important first step, and there was strong support for further strengthening the guidelines and making their provisions mandatory for wind energy developers. See, e.g., ABC et al., Wind Energy Guidelines Comments (May 19, 2011) ("The guidelines must be strengthened and made mandatory"); Black Swamp Bird Observatory, Wind Energy Guidelines Comments (May 18, 2011) ("If the Guidelines are to truly avoid and minimize negative effects to fish, wildlife and their habitats resulting from construction, operation and maintenance of land-based, wind energy facilities, then the Guidelines, once finalized, must be regulatory and not voluntary on all lands, public and private."); Cornell Lab of Ornithology, Comments to the U.S. Fish and Wildlife Service: Draft Land-based Wind Energy Guidelines (May 2011) ("We respectfully suggest that at least some components of the Guidelines move forward as mandatory."); Friends of Blackwater et al., Wind Energy Guidelines Comments and Eagle Conservation Plan Guidance Comments (May 19, 2011) at 2 ("Unfortunately, as presently written, the Guidelines cannot satisfy this fundamental objective for a national policy on land-based wind power projects because the Guidelines' provisions addressing siting, construction, operation, and monitoring are merely voluntary, i.e., wind energy developers can choose not to adhere to the requirements in the Guidelines."); Conservation Biology Inst., Comments on Wind Energy Guidelines (May 19, 2011) ("the proposed wind energy guidelines, as drafted, are unlikely to lead to the types of rigorous regional analyses that are necessary to adequately assess potential ecological and cumulative impacts…. The guidelines should be

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are 21 current members in the Committee – 43% are wind industry representatives where 7 members work in wind energy companies and 2 members are lawyers who represent wind energy companies. See DOI Press Release, Interior Secretary Kempthorne Names Members for Committee to Address Wildlife Impacts of Wind Turbines (Oct. 26, 2007); see also FWS, Committee Background, http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee_information.html (providing a list of the current members of the Committee).

[109] Available at http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee.html (last visited Dec. 12, 2011).

[110] Available at http://www.fws.gov/windenergy/index.html (last visited Nov. 17, 2011).

regulatory, not voluntary, on both public and private lands, and should be enforced."); Pa. Game Comm'n, FWS Draft Land-based Wind Energy Guidelines (May 2011) ("the Guidelines would be more effective if they are regulatory rather than voluntary."); San Diego Audubon Soc'y, Wind Energy Guidelines Comments (May 19, 2011) ("Given the strong federal emphasis on expanding wind power throughout the country, mandatory guidelines are absolutely essential to preserve our avian heritage. They need to be mandatory now, before thousands of new wind turbines, transmissions lines, and access roads are installed in inappropriate locations, not later when it is too late."); Email Comment from Roger Shamley, President Chicago Audubon Soc'y (Mar. 5, 2011) ("I suggest that if you are serious about this issue that you make compliance mandatory, rather than optional."); Pub. Employees for Envtl. Responsibility (PEER), Wind Energy Guidelines Comments (May 19, 2011) ("Making the Guidelines voluntary rather than mandatory renders them meaningless…. PEER urges USFWS to make mandatory Guidelines for the siting of these facilities.").[111]

Nonetheless, the Committee itself – which in any event under FACA may only play a purely "advisory" role in the decision-making process, 5 U.S.C. App. II § 2(b)(6) ("the function of advisory committees should be advisory only") – expressed its "disappoint[ment]" with the agency's strengthened guidelines, and urged the agency to modify its recommendations in order "to mirror the FAC Recommendations." FWS, April 27, 2011 Wind Federal Advisory Committee Meeting Summary 2, 18 (2011).[112] Indeed, although FWS initially requested the public to specifically comment on whether the Wind Guidelines First Draft should be made mandatory, in response to pressure from the Wind FAC, FWS did not again raise or address this issue, despite extensive public comments (cited above) urging FWS to make the guidelines mandatory. See id. at 14 (summarizing FWS's position that, "FWS did not intend to write language that gave it control over the project or the process."); see also id. at 15 (summarizing the FAC's concern that "[t]he Draft Guidelines shift from trust and communication with the FWS to command and control by the FWS.").

Further, in response to extensive pressure (particularly from the industry representatives of the Committee), FWS substantially weakened the wildlife protections in its initial guidelines – so much so that on many issues the subsequent two drafts published by the agency presented a complete departure from the agency's previous position. See FWS, Revised Draft Land-Based Wind Energy Guidelines (July 12, 2011); ("Wind Guidelines Second Draft") and Wind Guidelines Third

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[111] Public comments on the Guidelines are available here: http://www.fws.gov/windenergy/index.html (last visited Nov. 17, 2011).

[112] Available at http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee_past_mtgs.html (last visited Nov. 14, 2011).

Draft (jointly, the "Revised Wind Guidelines"); see also FWS, Comparison of Wind Federal Advisory Committee Recommendations and Guidelines.[113]

For instance, the Wind Guidelines First Draft recommended pre-construction monitoring for a minimum duration of three years. However, that position of the expert agency on what was necessary to gather adequate pre-construction data for decision-making was modified substantially by draft Revised Guidelines (in accordance with the Committee Recommendations). Accordingly the Revised Guidelines eliminated the specific duration requirement for pre-construction studies. Another example of substantial watering down of FWS's own recommendations and language in the Guidelines concerns the agency's position on adaptive management. In the Wind Guidelines First Draft, FWS extensively premised its recommendations on the need for wind energy developers to carry out comprehensive adaptive management. See Wind Guidelines First Draft at 12 ("Monitoring should be designed to support the adaptive management decision-making/assessment process."); see also id. at 21 (discussing the applicability of adaptive management).

However, in the Revised Guidelines, FWS substantially weakened what were initially strong recommendations for adaptive management and went on to expressly state that: "[a]daptive management should not typically need to be applied to land-based wind energy projects because, in the majority of instances, when a developer follows the Guidelines, the impacts and the level of uncertainty should be low. Nevertheless, the tiered approach is designed to accommodate [adaptive management], when warranted." Wind Guidelines Third Draft at 22 (emphases added). The Service, however, proffered no new data to support the proposition that the impacts and level of uncertainty will be "low" in the absence of meaningful adaptive management.

Further, the changes made to the Guidelines based on the Committee's recommendations are designed to allow project developers to obtain assurances for non-prosecution in exchange for merely documenting FWS recommendations and developers' reasons for "disagreeing" with the Service to show "adherence" to the Guidelines. See Wind Guidelines Third Draft at 13 ("While the advice of the Service is not binding, neither can it simply be reviewed and rejected without a contemporaneously documented reasoned justification, at least if the developer seeks to have the benefit of the enforcement discretion provisions of these guidelines. Instead, proper consideration of the advice of the Service entails contemporaneous documentation of how the developer evaluated that advice and the reasons for any departures from it." (emphasis added)). Further, with respect to take of eagles by wind energy projects, in the Wind Guidelines Third Draft, FWS not only purported to provide non-enforcement assurances without regard to the applicable take permit regulations under BGEPA but, remarkably, did so based on the developers' own determination as to whether such take will occur. See id. ("If taking of eagles is not anticipated, adherence to the Guidelines would give rise to assurances regarding enforcement discretion if an unexpected taking occurs.").

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[113] All drafts of the Guidelines and related documents are available here: http://www.fws.gov/windenergy/index.html (last visited Nov. 17, 2011).

Thus, the Revised Guidelines eliminated important recommendations that FWS's own staff had initially adopted in the February 2011 Wind Guidelines First Draft – capitulating to the views of an industry-dominated advisory committee in lieu of the expert agency's own assessment of what is needed to conserve migratory birds and other wildlife resources held in trust for the American people. This is an apparent violation of FACA's directive that the "function of advisory committees should be advisory only," and in any event represents a failure to adopt a system even remotely approximating what the Service's own staff recognized as minimally acceptable to effectuate the MBTA.

Further, while the Revised Wind Guidelines are entirely "voluntary" in nature, the only measure that is "mandatory" as such is one imposed on FWS itself, and not the wind energy developer. The Revised Wind Guidelines impose no mandatory obligations on wind energy developers, but they require FWS to respond to industry proposals for site location within a truncated time frame, i.e., 60 days from receipt of the proposal. See Wind Guidelines Third Draft at 17 ("The Service has determined that Field Offices have 60 calendar days to respond to a request by a wind energy developer to review and comment on proposed site locations, pre- and post-construction study designs, and proposed mitigation."). If the agency fails to provide a response within 60 days, then the developer can proceed with construction of the project without waiting for Service input. Moreover, if the Service takes more than 60 days to respond to the industry proposal, the developer need only consider the Service's recommendations "if feasible" and no comparable flexibility is given to the Service, regardless of the size or complexity of the project, or its risk to wildlife. Id. ("If the Service does not respond within 60 days of receipt of the document, then the developer can proceed through Tier 3 without waiting for Service input. If the Service provides comments at a later time, the developer should incorporate the comments if feasible." (emphases added)).

Thus, despite being well-aware that wind energy projects will invariably take migratory birds protected under the MBTA, FWS has embarked on an approach that merely provides voluntary guidelines in lieu of mandatory obligations for wind energy developers, and that affords developers little incentive to abide by the determinations of FWS biologists as to which sites pose unacceptable risks to migratory birds. See infra Section E.3.ii (discussing various letters sent by FWS to wind energy developers and/or their consultants cautioning them about their project's wildlife impacts). There is no empirical, or even rational, basis for concluding that these guidelines, especially as so watered-down and weakened in response to industry pressure, will be sufficient to ameliorate the serious and growing impacts of poorly sited wind power projects on migratory birds. To the contrary, it is predictable that the Guidelines will have the opposite effect by, in essence, encouraging wind power companies to believe that they may avoid prosecution for violations of the MBTA by self-certifying that they have "complied" with the Guidelines simply by documenting their reasons for declining to abide by the Service's recommendations.

C.4. At present, FWS does not have any standards – not even voluntary guidelines – for addressing the impacts of offshore wind energy projects on migratory birds.

The "voluntary" Guidelines described supra, Section C.3, only apply to land-based wind energy projects and no such comparable document exists for avoiding and mitigating the serious wildlife impacts of offshore wind energy projects. The current draft of the Guidelines further states that "[o]ffshore wind energy projects may involve another suite of effects and analyses not addressed here." Wind Guidelines Third Draft at 16. In discussions in July and September 2011, FWS staff has told ABC personnel that while FWS might decide to prepare voluntary guidelines for offshore wind at some time in the future, the agency does not currently have a timeline for the preparation of such a document, and in fact has not made a decision to do so. Communication between Kelly Fuller, ABC and Albert Manville, FWS (July 12, 2011), and Jerome Ford, FWS (Sept. 20, 2011). Instead, FWS plans to provide case-by-case input to BOEM in regard to wildlife at proposed offshore wind facilities in federal waters. In addition, FWS plans to provide comments regarding Army Corps of Engineers' permits for offshore wind facilities.

FWS's approach to exercising oversight over offshore wind energy projects is extremely inadequate. At present, there are no mandatory standards or rules implementing the MBTA for offshore wind energy project developers. Indeed, there are not even inadequate "voluntary" guidelines such as those that exist for land-based projects. As a result, different FWS regional offices may propose varying methods and measures, resulting in no consistent standard for offshore wildlife protection. Furthermore, the lack of standardized regulatory guidance makes it impossible for offshore wind developers to plan ahead of time for what they will be asked to do. This uncertainty may complicate private-sector project financing, thus discouraging the development of offshore wind energy. In addition, in the absence of standardized regulatory guidance from FWS, other federal agencies that lack FWS's avian expertise may move into the void and issue what may become de facto offshore wind guidelines. In fact, BOEM has already taken a step down this road by including Best Management Practices ("BMPs") for reducing avian impacts of offshore wind projects in its Alternative Energy Programmatic Environmental Impact Statement. However, these BMPs set the bar very low and are entirely inadequate to reduce wildlife impacts. U.S. Minerals Mgm't Serv., OCS Alternative Energy and Alternate Use Programmatic Environmental Impact Statement at 2-25 to 2-26.[114]

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[114] The document lists merely five minimal BMPs: "The Lessee shall evaluate avian use of the project area and design the project to minimize or mitigate the potential for bird strikes and habitat loss. The amount and extent of ecological baseline data required will be determined on a project-by-project basis; Lessees shall take measures to reduce perching opportunities; Lessees shall locate cable landfalls and onshore facilities so as to avoid impacts to known nesting beaches; Wind turbine rotors should not come within 30 m (100 ft) of the ocean surface to minimize impacts to water birds; Lessees shall comply with the FAA and Corps requirements for lighting while using lighting technology (e.g., low-intensity strobe lights) that minimizes impacts to avian species." Needless to say, these five BMPs are not sufficient to avoid, minimize, and mitigate the impacts of offshore wind facilities on birds protected by the MBTA. Available at http://ocsenergy.anl.gov/documents/fpeis/Alt_Energy_FPEIS_Chapter2.pdf. (last visited Nov. 20, 2011).

It is also necessary for FWS to expeditiously take appropriate action to regulate the impacts of offshore wind energy projects on migratory birds because the regulatory processes of BOEM and the Corps will not ensure that all offshore wind energy projects adequately avoid, minimize and mitigate impacts to birds covered by the MBTA.

First, BOEM's regulatory authority over offshore wind projects is limited to those in waters over which BOEM has jurisdiction, which is currently limited to federal offshore waters and would not apply to state waters. In general, state waters extend three nautical miles from shore, however the state water limits in Texas and Florida (off the Gulf Coast) extend to about nine nautical miles. In addition, the Great Lakes are considered state waters. Office of Ocean and Coastal Res. Mgm't and Nat'l Oceanic and Atmospheric Admin., State Jurisdiction and Federal Waters 1 (2011).[115] The relative lack of federal regulatory processes in state waters has been marketed by some states, such as Texas, as a reason for offshore wind developers to develop projects in their state waters. Tex. Gen. Land Office, Texas Offshore Wind Energy ("Developers partnering with the Land Office find the state easy to do business in. Texas' unique coastal sovereignty - out to 10.3 miles - means less federal entanglement.").[116]

Second, while FWS can provide comments during BOEM and Corps processes, unless FWS has its own binding determination to issue under the MBTA, the agency's comments need not be followed, which will leave the agency without a clear path for fulfilling its mandate to protect migratory birds. Wind energy development in state water locations will present significant challenges if it is sited and operated without a concrete framework for avoiding, minimizing and mitigating wildlife impacts. As a general rule of thumb, more birds use near shore areas than locations farther out to sea. In the eastern United States, for example, large numbers of birds migrate along the Atlantic Coast. Likewise, the Texas Gulf Coast is heavily used by birds migrating to and from Globally Important Bird Areas. The Great Lakes are also potentially a difficult location because of the large amount of bird migration that takes place across them. Thus, offshore wind facilities in state jurisdictional waters are where some of the most serious impacts to birds protected by the MBTA could take place, but where FWS may have the least ability to fulfill its wildlife protection mandate, unless a permitting scheme such as that proposed in this Petition is adopted.

Wind energy development in waters outside of federal jurisdiction is already underway and several wind energy projects are being constructed in state waters – areas which, although covered by the MBTA's general prohibition on unauthorized take, may lack any other federal mechanism to the project affording an adequate review of wildlife impacts. The proposed Baryonyx offshore wind facility would entail 500 6-MW wind turbines between five and ten miles off the Texas shore, with

[115] Available at http://seagrant.gso.uri.edu/coast/cmsp_material/state_fed-waters.pdf (last visited Nov. 20, 2011).

[116] Available at http://www.glo.texas.gov/glo_news/hot_topics/articles/offshore-wind-energy.html (last visited Nov. 20, 2011).

transmission cables potentially crossing Padre Island, Padre Island National Seashore, Corpus Christi Bay, and Laguna Madre. The project has already completed a public comment period related to scoping for an environmental review document (EA or EIS) from the Corps. The Baryonyx project could be disastrous for wildlife, as the FWS comment letter made clear. See Letter from Allan M. Strand, FWS to Jayson Hudson, Corps (Aug. 15, 2011), Attachment L; see also Kelly Fuller, ABC, Comments on Permit Application SWG-2011-00511 (Baryonyx Corporation Offshore Wind Project (Aug. 17, 2011) (ABC comments submitted to the Corps).

In addition, it is unclear whether the Corps' environmental review will be rigorous, given that it is taking place in the context of permit requirements under the Clean Water Act, and that the Corps has a long track record of failing to address all of the adverse wildlife impacts flowing from its permitting decisions. The proposed Baryonyx offshore wind facility is not the only one being considered for Texas state waters. ABC has been informed that as of August, 2011, Coastal Point had an offshore lease with the Texas State Land Commission and Offshore Wind Systems had a permit from the Corps for an offshore wind testing structure. Personal communication between Kelly Fuller, ABC and Bob Blumberg, Texas General Land Office (Aug. 29, 2011). Coastal Point has since announced plans to install one offshore wind turbine by the end of 2011. See Nathanial Gronewold, Texas is Bullish on Offshore Wind (E & E News, Nov. 21, 2011), Attachment M. Offshore wind projects in Texas are of tremendous concern because the Texas Gulf Coast is the most sensitive coastal area for birds in the United States, and the State of Texas does not have its own wind energy permitting process with environmental review.

Wind turbine projects in the jurisdictional waters of other states have also been proposed. Although these are currently small proposals, the scale of offshore projects is expected to increase. In addition, in the wrong location, even a single offshore wind turbine could have serious impacts. Some examples of offshore wind energy project proposals in state waters are listed below:

- Gamesa Energy USA and Northrup Grumman International have proposed building a 5-MW wind turbine in lower Chesapeake Bay and the state's Marine Resources Commission has given approval for preliminary studies of the site to take place. FWS staff have raised concerns about potential bird impacts at the Chesapeake Bay location, but the agency was informed that the site could not be changed. See Email from Tylan Dean, FWS to Keith Hastie, FWS (Mar. 30, 2011), Attachment N.
- Fishermen's Energy, LLC has proposed a five-turbine, 20 MW wind facility approximately three miles off Atlantic City in New Jersey state waters. See Fishermen's Energy, LLC, FAQ.[117] In spring 2011, the project received all the necessary state permits and is currently awaiting a permit from the Corps. The company has also expressed interest in developing

[117] Available at http://www.fishermensenergy.com/faq.html (last visited Nov. 20, 2011).

offshore wind in the Great Lakes. Fishermen's Energy, LLC, VA Offshore Wind 2011 Presentation (June 22, 2011).[118]

- The University of Delaware has proposed a six-turbine offshore wind facility approximately 2.8 miles off the coast in Delaware state waters and has met with the Corps to discuss it. Corps, Wind Turbine Proposals within Philadelphia District (2011).[119]
- Deepwater Wind has proposed a five turbine offshore wind facility approximately three miles off Block Island, in Rhode Island state waters. Deepwater Wind, Block Island Wind Farm.[120] In September, 2011, Deepwater announced that a marine survey at the site had begun. See Deepwater Wind, Block Island Wind Farm Project Advances with Cutting-Edge Marine Surveys, Expanded Team (Sept. 22, 2011).[121]
- West Wind Works, LCC has expressed interest in building a 400 MW offshore wind facility three nautical miles south of Oahu. This location may be in the state waters of Hawaii. Email from Kyle Avery, West Wind Works to Hawaii Inter-island Renewable Energy Program, Public Scoping Comment on Hawaii Interisland Renewable Energy Program: Wind (Mar. 9, 2011).[122]
- The Lake Erie Energy Development Corporation (LEEDCO) and Freshwater Wind, LLC announced in January 2011 that they have a signed option with the state of Ohio to lease lake bottom land in Lake Erie for a 20 MW offshore wind facility of five turbines, approximately seven miles offshore NW of Cleveland. LEEDCo's reported goal is 1,000 MW of offshore wind development in Lake Erie by 2020. See Offshorewindbiz.com, LEEDCo and Freshwater Wind Sign Option With State Ohio to Lease Lake Erie to Build Offshore Wind Farm (Jan. 11, 2011).[123] According to an October 2011 Corps fact sheet, LEEDCo's project would be five to eight turbines, and the Corps is encouraging its construction in Lake Erie in order to judge impacts. Larger projects would be built later, up to 1,520 offshore wind

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[118] Available at http://vasierraclub.org/Goldsmith.pdf (last visited Nov. 20, 2011).

[119] Available at http://www.nap.usace.army.mil/cenap-op/regulatory/wind_turbine.html (last visited Nov. 20, 2011).

[120] Available at http://dwwind.com/block-island/block-island-project-overview (last visited Nov. 20, 2011).

[121] Available at http://dwwind.com/news/block-island-wind-farm-project-advances-with-cutting-edge-marine-surveys-expanded-team/?a=news&p=news (last visited Nov. 20, 2011).

[122] Available at http://www.hirepeis.com/documents/scopingcomments/ngos_private_entities/WestWindWords.pdf (last visited Nov. 20, 2011).

[123] Available at http://www.offshorewind.biz/2011/01/09/leedco-and-freshwater-wind-sign-option-with-state-ohio-to-lease-lake-erie-to-build-offshore-wind-farm-usa/ (last visited Nov. 20, 2011).

turbines in the Great Lakes state waters of New York, Ohio, and Pennsylvania. See Corps, Offshore Wind Farm Sitings on the Lower Great Lakes Fact Sheet (Oct. 2011).[124]

Further, the first offshore wind energy project in federal waters approved by the federal government – the Cape Wind project – has raised several concerns about its wildlife impacts, particularly to migratory birds. Several environmental organizations including Public Employees for Environmental Responsibility have challenged that decision on the grounds that the project, as designed, will kill thousands of federally protected birds, without the level of pre-construction surveying that had been recommended by FWS and without any coherent post-construction monitoring or mitigation plan in place for the project. See Second Amended Complaint at 27, 31, Public Employees for Environmental Responsibility v. Bromwich, Case No. 1:10-cv-01067-RMU (D.D.C. 2010).

Thus, as things presently stand, there are patently inadequate, if not counterproductive, voluntary "Guidelines" for land-based wind power projects and not even a guidance document for offshore projects. On the other hand, as described in detail infra, Section D.2 and Section E.1, FWS has more than sufficient legal authority to establish meaningful, effective measures for protecting migratory birds.

D. STATUTORY BACKGROUND: THE BROAD SCOPE OF THE MBTA'S TAKE PROHIBITION

D.1. The MBTA is a broad wildlife conservation statute that prohibits both intentional and incidental take, unless expressly permitted by FWS.

The MBTA is a conservation statute "designed to prevent the destruction of certain species of birds." Andrus v. Allard, 444 U.S. 51, 52-53 (1979) (noting that the statute was originally enacted to give effect to the 1916 convention between the United States and Great Britain (then for Canada) for the protection of migratory birds, "and for other purposes.").[125] Subsequent MBTA amendments ratified similar bilateral conventions with Mexico in 1936, Japan in 1972, and Russia in 1976.

At present, approximately 1,007 bird species are protected under the Act, ranging from a wide variety of songbirds, waterfowl, and shorebirds to hawks, owls, vultures, and falcons, including

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[124] Available at http://www.lrb.usace.army.mil/Factsheets/NYS/NY-22/Offshore%20 WindFarms%20Oct%202011.pdf (last visited Nov. 20, 2011).

[125] The phrase "other purposes" has been interpreted to mean purposes other than giving effect to the treaty wherein "Congress intended to invoke its own powers to accomplish other purposes than those enabled by the treaty." Cerritos Gun Club v. Hall, 96 F.2d 620, 627-628 (9th Cir. 1938).

Golden Eagles and Bald Eagles.[126] See FWS, Revised List of Migratory Birds and Your Permit: Questions and Answers (Nov. 1, 2010).[127] These species are shared natural resources subject to FWS's "federal trust responsibility," i.e., FWS, as a trustee of these resources, has the duty to conserve, protect and enhance migratory birds. See FWS, Recommendations to Avoid Adverse Impacts to Migratory Birds, Federally Listed Species, and Other Wildlife form Communication Towers & Antennae (2000) ("Migratory birds are a federal trust resource responsibility, and the Service considers migratory bird concentration areas environmentally significant."); see also Wind Guidelines Second Draft at 3, 12.

The MBTA prohibits the taking or killing of migratory birds, as well as any attempt to take or kill migratory birds or any part, nest, or eggs of any such bird, "at any times, by any means, or in any manner." 16 U.S.C. § 703; see also Andrus, 444 U.S. at 56, 57, 59–60 (describing the statutory prohibitions of the MBTA as "comprehensive," "exhaustive," "carefully enumerated," "expansive," and "sweepingly framed"). Regulations implementing the statute explain that the term "take" means to "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 C.F.R. § 10.12. Significantly, the statute does not have a mens rea requirement, i.e., entities that violate the Act can be prosecuted on a strict liability basis regardless of intent or motive to take or kill migratory birds. Further, it is pertinent to note that unlike BGEPA's take prohibition, the MBTA also prohibits "attempt" to take. Compare BGEPA, 16 U.S.C. § 668c and 50 C.F.R. § 22.3 with MBTA, 16 U.S.C. § 703 and 50 C.F.R. § 10.12.

Plainly, as courts have agreed, the take prohibition in the MBTA is broad and prohibits both intentional take, such as hunting, and incidental or unintentional take, such as bird mortality due to collision with wind turbines. See, e.g., Ctr. for Biological Diversity v. Pirie, 201 F. Supp. 2d 113 (D.D.C. 2002) (military training exercises of the Department of the Navy resulting in incidental take of migratory birds without a permit violated the MBTA); United States v. Apollo Energies, Inc., 611 F.3d 679, 684 (10th Cir. 2010) (failure to bird-proof oil drilling equipment resulting in incidental take of migratory birds is a violation of the MBTA); United States v. Moon Lake Elec. Ass'n, 45 F. Supp. 2d 1070 (D. Colo. 1999) (failure to install protective equipment on power poles by electrical association resulting in incidental take of migratory birds is a violation of the MBTA); United States v. FMC Corp., 572 F.2d 902 (2d Cir. 1978); United States v. Corbin Farm Serv., 444 F. Supp. 510

[126] Bald and Golden Eagles are protected under both the MBTA and BGEPA. BGEPA makes it illegal to take any bald or golden eagle, or any part, nest or egg thereof. 16 U.S.C. § 668a. BGEPA provides broad authority to FWS to issue permits for the take of Bald or Golden Eagles in certain circumstances, provided that such permits are compatible with the preservation of the species. Id. § 668a. FWS has recently promulgated regulations establishing a general permit process for incidental takes, under which permits may be granted for unavoidable incidental takes, subject to compliance with appropriate avoidance, minimization and mitigation measures. 50 C.F.R. § 22.6(c).

[127] Available at http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/Part%2010.muscovy%20Fact%20Sheet.11-1-2010.pdf (last visited Nov. 8, 2011).

(E.D. Cal. 1978) (both cases holding that bird deaths related to pesticide use resulting in incidental take is a violation of the MBTA).

In brief, the MBTA is a national conservation statute which is premised on the "important public policy behind protecting migratory birds," FMC Corp., 572 F.2d at 908, and prohibits both intentional and incidental take.

D.2. **FWS can authorize limited take of protected birds *only* by exercising its broad authority to promulgate regulations and issue take permits under the MBTA.**

Despite the broad take prohibitions embodied in Section 703 of the Act, the scope for FWS to promulgate regulations permitting take and implementing the treaties, "render[s] the initial flat [take] prohibition eminently workable." Larry Martin Corcoran & Elinor Colbourn, Shocked, Crushed and Poisoned: Criminal Enforcement in Non-hunting Cases Under the Migratory Bird Treaties, 77 Denv. U. L. Rev. 359, 371 (1999). Under Section 704 of the MBTA, FWS is "authorized and directed" to determine the exceptions to the MBTA's take prohibition, i.e., FWS has the sole authority and responsibility "to determine when, to what extent, if at all, and by what means" taking of migratory birds is permissible, and to "adopt suitable regulations permitting and governing the same." 16 U.S.C. § 704(a);[128] see also infra Section E.1 (discussing in detail the broad rulemaking authority of FWS over incidental takes).

Such regulations are crucial because in the absence of authorization by FWS regulations for take of migratory birds, activities that kill or have the potential to kill migratory birds are "otherwise *wholly* unlawful." United States v. Catlett, 747 F.2d 1102, 1105 (6th Cir. 1984); see also, e.g., Ctr. for Biological Diversity v. Pirie, 201 F.Supp.2d 113 (D.D.C. 2002) (enjoining military training exercises of the Department of the Navy in the absence of appropriate permit from FWS for incidental take of migratory birds). In addition, under Section 712 of the MBTA, FWS is also expressly authorized to issue implementing regulations related to the international migratory bird treaties. See MBTA § 712(2).

Further, it is well-established that the delegation of authority to the agency was a valid exercise by Congress of its treaty and commerce powers. Bailey v. Holland, 126 F.2d 317, 321 (4th Cir. 1942) (holding that regulations promulgated by the Secretary of Interior prohibiting the hunting of migratory wildfowl on land and water adjacent to certain federally owned lands are valid).

FWS has recognized that its authority to issue take permits under the MBTA stems from the MBTA, 16 U.S.C. §§ 703-712, and its implementing regulations, 50 C.F.R. Pts. 10, 13, 21, 22. See

[128] The authority vested in the President in Section 704(a) has been delegated to the Secretary of the Interior. See Executive Order 10250: Providing for the Performance of Certain Functions of the President by the Secretary of the Interior § 2(b) (June 5, 1951).

FWS, Manual, Authorities, Objectives, and Responsibilities for Migratory Bird Permits, 724 FW 1 (Aug. 6, 2003);[129] see also Meredith Blaydes Lilley & Jeremy Firestone, Wind Power, Wildlife, and The Migratory Bird Treaty Act: A Way Forward, 38 Envtl. L. 1167, 1180 (2008) ("Section 704 of the MBTA confers permitting authority to the Secretary of the Interior, who has, in turn, delegated that authority to U.S. Fish and Wildlife Service."). Further, FWS has stated that the objective of the migratory bird permit program is "[t]o promote the long-term conservation of migratory bird populations while providing opportunities for the public to study, use, and enjoy migratory birds consistent with the [MBTA] and [BGEPA]." Id.

At present, FWS issues MBTA take permits for a range of activities such as import/export, scientific collecting, taxidermy, waterfowl sale and disposal, educational use, game bird propagation, salvage, falconry, raptor propagation, rehabilitation, control of depredating migratory birds, and special purpose activities. See FWS, Manual: Migratory Bird Permits, 724 FW 2 (Aug. 6, 2003).[130] Permittees must maintain accurate records of their permitted activities and may be required to submit reports covering those activities to the Regional Migratory Bird Permit Office. Id. FWS may suspend or revoke a migratory bird permit for a violation of the terms and conditions of the permit or the regulations under which the permit was issued, or for any reason set forth in 50 C.F.R. § 13.27 (permit suspension) and 50 C.F.R. § 13.28 (permit revocation). Id. The validity of any permit is conditioned on observance of all applicable foreign, state, local, or other federal laws. Id. Further, regardless of issuance of a permit, FWS has expressly cautioned that "[t]he migratory birds, nests, eggs, and any portions thereof remain in the stewardship of the Fish and Wildlife Service and may be recalled at any time." Id.

Accordingly, FWS has the statutory mandate to protect "public trust resources" protected under the MBTA and may only authorize take of such resources in accordance with Section 704(a) of the Act, i.e., through "suitable regulations." In the absence of such authorization, any activities that take or have the potential to take protected birds are flatly unlawful.

D.3. FWS has the primary responsibility to enforce the MBTA and its implementing regulations.

The MBTA provides for both misdemeanor, 16 U.S.C. § 707(a), as well as felony offenses. Id. § 707(b). "Any person, association, partnership, or corporation" that "violate[s] any provisions" of the Act or its implementing regulations is guilty of a misdemeanor. Id. § 707(a). On the other hand, felony offenses are more limited in nature and involve "knowingly" taking birds for sale or barter. Id. § 707(b). Thus, taking of migratory birds without an appropriate permit can result in a criminal conviction – either a misdemeanor or, in some circumstances, a felony conviction.

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[129] Available at http://www.fws.gov/policy/724fw1.html (last visited Nov. 17, 2011).

[130] Available at http://www.fws.gov/policy/724fw2.html (last visited Nov. 17, 2011).

Unlike the ESA, the MBTA contains no citizen suit provision, meaning that entities other than the federal government may not initiate legal action against private parties for violating the Act. However, as a number of cases have recognized, private parties may use the APA to pursue civil claims against federal agencies for taking actions that authorize or lead to violations of the MBTA. See, e.g., City of Sausalito v. O'Neill, 386 F.3d 1186 (9th Cir. 2004); Humane Soc'y of the U.S. v. Glickman, 217 F.3d 882 (D.C. Cir. 2000). In any event, because the MBTA does not contain a citizen suit provision, FWS has the primary responsibility to administer and enforce the Act.

Further, in 2001, President Clinton executed Executive Order 13186, 66 Fed. Reg. 3853 (Jan. 17, 2001) ("Migratory Bird Executive Order"),[131] which identified the responsibilities of federal agencies to protect migratory birds under the Act. The Executive Order directs federal agencies to take actions to protect and conserve migratory birds. The Order resulted in memorandums of understanding ("MOUs") between certain federal agencies and FWS, which memorialize actions that each party will take to fulfill their respective responsibilities under the Act. See, e.g., MOU Between BLM and FWS to Promote the Conservation of Migratory Birds (Apr. 2010).[132]

E. DISCUSSION: FWS HAS BOTH THE LEGAL AUTHORITY AND COMPELLING CONSERVATION REASONS TO ESTABLISH AN MBTA PERMITTING REGIME FOR WIND POWER PROJECTS.

E.1. FWS has broad regulatory and permitting authority under the MBTA to regulate incidental take by wind energy projects.

Section 703 of the MBTA establishes a strict liability prohibition against take of listed migratory birds "at any time, by any means or in any manner" "[u]nless and except as permitted by regulations[.]" See 16 U.S.C. § 703 (emphasis added). Pursuant to Section 704, FWS is authorized to permit "take" through "suitable regulations" so long as such taking is compatible with the terms of the migratory bird conventions. Id. § 704(a); see also Fund for Animals v. Kempthorne, 538 F.3d 124 (2d Cir. 2008).

In establishing such regulations, FWS may consider factors such as the zones of temperature and the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of birds. 16 U.S.C. § 704(a). The regulations may stipulate "when" take is permissible, "to what extent," and "by what means." Id. In addition, under Section 712, FWS is authorized to issue

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[131] Available at http://frwebgate.access.gpo.gov/cgibin/getdoc.cgi?dbname=2001_register&docid=fr17ja01-142.pdf (last visited Nov. 8, 2011).

[132] Available at http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_information/2010/IB_2010-110.html (last visited Nov. 8, 2011).

"such regulations as may be necessary to implement" the migratory bird treaties with Canada, Russia, Japan, and Mexico. Id. § 712(2).

The rulemaking authority conferred upon the Secretary has been "liberally construed," Bailey v. Holland, 126 F.2d 317, 322 (4th Cir. 1942), and is "greatly flexible." Fund for Animals v. Norton, 365 F. Supp. 2d at 419. FWS has "broad permitting authority," Kempthorne, 538 F.3d at 124, and "plenary power" to establish permitting regulations controlling the "taking of migratory birds, which is otherwise *wholly unlawful*." Catlett, 747 F.2d at 1105.

FWS's "broad permitting authority" has been recognized to encompass authority to regulate both intentional and non-intentional or incidental take. Indeed, as described below, FWS's regulatory authority over incidental take has been recognized not only by FWS and federal courts, but by Congress itself.

i. ***Congress has recognized FWS's broad rulemaking authority over incidental take under the MBTA.***

The MBTA authorizes FWS to regulate both intentional and incidental take. Congress recognized FWS's authority to regulate incidental take when it enacted the National Defense Authorization Act for FY 2003 ("National Defense Act"). Pub. L. No. 107–314, § 315, 116 Stat 2458 (Dec. 2, 2002). Section 315 of the Act provides that "the Secretary of the Interior shall exercise the authority of that Secretary under [Section 704(a) of the MBTA] to prescribe regulations to exempt the Armed Forces for the incidental taking of migratory birds during military readiness activities[.]" Id. (emphasis added). The Act clearly indicates that Congress did not bestow new authority on FWS to regulate incidental take, but directed it to exercise its existing authority under the MBTA to allow incidental take by the Armed Forces. Accordingly, there can be no legitimate dispute that FWS has the authority to establish permitting regulations for particular activities that are otherwise legitimate but that have adverse impacts on migratory birds.

Further, the legislative history of the National Defense Act shows that Congress deliberately rejected the original proposal to provide a blanket legislative exemption for military activities from the take prohibitions of the MBTA, and instead chose a course of action that would involve FWS exercising its regulatory authority and oversight over the Armed Forces. 148 Cong. Rec. S10858-01, 2002 WL 31520009 at S10861 (Nov. 13 2002) ("We were able to modify a House provision which authorized the exemption of certain Department of Defense activities from the provisions of the Migratory Bird Treaty Act. That was a highly controversial action on the part of the House. We were able to obtain some important concessions in the conference relative to that provision, including an agreement to structure the provisions so that the Department of Interior will be required to exercise its regulatory powers over the Department of Defense activities impacting migratory birds and to require appropriate actions to mitigate the impact of Department of Defense actions on migratory birds." (emphasis added)); see also id. at S10868 ("it is clear in Subsection (d) [of Section 315 of the National Defense Act] that the authority of the Secretary of the Interior to prescribe regulations for the incidental taking of migratory birds during military readiness activities is limited to the Secretary's authority under section 3(a) of the Migratory Bird Treaty Act").

The experience with the National Defense Act further demonstrates that, even with activities as crucial as those necessary for national defense preparedness, Congress did not endorse a wholesale exemption from the MBTA (which, as discussed further below, is tantamount to what the wind power industry is now receiving in view of the Service's systemic failure to enforce the Act's take prohibition against wind power projects), nor did Congress authorize the military to take a purely voluntary approach to MBTA compliance.

Thus, FWS does not require any additional authorization from Congress to regulate incidental take and can do so by exercising its existing authority under the MBTA.

ii. *FWS has already established regulations for permitting certain incidental takes.*

As a result of the National Defense Act, FWS promulgated regulations governing take of migratory birds by the Armed Forces incidental to military readiness activities. See 50 C.F.R. § 21.15 (2007). The regulations require the Armed Forces to "confer and cooperate with the Service to develop and implement appropriate conservation measures" for "those ongoing or proposed activities" that may result in a significant adverse effect on a population of migratory bird species.[133] Id. § 21.15(a)(1) (emphasis added). However, the incidental take authorization provided therein can be suspended or withdrawn by the Secretary. The Secretary can "suspend" take authorization if he determines, after seeking the views of the Secretary of Defense and consulting with the Secretary of State, that the take authorization is no longer compatible with the migratory bird treaties. Id. § 21.15(b)(1). The Secretary can also "withdraw" take authorization in certain circumstances when a proposed military readiness activity is likely to result in significant adverse effects on the population of a migratory bird species. Id. § 21.15(b)(2).

In establishing the incidental take regulations for military incidental take, FWS reiterated that the agency had authority to regulate incidental take under the MBTA, independent of the National Defense Act's directive:

[133] "Significant adverse effect on a population" has been defined by FWS to mean "an effect that could, within a reasonable period of time, diminish the capacity of a population of migratory bird species to sustain itself at a biologically viable level. A population is 'biologically viable' when its ability to maintain its genetic diversity, to reproduce, and to function effectively in its native ecosystem is not significantly harmed. This effect may be characterized by increased risk to the population from actions that cause direct mortality or a reduction in fecundity. Assessment of impacts should take into account yearly variations and migratory movements of the impacted species. Due to the significant variability in potential military readiness activities and the species that may be impacted, determinations of significant measurable decline will be made on a case-by-case basis." 50 C.F.R. § 21.3.

> [T]he authorization that this rule provides is essential to preserving the Service's role in determining what military readiness activities, if any, create an unacceptable risk to migratory bird resources and therefore must be modified or curtailed…. In the Authorization Act, Congress directed the Secretary to utilize his/her authority to permit incidental take for military readiness activities. Furthermore, Congress itself by passing the Authorization Act determined that allowing incidental take of migratory birds as a result of military readiness activities is consistent with the MBTA and the treaties. Thus, this rule does not abrogate the MBTA… The Defense Authorization Act does not limit that authority [of FWS under Section 704 of the MBTA]… the Defense Authorization Act does not restrict or limit our authority in 16 U.S.C. 704 and 712 relative to administering and enforcing the MBTA and complying with the four migratory bird treaties…. Even in the absence of the Authorization Act, regulations authorizing take incidental to military readiness activities are compatible with the terms of the treaties, and therefore authorized by the MBTA.

FWS, Final Rule: Migratory Bird Permits - Take of Migratory Birds by the Armed Forces (Feb. 28, 2007) ("Military Take Final Rule") (emphases added).

In addition to the incidental take regulations for military take, other existing regulations promulgated under the MBTA enable FWS to regulate and authorize certain incidental takes. For example, under 50 C.F.R. § 21.27, FWS has the authority to issue special purpose permits for take that is otherwise outside the scope of the standard form permits of Part 21. See United States v. Winddancer, 435 F.Supp.2d 687, 690 (M.D. Tenn. 2006) ("50 C.F.R. § 21.27 provides for special purpose permits available to all citizens 'for special purpose activities related to migratory birds, their parts, nests, or eggs' that are not otherwise provided for by the other permit provisions."); see also Military Take Final Rule at 8947 ("Special purpose permits may be issued for actions whereby take of migratory birds could result as an unintended consequence."); Wind FAC Legal Subcommittee White Paper at 13 (Oct. 22, 2008) ("FAC Legal White Paper").[134] The relevant portion of the regulation provides that:

> **§ 21.27 Special purpose permits.**
> Permits may be issued for special purpose activities related to migratory birds, their parts, nests, or eggs, which are otherwise outside the scope of the standard form permits of this part. A special purpose permit for migratory bird related activities not otherwise provided for in this part may be issued to

[134] Available at http://www.fws.gov/habitatconservation/windpower/Subcommittee/Legal/Reports/Wind_Turbine_Advisory_Committee_Legal_Subcommittee_White_Paper_(Final_As_Posted).pdf (last visited Nov. 17, 2011).

> an applicant who submits a written application containing the general information and certification required by Part 13 and makes a sufficient showing of benefit to the migratory bird resource, important research reasons, reasons of human concern for individual birds, or other compelling justification.

50 C.F.R. § 21.27 (emphases added).

FWS has issued special purpose permits to authorize certain incidental takes and to exercise ongoing federal oversight over such activities. For example, FWS has issued a special purpose permit to the Channel Islands National Park permitting incidental take of migratory birds resulting from spraying rat poison in order to eradicate black rats on Anacapa Island. See Anacapa Island Restoration Project, Channel Islands National Park, Phase I MBTA Summary Report (2002) (explaining that on Nov. 16, 2001, FWS issued a Special Purpose Permit (MB050154-0) providing incidental take authorization to Channel Islands National Park), Attachment O; see also FWS Memo from Acting Director to Regional Directors, Migratory Bird Permits for Controlling Invasive Species (Jan. 20 2010) ("FWS Invasive Species Memo") (advising that FWS may process applications for special purpose permits under 50 C.F.R. § 21.27 for take of migratory birds incidental to eradication or control of invasive species);[135] FAC Legal White Paper at 13-14 ("[Special purpose permits] potentially could be used to authorize incidental take caused by wind energy projects. For example, a wind energy project theoretically could apply to FWS for a special use permit for an incidental take of birds based on a showing that the wind facility was providing an overall positive benefit to the migratory bird resource, perhaps through accompanying mitigation measures, or constitutes a situation of compelling justification due to the benefits of renewable energy generation.").

Indeed, it appears that FWS has previously undertaken the process of developing general incidental take regulations. See FWS Invasive Species Memo ("The [FWS] Division of Migratory Bird Management is continuing work towards developing regulations to address the larger issue of incidental take of migratory birds. In the meantime, staff should continue to work with our agency counterparts to consider migratory bird impacts during project planning and to incorporate conservation measures where appropriate[.]"). In fact, during the course of litigation concerning take of migratory birds incidental to military readiness activities – a case that was eventually dismissed on mootness grounds upon the enactment of the National Defense Act – the federal government went on record to state that FWS had already drafted a proposed rule that would authorize incidental take of migratory birds by federal agencies. See Brief of Fed. Defendants-Appellants, Ctr. for Biological Diversity v. England, 2002 WL 34248159 (D.C. Cir. Sept. 17, 2002). In that case, the government argued as follows:

[135] Available at http://nctc.fws.gov/CSP/Resources/mig_birds/CD/MBTA%20Resources/invasive_species_memo.pdf (last visited Dec. 11, 2011).

> There are several conceivable avenues by which the Navy could come into compliance with the district court's holding that its exercises on FDM violate the MBTA. First, the Navy may obtain a permit from the FWS. Indeed the Navy is actively pursuing an MBTA permit [under 50 C.F.R. s 21.27], in compliance with the court's order… Second, the Navy may petition the FWS to amend the regulations to authorize its taking of migratory birds. The MBTA grants the FWS this authority. 16 U.S.C. ss 704, 712(2). Although the FWS has in the past relied upon its enforcement discretion in cases of unintentional takes, it has already drafted a proposed rule that would authorize the unintentional taking of migratory birds by federal agencies incident to other lawful activities.

Id. (emphasis added).

Thus, FWS itself has been on record for many years that it has the authority to issue regulations circumscribing the conditions under which particular entities or activities may incidentally take migratory birds.

iii. *Federal courts and other sources have also recognized that FWS has the authority to regulate incidental take under the MBTA.*

As explained supra, Section D.2, federal courts have also recognized the "broad" "plenary power" of FWS to regulate take under Section 704(a) of the MBTA. In fact, regulations promulgated by FWS to avoid and minimize incidental take under the MBTA have been upheld at least in one instance. Nat'l Rifle Ass'n of Am. v. Kleppe, 425 F. Supp. 1101 (D.D.C. 1976). In that case plaintiffs challenged the adoption of regulations which required the use of steel shot in 12-gauge or larger shotguns for hunting. Although the regulations were related to intentional taking, the stated purpose for establishing these regulations was to avoid and minimize incidental take, i.e., "to limit further deposition of lead pellets in areas used by aquatic birds. . . . (which cause) lead intoxication and death…" Id. at 1103-04. The court upheld the regulations as being grounded in Section 704 of the MBTA. Id. at 1110. This decision was affirmed by the U.S. Court of Appeals for the D. C. Circuit, Nat'l Rifle Ass'n of Am. v. Andrus, 571 F.2d 674 (Table) (D.C. Cir. 1978), and has also been relied on in cases concerning other environmental statutes. See, e.g., Conn. Coastal Fishermen's Ass'n v. Remington Arms Co., 989 F.2d 1305, 1317 (2d Cir. 1993) (holding that lead shot was subject to regulation as hazardous waste under the Resource Conservation and Recovery Act of 1976).

Further, other sources have also recognized the authority of FWS to regulate incidental take. For example, the committee established by DOI under FACA to advise FWS on developing effective measures to avoid or minimize wildlife impacts related to land-based wind energy facilities, has also concluded that FWS has the authority to regulate incidental take, specifically in the wind energy context:

> The language of the MBTA gives the FWS authority and discretion to adopt regulations to permit reasonable activities that result in the taking of birds. Congress, in Section 704 of the MBTA, expressly authorizes the promulgation of regulations that permit the taking of migratory birds in a broad grant of authority to the FWS… From this broad Congressional grant of authority in Section 704(a), the FWS may have the authority to promulgate regulations establishing a new permit that would allow for the taking of birds at wind energy developments under certain conditions. Although the FWS does not have express authorization in the MBTA to issue "incidental take permits" as provided in the ESA, the broad grant of authority in Section 704 seems to allow issuance of such permits should the FWS choose to exercise this authority in the wind energy and other contexts. This would require the promulgation of a new regulation by the FWS.

FAC Legal White Paper at 13-14 (emphases added).[136]

In addition, FWS has been advised by its legal department that regulations specifically tailored for permitting incidental take may be more appropriate than using the mechanism provided for allowing incidental take through issuance of special purpose permits under 50 C.F.R. § 21.27. See Memorandum from Pete Raynor, Assistant Solicitor, Fish and Wildlife Branch, to John Rogers, Deputy Director, FWS, Permitted Incidental Take of Migratory Birds Listing Under the Endangered Species Act 3 (Feb. 5, 1996) ("although [50 C.F.R.] § 21.27 appears to be broad enough to encompass the permitting of unintentional take for the purposes of the MBTA, that section is not narrowly focused on incidental take. A regulatory permitting program specifically geared to the problems of incidental take may be advisable." (emphasis added)), Attachment P.

In sum, Sections 704(a) and 712(2) of the MBTA provide broad authority to FWS to promulgate regulations regulating, and authorizing certain incidental takes, subject to appropriate conditions and ongoing federal oversight. Accordingly, FWS clearly has the requisite rulemaking authority to establish a permitting scheme to regulate the incidental take of migratory birds by wind energy projects.

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[136] The White Paper prepared by the Legal Subcommittee was adopted by the full Wind Turbine Guidelines Federal Advisory Committee. See Appendix B (FAC Legal Subcommittee White Paper), Committee Recommendations.

E.2. Wind energy projects have been taking and are likely to continue to take migratory birds in violation of the MBTA's take prohibition.

As noted supra, see Section C.2, FWS is well aware that many wind energy projects are either already in operation or are being planned that will take migratory birds in violation of the MBTA. See Wind Guidelines Third Draft at 15 ("The Service recognizes that hundreds of wind energy projects exist and are being planned."). By 2020, it is expected that an exponential increase of wind turbines will kill at least one million birds each year, and impact almost 20,000 square miles of terrestrial bird habitat, and another 4,000 square miles of marine habitat. See ABC's Bird-smart Wind Principles.

Further, as explained supra, Section C.1, present-day utility scale wind turbines are massive machines and their size continues to increase on a regular basis. However, such an increase in turbine size also expands the rotor-swept area of the blades (at present exceeding 400 acres), which in turn further increases the potential for bird collisions. See FWS 2011 MBTA Conference Presentation at 5-6 (the rotor swept area of wind turbines has increased from 3,700 square meters (about 1 acre) in 2000 to 15,000 square meters (3.8 acres) in 2010). Like other for-profit industries that are made to internalize the environmental costs of their operations, the wind industry should be required to internalize the costs related to the impacts of its projects on migratory birds and other wildlife that have concrete societal benefits in terms of ecosystem functioning, ecotourism, and the like. See Cornell Lab of Ornithology, Comments to the U.S. Fish and Wildlife Service: Draft Land-based Wind Energy Guidelines (May 2011) ("we strongly encourage the Guidelines to require research protocols and open access to wildlife research data as a mandatory "cost of doing business." (emphasis added)).

Indeed, especially since the wind power industry seeks to present itself as a "green" energy source that is part of the solution to climate change – and hence beneficial to wildlife – the industry should not be permitted to simultaneously undermine the conservation of migratory bird populations in violation of the MBTA, especially with regard to species already at risk or otherwise of conservation concern. Yet FWS already possesses definitive evidence, much of which is discussed in and attached to this Petition, that wind energy projects in the United States will inevitably kill, injure, or otherwise harm many of the 1007 migratory bird species listed under the MBTA, such as a wide variety of songbirds, raptors, and waterfowl including but not limited to, the Bald Eagle, Golden Eagle, Ferruginous Hawk, Swainson's Hawk, American Peregrine Falcon, Short-eared Owl, Flammulated Owl, California Condor, Whooping Crane, Snail Kite, Marbled Murrelet, Hawaiian Goose, Hawaiian Petrel, Bicknell's Thrush, Sprague's Pipit, Cerulean Warbler, Oak Titmouse, Lewis's Woodpecker, Brewer's Sparrow, Long-billed Curlew, Bay-breasted Warbler, and Blue-winged Warbler. See supra Section C.2. Indeed, the agency's voluntary guidelines are themselves grounded on the fact that wind turbines that fail to abide by basic standards for siting, construction, operation, and monitoring will take listed migratory birds in violation of the MBTA. Given the reality that the wind industry as a whole is in patent violation of the MBTA, FWS must ensure that the entire industry is brought into compliance with the Act, and that individual projects that refuse to comply will be subject to appropriate enforcement action. Such a comprehensive approach would be the simplest and most efficient method for assuring industry-wide compliance with the Act.

The reality is that migratory birds and wind turbines often tend to congregate in the same locations – corridors where strong winds blow. A majority of the nation's wind farms are located in major wind corridors – in general, the harder and more often the wind blows, the more efficiently the turbine works and the more power it creates. Given this reality and the high likelihood of conflict between wildlife protection and the industry, there is an urgent need for an appropriate means to resolve this conflict, and that is through an effective legal mechanism, i.e., regulations that balance the two objectives in a manner that promotes the industry by proving it with a reasonable degree of regulatory and legal certainty while at the same time protecting wildlife in compliance with federal wildlife law. Accordingly, this Petition seeks a permitting scheme that will facilitate siting decisions in a manner that avoids and minimizes wildlife impacts, and effectuates ABC's long-standing position with regard to wildlife impacts of wind energy projects – you can make a good site better through operational measures, but you cannot make a bad site good. In sum, the wind power industry is killing and otherwise harming migratory birds in clear violation of federal law and, consequently, steps need to be undertaken to bring the industry into conformance with the law while not needlessly impeding the development of wind power. The proposed regulations set forth in the Appendix to this Petition are designed to accomplish that result.

E.3. FWS should exercise its broad permitting authority to address the ongoing unregulated and wholly unlawful take of protected birds by wind energy projects.

As detailed below, there are several reasons grounded in fact, law and policy, for FWS to promulgate regulations governing the wildlife impacts of wind energy projects.

i. *FWS must encourage wind energy development by providing the industry a concrete and lawful means to comply with the MBTA.*

The crux of the problem is that the wind energy industry as a whole is in violation of the MBTA because essentially all projects are taking or inevitably will take MBTA-protected birds. See supra Section C.2; see also, e.g., supra Map 2.1 (map showing wind energy turbines that have been proposed in several areas of critical importance to birds). However, in the absence of a permitting system, even wind energy developers that know that their projects will take migratory birds and desire to operate within the law have no concrete means of doing so, short of abandoning the project.

The inadequate solution devised by FWS and the Committee, i.e., "voluntary" Guidelines in return for vague non-enforcement "assurances," does nothing to resolve this problem because the "guidelines do not authorize take under MBTA or BGEPA," and, regardless of efforts by individual projects to comply with the Guidelines, "[v]iolations of those statutes may result in prosecution." See Wind Guidelines Third Draft at 13. Indeed, the legal complications related to the voluntary

Guidelines have raised concerns not only among many in the conservation community but also by the U.S. Department of Justice.[137] In this regard, it is important to stress that federal agencies are not exempt from the MBTA's broad strict-liability take prohibition, and consequently any federal agency action that in effect authorizes or leads to take of migratory birds – in the absence of the specific mechanisms provided for in the MBTA – is itself a violation of the Act. See Humane Soc'y of the U.S. v. Glickman, 217 F.3d 882 (D.C. Cir. 2000). Thus, FWS itself is subject to the MBTA and therefore its actions, such as adoption of voluntary Guidelines that essentially endorse the unauthorized taking of migratory birds – by providing projects with any non-enforcement assurances at all – is in clear tension with the Act. See Migratory Bird Executive Order.

In Glickman, plaintiffs challenged implementation of a management plan for Canada Geese, which did not require the Department of Agriculture to seek permits before taking or killing such birds. The federal defendants argued that federal agencies were not subject to the MBTA and therefore need not obtain a permit before taking migratory birds. The court of appeals rejected the government's argument and held that the Department was required to seek a permit before implementing the management plan. That case may be particularly relevant in the context of the voluntary Guidelines, since there the court held that the Department of Interior's interpretive policy statement that allowed federal agencies to take without a permit violated the MBTA. Thus Glickman's ruling that mere non-binding policy statements of a federal agency could be in violation of the MBTA has clear implications for the legality of the voluntary Guidelines, because the Guidelines essentially endorse unauthorized take by wind energy projects without a permit, which is a clear violation of the MBTA by the agency.

Indeed, an agency need not itself be killing or taking birds to be in violation of the Act. See, e.g., Hill v. Norton, 275 F.3d 98, 106 (D.C. Cir. 2001) (subsequently superseded by statute) (holding that failure of the Department of Interior to list mute swans under the MBTA "ha[d] led to numerous adverse actions - including killing and egg destruction" and was therefore an action that violated the MBTA and was reviewable under the APA). Thus, FWS's failure to make the Guidelines mandatory – while providing assurances to developers that their compliance with the Guidelines will limit the agency's enforcement discretion – will likely lead to the unauthorized "taking" of birds by wind energy projects without a permit under the MBTA. Accordingly, FWS cannot, through non-binding Guidelines, absolve developers of liability for violation of the Act resulting from incidental take; and by purporting to do so FWS would itself be violating the MBTA and running afoul of the ruling in Glickman and other cases.

On the other hand, the Act expressly provides a mechanism for permitting take in Section 704, i.e., permitting take through "suitable regulations." 16 U.S.C. § 704(a). FWS should

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[137] This was communicated by FWS during the public comment session in the Wind Federal Advisory Committee meeting held on September 21, 2011. Further, ABC has repeatedly requested FWS to provide the meeting summary and recording of the September 2011 Committee meetings (as required under FACA, 5 U.S.C. App. 2 §§ 10(b)-(c)), and has to date not been provided the same.

implement Section 704 of the Act by promulgating regulations that not only establish mandatory standards for the industry, but also enable developers to cooperate with FWS in obtaining formal authorization through incidental take permits for appropriate projects, as envisaged in the Proposed Regulations. In sum, this is the critical juncture at which FWS must take stock of the legal and empirical inadequacy of the approach taken to date and then commit to a different one – which can build on the hard work done in drafting the Guidelines – under which wind energy developers have both a meaningful, reliable mechanism to site and operate their projects in a bird-friendly fashion, and a well-placed concern for potential agency enforcement if they do not.

ii. ***Mandatory standards for wind energy projects are necessary particularly due to the lack of enforcement of the MBTA by FWS against the wind industry.***

The MBTA does not have a citizen suit provision and therefore FWS has the primary responsibility to administer and enforce the Act. Many prosecutions for incidental take have been pursued by FWS under the MBTA, including against companies involved in resource and energy production. In 2009, for instance, the electric utility PacifiCorp paid approximately $1.4 million in fines and restitution and approximately $9.1 million to repair and replace equipment in order to minimize impacts on migratory birds, after pleading guilty to 34 counts of unlawfully taking Golden Eagles, hawks, and ravens in violation of the MBTA.[138] Also in 2009, Exxon-Mobil pled guilty to 85 violations of the MBTA for failure to take precautions to prevent the death of migratory birds at one of the company's petroleum facilities, and paid $600,000 in fines. Thus, there is a long history of these types of prosecution. See, e.g., United States v. Moon Lake Electric Ass'n Inc., 45 F.Supp. 2d 1070 (D. Colo. 1999) (prosecution of electric company for failing to take reasonable measures to minimize the impact of power lines on migratory birds); United States v. Stuarco Oil Co., 73-CR-129 (D. Colo. 1973) (prosecution of oil company for the death of 23 birds resulting from the company's failure to build oil sump pits in a manner that could keep birds away); United States v. Equity Corp., Cr. 75-51 (D. Utah 1975) (oil company charged for the death of 14 ducks caused by the company's oil sump pits); United States v. Union Tex. Petroleum, 73-CR-127 (D. Colo. 1973) (prosecution of oil company for no proper maintenance of oil sump pit).

As explained supra, see Section D.3, FWS has the primary responsibility to administer and enforce the MBTA. However, to date, despite conceded rampant violations of the MBTA by wind energy projects, FWS has never brought enforcement action against wind energy developers for incidental take. See Laura J. Beveridge, The Migratory Bird Treaty Act and Wind Development (N. Am. Wind Power, Sept. 2005) (opinion of attorney representing the energy sector that the government's ongoing reluctance to prosecute wind energy projects provides assurance to developers that they will not be held liable for avian deaths), Attachment Q.

[138] FWS News Release: Utility Giant to Pay Millions for Eagle Protection (July 10, 2009), http://www.fws.gov/mountain-prairie/pressrel/09-47.html (last visited Nov. 8, 2011).

Further, the agency is aware of large-scale illegal killing and potential take of MBTA-protected birds at many wind energy projects across the country not merely in violation of federal statutes but also, in some cases, in clear violation of the specific standards provided in the voluntary guidelines. See, e.g., Memo from Alan Forster, NedPower Mt. Storm LLC to Laura Hill, FWS, NedPower September 25, 2011 Monitoring Event (Oct. 10, 2011) (describing an "unusual number of bird casualties" found near a single turbine), Attachment R; Letter from FWS to Amber Zuhlke, Wind Capital Group, Big Lake Wind Facility in Palm Beach, Florida (July 1, 2011) ("Many recommendations within the Draft Eagle Guidance were not included in the pre-construction monitoring plan for identifying potential risk to eagles. The Service requests the Draft Eagle Guidance be followed…"), Attachment K. Thus, there are situations in which a company flatly admits bird mortality at its project, and yet FWS fails to bring any enforcement action. See, e.g., Memo from Stantec Consulting (consultants for developer) to Laura Hill, FWS, Bird Mortality at Laurel Mountain Substation Memo (Oct. 25, 2011) (reporting the death of 314 birds), Attachment J; Louis Sahagun, Federal Officials Investigate Eagle Deaths At DWP Wind Farm (L.A. Times, Aug. 3, 2011) (explaining that the Los Angeles Department of Water had reported raptor mortalities to FWS at its Pine Tree Wind Project in the Tehachapi Mountains).[139]

Although FWS has considerable discretion in deciding whom to prosecute for violation of the MBTA, Alaska Fish & Wildlife Fed'n & Outdoor Council v. Dunkle, 829 F.2d 933 (9th Cir. 1987), courts have held that an ongoing "pattern of non-enforcement of clear statutory language" amounts to "an abdication of its statutory responsibilities," which is a violation of the APA. Heckler v. Chaney, 470 U.S. 821, 833 n.4 (1985) (citing Adams v. Richardson, 480 F.2d 1159 (D.C. Cir. 1973) (emphasis added)); see also id. at 839 (Brennan, J., concurring) ("It may be presumed that Congress does not intend administrative agencies, agents of Congress' own creation, to ignore clear jurisdictional, regulatory, statutory, or constitutional commands[.]"). Accordingly, an ongoing practice and policy of non-enforcement while wind energy projects openly flout the MBTA may open FWS to suit under the APA, for engaging in a "pattern of non-enforcement of clear statutory language." This is still another reason why the promulgation of a system for permitting wind power projects is far preferable to FWS's existing approach, under which it has, at least as a practical matter, made it abundantly clear that it has no intention of enforcing the MBTA against such projects.

In fact, FWS is further exacerbating the problem of non-enforcement and implementation of the MBTA, by endeavoring to provide "assurances" to wind energy developers that they will not be prosecuted for violations of the MBTA even when the Service disagrees with their reasons for siting in a particular location and the project results in take of migratory birds. Even worse, the most recent published version of the wind Guidelines (as of this writing) recommends that "if the developer seeks to have the benefit of the enforcement discretion" of FWS, it must merely maintain

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[139] Available at http://articles.latimes.com/2011/aug/03/local/la-me-wind-eagles-20110803 (last visited Nov. 16, 2011).

"contemporaneous documentation of how the developer evaluated [FWS's] advice and the reasons for any departures from it." Wind Guidelines Third Draft at 13 (emphases added). Simply put, what this means is that a private company can claim to be in "compliance" with the Guidelines and entitled to non-enforcement assurances, while at the same time refusing to abide by the position of the biologists of the federal agency whose stated mission is to "conserve, protect, and enhance" migratory birds "for the continuing benefit of the American people" and which has the statutory duty under the MBTA to protect and prevent taking of migratory birds. FWS, Mission Statement;[140] see also Wind Guidelines Third Draft at 1 (explaining that the "the advice of the Service is not binding" and that "the guidelines leave decisions up to the developer.").

This is a counterproductive and almost certainly unlawful approach to managing migratory bird impacts, especially because FWS is frequently in disagreement with the developer's analysis of the wildlife risks posed by its project. See, e.g., Letter from Deborah Carter, FWS to Curry & Kerlinger, LLC (environmental consultants of developer) at 2 (Sept. 30, 2009) (explaining that the agency "disagreed" with the developer's "conclusions drawn from [the risk assessments]."), Attachment S; Letter from Laury Zicari, FWS to Dana Vallieu, TRC (May 11, 2011) at 6 (explaining that the studies conducted by the developer's consultants were insufficient to assess the project's impacts on Golden Eagles and providing several recommendations to modify the developer's approach), Attachment T; Letter from Gary Miller, FWS to Sue Oliver, Or. Dep't of Energy (Feb. 14, 2011) at 8-9 ("Throughout this energy facility siting process, the Service and [developer] have reached agreement on some issues, but many remain. The Service continues to have concerns with this Project…"), Attachment U; see also id. at 13-16 (FWS providing a chart of items identifying the developer's response to agency recommendations - on some issues the developer had "declined" to follow the agency's recommendations).

In particular, the voluntary Guidelines do not effectively address the most crucial problem related to impacts of wind energy projects on birds, i.e., poor siting, because they allow developers to build projects in high risk areas so long as they communicate with the agency and record their reasons for departure from the agency's advice. See, e.g., Letter from Michael D. George, FWS to Jay Prothro, BP Wind Energy, Southwest Power Pool Docket #ERII-3833 (Oct. 11, 2011) (FWS expressing frustration with developer's decision to proceed with the project in complete disregard to the agency's recommendations – "British Petroleum representatives and their consultants have repeatedly been advised of the unacceptability of the proposed BP wind project west of Merna given its high risk to whooping cranes and other migratory birds. The Service again recommends that the proposed BP wind project not proceed as planned [because it] provides an abundance of suitable habitat for the federally endangered whooping crane."), Attachment V; see also Letter from Robert D. Williams, FWS to Tim Carlson, Nevada Wind, Proposed Virginia Peak Wind Facility and Existing Golden Eagle Resources in the Pah Rah Range, Washoe County, Nevada (Aug. 13, 2010) at 2 (FWS contacted the developer by telephone when it had not heard back from the developer for

[140] Available at http://www.fws.gov/info/pocketguide/fundamentals.html (last visited Nov. 11, 2011)

more than a year since communication of its recommendations, only to find out that construction of the project was to begin in 45 days without regard for its recommendations), Attachment W; Letter from Scott Hicks, FWS to Xio Cordoba, Heritage Sustainable Energy (Nov. 4, 2011) (even though FWS had for many years recommended that the developer "not construct a commercial wind energy development on the Garden Peninsula because of the high potential for avian mortalities and violations of Federal wildlife laws," the developer informed FWS that it "intended to move forward with construction of the wind energy development, regardless of [FWS's] previous recommendations and wildlife concerns."), Attachment X.

Thus, although FWS provides certain recommendations to the wind industry, such as its recommendations that developers apply the tiered approach adopted in the Guidelines and that they communicate extensively with the agency, the reality remains that these Guidelines are entirely non-binding and there is no means to ensure that developers follow the recommendations of the very authority that has the statutory mandate to protect migratory birds and other wildlife.

Being the primary authority responsible for protecting wildlife and enforcing federal wildlife statutes such as the MBTA, FWS has the statutory responsibility to either enforce the Act effectively so that future violations are deterred or to establish a comprehensive regulatory regime that avoids and minimizes wildlife impacts at wind energy projects. By refusing to regulate or prosecute wind energy companies, FWS is essentially providing the industry a free pass to violate federal wildlife law, and at the same time creating a regulatory limbo which simply cannot afford legal certainty to projects that are in fact in violation of the MBTA.

iii. *Regulations are crucial in order to require wind energy developers to share information with FWS at the earliest stage of the project.*

Given that proper siting of wind energy projects is the most important element in avoiding and minimizing wildlife impacts, FWS has urged developers to "'come to us at the get-go, before a site has been selected [and] before a landowner agreement has been signed.'" John Clapp, FWS Official Urges Cooperation (N. Am. Windpower June 2011) (quoting Albert Manville, Senior Wildlife Biologist, FWS);[141] see also Letter from FWS to Chris Taylor, Element Power (Jan. 31, 2011) ("Developers should seek this consultation ***prior to*** making irrevocable commitments."), Attachment Y.

Unfortunately in the absence of mandatory rules requiring developers to obtain permits to proceed with particular projects, at present FWS is facing a situation where it is not only having difficulties in obtaining information from the industry but is also in some cases entirely unaware of the existence of projects that may have serious wildlife impacts. Clapp, supra (quoting Albert

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[141] Available at http://www.wind-watch.org/news/2011/06/03/fws-official-urges-cooperation/ (last visited Nov. 17, 2011).

Manville, Senior Wildlife Biologist, FWS, "'[u]nfortunately, right now in many cases, we find out about the development of a project through a news release or something on the evening news when we have not been consulted whatsoever, and that's frustrating.'" (emphasis added)); see also, e.g., Letter from Robert D. Williams, FWS to Tim Carlson, Nevada Wind, Proposed Virginia Peak Wind Facility and Existing Golden Eagle Resources in the Pah Rah Range, Washoe County, Nevada at 1 (Aug. 13, 2010) (stating that FWS "first became aware of this project when a local state agency contacted it"), Attachment W.

Further, increasingly some wind energy developers are becoming less forthcoming in sharing information with FWS and are proceeding with construction without regard to the agency's recommendations. See, e.g., Letter from Laury Zicari, FWS to Nicholas D. Livesay, Pierce Atwood LLP (attorneys of the developer) (Mar. 31, 2011) (FWS response to developer's application for an incidental take permit under BGEPA expressing "surprise" "to learn that USDA funded the project" and "to learn that groundbreaking for the project occurred despite the many concerns that [FWS] raised concerning this project" and even before completion of "two full seasons" of pre-construction studies as recommended by FWS for avoiding risks to Bald Eagles), Attachment Z; Letter from FWS to Chris Taylor, Element Power (Jan. 31, 2011) (despite developer's assurance that it would submit an ABPP based on the agency's recommendations, no such information was forthcoming from the developer – "Service biologists have not heard from any representative of the company, nor has the Service received a revised ABPP… We note that these deficiencies persist despite our attempts to work -cooperatively with the company to correct them."), Attachment Y; Letter from Robert D. Williams, FWS to Tim Carlson, Nevada Wind, Proposed Virginia Peak Wind Facility and Existing Golden Eagle Resources in the Pah Rah Range, Washoe County, Nevada at 2 (Aug. 13, 2010) ("We requested that you provide this information to us for review so that we could assist you in determining the level of risk of your project to golden eagles. To date we have not received the requested resource information."), Attachment W.

In addition, in some cases, developers are entering into confidentiality agreements with their hired biological consultants, thereby making it more difficult for the agency, and the public, to study the wildlife impacts of the projects.[142] See Manville 2009 Paper at 9 ("The transparency of research results conducted by wind industry consultants continues to be a recurrent frustration for USFWS—in part because of early project industry confidentiality issues.") (emphasis added).

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[142] In fact, when asked about the utility of such "confidentiality" agreements, a wind industry representative recently stated that the industry considered wildlife mortality information as "proprietary information." Statements made by FWS and Wind Industry Representative in a panel discussion on BGEPA during a conference on 'Reshaping the Migratory Bird Treaty Act' organized by Lewis and Clark Law School (October 21, 2011). More information on this conference is available here: http://law.lclark.edu/programs/environmental_and_natural_resources_law/conferences_and_lectures/2011_migratory_bird_treaty_act/

In addition, recent incidents have documented the inherent problems associated in having surveys, monitoring and assessments of wildlife impacts at wind energy projects conducted by consultants retained by and paid for by the project developers themselves. For example, in finding a wind power project in violation of the ESA, a federal district court expressly rejected the findings of one such developer-hired consultant in favor of other independent experts who appeared before the Court. See Animal Welfare Inst. v. Beech Ridge Energy LLC, 675 F. Supp. 2d 540, 582 (D. Md. 2009). In Beech Ridge, the court found that the developer-hired consultant performed minimal surveys, presented result-oriented analyses, and even suppressed important acoustic data, placing the interests of the company ahead of wildlife protection interests. As the Beech Ridge ruling makes clear, often consultants have inherent conflicts of interest that lead to their adoption of "a minimalist approach to [their] responsibilities," leading to the sort of unacceptable, insufficient, and result-oriented studies done at Beech Ridge. 675 F. Supp. 2d at 582.

Indeed, the wildlife mortality estimates documented by many wind energy projects are underestimates of actual mortality levels because of inconsistent reporting of incidental mortality, which is not handled in a standard way across the industry. Incidental mortality refers to carcasses found in addition to the official mortality searches, either occurring at a different time than the scheduled searches, or at a wind turbine that wasn't searched. Mortality studies generally do not include all of a facility's wind turbines. Not all mortality studies report incidental finds. For example, a report about bird and bat mortality at wind facilities in the Montezuma Hills of California did not include Swainson's Hawk fatalities in the report even though the researchers were aware of them and the Swainson's Hawk is a species of conservation concern. See H. T. Harvey & Assocs., Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area;[143] see also Shiloh IV Wind Energy Draft Environmental Impact Report 4-7 (Aug. 23, 2011) (noting the Swainson's Hawk fatalities were found during the above study at some wind projects), Attachment AA.

A significant amount of the mortality for many species as a whole may be found incidentally, not during the standardized searches. See K. Shawn Smallwood & Brian Karas, Comparison of Mortality Estimates in the Altamont Pass Wind Resource Area When Restricted to Recent Fatalities 3 (June 2008).[144] For example, often the bird and bat mortality estimates are based only on carcasses found in routine searches. Such estimates often do not take into consideration, (a) carcasses found incidentally (i.e., found outside regular/routine carcass searches); and (b) bird and bats killed due to major fatality incidents (usually caused due to lights being left on at a turbine or substation, or heavy fog). See, e.g., Curry & Kerlinger, LLC, A Study of Bird and Bat Collision Fatalities at the

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[143] Available at http://www.co.solano.ca.us/civicax/filebank/blobdload.aspx?blobid=10104 (last visited Dec. 11, 2011).

[144] Available at http://www.altamontsrc.org/alt_doc/p101_smallwood_karas_mortality_restricted_to_recent.pdf (last visited Dec. 11, 2011).

Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003 (Feb. 14, 2004) at 5 (wildlife mortality estimate did not take into consideration a major fatality incident that took place in May 2003, thus only carcasses found during standardized searches were used to calculate the mortality estimate).[145]

Finally, it has long been known that scavengers can remove carcasses before they are found and searchers do not always find all carcasses. Although mortality studies now attempt to correct for these factors, recent research suggests that some of the adjusted mortality numbers may still be too low. See K. Shawn Smallwood et al., Novel Scavenger Removal Trials Increase Wind Turbine–Caused Avian Fatality Estimates 74(5) J. Wildlife Mgmt. 1089 (2010), Attachment BB. Thus, there appears to be a serious problem of underestimating actual wildlife mortality at many wind energy projects.

In sum, a skewed picture of actual wildlife mortality at wind energy projects is emerging. In this regard, regulations requiring the developer to consult with FWS will enable the agency to thoroughly scrutinize the studies conducted and conclusions drawn by hired consultants in order to ensure unbiased biological information collection and surveying, and accurate analysis of biological data.

In the absence of mandatory regulations requiring the developer to consult FWS and share requested information, FWS cannot simply expect or rely upon the goodwill or cooperation of the industry. In any event, mandatory rules are required to resolve environmental conflicts in any given industry and are especially necessary to regulate the uncooperative actors in the industry that do not follow the law. Indeed, the good corporate actors that diligently follow the law are in effect penalized by a system that relies entirely on voluntary compliance because they will incur costs whereas less responsible companies will not.[146] Thus, there is a crucial need for establishing uniform industry-wide regulations so that FWS can exercise oversight on those developers and operators who will not otherwise cooperate with the agency.

The problems posed by a lack of information and failure to consult with FWS is further exacerbated by the fact that most wind energy projects are constructed on private lands. See Nat'l Research Council, Environmental Impacts of Wind-Energy Projects (Nat'l Academies Press, 2007) at 194. Thus, often, there is no "federal nexus" for wind energy projects to trigger NEPA review.

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[145] Available at http://www.wvhighlands.org/Birds/MountaineerFinalAvianRpt-%203-15-04PKJK.pdf (last visited Nov. 17, 2011).

[146] Good examples of such actors in the wind energy industry that are truly concerned about the impacts of their projects on migratory birds are some that have recently decided to abandon sites that are particularly adverse to wildlife. See, e.g., Richard Cockle, Developers drop plans for two wind farms on Steens Mountain slopes, but still plan a third (The Oregonian, Nov. 17, 2011), http://www.oregonlive.com/pacific-northwest-news/index.ssf/2011/11/developers_drop_plans_for_two.html (last visited Nov. 22, 2011)

See Manville 2009 Paper at 9 ("Since the vast majority of wind development is currently on private lands, the USFWS lacks any strong federal nexus"). Simply put, this means that there may be hundreds of wind turbines on private lands entirely outside the scrutiny of FWS due to the lack of any current mechanism that triggers FWS review. See, e.g., Email from Wende S. Mahaney, FWS to Donald E. Murphy, Maine Department of Conservation, First Wind - Blue Sky East, LLC Bull Hill Wind Project Development Application (Mar. 07, 2011)[147] (FWS biologist stating that the agency will not be submitting comments on the state permit application of a wind energy developer because "[i]t is our understanding that all wetland fill impacts are being avoided, so the project does not trigger federal jurisdiction with the Corps of Engineers. That being the case, there is no requirement for consultation under the federal Endangered Species Act … So, I don't believe USFWS will be submitting any comments… Many bird and bat issues are "flying under the radar screen" (pun intended......) for USFWS."). Indeed, many more bird impacts due to wind energy projects will be "flying under the radar screen" of FWS under the approach adopted in the voluntary Guidelines, where FWS staff are required to respond to wind energy developers within a truncated 60 day review period. As explained supra, see Section C.3, the Guidelines impose the 60-day review requirement on FWS, regardless of the size or complexity of the project, or its risk to wildlife.

iv. ***FWS should take action to prevent destruction of migratory birds before the actual taking occurs.***

The MBTA is a strict liability statute. See United States v. FMC Corp., 572 F.2d 902 (2d Cir. 1978). In essence what this means is that regardless of intent to violate the law, "when one enters into a business or activity for his own benefit, and that benefit results in harm to others, the party should bear the responsibility for that harm." Id. at 907. "The [MBTA] does not include as an element of the offense 'willfully, knowingly, recklessly, or negligently' [because] Congress recognized the important public policy behind protecting migratory birds." Id. at 908 (emphasis added).

The "public policy behind protecting migratory birds" informs FWS's "federal trust responsibility" over migratory bird species. Specifically, this policy governs FWS's MBTA-permit program which is premised on the need to prevent destruction of migratory birds by taking precautionary measures, such as requiring appropriate permits, before the actual taking or killing of birds takes place. See, e.g., 50 C.F.R. § 21.22(a) (banding permits required "before any person may capture migratory birds"); id. § 21.23(a) ("scientific collecting permit is required before any person may take"); id. § 21.24(a) (taxidermist permit is required before any person may perform taxidermy"); id. § 21.27(a) ("special purpose permit is required before any person may lawfully take"); see also Fund For Animals v. Norton, 281 F.Supp.2d 209, 217 (D.D.C. 2003) ("The MBTA authorizes the Secretary of the Interior to promulgate regulations permitting the taking of migratory birds as long as the regulations are consistent with the Convention. The regulations prohibit the

[147] Available at http://www.maine.gov/doc/lurc/projects/Windpower/FirstWind/BlueSkyEast/DP4886/Application/ Comments/Federal_Agencies_Comments.pdf (last visited Nov. 15, 2011).

taking [] of any migratory birds except as allowed by a valid permit." (Citing 50 C.F.R. § 21.11) (emphasis added and other citations omitted)).

The precautionary approach is further reiterated in the MBTA definition of "take" which, like the definition of "take" under the ESA, prohibits "acts that lead to the taking of protected species." United States v. Apollo Energies, 611 F.3d 679, 684 n.3 (10th Cir. 2010) (citing Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687 (1995) ("The *regulatory* definition of 'take' [in the MBTA] is the same as the ESA's *statutory* definition except that the regulatory definition omits to 'harass' and 'harm.'"). Further, in the context of ESA enforcement, courts have accepted the reasonable certainty of future unlawful takes as sufficient to support remedies designed to prevent such takes from occurring, such as issuing an injunction against construction and operation until the developer obtains an appropriate take permit. See, e.g., Beech Ridge Energy LLC, 675 F. Supp. 2d at 545, 580 (holding that ESA requires courts to carefully scrutinize an activity that may take endangered species without a permit and granting injunction against wind energy project for likely take of endangered Indiana bat). In Beech Ridge, the court examined the potential conflict between two federal policies relevant to wind energy projects, one favoring the protection of endangered species under the ESA, and the other encouraging development of renewable energy resources, and observed that "[t]he two vital federal policies at issue in this case are not necessarily in conflict" so long as the project developer obtains take authorization in accordance with the ESA. Id. at 582-583. The court admonished the industry that, "[t]he development of wind energy can and should be encouraged, but wind turbines must be good neighbors" and that "the only way in which the Court will allow the [wind energy] project to continue" was through the permitting process under Section 10 of the ESA. Id.

Analogies for preventative regulations can also be drawn from conservation schemes in other federal wildlife laws that are premised on the precautionary approach to wildlife protection and are designed to prevent or minimize the taking of protected wildlife. The ESA and the Marine Mammal Protection Act ("MMPA"), 16 U.S.C. § 1361 et seq., also prohibit unauthorized take of protected wildlife. Further, like the MBTA those statutes provide FWS with broad rulemaking authority to protect such wildlife. For example, FWS has promulgated regulations under the ESA and the MMPA for protecting manatees through the establishment of "manatee protection areas" where waterborne activity is prohibited or subject to restrictions. 50 C.F.R. §§ 17.100-108. FWS describes the manatee regulations as "protective regulations," designed to "reduce the incidence of manatee injuries and deaths." FWS, Final Rule Providing for the Establishment of Manatee Protection Areas, 44 Fed. Reg. 60962 (Oct 22, 1979).

Similarly, in the case at hand, FWS should establish a mechanism through regulations to anticipate incidental take by wind energy projects and to be actively involved in ensuring that such projects are not constructed on sites that pose an undue risk to migratory birds and that any impacts that do occur are minimized and mitigated. Indeed, the incontrovertible evidence that wind energy projects, if operated as designed, will foreseeably take some migratory birds protected under the MBTA, strongly supports creation of a system for limiting the amount of take that will occur.

v. ***The wind energy industry particularly lends itself to federal oversight through appropriate regulations established under the MBTA.***

As explained above, FWS has the authority to regulate incidental take and there are several concrete reasons for establishing such a regulatory scheme for incidental take by wind energy projects. Further as explained infra, see Section E.4, the permitting scheme recommended in this Petition is particularly beneficial for regulating the incidental take by wind energy projects. Other mechanisms may be more appropriate for other incidental takes. See, e.g., Memo from Willie R. Taylor, FWS to FCC, FCC Draft Programmatic Environmental Assessment (DPEA), Antenna Structure Registration (ASR) Program (recommending that FCC "create a programmatic approach to authorizing communication towers that, along with its goal of avoiding and minimizing hazards to air navigation, explicitly seeks to avoid or minimize bird mortality."), Attachment CC.

The wind energy industry has sought to trivialize incidental take of birds by wind energy projects by comparing it to the level of avian mortality due to other incidental takes, such as cat predation, collision with windows and vehicles, and other external threats – presumably in order to downplay the risk of wind energy projects to wildlife. See, e.g., EDP Renewables, FAQs: Wind Technology[148] (website of leading wind energy developer arguing that "wind's overall impact on birds is lower than other sources of avian mortality such as vehicles, buildings and house cats."). Further, objections have been raised (mostly by the industry) that incidental take regulations for wind energy projects will mean that FWS will be required next to regulate all forms of incidental take.

This justification (that other actions are incidentally taking birds as well) is a specious argument that fails to recognize several key issues, explained in detail below, including that bird mortality is cumulative across the full spectrum of causes and that different sources of anthropogenic bird mortality variously impact different species. It also sidesteps the crucial issue, i.e., are bird mortalities from wind farms an issue of concern from an environmental standpoint, and is a permitting scheme an appropriate way of addressing it? The simple answer to both questions is "yes." Wind turbines have burgeoned and continue to develop across the nation in critical bird areas and constitute a serious threat to many bird species. A permitting process is an appropriate means of both alleviating that threat and allowing wind energy development in a more bird friendly fashion. See supra Section C.2. In addition, as explained below, it is eminently clear that incidental take by wind energy projects is distinct from many other modes of incidental take and is, in any event, particularly appropriate for regulation by FWS.

FWS itself has expressly recognized that "[s]iting of a wind energy project is the most important element in avoiding effects to species and their habitats." Wind Guidelines First Draft at

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[148] Available at http://www.edprenovaveis.com/Technology/WindTechnology/FAQs (last visited Nov. 10, 2011).

8; Letter from FWS to Amber Zuhlke, Wind Capital Group, Big Lake Wind Facility in Palm Beach, Florida (July 1, 2011) ("[FWS] supports properly-placed renewable energy projects and is willing to assist companies in positioning these projects on the landscape in locations that are compatible with wildlife and their habitats."), Attachment K. Indeed, FWS biologists have recognized that even a single turbine can pose a serious threat to wildlife if it is constructed in an improper site. See, e.g., Letter from Mary Knapp, FWS concerning the operation of a single 25 kW wind turbine at Kelleys Island, Ohio at 6 (June 8 2011) ("The Service is concerned that the proposed project may result in take of migratory birds due to its location… While the small size and rotor-swept area of the turbine may aid in minimizing the likelihood of a migratory bird being struck, overall the Service believes this site poses a high risk to birds."), Attachment DD; see also Cornell Lab of Ornithology, Scientists to Investigate Impacts of Wind Energy on Migratory Wildlife (July 27, 2009) ("'We know that in some locations a small percentage of wind turbines may cause the majority of bird and bat deaths. For example, Altamont Pass, east of Oakland, California, is an extreme case: in an area used regularly by migrant and resident raptors, only a fraction of the 5,000 turbines are responsible for most of the raptor deaths annually."' (quoting Dr. Andrew Farnsworth of the Cornell Lab of Ornithology)).[149]

FWS has also recognized that in certain situations the most appropriate means to address the potential wildlife impacts of any given wind energy project is that the project is simply not constructed at a particular site. See, e.g., Wind Guidelines Third Draft at 36 (recommending abandoning a project site if there is "a high probability of significant adverse impacts to species of concern or their habitats"); Wind Guidelines Second Draft at 16 (explaining the possible outcomes arising from collection of information and cooperation with FWS and describing one such outcome as "the project site is abandoned because the risk is considered unacceptable."); see also Cornell Lab of Ornithology, Scientists to Investigate Impacts of Wind Energy on Migratory Wildlife (July 27, 2009)[150] ("Due to our significant [wildlife] concerns over the proposed project location, we encourage [the developer] to consider alternative locations to explore wind energy in the Southeast, with consideration of the issues outlined").

Thus, for some projects, the best available scientific information will indicate that the project should not be constructed at that site. As more and more projects are being constructed in pristine forested mountains and ridgelines, designated Important Bird Areas, and high risk areas crucial to migratory birds such as migratory bird flyways, feeding and nesting areas, and areas of high bird concentrations (i.e., rookeries, leks, state or federal refuges, staging areas, wetlands, riparian corridors, etc.) – without any mandatory standards and regulation whatsoever – mortality and habitat fragmentation due to wind energy projects is increasing tremendously. See, e.g., Letter from Thomas R. Chapman, FWS to Colonel Philip Feir, Corps at 10 (Mar. 12, 2009) ("Wind turbines located on ridgelines in the project area may pose multiple threats to migrating birds."), Attachment

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[149] Available at http://www.birds.cornell.edu/pr/wind_wildlife_pr.html (last visited Nov. 14, 2011).

[150] Available at http://www.birds.cornell.edu/pr/wind_wildlife_pr.html (last visited Nov. 14, 2011).

EE; Letter from David A. Stilwell, FWS to Michael Speerschneider, EverPower Wind Holdings (July 11, 2011) (discussing potential for incidental take of Bald Eagles or Golden Eagles as a result of the turbine blades striking eagles during migration, or as they pass through the project area on their way to foraging or roosting sites and cautioning that the project is located in an Important Bird Area), Attachment FF. In light of the unique significance of siting of massive wind turbines – which are inherently hazardous to birds and other flying animals – and hence the need for developers to work with FWS at the early stages of the project, the wind energy industry lends itself to appropriate regulation under the MBTA.

Additionally, it is also important to identify the particular species at risk at wind energy projects. Comparing other mortality threats, such as cat predation, to bird mortality from wind turbines is a misleading comparison because the birds threatened by wind turbines, often placed in critical bird migratory routes and habitats, disproportionately include species of particular conservation concern, particularly raptors such as the Bald Eagle, Golden Eagle, Ferruginous Hawk, Swainson's Hawk, and American Peregrine Falcon. See, e.g., Letter from Laury Zicari, FWS to Dana Vallieu, TRC (May 11, 2011) at 6 ("New information about migration and movements of golden eagles suggest this species may be the raptor most vulnerable to wind power in the eastern U.S." (emphasis added)), Attachment T; see also supra Section C.2. For example, a comparison of the types of bird species adversely impacted by wind energy projects with those that are taken due to cat predation demonstrates that this is an apples-to-oranges comparison – not only is it infeasible to develop a permitting scheme addressing cat predation but it is extremely unlikely that Bald Eagles could fall prey to house cats, or that California Condors could collide with skyscrapers, and yet they are at risk from poorly sited wind projects.

In addition, for many activities resulting in incidental take of migratory birds, implementing the MBTA wholly through post hoc enforcement actions (instead of establishing formal regulations for the same), may be feasible in light of the ready availability of effective avoidance and mitigation measures, such as use of anti-perching devices on power lines to avoid electrocution of birds, specific types of glass for tall buildings to avoid bird collisions, and bird-proofing oil drilling equipment to avoid bird deaths in oil and waste pits. Imposing sanctions for a company's failure to implement such measures may be an appropriate way of both punishing an individual violator and sending the message to an entire industry as to what is necessary to avoid migratory bird takes. At present, however, the best available science does not provide a similar 'quick-fix' solution for wind turbines to avoid bird mortality. See FWS 2011 MBTA Conference Presentation (explaining that FWS is lacking uniform best management practices for the industry, "except through *proper site location*"). Further, there may never be an across-the-board readily-applicable measure for avoiding and mitigating impacts of wind energy projects on migratory birds because, as explained above, due to the inherently hazardous nature of wind power for birds, the most significant step for avoiding impacts is proper siting of wind turbines, and, hence, in some situations, the best solution is to identify another site for the project. Post hoc enforcement, even if pursued by FWS – and, as discussed supra, Section E.3.ii, it never is pursued when it comes to wind power projects – is simply not an effective means for addressing poor facility siting, the most fundamental factor in avoiding or minimizing bird impacts.

Moreover, the fact that other threats to birds exist does not provide a free pass to the wind industry to exacerbate wildlife mortality and violate the MBTA and other wildlife protection laws. To the contrary, the fact that migratory birds are killed by preexisting sources is an additional reason to avoid, minimize, and mitigate a new source of mortality before it irreversibly contributes to a further decline in bird populations. See FWS 2011 MBTA Conference Presentation at 16 (Comparing direct impacts of wind to other sources of anthropocentric mortality is not helpful since "overarching issues are about cumulative impacts – ALL things impacting birds"); see also, e.g., Letter from Laury Zicari, FWS to Dana Vallieu, TRC (May 11, 2011) at 6 (explaining that given that Golden Eagles in Maine were seriously impacted by pesticide contamination, "the potential harm to golden eagles from an additional source of mortality makes careful evaluation of the siting and effects of proposed wind power facilities essential"), Attachment T. Indeed, once again, the need to properly avoid, minimize and mitigate wildlife impacts is especially crucial for an industry that seeks to market itself as "green energy" and environmentally friendly.

Lastly, with regard to the oft-cited unjustified objection against regulating incidental take of wind energy projects under the MBTA, i.e., that the agency would eventually be required to regulate innocent incidental takes (such as accidentally killing a bird while driving a car), it should be noted that courts have clarified that the MBTA does not lead to such "absurd results." United States v. Moon Lake Elec. Ass'n, 45 F. Supp. 2d 1070, 1084 (D. Co. 1999). Such cases of incidental take from activities that have a low likelihood of impacting migratory birds – such as the probability that any single driver will kill a bird -- can clearly be distinguished from incidental take by wind energy projects on the basis of foreseeability of wildlife impacts, i.e., "if the injury be one which might be *reasonably anticipated or foreseen as a natural consequence of the wrongful act.*" Id. at 1085 (internal citation and quotation marks omitted). In Moon Lake the Court observed as follows:

> Because the death of a protected bird is generally not a probable consequence of driving an automobile, piloting an airplane, maintaining an office building, or living in a residential dwelling with a picture window, such activities would not normally result in liability under § 707(a), even if such activities would cause the death of protected birds. Proper application of the law to an MBTA prosecution, therefore, should not lead to absurd results…

Id.

In fact, in Moon Lake, the Court examined the many facets of the MBTA and its implementing regulations that enable avoiding such "absurd results," and expressly identified, as an example, Section 704 of the MBTA under which "the Secretary has established when and how migratory birds may be taken, killed, sold, etc." Id. (citing implementing regulations establishing permit requirements under the MBTA). Indeed, in the context of incidental take by wind energy projects, the “absurd result” is that in the absence of appropriate regulations the industry’s ordinary operation will inevitably and predictably place it in violation of federal law. FWS should promulgate regulations establishing mandatory standards and an incidental take permit system in order to avoid such a situation of having an industry (that the federal government especially wants to encourage and support) that is largely violating the MBTA.

In the end, FWS cannot refuse to promulgate needed permitting regulations for wind energy projects merely because other threats to wildlife exist or because such regulations will have purported implications for incidental bird deaths from everyday acts such as driving a car. Massachusetts v. E.P.A., 549 U.S. 497, 533 (2007) (an agency must proffer a “reasoned justification” for declining to regulate where it has statutory authority to do so).

E.4. Incidental Take Permits for Certain Wind Energy Projects Will Effectively Protect Migratory Birds, And Also Afford More Certainty to Wind Energy Developers.

As explained supra, Section D.2, FWS has very broad rulemaking authority under the MBTA to promulgate regulations so long as the regulations are “compatible” with the four migratory bird treaties. 16 U.S.C. § 704(a). In accordance with the MBTA, FWS has expressed statutory authority to promulgate regulations establishing a broad framework for wind energy development subject to mandatory conditions. Id.; see also id. § 712(2). ABC strongly recommends that such regulations adopt a process for issuing individual incidental take permits for certain wind energy projects, as recommended in the Proposed Regulations. See Appendix: Proposed Regulations.

The Proposed Regulations enable FWS to effectively carry out its statutory mandate to protect wildlife through establishing a clear permitting process under which the agency can regulate the siting of wind energy projects and their impacts on wildlife. As set forth in the Appendix, the Proposed Regulations would categorically require both land-based and offshore wind power projects to apply for MBTA permits. Both operating and planned projects would be required to comply with the Regulations, although the obligations would differ somewhat in light of the reality that siting alternatives for operating projects differ from those for projects that are still in the planning phase. With respect to the latter, the Proposed Regulations would afford a clear, up-front mechanism by which the Service can steer projects away from the most problematic sites. In addition, for both operating and planned projects, the Proposed Regulations would require FWS to adopt measures for minimizing and mitigating impacts on migratory bird populations to the maximum extent practicable.

In contrast to the present system – in which the conservation and independent scientific communities have, at best, ad hoc access to pertinent information and involvement in the review of wind power projects – the Proposed Regulations would ensure that there is at least some opportunity for public comment before an MBTA permit is issued. At the same time, as to projects for which the Service determines there is a low likelihood of adverse impact on bird populations, the Proposed

Regulations would provide for expediting project review and permit approval. Because the issuance of an MBTA permit is a federal action necessitating review under NEPA, the proposed permitting scheme would also afford a firm basis on which significant impacts to wildlife otherwise unprotected by federal law (e.g., unlisted bat species, and birds unprotected by the MBTA) would be addressed.

For a variety of reasons, implementing an effective incidental take mechanism along the lines of the Proposed Regulations is advantageous to the wind industry, FWS, and wildlife interests, in that it recognizes the value of renewable energy development and provides greater regulatory and legal certainty to the industry, while also enabling FWS to far more effectively carry out its statutory mandate to conserve federally protected wildlife, and avoid and minimize the harmful taking of migratory birds to the maximum extent practicable.

i. ***The permit mechanism recommended in the Proposed Regulations enables FWS to require developers to consult FWS and to establish mandatory standards for the siting, construction, and operation of wind energy projects.***

Unlike the Wind Guidelines, the Proposed Regulations enable FWS to require developers to consult and share information with the agency at the earliest stage of project planning. The Proposed Regulations enable FWS to ensure that projects are not constructed in high risk areas. For other projects that may have adverse impacts but which can be avoided or minimized through effective mitigation measures, FWS may issue individual incidental take permits that authorize the project subject to the terms and conditions stipulated in the permit. For the remaining projects that may have minimal impacts, the Proposed Regulations envisage a broad framework for authorizing such projects subject to a determination by the agency, and other standards and criteria that are prescribed in the Proposed Regulations and otherwise by the agency.

In the context of military incidental take, FWS chose to implement the MBTA through a broad authorization subject to mandatory conditions, in lieu of an approach that required individual take permits. However, the Service's reason for not imposing more comprehensive and concrete obligations on the Armed Forces is related to the reasonable expectation that the Armed Forces will be addressing the impacts of its actions through the NEPA process. See Military Final Rule at 8939-40. As NEPA only applies to federal agency actions, the same treatment cannot be assured for wind energy projects that lack any clear nexus to a federal agency action. Further, three other reasons provided by FWS for structuring the regulatory system for military incidental in the form of a "broad, automatic authorization," and that distinguish it from incidental take by wind energy projects are – (1) that military readiness activities rarely have significant impacts; (2) that the Armed Forces like other federal agencies are required to comply with the Migratory Bird Executive Order; and (3) that it was especially important not to create a complex process in light of the importance of military readiness to national security. Id. at 8947. This indicates an acknowledgment by FWS that it has the authority to promulgate regulations for issuing individual permits for incidental takes - but chose not to exercise this authority in the military take context given the unique features of that context. See id. ("Without the rule, the Armed Forces might not be able to complete certain military readiness activities that could result in the take of migratory birds pending issuance of an MBTA take permit[.]").

Further, the reality that FWS is lacking uniform best management practices for the industry, "except through *proper site location*," FWS 2011 MBTA Conference Presentation, only strengthens the case for imposing concrete obligations on developers to consult FWS, in advance of project construction, in accordance with the "precautionary" principle that FWS itself has expressly relied on while advising wind energy developers. See, e.g., Letter from FWS to Amber Zuhlke, Wind Capital Group, Big Lake Wind Facility in Palm Beach, Florida (July 1, 2011) ("Wind facilities have not previously been sited in areas with Everglade snail kite presence or habitat; thus, there are no data indicating the potential risk of wind turbines on snail kites. Therefore, a conservative approach using precautionary principles is required."(emphasis added)), Attachment K.

ii. *The Permit mechanism recommended in the Proposed Regulations provides a means to protect species of concern that are not yet listed under federal wildlife laws, such as certain bat species.*

The permit mechanism in the Proposed Regulations will do more than protect birds listed under the MBTA – it will trigger NEPA review providing much needed protection for bats and other wildlife. One justification often cited for retaining "voluntary" guidelines in lieu of mandatory standards for wind energy projects is that the voluntary guidelines need not necessarily be tied to existing federal wildlife laws such as the ESA, MBTA, and BGEPA, and would therefore facilitate protection of both birds and bats that are not listed or protected under those statutes. See, e.g., Julia Pyper, New Bird Kills Raise Questions About Growth Of Wind Industry (E&E ClimateWire, Oct. 31, 2011) (quoting John Anderson, AWEA's Director of Siting Policy, that "there will actually be greater protection if the guidelines are voluntary" because this would entail protection of wildlife outside the scope of certain federal wildlife laws).

Although certain bat species such as hoary bats, red bats, and silver-haired bats, and certain birds, including such as sage grouse and prairie chickens[151] are not presently protected under the ESA, MBTA, or any other federal wildlife protection statute, and they could in theory be addressed

[151] Both the Lesser Prairie-Chicken and the Greater Sage-Grouse, are ESA candidate species and FWS Birds of Conservation Concern, which are not covered by MBTA. The population of the Lesser Prairie-Chicken is estimated at merely 32,000, while that of the Greater Sage-Grouse is estimated at only 150,000. Wind energy development is a serious threat to both species because much of the species' remaining ranges coincide with areas containing strong wind resources. Thus, wind turbines and associated transmission lines are likely to be a barrier to movements of both Greater Sage-Grouse and Lesser Prairie-Chicken. For example, in 2009, in Oklahoma alone there were approximately 250 wind turbines in Lesser Prairie-Chicken range, with at least another 1,300 proposed. Christin L. Pruet et al., It's Not Easy Being Green: Wind Energy and a Declining Grassland Bird, 59 BioScience 257, 260 (Mar. 2009), http://vmpincel.bio.ou.edu/download/publications/bio.2009.59.3.10.pdf.

by the Wind Guidelines, those Guidelines, once again, are entirely voluntary, and may be complied with by a project developer merely recording its reasons for disagreeing with the Service on site selection or any other issues. Therefore, the Guidelines will not effectively protect any wildlife.

On the other hand, the permit process in the Proposed Regulations will afford a far better mechanism for addressing project impacts on even non-MBTA protected birds, unlisted bat species, and other wildlife currently unprotected under federal law. This is because the proposed issuance of a federal MBTA permit will trigger NEPA review, which will necessarily encompass any significant impacts on any wildlife populations. See 42 U.S.C. § 4332 (requiring an analysis of "environmental impact[s] of the proposed action" for "major Federal actions significantly affecting the quality of the human environment"); 40 C.F.R. § 1508.18 (defining "Major Federal Action" as "actions with effects that may be major and which are potentially subject to Federal control and responsibility" such as "[a]pproval of specific projects… approved by permit or other regulatory decision."). NEPA requires the agency to consider a "range of alternatives" to the proposed action, including the no-action alternative, and to identify appropriate mitigation measures to address the various impacts of the proposed action. 40 C.F.R. § 1505.1(e). Thus, the proposed regulations do encompass a mechanism of protection of both listed and non-listed wildlife and, because the permitting process, as proposed, would also involve public comment, it would allow for a far more meaningful opportunity to address impacts on otherwise unprotected birds, bats, and other wildlife than under the entirely voluntary Guidelines, which, among other problems, afford no basis on which conservation groups or other members of the public may weigh in on project impacts on an ongoing basis.

Moreover, nothing in the proposed regulations would preclude FWS from establishing both a mandatory permitting system for species protected under the MBTA, and voluntary guidelines for otherwise unprotected species – just as the existence of permitting processes under the ESA and BGEPA did not preclude the Service from drafting the current Guidelines. In fact, the process proposed here and guidelines focused on otherwise unprotected species could function in an entirely complementary fashion, with such Guidelines being brought to bear on the NEPA analysis that must be conducted on the MBTA permit application.

iii. *The permit mechanism recommended in the Proposed Regulations enables an evaluation of cumulative effects of wind energy development on a regional and national level.*

As discussed previously, the cumulative effects of the ever-escalating increase in wind projects, along with other impacts on migratory birds, pose extremely serious threats to the survival, habitat and behavior of migratory birds. In particular, habitat fragmentation from poorly sited wind power projects is an important contributor to cumulative impacts. Under the Proposed Regulations, the extent to which a proposed project will contribute to habitat loss and fragmentation, and other forms of cumulative impact, can be thoroughly evaluated in light of the early blueprints of a project, especially since the project's footprint and infrastructure needs (such as access roads, transmission lines, and substations) should already be fairly well determined by that time. Similarly, consideration of adjacent projects and other habitat-harming activities can be accomplished early in project planning (although they may need to be reviewed if other projects are added during the development phase).

In contrast, the approach adopted by FWS in the voluntary Guidelines utterly fails to provide appropriate measures and directives to study, avoid and mitigate cumulative effects at a national or regional level. The Guidelines explicitly state that "where there is no federal nexus, individual developers are not expected to conduct their own cumulative impacts analysis." Thus, the Guidelines recommend an analysis for cumulative effects by federal agencies only for projects that have "a federal nexus" such as those that "require a federal permit." Id. at 21. This does not result in a thorough analysis of cumulative effects of wind energy development, particularly because most wind energy projects are constructed on private lands with no "federal nexus," other than the impact on birds protected under MBTA and BGEPA. Further, the Guidelines recommend that the developers "communicate" with the agency about cumulative effects of the project only in the final phase of the project where construction is complete and the developer is considering the need for post-construction studies. See Wind Guidelines Third Draft at 14-15 (recommending in Tier 5 – tier dealing with post-construction studies and research – that the developer "communicate with the Service about ways to evaluate cumulative impacts on species of concern, particularly species of habitat fragmentation concern"). In short, FWS has so far failed to take any concrete and effective measures to address the cumulative impacts of wind energy development. This is especially troubling since, as illustrated supra, see Map 2.1, there are hundreds of wind energy projects that have likely been constructed (and more in the pipeline) and many of these projects are built along common migratory corridors and have serious direct and indirect impacts on birds.

iv. ***The Permit mechanism recommended in the Proposed Regulations provides an opportunity for concerned citizens to ensure compliance with the MBTA.***

Citizen suits are useful tools that empower citizens, including individuals and non-profit groups, to enforce federal law and supplement federal enforcement of the law. Unlike the ESA, however, the MBTA does not contain a citizen suit provision that allows "any person" to bring a civil suit to enjoin violation of the statute. 16 U.S.C. § 1540(g)(1)(A). The only means by which a private lawsuit can be brought to enforce the MBTA is via the APA and only then in the event that there is a federal agency action involved in project planning or pursuit, i.e., lawsuits under the APA cannot be brought directly against a private party or state/municipal agencies and may only be brought against federal agencies when they take a final action that is connected to the alleged violation (for example where a wind energy project is located on public lands, or where it requires a permit from the Corps or another federal agency). Consequently, with regard to incidental take by wind energy projects, at present, the primary means of enforcing the MBTA must be through FWS enforcement actions – an avenue for enforcement that is essentially meaningless and is certainly not an effective check unless FWS opts to enforce the Act for at least flagrant violations of the Act, which has never happened in the context of wind power projects. See supra Section D.3.

The permit mechanism envisaged in the Proposed Regulations will effectively address this overriding problem of non-enforcement of the MBTA because the process is specifically designed to delineate the conditions under which the Service may authorize the take of migratory birds in connection with wind power projects. In addition, issuance of a federal incidental take permit under the MBTA will constitute a final federal agency action thereby triggering the availability of APA review. Consequently, the grant (or denial) of a permit can be set aside by a federal court if it is found to be "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706(2).

v. *The Permit mechanism recommended in the Proposed Regulations will not unnecessarily constrain the agency's staff and resources.*

For many years now, FWS has been grappling with drafting and implementing voluntary Guidelines for wind power projects, thereby expending a large amount of time, money and other resources of the agency on a cause that, unfortunately, has proven to be of little value in attaining its stated objective, i.e., to effectively avoid and minimize wildlife impacts of wind energy projects. In 2011 alone, FWS has issued three iterations of voluntary Guidelines (in a process that substantially weakened the initial agency recommendations), and as of the date of this writing is yet to finalize the Guidelines. In the meantime, wind power projects continue to proliferate, and adverse impacts on migratory birds and other wildlife continue to become ever more severe in the absence of better mechanisms for addressing and ameliorating such impacts.

Further, for wind energy developers that do consult the agency, the Guidelines envisage a "tiered approach" whereby the agency is expected to be involved in all phases of the project, albeit on an informal "voluntary" basis. While the Guidelines essentially treat the agency as a quasi-permitting authority requiring it to evaluate extensive information and provide advice to the developers, unlike a formal permitting system, FWS does not obtain appropriate permit fees which typically provide some amount of resources and revenue to the agency. See, e.g., 50 C.F.R. §13.1(d)(4) (specifying applicable fee for take permits under federal wildlife laws such as the MBTA, BGEPA, and ESA). Thus, this is plainly not a cost-effective arrangement because under the Guidelines, the agency is in any event using extensive resources and expending the time of its experienced staff, to make non-binding recommendations that the project proponents are free to disregard (so long as they document their reasons for disagreeing).

In sharp contrast, under the proposed permitting system, FWS will inevitably obtain much more conservation bang for its buck – and will also be able to defray at least some of its expenses in processing applications through appropriate permit fees, as it has done with other permitting regimes.

vi. *The Permitting mechanism recommended under the Proposed Regulations complements the protections afforded by the ESA and BGEPA.*

While a wind energy developer is able, when the relevant criteria are satisfied, to obtain an incidental take permit for impacts on endangered or threatened species of birds under the ESA, there is presently no comparable mechanism for authorizing take by developers under the MBTA, which strictly prohibits take of all birds protected under the Act in the absence of a permit issued pursuant to the Act. This places project developers in the legally untenable position of obtaining a federal permit under one law (the ESA) for taking a particular species, but being in violation of another law for taking the very same species. See Memorandum from Pete Raynor, Assistant Solicitor, Fish and Wildlife Branch, to John Rogers, Deputy Director, FWS, Permitted Incidental Take of Migratory Birds Listing Under the Endangered Species Act (Feb. 5, 1996) at 2 ("ESA incidental take documents do not provide any relief from the prohibitions of the MBTA and BGEPA; indeed, some of those documents specifically state that they do not provide any such relief. Therefore, an applicant that wants complete protection from prosecution for the take of an ESA-listed migratory bird pursuant to an ESA incidental take document must also seek a permit under the MBTA, or []BGEPA"), Attachment P. In addition, by issuing an ITP that authorizes a project that will result in the take of migratory birds – in the absence of any permitting mechanism under the MBTA for doing so – FWS places itself at risk of being sued under the APA. See supra Section D.3. The Proposed Regulations rectify these problems and legal confusion, at least insofar as wind power projects are concerned by authorizing FWS to issue take permits under the MBTA, as well as the ESA.

The Proposed Regulations will also resolve legal anomalies involving Golden Eagles and Bald Eagles, and result in enhanced protection of those species. Although incidental take permits can be issued for eagles under BGEPA, in the absence of a permitting scheme under the MBTA, even wind power projects receiving BGEPA permits will be in at least technical non-compliance with the MBTA. More importantly, while providing for the issuance of take permits, nothing in the BGEPA regulations categorically requires wind power projects to obtain such a permit, even where FWS biologists believe that eagle take is likely. Worse, the current version of the Guidelines provide that if project developers themselves do "not anticipat[e]" taking eagles, and "adhere" to the Guidelines by documenting their disagreement with the Service concerning the likelihood of take, this alone "would give rise to assurances regarding enforcement discretion if an unexpected taking occurs." Wind Guidelines Third Draft. Accordingly, with regard to wind power projects, the Guidelines undercut any potential safeguards afforded by the BGEPA regulations, by not only providing that project developers may override the concerns of FWS biologists, but that they may even obtain "assurances regarding enforcement discretion" if they do so and nonetheless kill or otherwise take a Bald or Golden Eagle. Id.

The Proposed Regulations would both resolve the legal anomaly concerning compliance with the MBTA and BGEPA, and also far better protect eagles than at present. The Proposed Regulations would categorically provide that all wind power projects must, prior to construction, obtain an

MBTA permit, thus necessarily triggering a FWS (and public) review of all potential migratory bird impacts, including to eagles in the vicinity or migrating through the project site.

vii. *The Permitting Mechanism recommended under the Proposed regulations will afford more legal and regulatory certainty to the wind power industry than can be afforded under the current, confusing regulatory regime.*

According to the wind power industry, regulatory uncertainty and potential criminal liability under the MBTA has been a barrier to the growth of the industry and has proven to be especially troubling in terms of securing investor confidence. See, e.g., Bryan McBournie, Q&A with Peter Duprey: Leading in an uncertain energy industry (interview with CEO of Broadwind Energy, a provider of products and services primarily for the wind-energy industry, who stated, "[w]e undoubtedly need more regulatory certainty to help tame the volatility of the wind industry in the U.S., as the industry will remain challenged without it." (emphasis added)).[152] The wind industry desires regulatory and legal certainty particularly with regard to the application of federal wildlife laws to wind energy projects.

In contrast to the voluntary Guidelines, the establishment of a permitting scheme under the Proposed Regulations would provide far greater regulatory and legal certainty to wind energy developers and their investors, and will also establish a level playing field for all wind energy developers. By failing to impose clear regulatory obligations on wind energy projects to anticipate and avoid migratory bird impacts before they occur, and by largely allowing the industry itself to make siting decisions, FWS has not only effectively penalized those companies that do attempt to comply with the agency's guidance – since they are essentially placed at a competitive disadvantage with those companies that refuse to do so – but has also tacitly approved widespread disregard for wildlife statutes the Service is entrusted to enforce. Indeed, since the Service cannot lawfully extend non-enforcement assurances for compliance with voluntary Guidelines – particularly Guidelines that allow wind power projects to "comply" merely by recording their reasons for disagreeing with the Service's concerns – under the current regime, wind power projects will necessarily be facing an ongoing risk of prosecution when they, inevitably, take migratory birds in violation of the MBTA. In addition, there is nothing to prevent a new Administration from adopting, if it so chooses, a tougher stance when it comes to enforcing the MBTA against wind power projects that are in fact in violation of the law. And, where there is a federal nexus to a project, compliance with anemic Guidelines surely will not insulate a project from APA review and a potential ruling by a federal court that an agency's approval of a project should be set aside because it will lead to migratory bird takes in violation of the MBTA.

In short, with a valid permit in hand, wind power developers would not face these risks, but rather would be provided assurance against prosecution so long as they comply with the terms and conditions of the permit. Thus, the Proposed Regulations will enable the wind industry to have far

[152] Available at http://smartblogs.com/leadership/tag/renewable-energy/ (last visited Dec. 11, 2011).

greater predictability and regulatory certainty, while also far better establishing itself as a genuinely green and environmentally protective industry.

E.5. The Proposed regulations are compatible with the international migratory bird treaties.

As explained supra, Section D.1, the MBTA is the domestic implementing legislation for various international treaties designed to safeguard migratory birds and their habitats. Accordingly, the present system of non-regulation of wind power projects, and reliance on voluntary Guidelines and industry self-certification of compliance with them, flouts not only the statute, but also the underlying conventions. On the other hand, regulation of incidental take by wind energy projects, as proposed in this Petition, is entirely compatible with the terms of the migratory bird conventions. Indeed, the large-scale ongoing taking of a wide variety of bird species protected under the migratory bird conventions, coupled with lack of oversight, regulation, and enforcement of the law by FWS, is a clear contravention of the conventions.[153] Further, FWS has previously determined, albeit in the context of military incidental take, that regulations permitting incidental take are compatible with all four migratory bird conventions. See Military Take Final Rule at 8946.

i. *Convention between the United States and Canada*

The United States entered into a convention with Great Britain (for Canada) in 1916 for the protection of migratory birds in the United States and Canada. See 39 Stat. 1702 (1916). This convention was amended in 1995 by a protocol which replaced most of the provisions of the original convention. See Protocol Amending the 1916 Convention for the Protection of Migratory Birds, S. Treaty Doc. No. 104-28, 1995 WL 877199 ("1995 Protocol") (hereinafter jointly referred to along with the convention as "Canada Treaty").

The 1995 Protocol recognized the commitment of both parties towards "long-term conservation of shared species of migratory birds" through a comprehensive international framework that involves, among other things, regulation of take. See Preamble, 1995 Protocol. The Treaty requires the parties to "ensure the long-term conservation of migratory birds" in accordance with certain "conservation principles" such as managing migratory birds internationally, ensuring a variety of sustainable uses, sustaining healthy migratory bird populations for harvesting needs, providing for and protecting habitat necessary for the conservation of migratory birds, and restoring depleted populations of migratory birds. Id. Art. II. The Treaty recognizes that the conservation principles may be achieved through means such as monitoring and regulation. Id. Further, the Treaty expressly provides that "subject to laws, decrees or regulations to be specified by the proper

[153] Moreover, the obligation of nations, to ensure that activities within their jurisdiction or control do not harm the environment beyond their territory, is also firmly entrenched in customary international law. See, e.g., Co-operation in the Field of Environment Concerning Natural Resources Shared by Two or More States, U.N.G.A.Res. 3129 (XXVIII) (1973).

authorities," the taking of migratory birds may be allowed at any time for specific purposes consistent with the conservation principles. Id. Art. II(3). In addition, the Treaty requires parties to seek means to prevent damage to migratory birds. Id. Art. IV(a).

In sum, the Canada Treaty contemplates the permitting of take through regulation "for specific purposes" consistent with the conservation principles of the Treaty and subject to appropriate regulations. Regulations monitoring and regulating incidental take by wind energy projects will likely be compatible with the terms of the Canada Treaty. Such regulations facilitate the parties' long-term commitment to conserve migratory birds through appropriate regulations and are consistent with the conservation principles adopted in the Treaty.

ii. *Convention between the United States and Mexico*

In 1937, the United States entered into a convention with Mexico for the protection of migratory birds and game mammals. See Convention between the United States of America and Mexico for the Protection of Migratory Birds and Game Mammals, 50 Stat. 1311, T.S. No. 912 (1937) ("Mexico Treaty"). The Treaty recognized that "it is right and proper to protect the said migratory birds . . . in order that the species may not be exterminated," and that there is a need "to employ adequate measures which will permit a rational utilization of migratory birds for sport as well as for food, commerce and industry." Id. Preamble (emphasis added).

Specifically, the Mexico Treaty allows the parties to use "adequate methods which will permit…the utilization of [migratory birds] rationally for purposes of sport, food, commerce and industry." Id. Art. I (emphases added). Towards this end, the Treaty requires the parties "to establish laws, regulations and provisions" to satisfy the need to permit rational utilization of migratory birds for various uses, including, commerce and industry. Such regulations may adopt various appropriate measures such as establishment of "refuge zones" in which taking will be prohibited, and prohibition of the killing of migratory insectivorous birds. Id. Art. II.

In sum, the Mexico Treaty allows parties to adopt regulations permitting take of migratory birds for industry or commerce on a rational utilization basis. Thus, regulations permitting incidental take by wind energy projects will likely be compatible with the terms of the Mexico Treaty so long as the taking is based on a rational utilization of the resources and measures are adopted to ensure against the extermination of any species.

iii. *Convention between the United States and Japan*

The United States entered into a treaty with Japan in 1972 for the protection of migratory birds and birds in danger of extinction. See Convention Between the Government of the United States of America and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction, and Their Environment, T.I.A.S. No. 7990, 25 U.S.T. 3329, 1974 WL 166630 (U.S. Treaty) (1974) ("Japan Treaty"). The Japan Treaty recognizes that the "great value" of migratory birds can be "increased with proper management," and that there is a need to take measures for the "management, protection, and prevention of the extinction of certain birds." Id. Preamble (emphasis added).

The Japan Treaty prohibits the taking of migratory birds. Id. Art. III. However, "[e]xceptions to the prohibition of taking may be permitted in accordance with the laws and regulations [of the parties]….[for] specific purposes not inconsistent with the objectives of this Convention." Id. Further, the Treaty recognizes that special protection is required for preservation of birds that are in danger of extinction. Id. Art. IV(1). In addition, the Treaty provides that the parties shall endeavor to establish sanctuaries and other facilities for the protection and management of migratory birds. Id. Art. III(3). The parties are also required to "take measures necessary to carry out the purposes" of the Treaty. Id. Art. VII.

In sum, the Japan Treaty allows parties to permit taking through regulations in accordance with applicable law so long as it is consistent with the objectives of the conventions. Thus, regulations governing incidental take by wind energy projects will likely be compatible with the terms of the Japan Treaty if it facilitates the objectives of the Treaty and, as stated in its preamble, protects and prevents the extinction of migratory birds.

iv. *Convention between the United States and Russia*

The United Stated entered into a treaty with Russia in 1978 to conserve migratory birds and their environment. See Convention between the United States of America and the Union of Soviet Socialist Republics Concerning the Conservation of Migratory Birds and Their Environment, T.I.A.S. No. 9073, 29 U.S.T. 4647, 1978 WL 182150 (U.S. Treaty) (1978) ("Russia Treaty"). The Russia Treaty recognizes that - the value of migratory birds can be "increased under proper management;" that there is a need to protect migratory bird species along with their flyways, and breeding, wintering, feeding and moulting areas; and that certain endangered bird species are in need of particular protective measures. Id. Preamble (emphasis added).

The Treaty requires the parties to prohibit the taking of migratory birds. Id. Art. II(1). "Exceptions to these prohibitions may be made on the basis of laws, decrees or regulations" for "specific purposes" not inconsistent with the principles of the Treaty. Id. (emphasis added). To the extent possible, the parties are required to prevent "detrimental alteration" of the environment of migratory birds. Id. Art. IV(1). Accordingly, the parties are required to identify areas of breeding, wintering, feeding and moulting that are of special conservation importance to migratory birds. Id. Art. IV(2)(c). In addition, the Treaty enables the parties to enter into special agreements for the conservation of particular species of migratory birds, id. Art. II(3), and to undertake necessary measures to establish preserves, refuges, and protected areas for the conservation of migratory birds and their environment. Id. Art. VII. The Treaty specifically provides that parties may adopt stricter domestic measures that are deemed to be necessary to conserve migratory birds and their environment. Id. Art. IX.

Similar to the other conventions, the Russia Treaty allows parties to devise exceptions to the take prohibition so long as it is consistent with the principles of the Treaty. Regulations governing incidental take by wind energy projects are necessary to ensure that important bird areas such as flyways are protected and that wind turbines are not constructed in such areas of special conservation importance. Thus, regulations for take by wind energy projects are not only compatible with the terms of the Russia Treaty, but will likely also facilitate the Treaty's mandate to prevent "detrimental alteration" of migratory bird habitat.

F. CONCLUSION

ABC requests that FWS issue, as expeditiously as possible, new regulations based on those proposed in this Petition, see Appendix: Proposed Regulations, pursuant to Sections 704(a) and 712(2) of the MBTA, for establishing a framework for regulating and authorizing conditional take by wind energy projects.

APPENDIX: PROPOSED REGULATIONS

PERMITS FOR WIND POWER PROJECTS PURSUANT TO THE MIGRATORY BIRD TREATY ACT

Subpart A – Introduction

§ 1.1 Purpose of Regulations

These regulations are designed to facilitate the development of wind power projects while, to the maximum extent practicable, avoiding, minimizing, and mitigating their adverse impacts on birds protected by the Migratory Bird Treaty Act ("MBTA"). The regulations contained in this part supplement the Department of the Interior's general permit regulations contained in Part 13 of this subchapter, as well as the Department's general regulations implementing the MBTA contained in Part 21 of this subchapter. Compliance with the regulations contained in this part does not relieve wind power projects from also complying, where applicable, with other regulations that impose requirements or prohibitions concerning particular migratory birds, such as regulations implementing the Endangered Species Act ("ESA") and the Bald and Golden Eagle Protection Act ("BGEPA").

§ 1.2 Definitions

In addition to definitions contained in Part 10 of this chapter, and unless the context requires otherwise, as used in this part:

FWS or Service is the United States Fish and Wildlife Service.

Migratory bird is any species that is covered by the MBTA and treaties implementing the MBTA.

Person means any individual, corporation, partnership, academic institution or any legal entity formed in any manner for the purpose of developing, constructing, and/or operating a wind power project.

Practicable alternative is an alternative site for a proposed wind power project that would accomplish essentially the same objectives as the proposed project without significantly increased costs or other practical or financial constraints.

Wind power project means any land-based or offshore project that uses, or is designed to use, the wind to generate electricity within the jurisdiction of the United States and includes but is not limited to, the project's wind turbines and associated infrastructure such as transmission lines, substations, meteorological towers, and access roads.

§ 1.3 General Requirements and Exceptions

§ 1.3.1 General Permit Requirements

No person shall construct or operate a wind power project except as may be permitted under the terms of a valid permit issued pursuant to the provisions of this part and Part 13, as well as any other applicable regulations issued pursuant to the ESA, BGEPA, or other pertinent law. A wind power project that is in receipt of a valid permit issued pursuant to this part and that is in compliance with that permit shall not be subject to criminal or civil penalties for violation of the take prohibition of the MBTA.

§ 1.3.2 General Exception to Permit Requirement

Any wind power project that is operational – *i.e.*, generating any electricity through turbine operation – on the date that these regulations become effective may continue to operate without a permit issued pursuant to this part so long as a complete application for such a permit that complies with § 1.5, as set forth below, is submitted to FWS within 120 days of the date that these regulations become effective. For the purpose of these regulations, any substantial upgrade, modification, or expansion of the project that has the potential to impact migratory birds – *e.g.*, an expansion in the number of turbines or the rotor swept area – is treated as a new project.

§ 1.4 Specific Permit Provisions Applicable to Non-Operational Wind Power Projects

§ 1.4.1. General Requirement

The requirements of this part must be satisfied in order for any non-operational wind power project – *i.e.*, a project that is not generating electricity on the date that these regulations become effective – to obtain a permit pursuant to this part.

§ 1.4.2. Contents of Permit Application

Each application for a permit pursuant to this section must contain the following, along with any other information that FWS may prescribe in guidance supplementing these regulations:

(a) a detailed description of the proposed site for the project, including the proximity of the site to known ridges and other migratory routes, nesting locations, wetlands and other areas where migratory birds are present, and other resources of particular importance to migratory birds;

(b) detailed descriptions and results of all preconstruction surveys that are of sufficient duration, nature, and scope to reasonably evaluate the extent to which (1) a particular proposed site is used by specific species of migratory birds; (2) the degree of risk that the site poses to the various species of birds that use the site; and (3) local siting of turbines or other design modifications may be employed to avoid or mitigate the risk to affected bird species. In determining the duration, nature, and scope of surveys that will be deemed adequate for a particular site, and who is qualified to conduct such a survey, the project developer shall comply with any written guidance issued by FWS supplementing these regulations, and shall consult as appropriate with the Migratory Bird Permit Office of the Regional FWS Office in which the proposed project is located;

(c) a detailed description of the proposed project, including (1) the number, size and type of turbines contemplated; (2) the anticipated life of the project; (3) the proposed layout of the entire project, including turbines, transmission lines, power stations, roads, and other physical features; (4) the proposed schedule for project construction; (5) the applicant's proposed pre-construction and post-construction monitoring plans; (6) all measures that the applicant is proposing to undertake to avoid, minimize, and mitigate the effects of the anticipated take of migratory birds to the maximum extent practicable; and

(d) any other information that FWS may request to evaluate and study the wildlife impacts of the project.

§ 1.4.3. Public Comment

The public will be afforded an opportunity to comment on each application for a permit. The public comment period will be for a period of no less than thirty days. If, after reviewing the application, FWS believes that the project poses a low risk for migratory birds, and will not otherwise have any significant adverse environmental impacts, the Service's notice soliciting public comment will advise the public that the Service intends, subject to the consideration of public comments, to expedite its review of, and determination on, the application.

Prior to the initiation of the public comment period, FWS will make available to the public all survey data and other information submitted by the permit applicant in support of the application. If FWS complies with the National Environmental Policy Act ("NEPA") by preparing an Environmental Assessment ("EA") in connection with the permit application, the Service will make the EA available to the public prior to the initiation of the comment period on the permit application. If the Service complies with NEPA by preparing an Environmental Impact Statement ("EIS") in connection with the project, the Service will coordinate public comment on the permit application with public comment on the EIS.

§ 1.4.4. Evaluation of Permit Applications

In determining whether to issue a permit, the Service will evaluate all factors relevant to whether a permit may be issued consistent with the purposes of the MBTA, including but not limited to:

(a) the overall impact of the project on migratory birds and important migratory bird habitat, and the extent to which the project is compatible with the maintenance of populations of migratory birds likely to be affected by the project, taking into account the cumulative present and projected impacts of other activities on the affected bird species, including from other wind projects;

(b) the proximity of the project to important bird habitats, including migratory routes and nesting, roosting, and/or feeding areas;

(c) the proposal for pre-construction and post-construction monitoring;

(d) whether the applicant has proposed avoidance, minimization, mitigation, and monitoring measures to reduce the take and the adverse effects of the take to the maximum extent practicable;

(e) the extent to which the project will result in adverse impacts to any species that FWS has determined qualify as a Bird of Conservation Concern and any species that is a candidate for listing under the ESA; and

(f) whether there are practicable alternative sites for the project that would have a less deleterious impact on migratory bird populations and habitats.

§ 1.4.5 Required Determinations

Before issuing a permit, FWS must find that:

(a) the effects of the anticipated take and required mitigation, together with cumulative effects of other activities and additional factors affecting the bird populations and habitats impacted by the project, are compatible with the maintenance and conservation of bird populations, particularly populations of birds designated by FWS as Birds of Conservation Concern and bird species that are candidates for listing under the ESA;

(b) the permit applicant will conduct appropriate, adequate pre-construction and post-construction monitoring;

(c) the permit applicant will to the maximum extent practicable avoid, minimize, and mitigate adverse effects on migratory birds and important migratory bird habitats;

(c) the permit applicant will conduct such monitoring and adaptive management as the Service determines is necessary to fully and effectively evaluate the impact of the project, including the efficacy of minimization and mitigation measures, on migratory birds and migratory bird habitat, and to evaluate whether changes need to be made in the project's operation in order to better minimize and mitigate the impact on migratory birds; and

(d) there are no practicable alternatives to the project as proposed that would entail less adverse impact on migratory birds.

§ 1.4.6 Permit Conditions

FWS will attach to any issued permit such terms and conditions, including if appropriate specified take limits, and requirements for additional mitigation, adaptive management and monitoring, as are deemed necessary to avoid, minimize, and mitigate to the maximum extent practicable the adverse effects of the project on migratory birds. The permit holder must comply with all such terms and conditions, as well as with the avoidance, minimization, and mitigation measures set forth in the permit application and approved by the Service.

§ 1.4.7 Permit Duration

The duration of each permit issued under this section will be designated on its face, and will be based on the duration of the proposed project, the level of anticipated impacts, the difficulty of reliably predicting the impacts, and the likelihood that adaptive management will be able to address impacts beyond those anticipated. In no event, however, will the permit length exceed five years unless it is extended in response to a renewal request that must be made available for public comment in accordance with this subpart prior to action by FWS.

§ 1.4.8 Monitoring and Incident Reports

The permit terms and conditions shall specify the frequency with which monitoring reports must be prepared and submitted to FWS but in no event will such reports be required less than annually. In addition, the permit terms and conditions will require the permit holder to promptly submit incident reports containing detailed information about any incidents involving major wildlife mortality. All monitoring and incident reports will promptly be made available to the public.

§ 1.4.9 Revocation, Suspension and Modification

The Service shall revoke and/or suspend any permit when it determines that a permitted project is failing to comply with the requirements in this subpart, or, for any reason, is having a significant adverse effect on a migratory bird population and that is not promptly addressed by modification of the permit. The Service may modify the terms and conditions of the permit if necessary to avoid, minimize and mitigate the impacts of the project, and subject to public comment. Any member of the public may petition the Service to revoke, suspend, or modify a permit on these grounds, and the Service shall respond to any such petition in a timely manner and no later than 90 days after receipt of the petition. For purposes of this provision, a significant adverse effect is one that could, within a reasonably foreseeable period of time, diminish the capacity of a population of migratory birds to sustain itself at a biologically viable level. A population is 'biologically viable' when its ability to maintain its genetic diversity, to reproduce, and to function effectively in its native ecosystem is not significantly harmed**.**

§ 1.5 Permit Provisions Applicable to Operational Wind Power Projects

All of the foregoing provisions shall also be applicable to operational projects, except that the applicant need not address the practicability of alternative sites and the Service will not base any decisions on that factor. In imposing any permit terms or conditions the Service will take into account the extent to which ongoing project operations may reasonably be modified without causing significant disruptions in the operation of the project.

§ 1.6 Review Period

FWS will review and make a decision on whether to grant a permit within a reasonable time in light of such factors as the complexity and size of the project and the degree of risk it poses to migratory birds. For a project for which the Service decides to prepare an EA rather than an EIS, the

Service will ordinarily make a final decision on a permit application no later than 12 months after a complete application is received by the Service.

***

LIST OF ATTACHMENTS

A. Daniel J. Lebbin et al., ABC, The North American Bird Conservancy Guide to Bird Conservation (2010) (excerpts)

B. Tamara Enz & Kimberly Bay, Post-Construction Avian and Bat Fatality Monitoring Study, Tuolumne Wind Project, Klickitat County, Washington, Final Report, April 20, 2009 to April 7, 2010 (July 6, 2010) (excerpts)

C. J. K. Fiedler et al., Results of Bat and Bird Mortality Monitoring at the Expanded Buffalo Mountain Windfarm, 2005 (June 28, 2007) (excerpt)

D. David P. Young, Jr. & Zapata Courage, Avian/Bat Monitoring September 25, 2011 Memo (Sept. 30, 2011)

E. BioResource Consultants Inc., 2009/2010 Annual Report Bird and Bat Mortality Monitoring, Pine Tree Wind Farm, Kern County, California (Oct. 14, 2010)

F. Albert Manville, FWS, Presentation on Shoreline, Near-shore, and Offshore Wind Energy Development in Texas State Waters: Tools to Help Avoid or Minimize “Take” of Waterbirds and Other Avifauna (2011)

G. Albert Manville, FWS, Presentation on Framing the Issues Dealing with Migratory Birds, Commercial Land-based Wind Energy Development, USFWS, and the MBTA (Oct. 21, 2011)

H. Letter from Laury Zicari, FWS to Jennifer McCarthy, Corps (May 11, 2011)

I. Albert Manville, FWS, Towers, Turbines, Power Lines, and Buildings – Steps Being Taken By the U.S. Fish and Wildlife Service to Avoid or Minimize Take of Migratory Birds at These Structures (July 17 2009)

J. Memo from Stantec Consulting (consultants for developer) to Laura Hill, FWS, Bird Mortality at Laurel Mountain Substation Memo (Oct. 25, 2011)

K. Letter from FWS to Amber Zuhlke, Wind Capital Group, Big Lake Wind Facility in Palm Beach, Florida (July 1, 2011)

L. Letter from Allan M. Strand, FWS to Jayson Hudson, Corps (Aug. 15, 2011)

M. Nathanial Gronewold, Texas is Bullish on Offshore Wind (E & E News, Nov. 21, 2011)

N. Email from Tylan Dean, FWS to Keith Hastie, FWS (Mar. 30, 2011)

O. Anacapa Island Restoration Project, Channel Islands National Park, Phase I MBTA Summary Report (2002)

P. Memorandum from Pete Raynor, Assistant Solicitor, Fish and Wildlife Branch, to John Rogers, Deputy Director, FWS, Permitted Incidental Take of Migratory Birds Listing Under the Endangered Species Act (Feb. 5, 1996)

Q. Laura J. Beveridge, The Migratory Bird Treaty Act and Wind Development (N. Am. Wind Power, Sept. 2005)

R. Memo from Alan Forster, NedPower Mt. Storm LLC to Laura Hill, FWS, NedPower September 25, 2011 Monitoring Event (Oct. 10, 2011)

S. Letter from Deborah Carter, FWS to Curry & Kerlinger, LLC (environmental consultants of developer) (Sept. 30, 2009)

T. Letter from Laury Zicari, FWS to Dana Vallieu, TRC (May 11, 2011)

U. Letter from Gary Miller, FWS to Sue Oliver, Or. Dep't of Energy (Feb. 14, 2011)

V. Letter from Michael D. George, FWS to Jay Prothro, BP Wind Energy, Southwest Power Pool Docket #ERII-3833 (Oct. 11, 2011)

W. Letter from Robert D. Williams, FWS to Tim Carlson, Nevada Wind, Proposed Virginia Peak Wind Facility and Existing Golden Eagle Resources in the Pah Rah Range, Washoe County, Nevada (Aug. 13, 2010)

X. Letter from Scott Hicks, FWS to Xio Cordoba, Heritage Sustainable Energy (Nov. 4, 2011)

Y. Letter from FWS to Chris Taylor, Element Power (Jan. 31, 2011)

Z. Letter from Laury Zicari, FWS to Nicholas D. Livesay, Pierce Atwood LLP (attorneys of the developer) (Mar. 31, 2011)

AA. Shiloh IV Wind Energy Draft Environmental Impact Report (Aug. 23, 2011) (excerpt)

BB. K. Shawn Smallwood et al., Novel Scavenger Removal Trials Increase Wind Turbine–Caused Avian Fatality Estimates, 74(5) J. Wildlife Mgmt. 1089 (2010)

CC. Memo from Willie R. Taylor, FWS to FCC, FCC Draft Programmatic Environmental Assessment (DPEA), Antenna Structure Registration (ASR) Program

DD. Letter from Mary Knapp, FWS concerning the operation of a single 25 kW wind turbine at Kelleys Island, Ohio (June 8 2011)

EE. Letter from Thomas R. Chapman, FWS to Colonel Philip Feir, Corps (Mar. 12, 2009)

FF. Letter from David A. Stilwell, FWS to Michael Speerschneider, EverPower Wind Holdings (July 11, 2011)

Arnold Schwarzenegger
Governor

PERMITTING SETBACK REQUIREMENTS FOR WIND TURBINES IN CALIFORNIA

PIER INTERIM PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
California Wind Energy Collaborative

November 2006
CEC-500-2005-184

Prepared By:
Scott Larwood and C. P. van Dam
California Wind Energy Collaborative
Davis, California
Contract No. 500-02-004
Work Authorization MR-017

Prepared For:
California Energy Commission
Public Interest Energy Research (PIER) Program

Mike Kane, Dora-Yen Nakafuji, Ph.D
Contract Manager

Mike Kane
Project Manager

Elaine Sison-Lebrilla, P.E.
Manager
ENERGY GENERATION RESEARCH OFFICE

Martha Krebs, Ph.D.
Deputy Director
ENERGY RESEARCH & DEVELOPMENT DIVISION

B.B Blevins
Executive Director

Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission), conducts public interest research, development, and demonstration (RD&D) projects to benefit the electricity and natural gas ratepayers.

The PIER program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy-Related Environment Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

Permitting Setback Requirements for Wind Turbines in California is an interim report for the Windplant Optimization project (contract number 500-02-004, work authorization number MR-017) conducted by the California Wind Energy Collaborative. The information from this project contributes to PIER's Renewable Energy Technologies program.

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Abstract

The California Wind Energy Collaborative was tasked to look at barriers to new wind energy development in the state. Planning commissions in the state have developed setback standards to reduce the risk of damage or injury from fragments resulting from wind turbine rotor failures. These standards are usually based on overall turbine height. With the trend toward larger capacity, taller towers and longer blades, modern wind turbines can be "squeezed out" of parcels thus reducing the economic viability of new wind developments.

Current setback standards and their development are reviewed. The rotor failure probability is discussed and public domain statistics are reviewed. The available documentation shows rotor failure probability in the 1-in-1000 per turbine per year range. The analysis of the rotor fragment throw event is discussed in simplified terms. The range of the throw is highly dependent on the release velocity, which is a function of the turbine tip speed. The tip speed of wind turbines does not tend to increase with turbine size, thus offering possible relief to setback standards. Six analyses of rotor fragment risks were reviewed. The analyses do not particularly provide guidance for setbacks. Recommendations are made to use models from previous analyses for developing setbacks with an acceptable hazard probability.

Keywords: Wind turbines, wind power, wind energy, permitting, zoning, ordinances, hazards

Executive Summary

Introduction

California counties have adopted setbacks for wind turbines primarily to account for the risk of fragments from the rotor. These setbacks are usually based on overall turbine height, which includes the tower height and the radius of the blade. With evolution in the industry to larger turbines, these setbacks increase in total distance and become a hindrance to wind energy development. The authors present a hypothetical example where the total energy production of a windplant is reduced with the application of larger, modern turbines.

Purpose

The purpose of this report is to summarize wind turbine setbacks in California and to describe any connection between rotor failure and windplant setback requirements.

Project Objectives

The objectives of this study of wind turbine setbacks were to:

- Document and compare current wind turbine setbacks in California
- Report on how the setbacks were developed
- Report on the probability of rotor failure
- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

Project Outcomes

The outcomes of the project were:

- The authors gathered information regarding turbine setbacks by interviewing county planning personnel, studying the county ordinances, and conducting a literature search of the subject. Wind turbine setbacks were documented for California counties with existing and future wind energy development, including Alameda, Contra Costa, Kern, Merced, Riverside, and Solano counties. Comparisons were made between the various ordinances.
- From this data the authors developed a picture of how the turbine setbacks were established. The majority of the ordinances were developed by ad hoc groups of local interests and the fledgling wind energy industry.
- The authors conducted a literature survey regarding the probability of rotor failure. Several sources of information were obtained. These include failure reports of turbines in Alameda County, failure data from Denmark and Germany reported in the WindStats periodical, and a Dutch report on European rotor

failures. The probability of rotor failure varied from 1-in-100 to 1-in-1000 turbines per year.

- The authors present a simplified analysis of the rotor fragment hazard to compare to more complex analyses. The analyses of six researchers were found in a literature survey of varying complexity. Results were compared to determine if setback criteria could be developed.

Conclusions

Wind turbine setbacks vary by county. The counties typically base the setback on the maximum of a fixed distance or a multiple of the overall turbine height. A common setback is three times the overall turbine height from a property line.

There is no evidence that setbacks were based on formal analysis of the rotor fragment hazard.

The most comprehensive study of wind turbine rotor failures places the risk of failure at approximately 1-in-1000 turbines per year.

The maximum range of a rotor fragment is highly dependent on the release velocity that is related to the blade tip speed. Tip speed tends to remain constant with turbine size; therefore, the maximum range will tend to remain constant with turbine size. In the analysis of rotor fragment trajectories, the most comprehensive models yielded results that showed the shortcomings of simpler methods. Overall, the literature shows the possibility of setbacks for larger turbines may be based on a fixed distance and not the overall height.

Recommendations

The authors recommend that a comprehensive model of the rotor fragment hazard be developed based on the results of the literature review. This tool would then be used with a variety of turbine sizes with the objective to develop risk-based setback standards.

Benefits to California

The information provided in this report can be used by California planning agencies as a background for evaluating wind turbine setbacks. Researchers can also use the information as background for developing models of the rotor fragment hazard.

1.0 Introduction

1.1. Background and Overview

California has played a pivotal role in the creation and evolution of the wind-based electric power generation industry. Wind power is unique in the visibility and exposure to the public as compared to other forms of power generation. By necessity, communities have become involved in planning for the development of wind power in their jurisdiction. Both the regulation and technology of wind power evolved together in the last two decades.

Particular attention was made to protect the public from hazards. With the advent of a new technology, the probability of failure tends to be higher because the physics are not well understood. The engineering of the technology must also be balanced with economics, and the balance is very tenuous at the beginning of a new venture. Equipment and business failures plagued the industry in the last two decades, and legacy equipment still fails at a relatively high rate today.

One hazard possibility of wind turbines is the failure of a portion of the rotor resulting in fragments being thrown from the turbine. Concerns over public exposure to this risk led the counties to develop setbacks from adjacent properties and structures. The development of county ordinances took place independently of each other; however in most cases the fledgling wind power industry was involved in the development (McClendon and Duncan 1985). In general, the setbacks were based on the heights of the turbines.

Utility scale turbines installed in California have evolved from 50 kilowatt (kW) machines of 25 meter (m) overall height to 3.0 megawatt (MW) machines of 126 m overall height. The nature of that evolution, in general, is that manufacturers stop production of smaller turbines due to improved economics of the new larger turbines. With increased overall height, the setback distance is increased, and modern turbines can be “squeezed out” of developments.

The California Wind Energy Collaborative (CWEC, http://cwec.ucdavis.edu/), through its “Windplant Optimization” task, was directed to prepare this white paper on permitting issues in regards to the rotor fragment risk. The concern over restrictions on development was the impetus to study current ordinances and the rotor fragment risk. Two possibilities offer the potential for relief in this area. Modern wind turbines might offer higher reliability, thus lowering the risk of rotor failure. Second, in the event of a rotor failure, the hazard area is governed by the blade tip speed. The tip speed tends to remain constant with turbine size. Therefore, more appropriate setbacks might be a fixed distance, and not a function of the turbine size. These possibilities, along with background research, are discussed in this report.

1.2. Example Windplant and the Problem with Current Setbacks

Setbacks are established to minimize risk of damage or injury from component failure on property and personnel. The setbacks are usually a multiple of the total turbine height, from tower base to upper extreme point of the rotor (see Figure 1). Generally the setbacks can vary from 1.25 to 3 times the overall machine height. Larger setbacks are sometimes required for special areas. In contrast to these standards, counties in California with more rural development, such as Merced and San Joaquin, use building setbacks and do not distinguish wind turbines separately.

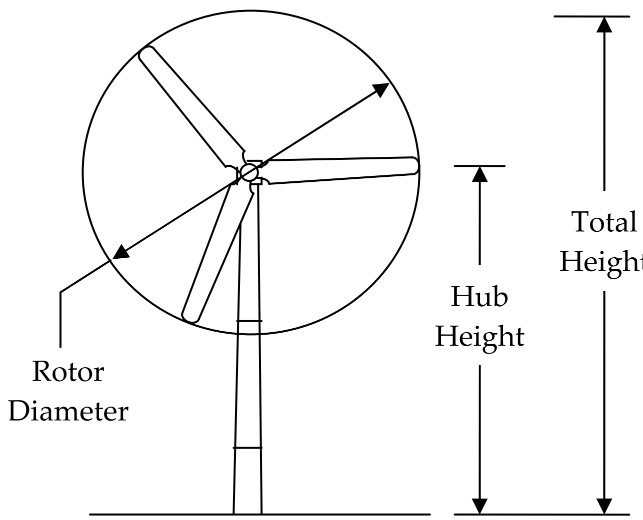

Figure 1. Wind turbine dimensions

As an illustration of the potential of setbacks limiting modern wind energy development, consider the following hypothetical situation. A developer has a 1000 by 1000 m (1 square kilometer or 247 acres) parcel of land available in a county requiring a setback three times machine total height. The site has a strong prevailing wind direction, and the machines are to be spaced in consideration of wake effects of 3 diameters crosswind and 10 diameters downwind. Two machines are considered:

1.2.1. 1. Vestas V-47

- 660-kW full rating
- 47 m rotor diameter
- 50 m tower height

1.2.2. 2. General Electric GE 1.5s

- 1500-kW full rating
- 70.5 m rotor diameter
- 65 m tower height

The layouts are shown in Figure 2 and Figure 3, with shaded zones representing the setback areas. The overall height is the sum of the tower height plus half the rotor diameter.

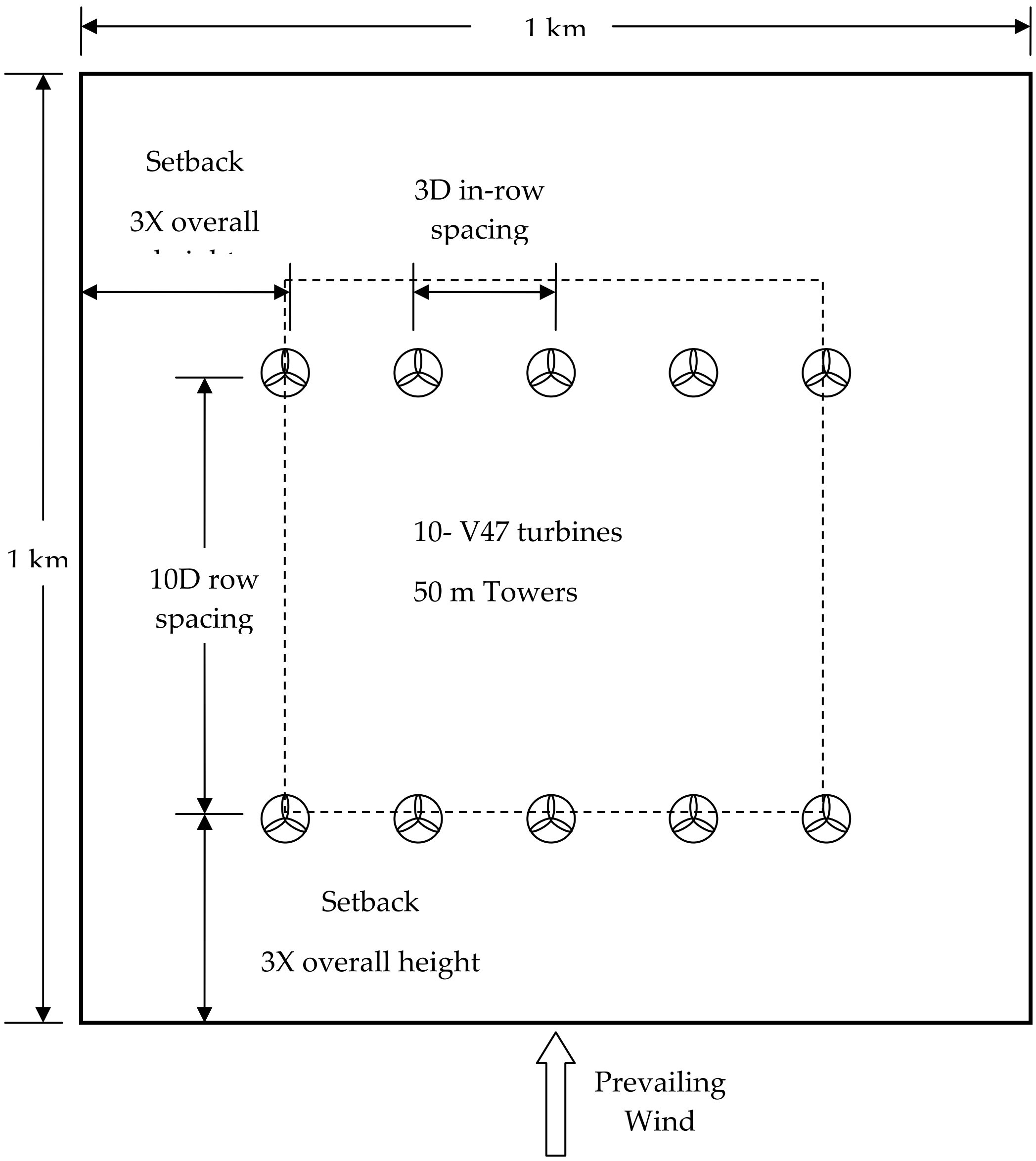

Figure 2. Layout for V-47 wind turbines based on setback requirement of three times total turbine height

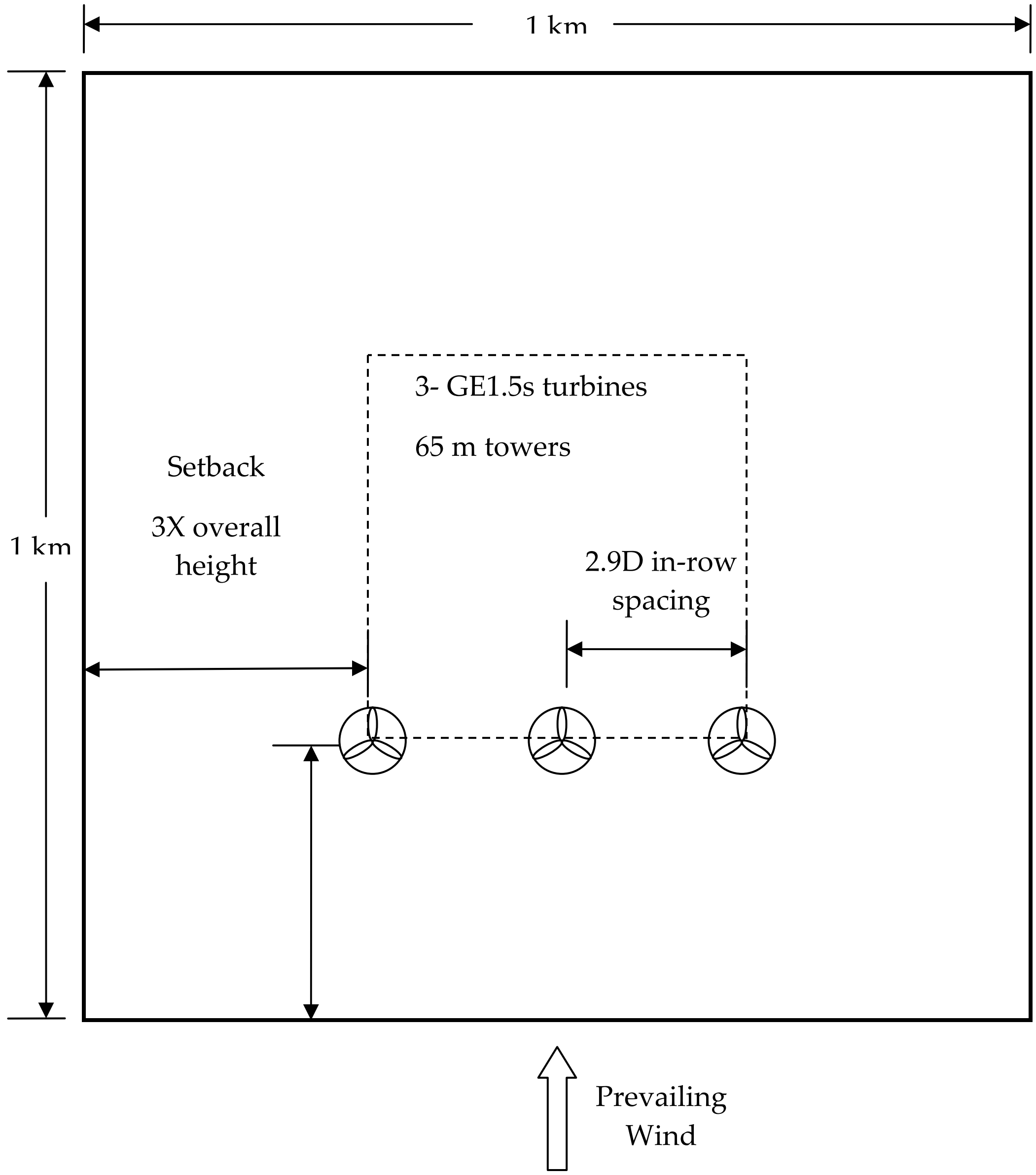

Figure 3. Layout for GE 1.5s machines based on setback requirements of three times total turbine height

For the V47 machine, the spacing requirements and setbacks allow for 10 machines with total rating of 6.6 MW. In contrast, the requirements allow only three GE 1.5 turbines with total rating of 4.5 MW. The crosswind spacing in this case would probably be reduced slightly. Downwind spacing requirements would force a second row of turbines off the parcel. The setback requirements for this example result in lower energy production with the application of larger, modern machines. The options available to a developer are further constrained with the current trend of manufacturers producing larger machines, and phasing out the production of smaller machines such as the V-47.

1.3. Project Objectives

Project objectives for this study were to:

- Document and compare current wind turbine setbacks in California
- Report on how the setbacks were developed
- Report on the probability of rotor failure
- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

Wind turbine setbacks are codified for reasons other than safety. Scenic corridors might be established so that views are not adversely impacted by new structures. Acoustic emissions from turbines might limit siting. Maximum sound pressure levels might be established at property lines or dwellings, constraining the placement of turbines. This report deals specifically with the issue of the rotor fragment hazard.

2.0 Project Approach

For each of the project objectives, the authors took the following approaches:

- Document and compare current wind turbine setbacks in California

The authors considered only counties with existing utility-scale wind power development. These counties are Alameda, Contra Costa, Kern, Merced, Riverside, San Joaquin, and Solano. The authors obtained the majority of the county ordinances from the Internet. Many counties have their codes residing on Ordlink (http://ordlink.com/), a LexisNexis product. All county planning departments were contacted for any additional information. In some cases, the wind energy ordinance was a separate document (Solano 1987) or part of an Environmental Impact Report (Alameda 1988b). The setbacks were organized into a tabular format for comparison.

- Report on how the setbacks were developed

The authors conducted interviews with county planning personnel on this topic. The authors also conducted a literature survey on the Internet and reviewed the conference proceedings of the American Wind Energy Association, the British Wind Energy Association, and the European Wind Energy Association.

- Report on the probability of rotor failure

The authors conducted a literature survey on this topic with the sources mentioned above, and searched the annual conference proceedings of the American Society of Mechanical Engineers technical conference on wind energy.

During the study, CWEC obtained records of Alameda County turbine failures. These data were compiled and analyzed. The authors also compiled failure data from European turbines reported in *WindStats,* a quarterly newsletter of Windpower Monthly. CWEC also translated and reviewed an interim report on rotor failures prepared by the Netherlands Energy Agency.

- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

The authors conducted a literature survey with sources mentioned above, and developed a simple model of the rotor fragment hazard to outline certain characteristics of the problem. The method and results for each researcher is described. Where possible, the results are compared across analyses.

3.0 Project Outcomes

3.1. Current Wind Energy Ordinances

The majority of the county ordinances were obtained from the Internet. The authors strongly suggest checking the current information available on the websites. Checking the requirements is especially important during the lifetime of a development project. Current ordinances and their safety setback requirements are summarized in Table 1.

Table 1. Setback references in California county ordinances

	Internet Site	Ordinance	Setback Reference
Alameda	Code for wind energy not available on internet	Draft Environmental Impact Report, Repowering a Portion of the Altamont Pass Wind Resource Area, Appendix A, Alameda County Windfarm Standard Conditions	Paragraph 15. Safety Setback
Contra Costa	http://www.co.contra-costa.ca.us/	County Code, Title 8 Zoning, Ch. 88-3 Wind Energy Conversion Systems	88-3.602 Setback Requirements
Kern	http://ordlink.com/codes/kerncoun/	Title 19 Zoning, Chapter 19.64 WIND ENERGY (WE) COMBINING DISTRICT	19.64.140 Development standards and conditions
Merced	http://web.co.merced.ca.us/planning/zoningord.html	Zoning Code (Ordinance) Ch. 18.02, Agricultural Zones	Table 5 Agricultural Zones Development Standards
Riverside	http://www.tlma.co.riverside.ca.us/planning/ord348.html	Ordinance 348, Section 18.41, Commercial Wind Energy Conversion Systems Permits	18.41.d(1) Safety Setbacks
Solano	Code for wind energy not available on internet	Wind Turbine Siting Plan and Environmental Impact Report 1987	Page 17 Safety Setbacks

Table 2 compares setbacks for several of the counties organized by feature that the turbine must be displaced from, such as a property line. The distances are stated in multiples of overall turbine height (Figure 1). If a fixed distance is included with the multiple, then the maximum of the two values must be used for the setback.

Table 2. Safety setback comparison. Note: for reference purposes only. Check counties for current zoning requirements.

	Property Line	Dwelling	Roads	Reductions in Setbacks
Alameda County	3x/300 ft (91 m), more on slope	3x/500 ft (152 m), more on slope	3x/500 ft (152 m), 6x/500 ft from I-580, more on sloped terrain	maximum 50% reduction from building site or dwelling unit but minimum 1.25x, road setback to no less than 300 ft (91 m)
Contra Costa County	3x/500 ft (152 m)	1000 ft (305 m)	None	exceptions not spelled in ordinance can be filed with county
Kern County	4x/500 ft (152 m) <40 acres or not wind energy zone, 1.5x >40 acres	4x/1000 ft (305 m) off-site	1.5x	With agreement from adjacent owners to no less than 1.5x
Riverside County	1.1x to adjacent Wind Energy Zones	3x/500 ft (152 m) to lot line with dwelling	1.25x for lightly traveled, 1.5x/500 ft (152 m) for highly traveled.	None
Solano County	3x/1000 ft (304 m) adjacent to residential zoning, 3x from other zonings	3x/1000 ft (304 m)	3x	Setback waived with agreement from owners of adjacent parcels with wind turbines

Table 2 shows that counties have different requirements. Riverside County maintains the minimum setback distances to properties with adjacent wind energy zoning.

Alameda County has adjustments for sloping terrain. If the ground elevation of the turbine is two or more times the height of the turbine above the feature, the setback distance increases from three times to four times. With the exception of Riverside County, all allow for reduction of the setback distance with special consideration. The Altamont Repowering EIR (Alameda County 1998) is an example of a reduced setback, which resulted from a developer submitting a rotor fragment risk analysis as substantiation for the reduction.

Merced County has some wind energy development in the Pacheco Pass area, and utilizes standard building setbacks for wind turbines in agricultural districts. San Joaquin County has similar requirements for the development in the Altamont Pass area.

3.2. Setback Development

With the exception of Solano County, the ordinances are not explanatory documents. Background information is not provided. The most comprehensive paper on the subject of wind energy permitting in California comes from McClendon and Duncan. Although this paper was written in 1985, it captures the essence of the process at the time and generally, not much has changed in the interim. Another paper by Throgmorton (1987) focuses on Riverside County development exclusively. Further clues to the development of standards are found in Environmental Impact Reports written for the counties on specific developments. The counties are discussed separately below.

References in the literature to safety setbacks are scarce. One is found in Taylor (1991). Taylor proposed setbacks for a 30 m diameter rotor machine, but no tower height is mentioned. The proposed setbacks were 120–170 meters from a habitation or village, 50 meters from a lightly traveled road, and 100 meters from a heavily traveled road. A Windpower Monthly article regarding a rotor failure in Denmark (Møller 1987) mentions setbacks for safety. A setback of 90 meters plus 2.7 times the rotor diameter was proposed. The Wind Energy Permitting Handbook available from the National Wind Coordinating Committee (NWCC 2002) provides no guidance on setbacks. In all the above references, there is no discussion of the technical basis for the setbacks.

3.2.1. Alameda County Ordinance

Alameda County, encompassing most of the Altamont pass, was one of the first regions in the world to have large-scale wind energy development. Until recently, the Altamont Pass area has been isolated from population centers, lowering the possibility of conflict with the community. The McClendon and Duncan paper (1985) reported that concerns over safety and reliability of wind turbines resulted in an ad-hoc public/industry group to develop new standards. The setbacks as they stand today are found in Resolution Number Z-5361 of the Zoning Administrator of Alameda County, dated September 5, 1984. There is no known technical description on how the setbacks were developed.

3.2.2. Contra Costa County Ordinance

Contra Costa encompasses the northern portion of the Altamont pass. The zoning language is much less specific than Alameda County, but the setbacks are similar.

3.2.3. Kern County Ordinance

According to county personnel and McClendon and Duncan (1985), the standards for Kern County were developed with an ad-hoc committee of wind energy people and other interests, as in the case with Alameda County. Kern has stricter setbacks for properties not zoned for wind energy development, but is less restrictive for roads (see Table 2).

3.2.4. Riverside County Ordinance

Riverside County is an area of intense development. Regulations were established after an extensive Environmental Impact Report (EIR) by Wagstaff and Brady (Riverside County California, United States Bureau of Land Management et al. 1982). Clues to the majority of the setback distances are in the report. Although there is no technical basis for the original setback of three times the total height of the turbine, one can infer that this distance arose from the discussion of wake effects. It was expected that in-row spacing for wake effects would be six diameters, and adjacent wind energy parcels would require a spacing of at least half this distance. The report also mentions an estimate of the fragment throw distance for the MOD-0A, an early Westinghouse machine. The stated value of 500 ft (152 m) translates to three times overall height for this turbine. Evolution of the ordinance resulted in reduction of some of the setbacks, which now seem to offer a buffer for the possibility of tower collapse.

3.2.5. Solano County Ordinance

Solano County also developed wind turbine requirements with industry involvement in 1985. The outcome of this work was the Solano County Wind Turbine Siting Plan (Solano County 1987), which remains the guide for permitting in the county. The plan supercedes the current language in the zoning ordinance that has setbacks of 1.25 times the overall turbine height. This plan was developed by the authors of the Riverside County EIR, and proposes a "three times" setback. The estimated rotor fragment risk of the MOD-0A is again mentioned. There is a comparison of the setbacks with the rotor fragment risk of the MOD-2 turbine. The throw distance of this turbine in a vacuum was estimated to be 1300 feet (396 m, 3.7 times overall turbine height) for a broken tip and 700 feet (213 m, 2 times overall turbine height) for the whole blade. There is no technical discussion for these values and they are not tied into the proposed spacing. The Montezuma Hills EIR (Solano County and Earth Metrics 1989), proposed a three times diameter safety setback, with no consideration for turbine height. Neither reference provides a technical basis for the setback distance.

3.3. Rotor Failure Probabilities

This section discusses the probability of a rotor failure occurring. Probabilities will be discussed in terms of ratios. For example, a coin toss with heads has a one in two probability, represented equally as 0.5, ½, 5×10^{-1}. A probability of something occurring once in one-hundred trials can be represented as 10^{-2}. The probability applied to rotor failures will be stated as the probability of failure for a turbine in one year of operation. A probability of 10^{-2} per turbine per year can then be understood that on average there will be one rotor failure in a year for every 100 turbines.

Reporting on turbine failures is very limited, most likely due to the sensitivity of the industry. There are few accounts of turbine failure in the literature. There are statistics in the public domain that will be discussed below.

Types of rotor failures are as follows:

- Root-connection full-blade failure
- Partial-blade failure from lightning damage
- Failure at outboard aerodynamic device
- Failure from tower strike
- Partial-blade failure due to defect
- Partial-blade failure from extreme load buckling

Some of the causes of rotor failures:

- Unforeseen environmental events outside the design envelope
- Failure of turbine control/safety system
- Human error
- Incorrect design for ultimate loads
- Incorrect design for fatigue loads
- Poor manufacturing quality

Not surprisingly, most failures are a combination of these factors, which points to the complexity of the technology. The probabilities of some events are highly correlated with each other. For example, loss of grid power is highly correlated with high wind events. The potential then exists for a control system malfunction due to loss of power to coincide with a high loading event. Thus the turbine designer must plan for both events occurring simultaneously.

3.3.1. Rotor Failures in the Literature

One of the earliest documented rotor failure events comes from one of the first applications of utility-scale wind energy (Putnam 1948). It is also one of the few accounts with a published distance. The Smith Putnam 1.25 MW turbine suffered a rotor failure in its test campaign resulting in a blade throw of 750 ft (230 m), or 3.7 times the overall height. The failure was attributed to lack of knowledge of the design loads for the turbine. The blade throw was probably exacerbated by siting on a slope (approximately ten degrees). The blade was of steel construction, with a weight of eight tons (mass of 7260 kg). That is at least 50% heavier than modern construction. A heavier blade could fly farther due to a reduced drag-to-weight ratio (Eggers, Holley et al. 2001).

The next period of literature deals with the analysis of large-scale turbines under development in the 1970s and early 1980s. Although the possibility of failure was discussed, no mention of the probability was placed forward for the Department of Energy (DOE) MOD series turbines such as the General Electric MOD-1 (General Electric 1979) and the Boeing MOD-2 (Lynette and Poore 1979). The Solar Energy Research Institute (SERI) conducted a preliminary study of wind turbine component reliability (Edesess and McConnell 1979). Using an analysis of the individual failure rate estimates and inspection intervals of the rotor and braking systems, the authors predicted a failure rate for the wind turbine rotor at 1.2×10^{-2} per turbine per year.

A strong early wind program in Sweden prompted studies of the subject (Eggwertz, Carlsson et al. 1981) where the first attempts at analyzing the rotor fragment risk were made. The first guess at the probability of failure was made at 1 in 100,000 (10^{-5}) failures per turbine per year.

The evolution of the wind industry back to smaller turbines brought large scale manufacturing and experience was gained with equipment failures. In a 1989 paper (De Vries 1989) conducted a blind survey of manufacturers that reported on 133 turbine failures in the industry. De Vries also placed probabilities at 2×10^{-2} rotor failures per turbine per year for the Netherlands, 3 to 5×10^{-3} for Denmark and 3×10^{-3} for the United States. This is two to three orders of magnitude higher than that predicted by Eggwertz, but closer to the SERI analysis.

Failures are occasionally reported in Windpower Monthly. They have reported a rotor overspeed failure in Denmark (Møller 1987) and full-blade failures in Spain (Luke 1995). A report in the technical literature comes from Germanischer Lloyd (Nath and Rogge 1991), one of the certification bodies for wind energy. The paper describes two medium-size turbine rotor failures. The rotor diameter and tower height were not reported. One failure was attributed to insufficient shutdown braking force resulting in overspeed, and blades were thrown to 150 and 175 meters. The other failure was attributed to poor manufacturing quality and blade fragments were thrown 200 meters. Updates to certification requirements were made as a result of the failure investigations. These certification requirements call for redundancy in safety shutdown systems and quality control in the blade manufacturing process. De Vries had also earlier suggested stricter certification requirements to reduce the rotor failure rate.

One wind turbine manufacturer has made a public testimonial of their rotor failure rate. A managing engineer at Vestas, in testimony for the Kittitas Valley Wind Power Project in Washington State (Jorgensen 2003), declared that there had been only 1 blade failure in 10,000 units for 12 years. The failure reported occurred in 1992 on a V39-500 kW machine when a blade was thrown 50–75 meters. If an average of six years of total operation for the entire fleet is assumed, the failure rate would be estimated at 1.6×10^{-5} rotor failures per turbine per year.

3.3.2. Alameda County Turbine Failure Data

Under Article 15 of the Alameda County Windfarm Standard Conditions (Alameda County 1998a), a windfarm operator must notify the County Building Official of any tower collapse, blade throw, fire, or injury to worker. Recent files of failure data from the county building department were compiled by the CWEC in order to determine failure rates. County representatives claim that not all operators have been diligent in their reporting, but one operator of Kenetech 56-100 machines has been. These turbines are 100 kW machines with 56 ft (17 m) diameter rotors. The majority were manufactured in the 1980s. The failure reports only indicate the failure type. There is no mention of rotor fragment distance (if fragments were thrown from the turbine), or the conditions at time of failure. The failures could have been discovered as the result of an inspection before any part had separated from the turbine. The failure data covered the year 2000 to fall of 2003. The number of Kenetech 56-100 machines in operation by this operator was obtained from the California Wind Performance Reporting System (http://wprs.ucdavis.edu/).

For the time period of the reports, the rotor failure rate was 5.4×10^{-3} failures per turbine per year. This value coincides well with that reported by De Vries (1989). As a comparison the failure rate for the tower was 6.9×10^{-4} failures per turbine per year, an order of magnitude less probable than the rotor failure rate.

3.3.3. WindStats Turbine Failure Data

WindStats is a technical publication for the wind industry published quarterly in Denmark. Failure data are available for wind turbines located in Denmark and Germany. The Denmark data have been available since 1993; the Germany data since 1996. Like the Alameda County data, the data only indicate failure type. There is no mention of rotor fragment distance (if it occurred at all), or the conditions at the time of failure, are mentioned. CWEC compiled data through the spring 2004 issue.

For Denmark, the failure rate for rotors was 3.4×10^{-3} failures per turbine per year. Again, this is within the values reported by De Vries (1989) in the late 1980s. The tower failures for the same period are 1.0×10^{-4}. As with the Alameda data, the tower failure probability is an order of magnitude lower than the rotor failures. For Germany, the data are reported as “rotor” failures, which for the reporting period were 1.5×10^{-2} failures per turbine per year. This is an order of magnitude higher than the Denmark data, but on the same order of the Netherlands in De Vries. There are no apparent trends in the data indicating changes in failure rates over time.

3.3.4. Dutch NOVEM Report

During the writing of this report the Netherlands Agency for Energy and the Environment (NOVEM) was writing a handbook on wind turbine siting due to the risk posed by wind turbines. The overall report is summarized in English by Braam and Rademakers (2004) from the Energy Research Centre of the Netherlands, ECN, and the report was published in Dutch in 2005 (Braam, van Mulekom et al. 2005). The CWEC received approval from the authors to translate Appendix A of the handbook and it is included in Appendix A of this document.

The appendix from the handbook reviews data from two large databases of wind turbines in Denmark and Germany. The database covers turbine operation from the 1980s until 2001. The authors analyzed the data and recommended values of risk for the following failure events:

- Failure at nominal operating rpm 4.2×10^{-4}
- Failure at mechanical breaking (~1.25 time nominal rpm) 4.2×10^{-4}
- Failure at mechanical breaking (~2.0 time nominal rpm) 5.0×10^{-6}

The authors compared these results to earlier values developed by European agencies in the earlier 1990s, with the overall blade failure rate declining three times. It is expected that with the maturity of the industry blade failures will continue to decrease.

Documented blade failures and distances were also reported in the handbook. The maximum distance reported for an entire blade was 150 m, for a blade fragment the maximum distance reported was 500 m.

3.4. Rotor Fragment Analyses

This section discusses the estimates of rotor fragment risk as determined by six researchers. The impetus behind these investigations was to study the hazard potential of the rotor failure. While rotor failures can occur with the machine operating or stationary, these studies were limited to the operating case.

3.4.1. Background of Rotor Fragment Models

Parked Turbines

Wind turbines are parked if the wind speed is out of the operating range, or if there is fault detected while the wind speed is within the operating limits. The typical high wind shutdown for a wind turbine is 25 meters/second, m/s. The turbine is usually designed to withstand a peak gust outlined by the International Electrotechnical Commission (IEC). Peak gusts for various wind classes are shown in Table 3. The peak gust is defined as a three-second average gust that has a fifty percent probability of occurring in fifty years, more succinctly known as "50-year wind." The IEC wind classes are also distinguished by the annual average wind speed. All wind speeds are designated at hub height.

Table 3. IEC peak gusts

IEC Class	I	II	III
50-year wind	70 m/s	59.5 m/s	52.5 m/s
Annual Average	10 m/s	8.5 m/s	7.5 m/s

If a rotor has failed in a parked condition, there is no initial velocity of any fragment coming off. Any movement away from the turbine is governed by gravity and the aerodynamic force on the fragment. None of the analyses studied the failure of the parked turbine, and it is assumed that failure during operation will result in a higher probability of the blade or the blade fragment flying farther.

Ballistics Models

Analysis of rotor failure uses methods of classical dynamics in order to describe the problem. Figure 4 is a representation of a rotor failure. If there is a rotor failure, either a fragment or the entire blade, the motion of the fragment is governed by specific forces. If the failure has taken place while the turbine is operating, the fragment has an initial velocity due to rotation, while in flight the motion is constrained by gravity and aerodynamic forces. The initial velocity of the rotor fragment is a function of the tip velocity, determined by Equation 1:

$$\text{Equation 1} \qquad V_{tip} = \Omega R$$

where:

$\Omega =$ Rotor rotational speed, and

$R =$ Rotor radius

Normal operating tip speeds of the turbines studied in the literature varied from 40 m/s to 100 m/s. Modern wind turbines fall within this range. The tip speed is chosen to meet the performance requirements for the turbine and also to minimize acoustic emissions. The lower the tip speed, the lower the loads and noise from the blades for a given blade design. This can be compared to the low/high switch setting for a fan.

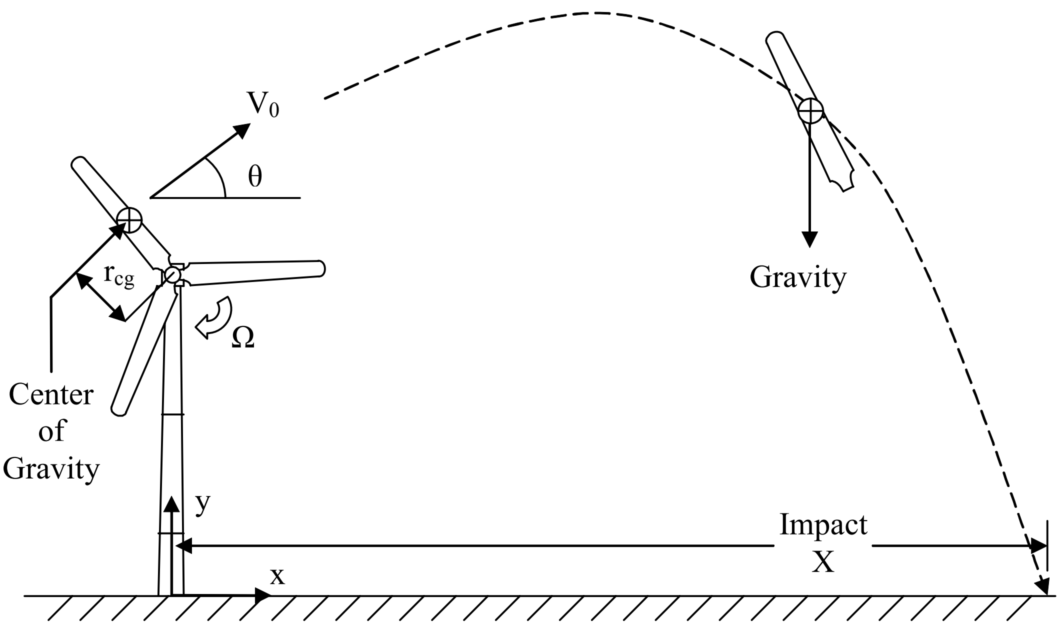

Figure 4. Rotor fragment schematic

If there is a failure of the rotor and a fragment is released, the initial velocity at separation is given by Equation 2:

$$\text{Equation 2} \qquad V_0 = \Omega r_{cg}$$

where:

$V_0 =$ Initial velocity of fragment at center of gravity

$r_{cg} =$ Radial position of the fragment center of gravity

At the time of separation, the blade or fragment has the same angular velocity (or spin) as the rotor.

A rudimentary model of ballistics is the path of a fragment in a vacuum. The only force acting on the fragment is gravity. This model is found in most elementary dynamics textbooks, such as Schaum's (Nelson, Best et al. 1998). The total ground range achieved by the fragment, with release height and impact height equal, is given by Equation 3.

Equation 3 $$X = \frac{V_0^2}{g} \sin 2\theta$$

where:

$X =$ Horizontal total ground range of a fragment in a vacuum

$g =$ Gravitational acceleration

$\theta =$ Release angle between the velocity vector and horizontal

The release angle is directly related to the blade azimuth, which is the position of the rotor at a particular time.

In a vacuum the aerodynamic forces are not modeled, the fragment is not affected by the ambient winds. The maximum range in a vacuum is achieved when the release angle is 45°. With this value of the release angle, Equation 3 becomes Equation 4.

Equation 4 $$X_{\max} = \frac{V_0^2}{g}$$

where:

$X_{\max} =$ Maximum horizontal range of a rotor fragment in a vacuum

The values of range from this simple model are not realistic because the atmosphere is not a vacuum. However, this simple model shows the importance of the release velocity because it is a squared term. For example, a 10% increase in release velocity increases the maximum range by 21%. This model also shows the dependence on the release angle. In any probability study, this would be a random parameter, because it is assumed that a rotor failure would not be dependent on the azimuthal angle.

Other models increase on the complexity of the vacuum model. The most common approach is to assume that the aerodynamic force is proportional to the square of the instantaneous velocity. The aerodynamic force is separated into lift and drag, and the constants of proportionality are called coefficients of lift and drag (C_L and C_D). Both the crosswind and downwind distances are determined. The solutions for the fragment range from these models (so-called two-degrees-of-freedom or 2 DOF models) cannot be solved directly and require numerical methods.

The next level of complexity assumes that C_L and C_D are dependent on the orientation of the fragment, and the fragment is allowed to rotate and translate (3 DOF or 6 DOF models).

Rotor Overspeed

One particularly hazardous failure scenario is turbine overspeed. The increased velocity in overspeed will over stress the rotor blade, and, in the event of a failure, increase the range of the fragment. The rotor is usually designed with a safety factor of 1.5. If the rotor loads are approximately proportional to the rotor speed (Eggers, Holley et al. 2001), the rotor could possibly fail at 150% of nominal rotor speed. To prevent this possibility, most wind turbines are equipped with redundant safety systems to shutdown the rotor. A turbine with industry certification (e.g. Germanischer Lloyd 1993), must have a safety system completely independent of the control system. The safety system must also have two mutually independent braking systems. Usually the blades pitch to release the aerodynamic torque while a brake is applied to the shaft. In the event of a failure in one system, the other system must be able to hold the rotor speed below maximum. An emergency shutdown is typically designed to occur if the rotor speed exceeds 110% of nominal. Even with redundant safety systems, rotor overspeed still occurs in industry, sometimes by human error when the safety systems have been defeated during maintenance.

Impact Probabilities

The analyses next turn to the probability that a fragment will land on a certain target or in a particular area in the range of the turbine assuming a rotor failure. The studies follow various approaches to determine this probability; this will be discussed below. The probability of impact is then multiplied by the probability of rotor failure, discussed in the previous section. The final result is the probability that a target fixed at a certain range from the turbine will be hit in one year. If targets are not fixed, such as cars on a roadway, then the probability must be multiplied again by the probability that the target will be in position. Mobile targets are not discussed in the analyses.

A simplified impact probability can be derived from Equation 3. Since this relationship is only valid for a ground release, only release angles of 0 to 180° (see Figure 4) result in movement away from the release point. Release angles of 180 to 360° result in impact at the base. The random release angle is assumed to have uniform distribution from 0° to 360°. Using methods of probability, the probability that a fragment will fall within an annulus that is less than the maximum range is given by Equation 5.

Equation 5 $$P\{X_1 \le X \le X_2 \le X_{max}\} = \frac{2}{\pi}\left[\arcsin\frac{X_2}{X_{max}} - \arcsin\frac{X_1}{X_{max}}\right]$$

where:

$X_1 =$ inner radius of annulus.

$X_2 =$ outer radius of annulus.

This relationship is plotted in Figure 5 for a normalized annular width of 0.05. Note that the relatively high probability of the fragment landing directly under the tower is not shown. The nature of the equation results in an increasing probability of impact in the outermost annuli, due to a wide range of release angles that provide nearly the maximum range. However, the annular area increases with increasing radius.

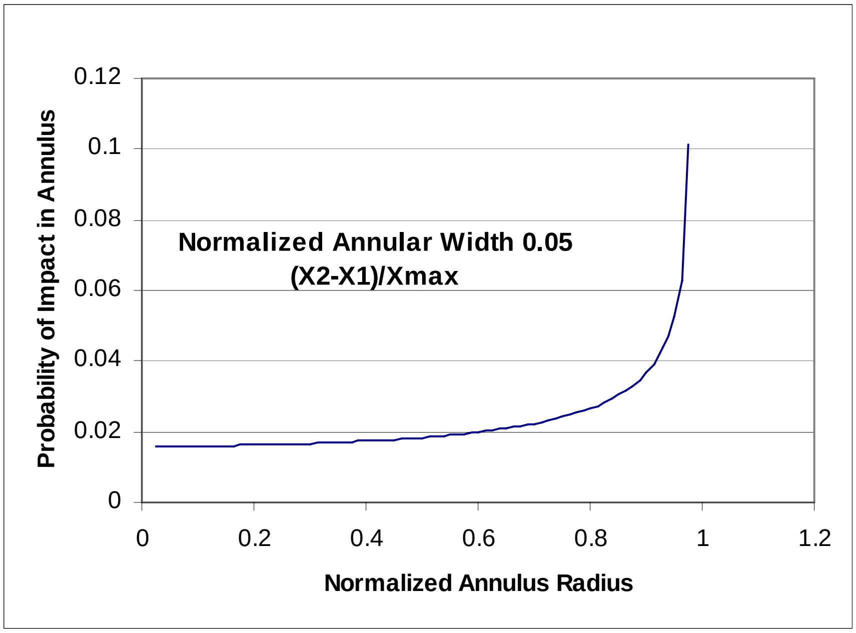

Figure 5. Probability of impact within an annular region

We next assume that the target is an annular sector, as in Figure 6.

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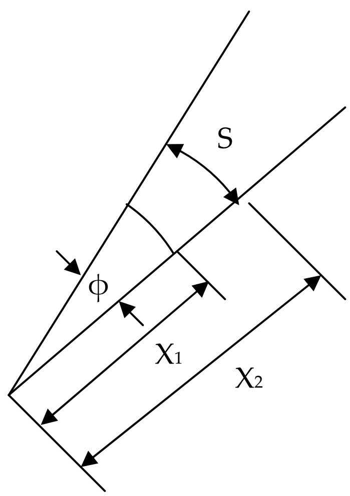

Figure 6. Target annular sector

In order to make the sector size roughly equal throughout the ballistic range, we set the outer arc length (S) equal to the annular width, given by Equation 6:

$$\text{Equation 6} \qquad S \equiv X_2 - X_1$$

The arc length is also given by

$$\text{Equation 7} \qquad S = X_2 \times \varphi$$

where:

$\varphi =$ Sector angle in radians (assumed to be small)

Equating Equation 6 and Equation 7 and solving for the sector angle we obtain:

$$\text{Equation 8} \qquad \varphi = \frac{X_2 - X_1}{X_2}$$

The probability of impact in this annular sector, assuming equal probability in all directions, is given by:

$$\text{Equation 9} \qquad P\{X_1, X_2, \varphi\} = \frac{\varphi}{\pi^2}\left[\arcsin\frac{X_2}{X_{\max}} - \arcsin\frac{X_1}{X_{\max}}\right]$$

This relationship is plotted in Figure 7. This simplified model shows a peak in probability near the tower base, and then a relatively constant probability until the probability rises again near the maximum range. This behavior is similar to more complex models incorporating aerodynamics. The peak at maximum range places a constraint on the overall hazard and acceptable setback distances.

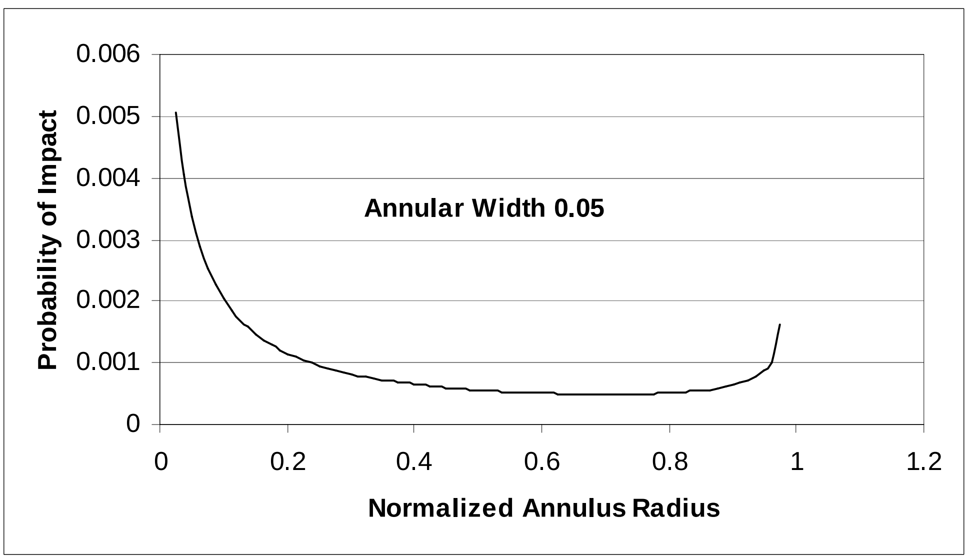

Figure 7. Probability of impact within annular sector

Multiple Turbines

If there is more than one turbine in the area, such as in a wind plant, then the individual probabilities must be added for a particular area. This is mentioned briefly in Macqueen (1983). The probabilities add according to the Law of Total Probability; for two turbines this is represented inEquation 10.

$$\text{Equation 10} \quad P(A+B) = P(A) + P(B) - P(A,B)$$

where:

$P(A+B) =$ Probability of A or B or both occurring

$P(A) =$ Probability of A occurring

$P(B) =$ Probability of B occurring.

$P(A,B) =$ Probability of both A and B occurring (Equation 11)

$$\text{Equation 11} \quad P(A,B) = P(A)P(B/A) = P(B)P(A/B)$$

where:

$P(B/A) =$ Conditional probability B occurring given A has occurred

$P(A/B) =$ Conditional probability of A occurring given B has occurred

If the events are independent, which would be the case in a random failure, the conditional probabilities are from Equation 12 and Equation 13.

$$\text{Equation 12} \quad P(B/A) = P(B)$$

$$\text{Equation 13} \quad P(A/B) = P(A)$$

The overall probabilities become Equation 14.

$$\text{Equation 14} \quad P(A+B) = P(A) + P(B) - P(A)P(B)$$

As an example, consider a region that has a 10^{-4} probability of impact from a Turbine "A" and a 10^{-5} probability of impact from Turbine "B". From Equation 14, the overall probability of impact is:

$$P(A+B) = 10^{-4} + 10^{-5} - (10^{-4} \times 10^{-5})$$
$$P(A+B) = 1.1 \times 10^{-4}$$

These formulae can be expanded for multiple turbines.

Overall Probability

The overall probability can then be compared to other risks. De Vries (1989) mentions a government policy in the Netherlands of one-in-a-million (10^{-6}) per year risk level for new industrial activities. This is on the same order of present-day industry quality programs, such as "Six-Sigma," with a failure rate objective of three-in-a-million. Previously we discussed rotor failure probabilities on the order of one-in-a-thousand (10^{-3}) to one- in-a-hundred (10^{-2}). If we assume a conservative value of one-in-a-hundred (10^{-2}), this results in a required probability of impact of less than one-in-ten-thousand (10^{-4}) per year.

3.4.2. Rotor Fragment Analyses in the Literature

Eggwertz, Sweden 1981

This is the first documentation of a rotor fragment analysis, and is a comprehensive report on turbine structural safety for the Swedish industry. At the time, megawatt-size turbines were being considered for power production in Sweden. The analysis referenced previous work in Sweden on the possibility of fragment gliding due to spin; however the extension of the fragment flight was considered negligible. For the examination of risk areas, the drag coefficient in the analysis was fixed at 0.5 for lateral and downwind directions, and the lift coefficient was assumed to be zero.

For the probability analysis the blade and azimuth locations were divided into equal spanwise sections and equal weighting was applied to failure at these sections. This allowed for a semi-random probability of failure of the blade at a particular section and at a particular azimuth. A total of 144 fragment releases were modeled. A discussion was made of the probability of rotor failure, mentioned in the Rotor Failure section, but no criteria were applied in the final analysis.

The discussion of the physics and probability of impact is very detailed. The risk area included considerations of sliding and rotation of the rotor fragment. The fragment was assumed to translate on the ground and come to a complete stop due to friction. The area surrounding the turbine was divided into 10-m rings and the fragment impact area within the ring was divided by the total ring area. The probability calculated assumes equal probability of launch for all wind directions. The result was the risk level that a target within a ring will be hit.

The overall analysis was conducted for a 39 m radius machine at an 80 m hub height operating at 25 rpm in a 7 m/s wind speed. This was considered to be the most likely operating condition. Assuming that a failure had occurred, the probability was high at the tower base and then relatively even at 10^{-3} until 200 m. The analysis showed the probability of impact from any fragment dropped off dramatically (below 10^{-5}) at 220 m. This throw distance is 1.8 times the overall turbine height. The throw distance for a probability of 10^{-4} is only slightly less than this value. The dramatic drop off in the probability at 220 m was used as a basis for the safety area around the turbine; however, the calculations were made at nominal operating conditions and at a single wind speed. Failures in an overspeed conditions would increase this area.

Montgomerie, Sweden 1982

Montgomerie (Montgomerie 1982) expanded on Eggwertz's work by modeling the fragment with a full six-degrees of freedom. The aerodynamic model is not explained but is referenced from an unpublished thesis in Sweden. Similar work would later be developed by Sørensen (1984a).

Montgomerie presents results for an example turbine similar to Eggwertz's. The break at the rotor and the azimuth at break are treated with equal probability. However, the new model includes a wind speed and wind direction distribution from the wind turbine site. The normally circular hazard contour is only made slightly oval with the wind direction distribution. The maximum throw distance for the example exceeds 1600 m and the distance for 10^{-4} probability is 1500 m. These values are much greater than Eggwertz's results; however, there is no explanation for the discrepancy between them. The results are also relatively higher than results presented by other researchers.

Macqueen, United Kingdom 1983

This work was conducted in the United Kingdom for the Central Electricity Generating Board. As in Sweden, the United Kingdom was considering generating electricity with megawatt-size wind turbines. Macqueen starts by bounding the problem with an analysis of the maximum launch velocity of a rotor fragment being limited by the approach of the speed of sound. An estimate of the maximum velocity is 310 m/s in an extreme overspeed condition for a typical turbine. The fragment distance would not exceed 10 km using classical ballistics results with no aerodynamic drag. It is unreasonable to expect setback criteria of this distance; the turbine rotor would probably fail at a much lower velocity, plus the aerodynamic drag acting on the fragment would greatly reduce the distance. However this provides an upper extreme limit.

The analysis followed the same lines as Eggwertz with analysis of gliding and tumbling and classical ballistics with average lift and drag coefficients. The tumbling analysis was to determine the conditions for stable, gliding flight of a fragment. Macqueen reasoned that the flight time of a fragment was several times longer than one tumbling period and therefore stable flight could not be expected. However gliding was considered as a rare case if the fragment did not leave with sufficient rotational energy. For the tumbling case, Macqueen reasoned a C_L of 0.0 and a C_D of 1.0. For gliding, lift was chosen as C_L= 0.8 and C_D= 0.4. Macqueen estimated the probability of gliding occurring in a potential failure at 10^{-2} to 10^{-3}.

Macqueen also included a discussion of a three-dimensional model of fragment flight, and concluded that the model did not show the fragment achieving a stable gliding condition. Macqueen concludes that the effect of lift in the three-dimensional case increases the range of flight by no more than 10%.

A series of runs at equally spaced azimuthal positions were used to develop the probability distributions. The possibility of sliding after impact was not addressed in the current work. He then separated the analysis into two failure events, one at a 10%

overspeed at average winds, the other at the maximum possible release velocity with an extreme gust. The turbine studied was of similar geometry to the MOD-2, with 91 m diameter rotor and 61 m hub height.

The probability of impact is weighted by area (per square meter), and assumes equal distributions in all directions. Probability distributions showed peaks near the tower and at the maximum range, similar to the results of the simplified model in Figure 7. The probability of impact was then a function of the target and fragment size. Macqueen reasoned that the rotor fragments would be large compared to target, making the probability independent of target size; however this would not be the case with a busy roadway, with many targets over a large area.

For overall probabilities Macqueen used the Eggwertz probability of 10^{-5} for rotor failures. Macqueen also compared the probabilities to a statistic of risk of death by lightning strike in the United Kingdom at 10^{-7} per year. For the turbine studied, a large 2.5 MW unit, the risk of being hit by a rotor fragment within 210 m (approximately two times overall height) is equivalent to being struck by lightning. However, these results were based on the rotor failure probability of 10^{-5} and the assumption of a target size less than the overall fragment area.

Sørensen, Denmark 1984

This investigation was part of the wind power program of the Ministry of Energy and the Electric Utilities in Denmark. The conference paper (Sørensen 1984b) was a summary of the full report in Danish. Detailed sensitivity studies are found in the Wind Engineering paper (Sørensen 1984a). The analysis is unique in that the aerodynamics of the fragment under ballistic motion was fully modeled. Sørensen used synthesized data from a NACA 0012 wing to simulate the fragment under various alignments. The blade fragment was broken into segments and the aerodynamic forces were determined independent of each other. The total force was then a summation of the individual forces. This approach is similar to current state-of-the-art modeling of wind turbine rotors in the industry. Three turbines of increasing size were studied.

The modeling showed that the fragment tumbling motion decayed as it reached the maximum height with the heavy end directed down as the fragment fell back to earth. This behavior was also described by Eggwertz in scaled model studies. The model behavior places into question the pure tumbling and constant aerodynamic coefficients of the other models. Comparison with these models showed that the average drag coefficient for the lateral throw would have to be varied from 0.15 to 0.4 to achieve similar results to the full aerodynamic model. These coefficients are lower than what has been considered by the other researchers. For the downwind range, the constant coefficient models predicted a much lower distance. Therefore, constant coefficient models would tend to predict shorter overall throw distances compared to Sørensen's method.

The *Wind Engineering* paper went through several sensitivity studies of the modeling parameters. A summary of these studies is presented in Table 4.

Table 4. Sensitivity studies by Sørensen in *Wind Engineering* paper

Subject	Description	Results
Airfoil Data	Analysis conducted on four airfoil data sets	7% spread in maximum range
Aerodynamic Unsteadiness	Dynamic aerodynamic loads modeled	12% reduction in maximum range with unsteady model
Autorotation	Model tendency of fragment to glide like helicopter rotor	Substantial reduction in range
Center of Gravity Location	Vary chordwise center of gravity position on fragment	Negligible effect for typical 25-35% chord line placement
Blade Pitch Angle	Blade pitch angle at moment of release	Large influence; pitch of maximum thrust had maximum range
Wind Velocity	Ambient wind velocity at moment of release	Large influence, partially due to dependence on pitch angle effect

The impact probabilities reported in the conference paper (Sørensen 1984b) assumed the target as a one-meter sphere. Sliding of the wreckage was assumed, with 25 meters of slide assumed for a throw greater than 75 m range. As stated before in the Macqueen (1983) discussion, these probabilities would have to be adjusted for targets larger than the blade fragment, such as a busy roadway, or a dwelling. The probability analysis followed the same approach as Eggwertz (1981) by dividing the region around the turbine into ring segments. Uniform wind direction was assumed.

Probabilities were only presented for the Project "K" turbine for a full 30-m blade throw and 10-m blade fragment throw. This turbine is of 1.5 to 2.0 MW size with a 60 m hub height. Release angle and wind speed were varied and multiple throws were calculated. The probabilities were presented as a function of tip speed. Results are shown in Figure 8, comparing the range with 10^{-4} probability (the "risk" range) to the maximum range.

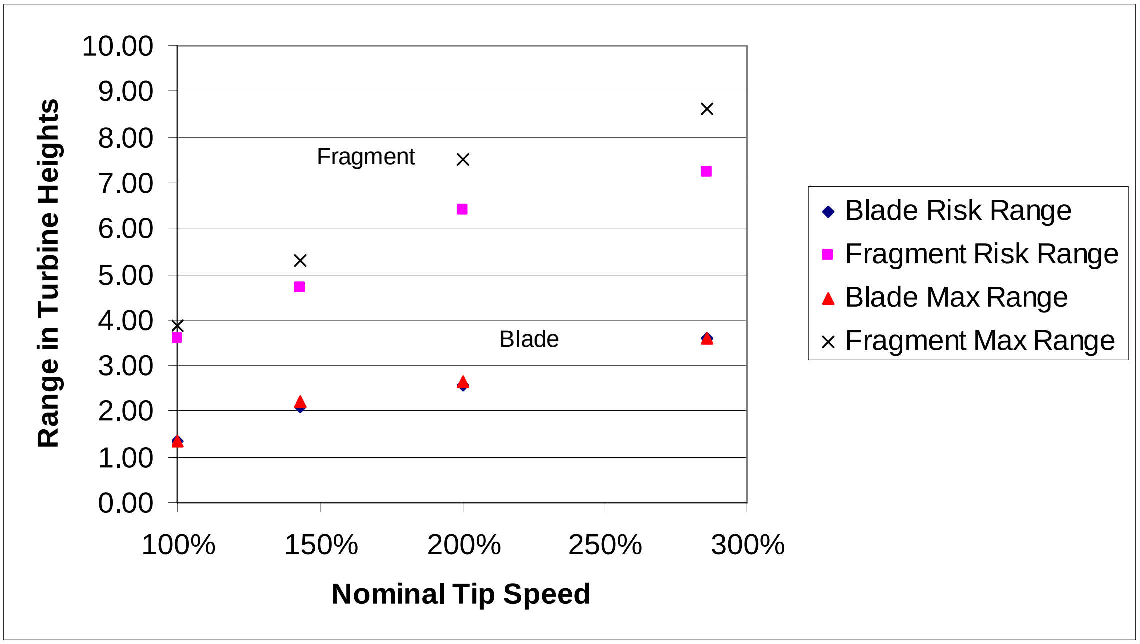

Figure 8. Throw distances in Sørensen conference paper with 1 × 10^{-4} probability risk range

The maximum ranges do not increase exponentially as would be predicted for a vacuum in Equation 4. This is the result of including the aerodynamic forces. Also, there is negligible difference for the full blade maximum range and range with 10^{-4} probability. This is not true for the fragment.

Turner, United Kingdom 1986 and 1989

Turner's (1986) work was a further expansion of MacQueen's work. He starts by developing a model of the probability similar to that in Section 0. He uses this model to form conclusions of the overall statistics of the more advanced problem. He used a Monte Carlo method to run simulations of fragment throws with the simple model, and then performed a chi-squared test with the exact solution of the simple problem to show the validity of the Monte Carlo method. He also developed a method to determine confidence levels after a certain number of throws so that an appropriate number of throws can be determined.

Turner assumed a geometric distribution for the probability of the rotor break point. It was assumed that inboard portions of the blade were twice as likely to break as outboard portions. Equal distribution was assumed for the azimuth position of break. For impact, he developed a bouncing model that he considered conservative based on data from artillery tests. He used a cutoff angle of 20° above which bouncing was not permitted. He also used Eggwertz model for sliding after impact.

Turner later expanded on his work to include a six-degree of freedom model of the fragment (Turner 1989). His model dynamics were similar to (Montgomerie 1982). The aerodynamic model used two-dimensional airfoil data with no adjustment for off-axis flow. A small drag value was added for spanwise flow. He presented results of Monte-Carlo simulations for several model conditions.

Eggers, United States 2001

This is the most recent analysis (Eggers, Holley et al. 2001) generated for the National Wind Technology Center in Colorado. The analysis used classical ballistic theory and assumed constant values of aerodynamic force coefficients. A discussion and analysis is made of the possibility of gliding flight assuming the blade achieves a stable gliding angle; it is assumed negligible. The low probability of this is reasoned due to the complex geometry of the blades, with varying chord, airfoil section, and twist. The mean values of drag ($C_D = 0.5$) and normal force coefficients are considered constant during flight. Half and full-blade fragments are analyzed.

An example turbine was studied with a 15.2 m rotor radius operating at 50 rpm in 11.2 to 22.4 m/s winds. A probability distribution, assuming equal weighting for all directions, was determined analytically and solved numerically. This method was unique in that several trials of throws were not necessary to obtain the distributions. Also assumed was that the failure was the result of an overspeed, and that the range of the overspeed failure was a Gaussian distribution between 1.25 and 1.75 times the nominal speed. Eggers, like Macqueen (1983), confirms peaks in the probability distribution near the tower and at maximum range. Two tower heights were also studied, showing higher probability at the tower base for the shorter tower. Probability values cannot be determined from the paper due to the limited resolution of figures.

3.4.3. Comparisons of Rotor Fragment Analyses

Studies of example turbines were performed in all the analyses discussed previously. A comparison is shown below in Figure 9. The maximum attainable lateral throw distance, normalized by overall turbine height, for a failure at nominal operating conditions is shown for the various analyses. The results show the drop in the normalized maximum throw distance with increasing turbine size.

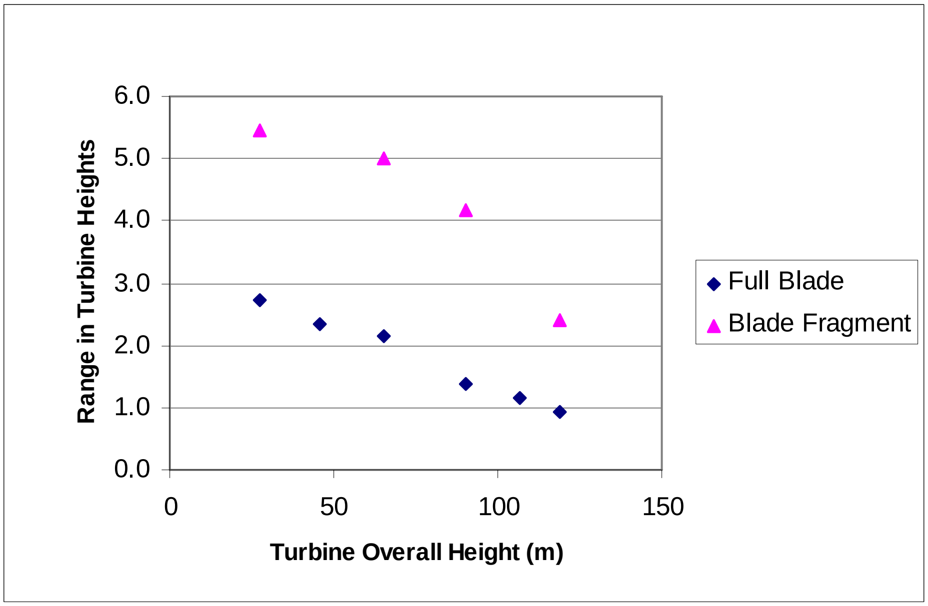

Figure 9. Comparison of rotor fragment analyses for maximum range at nominal operating conditions

4.0 Conclusions and Recommendations

4.1. Conclusions

This study was performed on setbacks for permitting of wind energy. Counties with past and future development of wind energy have setbacks based on overall turbine height. A simple example was presented showing the negative economic impact of setbacks based on size for modern turbines. The application and size of the setbacks varied widely across the counties. However, a common setback is three-times the overall turbine height from a property line.

Most setbacks were established early in the development of the wind industry and were outcomes of ad hoc groups of government and industry. Other counties followed suit based on the example of the early developments. There is some evidence for Riverside County that the "three-times" rule may have been an outcome of expected spacing to reduce waked operation losses. There is no evidence that setbacks were based on formal analysis of the rotor fragment risk.

CWEC also studied the probability of wind turbine rotor failure. Reporting of wind turbine failures are scarce in the literature, but available data from Alameda County and Europe show rotor failures from approximately one-in-one-hundred (10^{-2}) to one-in-one-thousand (10^{-3}) per turbine per year. The most comprehensive study from the Netherlands reported failures for European turbines of approximately one-in-one thousand (10^{-3}) per turbine per year.

Six studies examined modeling of the rotor fragment risk in detail. Several researchers analyzed but discounted the possibility of gliding flight, and instead used simplified aerodynamic models. Sørensen (1984a) used a three dimensional analysis of the rotor fragment flight and showed the limitations of the simplified models. The literature does not offer any guidance for applying setback distances that would be useful for wind energy planning.

Two observations can be made from a comparison of the analyses with failure at the nominal operating condition. The first is that as the overall turbine height increases, the range normalized by overall height decreases. This is primarily because the maximum range is dependent on turbine tip speed. As discussed previously, the tip speed has remained nominally unchanged as turbine size has increased. The other conclusion is that blade fragments fly farther than full blades. This is because the initial velocity at failure tends to be higher for the fragment than the entire blade. This result indicates that setbacks based on overall turbine height may be reduced for larger turbines.

4.2. Recommendations

The setback literature reviewed in this report does not provide an analytical rationale for determining wind turbine setbacks. However, after reviewing the literature for analysis of the rotor fragment hazard, CWEC proposes the following items to develop guidelines for setbacks.

4.2.1. Rotor Failure Rate and Operating Conditions at Failure

The rotor failure probabilities presented by Rademakers and Braam in Appendix A represent the most comprehensive study. The values presented in Section 3.3.4 should be used for analysis of the overall hazard. These values are organized by rotor speed, which can be used to set the release velocity at failure. However, the wind conditions at failure are not known. Simulations can be performed at several wind speeds, and either the worst case could be used, or the results can be weighted by a standard wind speed distribution.

Turbine Sizes

A mixture of turbine sizes should be studied to determine if setbacks should be a standard distance or a function of the turbine size. Turbine sizes currently marketed are 660 kW to 5 MW. Smaller turbines should be studied for stand-alone applications and review of existing hazards.

4.2.2. Position of Blade Break

Since the position of the failure cannot be predicted with certainty, the approach of Eggwertz (1981) to divide the blade into sections should be used. In addition to randomizing the break position, turbines with blade components such as aerodynamic devices, blade dampers, and lightning protection should be studied as fragments.

4.2.3. Aerodynamic Model

The methods of Sørensen (1984a) should be applied for the aerodynamic model. This model was the most comprehensive and showed the limitations of constant aerodynamic coefficient models. The model is well documented and can be updated to modern programming languages. There was an effort to update this program to MATLAB® at the Technical University of Denmark (DTU); however the status of this work is unknown.

Further studies could be conducted to incorporate shear and turbulence into the model. With these effects included, the rotor fragment might exhibit constant lift coefficient and drag coefficient behavior which might warrant use of simpler models.

The model should be built as a tool that can be used by the industry for use on any turbine to study specific cases, such as permitting waivers.

4.2.4. Impact Modeling

The methods of (Turner 1986) and Eggwertz (1981), or Sørensen (1984a) should be used to model the physics at impact. The methods include bouncing at impact and the effects of rotation and translation after impact.

4.2.5. Slope Effects

Slope effects were not included in the reviewed analyses. Because of the common placement of turbines on ridgelines, as in the Altamont and the Tehachapi wind resource areas, modifications to the setback distance should be studied. Modifications should be stated in simple language, similar to the language in the Alameda ordinance.

4.2.6. Validation Effort

None of the analyses have been validated with actual failures. Validation with an actual failure can be made with the following information:

- Turbine tower height
- Rotor diameter
- Position of failure on rotor
- Azimuth of failure (would be very hard to obtain)
- Rotor speed
- Pitch of blades
- Geometric details of the fragment (planform, airfoils, weight, center of gravity, twist distribution)
- Wind speed, direction, and local air density
- Distance and bearing of blade or fragment from tower base

Another effort would be to deliberately cause a rotor failure and obtain the above information. This test could be conducted on a turbine at the end of its useful life in a clear field. Explosive bolts or a ring charge could be used to separate the blade or fragment from the turbine. The azimuth at break must be carefully determined.

5.0 Benefits to California

Researchers should use the information as background for developing models of the rotor fragment hazard. California planning agencies should then use this new rotor fragment hazard information, together with the information in this report as a tool for modifying or establishing wind turbine setbacks.

A better understanding of the risks involved with wind energy will permit the development of appropriate methods to manage that risk, thereby increasing the acceptance of wind energy developments by local governments and the general public.

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7.0 Glossary

Specific terms and acronyms used throughout this paper are defined as follows:

Acronym	Definition
C_D	Coefficient of drag
C_L	Coefficient of lift
CWEC	California Wind Energy Collaborative
DOE	U.S. Department of Energy
DOF	degrees of freedom
DTU	Technical University of Denmark
EIR	Environmental Impact Report
IEC	International Electrotechnical Commission
kW	Kilowatt (1000 Watts)
m	Meters
m/s	Meters per second
MW	Megawatt (1,000,000 Watts)
NREL	National Renewable Energy Laboratory
RPM	Revolutions per minute
SERI	Solar Energy Research Institute (predecessor of NREL)
WECS	Wind Energy Conversion System

Attachment I

ANALYSIS OF RISK-INVOLVED INCIDENTS OF WIND TURBINES

Version 1.1, January 2005

L.W.M.M Rademakers and H. Braam

Energy Research Centre of the Netherlands (ECN)

PO Box 1

1755ZG Petten

The Netherlands

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H. Braam

G.J. van Mulekom

R.W. Smit

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1. INTRODUCTION

As part of the project "Handboek Risicozonering Windturbines (Guide for Risk-Based Zoning of Wind Turbines)," research was conducted on incidents involving wind turbines that may pose a risk to their surroundings. This information is used to quantify the failure events, as well as for the development of a method, described in the Guide, to calculate the risks. These risks include blade failure, tower failure, or any other parts of the wind turbine falling off. In order to determine these risks, it is necessary to understand the possible failure events, and the frequency of these events. Validation of the calculation method is impossible by means of experimentation, but in order to gain sufficient trust in the method it is necessary to have information on what part of the blade has fallen off, its size, and the distance it traveled after separation from the turbine.

To determine the failure frequency of blades, towers, and other parts of a particular wind turbine, the ISET (Institut für Solare Energieversorgungstechnik) in Germany and the EMD (Energie- og Miljødata) in Denmark have provided information [1,2]. Both institutes have a database containing energy production, incident, and maintenance information for most of the wind turbines in Germany and Denmark, respectively. Incidents and occurrences of importance are selected based on the raw data that is extracted from the ISET and IMG databases, in order to obtain insight into possible failure events. This information is also used to determine the frequency of failure events per year, as well as to provide information about the uncertainties. In this appendix the extracted data from the ISET and EMD databases are combined and then applied to calculate failure frequencies.

A supplementary study was conducted based on the throw distance, dimensions of thrown parts, etc. Based on information from the internet, magazines, and detailed information in ISET and EMD reports, a summary of incidents and the related throw distances for different types of turbines was made. The results of this research are included in this appendix.

When reading this report and applying the information in it, it is important to keep in mind the following:

- The data, particularly the number of incidents, are never complete. Not all incidents are reported or known to the ISET, EMD, or ECN. To prevent this from leading to false results, the population of wind turbines for which statistics are calculated is specifically chosen so that all incidents involving these turbines are known.
- It is not always possible to determine the way an accident developed. Sometimes it is clearly reported that a blade (or two blades) has broken off and landed 100 m from the turbine. Sometimes it is only reported that a blade has been damaged and replaced, without any reports of pieces that may have broken off and been thrown from the

turbine. In cases where the extracted data were incomplete, a suitable conservative interpretation of the data was applied.

Based on the information, five separate categories have been determined that are of importance for the risk analysis.

1. Whole turbine blades or very large blade pieces breaking off and being thrown.
2. Brake tips and other blade pieces such as blade surface panels, composite material, bolts, etc. being thrown from the turbine.
3. Tower collapsing.
4. Large parts, such as the nacelle, the whole rotor, or other main components, falling down.
5. Small parts, such as the anemometer or bolts, falling down from the nacelle or the hub.

The reasons for this classification are as follows.

1. A blade that has broken off can be thrown relatively far and has a large mass. It can cause relatively heavy damage to another object.
2. A brake tip or a small part of a blade can be thrown very far. Because it has a small mass, the chance of doing damage to another object is smaller than that of an entire blade.
3. The collapse of a tower usually means great risk to anything in close proximity of the turbine. The entire turbine has an extremely large mass and can therefore cause heavy damage to anything close to the turbine.
4. Similarly to the tower collapse, the fall of a large component such as a nacelle can cause heavy damage to anything close to the turbine.
5. Small parts that fall down cannot cause heavy damage. The risk area for this situation is limited to just a few meters from the tower.

Each category requires a different approach to the risk analysis.

The shedding of ice is not listed here explicitly. The calculation of vulnerable distance and risks for ice can be based on those for category 2 "brake tips and small parts of blades." The frequency of ice being thrown from a blade is very location dependent and therefore the importance of this phenomenon cannot be determined generally for a turbine. Furthermore, the AMvB [3] stipulates that wind turbines with ice on their blades are forbidden to start up.

In this report the following topics are addressed consecutively:

- Results of the analysis of the EMD database.
- Results of the analysis of the ISET database.
- Calculation of the frequency of failure for the categories listed above.
- Results of the analyses concerning the development of a calculation method for throw distances.
- A summary of the failure frequencies and a recommendation on the application of these values in risk analyses.

2. ANALYSIS OF DANISH FAILURE DATA

2.1 Introduction

Energie- og Miljødata (EMD) has a database that contains approximately 6000 turbines in Denmark. The energy production and failure data are registered for over half of these turbines. The owners of the turbines can voluntarily submit a monthly report to the Danish Association of Turbine Owners. This association performs an initial analysis of the information and then codes it. The data is then sent to EMD. EMD feeds the information into their database. In total, EMD has selected and reported 210 risk involved incidents [1].

The main goal of the analysis of the EMD-provided information is the selection of incidents and the calculation of failure frequencies for the five categories (blades, tips, tower, nacelle and rotor, or small parts). In determining the number of relevant incidents and determining the size of the population of turbines, attention is paid to the following.

- The size of the total population of turbines is not always known. Not all turbine owners submit monthly information. This can mean that there were no incidents, or that the incidents were not reported. In particular, energy production numbers of turbines that belong to electric utilities are submitted monthly, but incidents are seldom or never submitted. Of the remaining turbines, incident reports are regularly submitted with the energy production numbers. EMD has followed a conservative approach, and only included those turbines for which incidents are regularly reported. Most turbines belonging to electric utilities are therefore left out of the analyses. It is very probable that most turbines larger than 1 MW belong to the electric utilities. This is exactly the type of turbine that is most important for future risk analyses.
- Blade fracture is relevant to all turbines; a flyaway tip is only relevant to stall regulated turbines with blade tips. Therefore, the size of the total population can be different for each analysis.
- Most incidents are poorly documented, and the actual number of risk-involved incidents cannot be determined for certain. EMD uses codes to indicate which component failed, the reason for failure, and whether parts were thrown from the turbine. From the codes it is difficult to determine the size of the thrown object, the distance thrown, and the order of events. In some cases this information is included in the comments. Between 1993 and 2000 the code was expanded. Between 1984 and 1992, the code was severely restricted. It was seldom even noted whether a compromised turbine had done damage to the surrounding area. This made it possible for a turbine that had a complete failure and lost many parts (see Fig. 2.1) to be reported exactly like a turbine that had a complete failure and posed no risk to the surrounding area (see Fig. 2.2).

Fig. 2.1: Two examples of incidents that pose possible danger to the surrounding area.

Fig. 2.2: Two examples of turbines that failed, but caused no danger to their surroundings.

2.2 Turbine Population

The turbine population from 1984 through 2000, as provided by EMD, is separated into the different types. The results are presented in Fig. 2.3. At the end of the year 2000 the total turbine population reached about 2900 turbines. The total number of operating years reached almost 30,000. By far the most turbines are stall-regulated turbines.

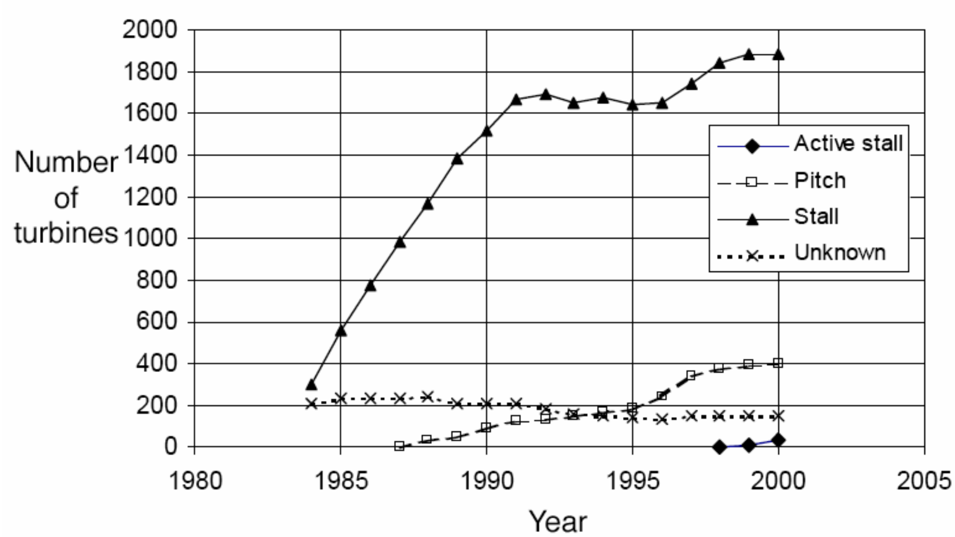

Fig. 2.3: Number of wind turbines in the EMD database, separated by type.

When the turbines are separated into groups based on rated output, the distribution as shown in Table 2.1 is established.

Table 2.1: Number of operating years, separated into groups based on rated output

Rated Output [kW]	Operating Years	Percentage
0 - 50	3229	11.0%
51 - 300	24368	82.8%
301 - 750	1769	6.0%
751 - 1300	47	0.2%
1301 -	0	0.0%
Total	29413	100.0%

2.3 Failures and Incidents

As is briefly discussed in paragraph 2.1, not all incidents are reported with enough detail to make unambiguous conclusions. EMD has created the following four categories to indicate how dangerous an incident is:

3. Definitely dangerous, unambiguously reported

2. May be dangerous, but not for certain

1. Not dangerous, unambiguously reported

0. Necessary information missing

In many cases it appeared difficult to indicate exactly whether a turbine had indeed lost parts as in Fig. 2.1, or was just heavily damaged as in Fig. 2.2. The final results from the selection of risk involved incidents are given in Table 2.2. The total can be seen in Table 2.3. This table includes the total number of operating years for each type. This number is obtained by summing the number of turbines in operation per year over all the years.

Table 2.2: Number of risk involved incidents per year for each regulation type. For each type, number of turbines in operation at that point is given per year.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Active stall															3	10	30
Blades																	
Tips																	
Turbine, nacelle, large parts																	
Small parts																	1
Pitch				4	35	53	88	126	134	153	170	183	239	339	373	389	399
Blades																	
Tips																	
Turbine, nacelle, large parts																	
Small parts																1	
Stall	300	557	772	984	1167	1386	1517	1664	1689	1648	1675	1642	1651	1743	1839	1885	1887
Blades							2	3		2	1	1		1	1		1
Tips									1						1	1	
Turbine, nacelle, large parts			1							1						1	
Small parts											5	2	4	1	2	3	2
Unknown	210	230	234	237	245	209	208	207	181	155	152	144	136	150	153	154	150
Blades			1		1												
Tips																	
Turbine, nacelle, large parts				1			1		2								
Small parts																	
Total # turbines	510	787	1006	1225	1447	1648	1813	1997	2004	1956	1997	1969	2026	2232	2368	2438	2466
Total # failures with dropped parts	0	0	2	1	1	0	3	3	3	3	6	3	4	2	4	6	4

Table 2.3: Total of all risk involved incidents, total for all operating years, and the number of operating years for each type of turbine.

	1984-1992	1993-2000	Total
Active Stall	**0**	**43**	**43**
Blades			
Tips			
Whole Turbine			
Small Parts		1	1
Pitch	**440**	**2245**	**2685**
Blades			
Tips			
Whole Turbine			
Small Parts		1	1
Stall	**10036**	**13970**	**24006**
Blades	5	7	12
Tips	1	2	3
Whole Turbine	1	2	3
Small Parts		19	19
Unknown	**1961**	**1194**	**3155**
Blades	2		2
Tips			
Whole Turbine	4		4
Small Parts			
Turbine Years	**12437**	**17452**	**29889**
Total Incidents	**13**	**32**	**45**
Total Suspected Incidents	55	51	106

In the time period between the years 1993 and 2000, in total there were 11 "category 3 incidents" reported, and 66 "category 2 incidents." Based on the information provided by EMD, and after reading the commentary, there appeared to be 51 suspicious incidents; of the 77 total incidents, 26 could be eliminated. Of the 51 suspicious incidents, 32 were proven risky and were included in the analysis. Between 1984 and 1992 there were 55 suspicious incidents, and 13 ended up being included in the analysis.

From the detailed analysis of the incidents, it seems that some cases involved multiple parts breaking off and being thrown. With blades, for example, it is possible for one, two, or three blades to be thrown. In the seven incidents involving blade throw between 1993 and 2000, a total of ten blades were thrown. There were no incidents reported that involved more than one object when it came to the tips and small parts. Clearly when the incident involved the tower or nacelle, only one object can be affected. That is why there is a multiplication factor of 10/7 used in calculating risk for the blades. The total number of incidents and the corresponding population of turbines are tabulated in Table 2.4.

In EMD's report, only failures of the whole turbine were reported; no distinction was made between the categories "nacelle and rotor" and tower failures. When the part listed was the "turbine," it was not immediately clear whether it was the tower or the nacelle that was affected. Later analyses of the raw data, according to tables 2.2 and 2.3, showed that at least 2, maybe even 3, of the 7 incidents involved the whole tower collapsing. That is why in table 2.4 there are half incidents.

Table 2.4: Overview of incidents in the total wind turbine population

Part	84-92	93-00	84-00	Factor	Total	Turbine Years	Notes
Blades	7	7	14	1.4	20	29889	Total number of turbines
Tips	1	2	3	1.0	3	24006	Total number of stall turbines
Nacelle	3.5	1	4.5	1.0	4.5	29889	Total number of turbines
Tower	1.5	1	2.5	1.0	2.5	29889	Total number of turbines
Small Parts		21	21	1.0	21	17452	Total number of turbines between 1993 and 2000
TOTAL	**13**	**32**	**45**				

As can be deduced from the previous paragraphs, determining the number of incidents within the scope of the entire turbine population is done with much uncertainty. The population used by EMD involves mostly three-bladed, stall regulated turbines, with a rated output of up to 750 kW. This population is made up of about 2900 turbines. Future turbines for which the risk analysis is being done will most likely be pitch regulated turbines with an output greater than 1 MW. It is these types of turbines for which EMD has little information. It is not clear if there were indeed no incidents, or if they merely were not reported.

2.4 Trends

Simultaneously the correlation between the age of a turbine and its frequency of failure was researched. For this the 32 critical incidents between 1993 and 2000 were divided into four time periods (0-5 years, 5-10 years, etc.). The number of incidents in each time period is divided by the number of turbines that fall into that category. (Note that determining the population of turbines in each category could not be done with great accuracy. The number of turbines between 0 and 5 years old was determined by subtracting the number of turbines in operation in 1995 from the number of turbines in operation in 2000. It is unclear whether there were turbines taken out of operation or replaced). Most failures were caused by turbines between 5 and 10 years old.

The relationship between the rated-power category of the turbines and their failure frequency was also researched. The number of incidents in each rated-power category is divided by the number of years in operation for each category. No trend is found.

3. ANALYSIS OF GERMAN FAILURE DATA

3.1 Introduction

ISET has made an inventory of "critical losses" that have occurred in Germany over the past 10 years. ISET has defined a "critical loss" in the following way.

A critical loss is a sudden and lasting change in a wind turbine that can potentially or definitely cause damage to the surrounding area. The cause of the change can be due to external sources (e.g. lightning and storm), or internal sources (fatigue).

It is therefore not conclusive that the recorded cases did cause damage to the surrounding area. This inventory is in principle based on the WMEP database (Wissenschaftliches Meß- und Evaluieringsprogramm), which is managed by ISET. Additional information was obtained from technical publications and the internet.

Information from approximately 1500 turbines in Germany has been collected in a systematic manner in the WMEP database since 1989. The results of these 1500 turbines provide a representative overview for the approximately 10,000 total turbines that have been installed in Germany. The database contains over 48,000 entries. In order to facilitate analysis of the database, the above definition for a critical loss is used as a starting point.

Based on this definition, a number of search criteria have been devised for the database. The most important criteria used are:

1. The shutdown of a turbine has to be the result of a failure (preventive maintenance and other planned activities are thereby eliminated);
2. Eligible failure modes are:
   - Storm
   - Lightning
   - Defective component
   - Defective assembly or mounting
   - Other causes;
3. A repair or a replacement is required for one of the following main components:
   - Rotor hub

- Blade
- Nacelle
- Tower

Repairs or replacements of gear boxes or generators are not included, because a failure of these components rarely causes potential danger to the surrounding area.

The automatic search of the database with the aforementioned criteria resulted in 152 matches. These matches are subsequently scrutinized one at a time by ISET, resulting in a further reduction of the number of incidents. This finally resulted in 43 cases that could actually be reported as involving serious damage.

These 43 cases involve the time period from 1991 until July 2001.

3.2 Turbine Population

The total number of operating years of all 1566 wind turbines included in the database at the end of July 2001 was about 13,000 years. The 43 serious damage incidents correspond to 0.33 critical incidents per 100 operation years.

3.3 Failures and Incidents

The 43 cases of turbine damage from the WMEP database are arranged by type of damage. The results are presented in Figure 3.1.

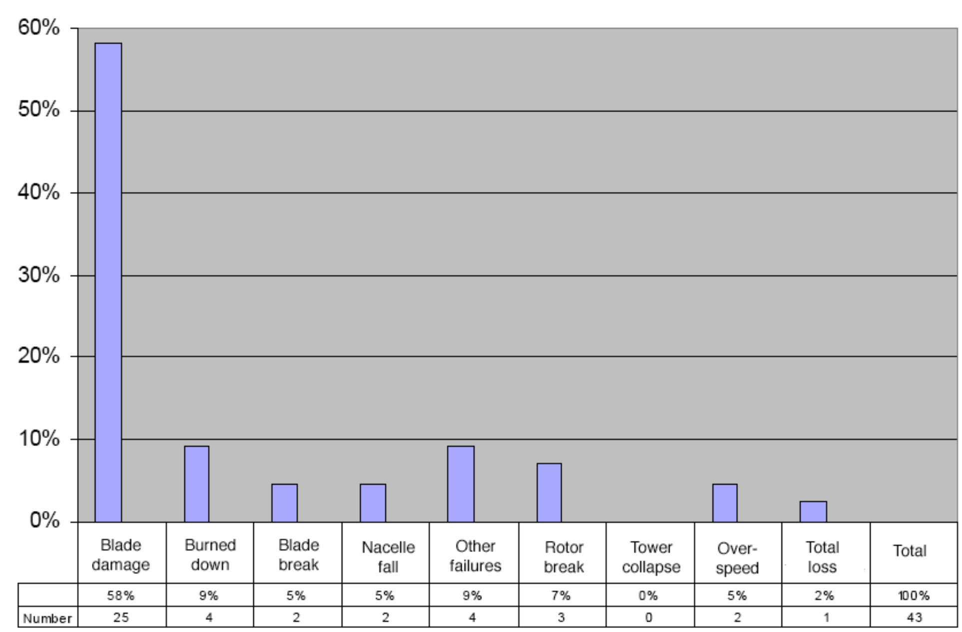

Fig. 3.1: Type of damage for 43 cases involving serious damage.

Blade fracture, rotor failure, nacelle fall, and tower collapse are all of importance to risk analyses, because it is these phenomena that can cause damage to people or objects in the nearby surroundings. The other types of damage result only in economic damages.

With regards to blade fracture, there has been one report of a case where one blade broke off the turbine. For the second case, no information is given on the number of fractured blades. For further analysis, a conservative conclusion was made that all three blades had fractured. So, in total, there were four broken blades in the two cases of blade fracture.

Three cases of rotor failure were reported. With this type of failure there are a few possibilities:

1. The rotor failure causes the blades to break off and to be thrown from the turbine.
2. The rotor breaks off and falls from the turbine. The parts fall close to the turbine and the effects are similar to those of a fallen nacelle.

One case was reported that involved blades striking the tower, and then breaking off. As a result, the number of cases of blade fracture becomes seven. In the other two cases it was reported that damage was found, but not whether blades were broken or a rotor fell. For these two cases it is assumed that it was the rotor that fell. It should be noted that there is no mention of brake tips falling, or of small parts falling from the nacelle or hub.

The total number of critical turbine damage cases that are relevant to the risk analysis is shown in Table 3.1. The research done by ISET focused on critical cases, therefore there is no information on small parts. Nowhere is there mention of brake tip failure.

Table 3.1: Number of critical turbine damage cases with the potential to cause danger to the surrounding area

Part	Number	Turbine Years
Blade separation	7	13000
Fallen nacelle and/or rotor	4	13000
Tower failure	0	13000

3.4 Trends

From the analysis conducted by ISET, the following trend develops. Lightning seemed to cause a great percentage (34%) of the heavy damage to turbine blades. However, as the blades include better lightning protection systems, the number of heavy damage cases decreases significantly. Now lightning causes only limited damage to the blade surface, near the receptors which during preventive maintenance can be repaired.

4. FAILURE FREQUENCIES

In Chapters 2 and Chapter 3 overviews are given for the total number of incidents per turbine part. The failure frequencies are calculated based on all reported incidents, from the EMD database as well as the ISET database. Table 4.1 gives an overview of the total number of incidents, and the number of turbine-years for which the incidents have relevance.

Table 4.1 also gives the calculated failure frequencies. The expected failure frequency value for each part is calculated by dividing the total number of incidents by the number of relevant turbine-years. It appears that the number of incidents is small compared to the number of turbine-years, so the calculated expected value has a non-negligible uncertainty that can be quantified by the probability density function of the expected value. The occurrence of a particular incident can be modeled with a Poisson process. In a Poisson process there is an invariable chance of an incident occurring in time. For n incidents in T turbine-years, the probability density function for the failure frequency per turbine-year, $f(\lambda)$, is given by the Gamma function [4], or

$$f(\lambda;\alpha,\beta) = \frac{\beta^{-\alpha}\lambda^{\alpha-1}\exp\left(\frac{-\lambda}{\beta}\right)}{\Gamma(\alpha)}$$

where

$$\alpha = n$$

$$\beta = 1/T$$

Next to the expected value in Table 4.1 is also listed the 95 % upper limit for the failure frequency.

Table 4.1: Failure frequencies per part.

Part	Total EMD and ISET		Failure Frequency [1/turbine-year]	
	Number	**Turbine years**	**Expected Value**	**95% upper limit**
Blades [1])	27	42889	$6.3*10^{-4}$	$8.4*10^{-4}$
Tips	3	24006	$1.2*10^{-4}$	$2.6*10^{-4}$
Nacelle	8.5	42889	$2.0*10^{-4}$	$3.2*10^{-4}$
Tower	2.5	42889	$5.8*10^{-5}$	$1.3*10^{-4}$
Small Parts	21	17452	$1.2*10^{-3}$	$1.7*10^{-3}$

[1]) Failure frequency is based on total number of turbine-years, so this indicates the chance of blade failure per turbine per year.

5. ANALYSIS OF INCIDENTS AND THROW DISTANCES

In addition to determining the failure frequencies of blades, tips, turbines, and small parts, attention was also paid to accident scenarios. To calculate the risk turbines pose to their surroundings, it is important to know what throw distances are probable and how large the separated parts are. Therefore, an analysis was done of incidents and accidents that are published in detail, for which the following sources are consulted:

- http://wilfriedheck.tripod.com/unf.htm
- http://querulant.com/querulant/wind
- http://home.wxs.nl/%Ewindshnieuws.htm
- http://home.wxs.nl/~hzwarber/wind/feiten/veilig.htm
- Energie- en Milieusp. 4-95
- Windnieuws ODE 94/1
- Windnieuws ODE 94/2
- Windnieuws ODE Febr. 95
- Windnieuws ODE April 95
- Windnieuws ODE Jan. 96
- Windnieuws ODE Juni 96
- Windnieuws ODE Sept. 96
- Duurzame Energie Dec. 95
- Duurzame Energie Febr. 95

The results of the analyses are presented in Figures 5.1 through 5.4. In these figures, one for each type of incident, the reported throw distance is presented (x-axis) as a function of the rated power (y-axis). The curves in each graph relate the approximate rotor diameter associated with corresponding rated power level. The curves are added to put the throw distances in perspective.

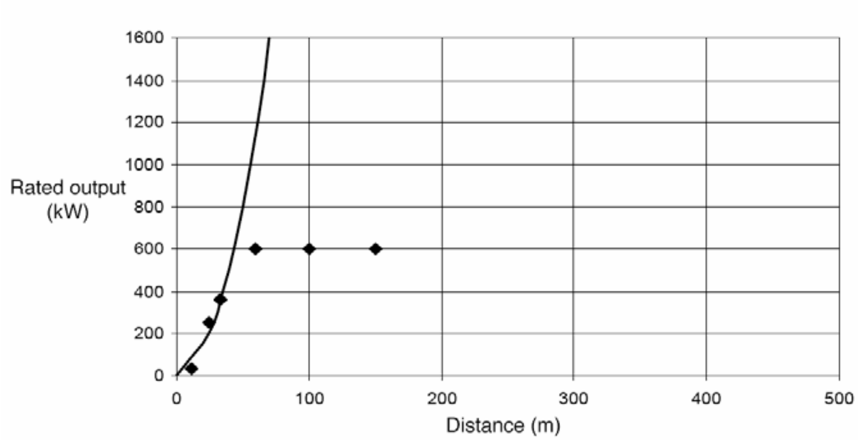

Fig. 5.1: Throw distance of entire blades as a function of the rater power output, the drawn line gives the rotor diameter.

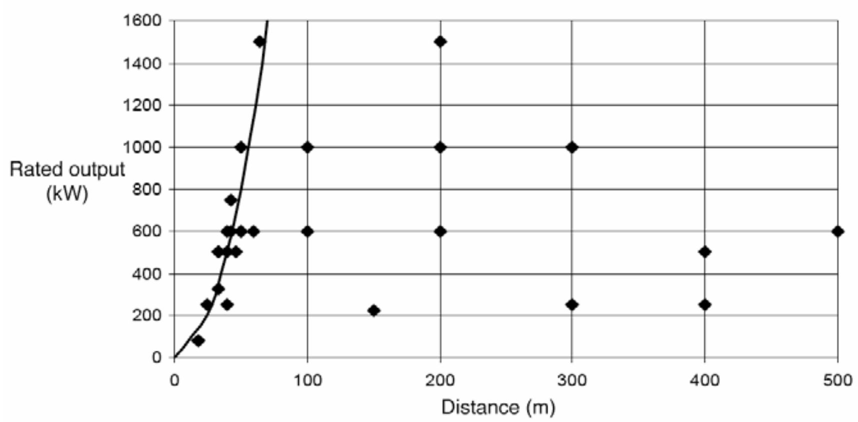

Fig. 5.2: Throw distance of tips and small blade pieces as a function of the rated power output, the drawn line gives the rotor diameter.

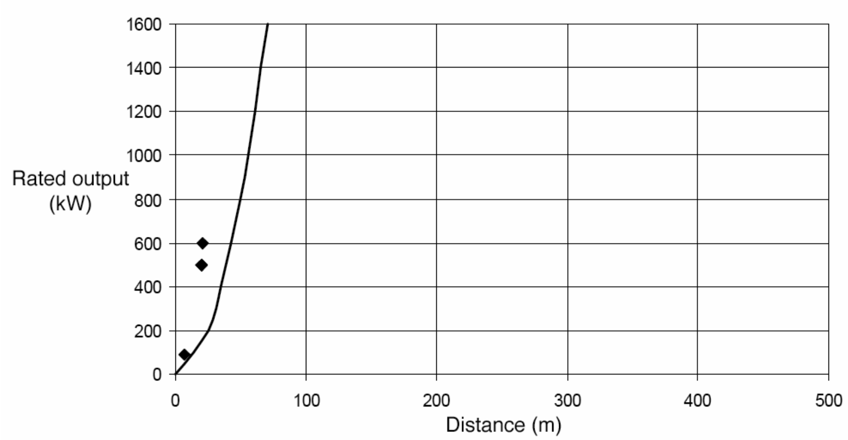

Fig. 5.3: Throw distance due to fall of nacelles and rotors, as a function of the rated power output, the drawn line gives the rotor diameter.

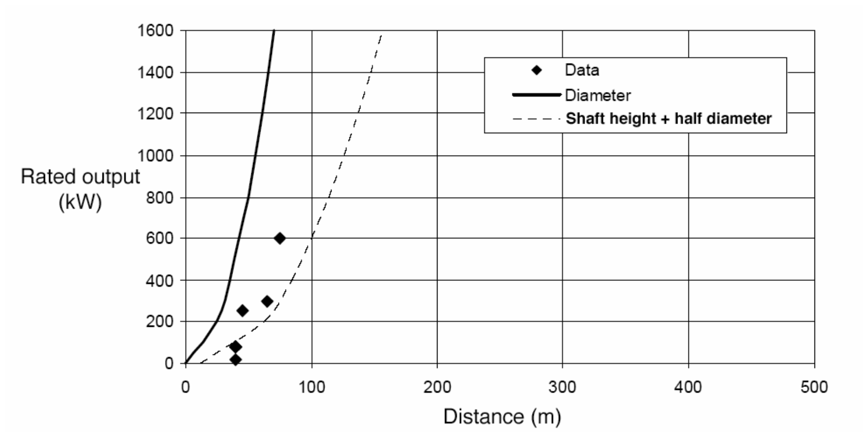

Fig. 5.4: Throw distance due to tower collapse as a function of the rated power output, the drawn line gives the rotor diameter. The dotted line gives the shaft height plus rotor radius (half diameter).

The following can be concluded from Figures 5.1 through 5.4.

- Small blade parts and tips can fly very far. The maximum distance reported is 500 m.
- The maximum throw distance of an entire blade found during this analysis is about 150 m. Distances of 400 and 600 meters for entire blades were also reported in publications. Nevertheless, attempts to confirm these numbers through contacting the owner or the publisher were unsuccessful.
- When a rotor or nacelle falls down, the risk zone is approximately equal to half a rotor diameter.
- When an entire tower fails, the risk zone is equal to the height of the tower plus half a rotor diameter.

6. CONCLUSIONS

6.1 Recommended Risk Analysis Values

ECN has analyzed the reported incident information for a large population of wind turbines in Denmark and Germany and determined the frequencies of:

- Blade fracture;
- Tips and other small parts breaking off;
- Tower failure at the tower root;
- Rotor or nacelle falling down;
- Small parts falling from the rotor or nacelle.

The chance of blade fracture is further separated into:

- Failure at nominal operating rpm (revolutions per minute);
- Failure during mechanical braking;
- Failure due to overspeed.

The ECN also did an in-depth study of the possible throw distances due to turbine failure. The results of this analysis are summarized in Table 6.1.

Table 6.1: Failure frequencies and maximum reported throw distances

Part	Failure frequency per turbine per year			Maximum throw distance [m] (reported and confirmed)
	Expected Value	95% upper limit	Recommended Risk Analysis Value [1/yr]	
Entire blade	$6.3*10^{-4}$	$8.4*10^{-4}$	$8.4*10^{-4}$	150
Nominal rpm			***$4.2*10^{-4}$***	
Mechanical braking			***$4.2*10^{-4}$***	
Overspeed			***$5.0*10^{-6}$***	
Tip or piece of blade	$1.2*10^{-4}$	$2.6*10^{-4}$	**$2.6*10^{-4}$**	500
Tower	$5.8*10^{-5}$	$1.3*10^{-4}$	**$1.3*10^{-4}$**	Shaft height + half diameter
Nacelle and/or rotor	$2.0*10^{-4}$	$3.2*10^{-4}$	**$3.2*10^{-4}$**	Half diameter
Small parts from nacelle	$1.2*10^{-3}$	$1.7*10^{-3}$	**$1.7*10^{-3}$**	Half diameter

6.2 Closing Remarks

Until now ECN, NRG, and KEMA and other organizations have conducted various risk analyses. The failure frequencies used for these analyses were derived from a study of Danish failure frequencies like those published between 1990 and 1992 in WindStats with the expected values for the failure frequencies of blade fracture per turbine split up into:

- Failure at nominal operating rpm $1.3*10^{-3}$ per year
- Failure during mechanical braking (~1.25 times nominal rpm) $1.3*10^{-3}$ per year
- Failure by overspeed (~2 times nominal rpm) $5.0*10^{-6}$ per year

The total chance of blade fracture per turbine was $2.6*10^{-3}$ per year. The analysis of the new failure information shows that this chance is decreased by a factor of 3.1 to $8.4*10^{-4}$. The recommended risk analysis value is 3.1 times smaller than the one used in the past.

Failure during overspeed is not reported in either ISET's or EMD's data. The ISET data did reveal that two incidents led to a long-lasting overspeed situation. The chance of this happening is therefore 2/13,000 = $1.5*10^{-4}$. The blades stayed in one piece in these situations. Until now the chance of overspeed was determined by multiplying the chance of electric grid failure (5 times per year), the chance of failure of the first brake system (10^{-3} per claim), the chance of failure of the second brake system (10^{-3} per claim), and the chance of blade fracture in this situation (=1). Here it is recommended to retain the old calculation value for blade fracture during overspeed, as $5.0*10^{-6}$ per year.

Information about the tower failures was until now never derived from failure frequency databases. Until now the assumption was made that the chance of a tower failure had to be at least ten times smaller than that of a blade failure because it goes nearly unreported. The calculation value of $1.0*10^{-4}$ was used. The new calculation value based on the 95% upper limit is 1.3 times larger than the value that was used in the past.

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Draft
Eagle Conservation Plan Guidance

U.S. Fish & Wildlife Service
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EXECUTIVE SUMMARY

The mission of the U.S. Fish and Wildlife Service is to work 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 Bald and Golden Eagle Protection Act (BGEPA), the Migratory Bird Treaty Act, and the Endangered Species Act. The draft Eagle Conservation Plan Guidance (draft Guidance) is intended to assist parties to avoid, minimize, and mitigate adverse effects on bald and golden eagles. The draft Guidance calls for scientifically rigorous surveys, monitoring, assessment, and research designs proportionate to the risk to eagles. The draft Guidance describes a process by which wind energy developers can collect and analyze information that could lead to a programmatic permit to authorize unintentional take of eagles at wind energy facilities.

The *Draft Eagle Conservation Plan Guidance Module 1: Wind Energy Development* (Draft Eagle Conservation Plan Guidance) provides recommendations for the development of *Eagle Conservation Plans* (ECPs) to support issuance of eagle programmatic take permits for wind facilities. Programmatic take permits will authorize limited, incidental mortality and disturbance of eagles at wind facilities, provided effective offsetting conservation measures that meet regulatory requirements are carried out. To comply with the permit regulations, conservation measures must avoid and minimize take of eagles to the maximum degree, and, for programmatic permits necessary to authorize ongoing take of eagles, advanced conservation practices (ACPs) must be implemented such that any remaining take is unavoidable. Further, for eagle management populations that cannot sustain additional mortality, any remaining take must be offset through compensatory mitigation such that the net effect on the eagle population is, at a minimum, no change. The Draft Eagle Conservation Plan Guidance interpret and clarify the permit requirements in the regulations at 50 Code of Federal Regulations (CFR) 22.26 and 22.27, and do not impose any binding requirements beyond those specified in the regulations.

The Service recommends that ECPs be developed in five stages. Each stage builds on the prior stage, such that together the process is a progressive, increasingly intensive look at likely effects of the development and operation of a particular site and configuration on eagles. The objectives, recommended actions, and recommended data sources for each of the five stages in the ECP are described in the following table. The Draft Eagle Conservation Plan Guidance recommends that project proponents employ fairly specific procedures in their site assessments so the data can be combined with that from other facilities in a formal adaptive management process. This adaptive management process is designed to reduce uncertainty about the effects of wind facilities on eagles. Project proponents are not required to use the recommended procedures, however, if different approaches are used, the proponent should coordinate with the Service in advance to ensure that proposed approaches will provide comparable data.

The Draft Eagle Conservation Plan Guidance recommend that at the end of each of the first four stages, project proponents determine which of the following categories the project, as planned, falls into: (1) high risk to eagles, little opportunity to minimize effects; (2) high to moderate risk to eagles, but with an opportunity to minimize effects; (3) minimal risk to eagles; or (4) uncertain.

Projects in category 1 should be moved, significantly redesigned, or abandoned because the project would likely not meet the regulatory requirements for permit issuance. Projects in categories 2, 3, and possibly 4 are candidates for ECPs. Service biologists are available to work with project proponents in the development of their ECP. Frequent close coordination from the outset is beneficial to the Service and the project proponents and it will help ensure the ECP meets the needs and requirements of all parties involved.

	Objective	**Actions**	**Data Sources**
STAGE 1	Identify potential wind facility locations with manageable risk to eagles at the landscape level	Broad, landscape-scale evaluation	Literature, agency files, on-line databases, experts
STAGE 2	Obtain site-specific data to predict eagle fatality rates and disturbance take at wind-facility sites that pass Stage 1 assessment.	Site-specific surveys (on and within 10 miles of project footprint) to determine eagle exposure rate in project footprint, the location and pre-construction occupancy and productivity of potentially-affected eagle nests, and to locate eagle migration corridors and stopover sites, foraging concentration areas, or communal roosts in the project area	800-m radius point count surveys in project footprint, nesting surveys in the project area, migration counts on likely migratory routes in the project area, roost searches and counts in the project area. Ideally conducted for 3 years pre-construction
STAGE 3	Conduct turbine-based risk assessment and estimate the fatality rate of eagles for the facility evaluated in Stage 2, excluding possible advanced conservation practices (ACPs)	Assess risk factors for each turbine, such as nearby cliff rim, migration pass, or prey concentration. Use results of this risk factor assessment along with an estimate of eagle exposure rate derived from Stage 2 data in Service-provided models to predict the annual eagle fatality rate for the project	Point count data from Stage 2 and turbine-based, risk-factor assessment
STAGE 4	Identify and evaluate ACPs that might avoid or minimize fatalities identified in Stage 3. When required to do so, identify compensatory mitigation necessary to reduce any remaining fatality effect to a no-net-loss standard	Re-run fatality prediction models with risk adjusted to reflect application of ACPs. Calculate required compensatory mitigation amount and identify the method to accomplish it	Turbine-based risk-factor assessment modified on a turbine-by-turbine basis after application of ACPs, and point count data from Stage 2
STAGE 5	Document annual eagle fatality rate and disturbance effects. Identify additional ACPs to reduce observed level of mortality, and determine if initial ACPs are working and should be continued. When appropriate, monitor effectiveness of compensatory mitigation	Conduct fatality monitoring in project footprint. Monitor occupancy and productivity of nests of eagle pairs that are likely using the project footprint. Monitor eagle use of communal roosts in the project area	Use line-transect surveys in project footprint to estimate the eagle fatality rate. Monitor nests adjacent to the project footprint to determine productivity for comparison with pre-construction levels. Count eagles at roosts for comparison with pre-construction levels, for 3 years post-construction, and targeted thereafter to assess effectiveness of any additional ACPs.

A. INTRODUCTION AND PURPOSE

The mission of the U.S. Fish and Wildlife Service (Service) is to work 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 statues including the Bald and Golden Eagle Protection Act (BGEPA), the Migratory Bird Treaty Act, and the Endangered Species Act. BGEPA prohibits all take of eagles unless otherwise authorized by the Service. A goal of BGEPA is to achieve and maintain stable or increasing populations of bald and golden eagles. The draft Eagle Conservation Plan Guidance (draft Guidance) is intended to provide a means of compliance with BGEPA by:

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

The draft Guidance calls for scientifically rigorous surveys, monitoring, risk assessment, and research designs proportionate to the risk to eagles. The draft Guidance was developed as a tool to assist wind energy developers and facility operators during the decision-making process, and describes a means by which to collect and analyze information that could lead to a programmatic permit to authorize unintentional take of eagles at wind energy facilities. The process described here is not required, but project proponents should coordinate closely with the Service concerning alternatives.

1. Purpose

The U.S. Fish and Wildlife Service (Service) published a final rule (Eagle Permit Rule) on September 11, 2009 under the Bald and Golden Eagle Protection Act (BGEPA) (50 Code of Federal Regulations [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 Draft Eagle Conservation Plan Guidance explains the Service’s approach to issuing programmatic eagle take permits under this authority, and provides guidance to permit applicants (project proponents), Service biologists, and biologists with other jurisdictional agencies on the development of draft *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) has increased dramatically in the range of the Golden Eagle in the western United States. Golden Eagles are vulnerable to collisions with wind turbines (Hunt 2002, Chamberlain *et al.* 2006), and in some areas such collisions are a major source of mortality (Hunt *et al.* 1999, 2002). Although significant numbers of bald eagle mortalities have not yet been reported at North American wind facilities, the closely related white-tailed sea eagle (*Haliaeetus albicilla*) has been killed regularly at wind facilities in Europe (Krone 2003, Cole 2009). Because of this risk to eagles, many of the current and planned wind facilities require permits under this provision in the regulations in order to be in compliance with the law. In addition to being legally necessary to comply with BGEPA and 50 CFR 22.26, the conservation practices and adaptive management necessary to meet standards required for issuance of these permits can offset the short- and long-term effect of wind 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, and we expect to release other modules in the near future specifically addressing other forms of eagle take. In all cases, the Draft Eagle Conservation Plan Guidance are 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 requirements.

The Draft Eagle Conservation Plan Guidance 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 these Draft Eagle Conservation Plan Guidance may not be applicable or possible. Project proponents with operating or soon-to-be operating facilities at the time this Draft Eagle Conservation Plan Guidance were first released that are interested in obtaining a programmatic eagle take permit should coordinate with the Service. The Service will work with project proponents to determine if the facility might be able to meet the permit requirements in 50 CFR 22.26 by conducting eagle fatality and disturbance monitoring and by agreeing to adopt reasonable operational avoidance and minimization measures that might reduce the eagle fatalities detected through monitoring. Sections of the Draft Eagle Conservation Plan Guidance that address these topics are relevant to both planned and operating wind facilities.

The Draft Eagle Conservation Plan Guidance is compatible with the more general guidelines provided in the *U.S. Fish and Wildlife Service Draft Land-based Wind Energy Guidelines* (guidelines which project proponents should consult on addressing other migratory bird issues associated with wind facilities). However, because the Draft Eagle Conservation Plan Guidance describes actions which help to comply with the regulatory requirements in the BGEPA for an eagle take permit as described in 50 CFR 22.26, they are more specific.

2. Legal Authorities and Relationship to Other Statutes and Guidelines

BGEPA is the primary law protecting eagles. It defines “take” as “to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, disturb individuals, their nests and eggs” (16 USC 668c). “Disturb” is defined by regulation at 50 CFR 22.3 in 2007 as “to agitate or bother a bald or golden eagle to a degree that causes…injury to an eagle, a decrease in productivity, or nest abandonment…” (USFWS 2007). A goal of BGEPA is to achieve and maintain stable or increasing populations of bald and golden eagles.

In 2009, two new permit rules were created for eagles. Under 50 CFR 22.26, the Service can issue permits that authorize limited 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. Further, as explained above, the regulation also authorizes ongoing or programmatic take, but requires that any authorized programmatic take is unavoidable after implementing 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 that the take is compatible with the preservation of each species, defined in USFWS (2009a) as "…consistent with the goal of increasing or stable 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 National Environmental Policy Act (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).

The programmatic permits under the BGEPA were originally envisioned to be broad, industry-wide take permits. However, the greatest demand in practice has been from individual companies, and as a result, we are seeing a demand for many smaller-scale permits covering individual installations that may take few eagles individually, but cumulatively could take many.

The Draft Eagle Conservation Plan Guidance is not intended to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, state, tribal, or local laws, statutes, or regulations. Wind facility projects that are expected to cause take of endangered or threatened wildlife species must still receive incidental take authorizations under sections 7 or 10 of the Endangered Species Act (ESA) of 1973 as amended (ESA; 16 United States Code [USC] § 1531 *et seq*.). A project proponent seeking an Incidental Take Permit (ITP) through the ESA section 10 Habitat Conservation Plan 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 must obtain a BGEPA permit or include the bald or golden eagle as a covered species in the HCP. If bald and 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 a BGEPA permit is denied, an ITP may not be issued in association with the proposed HCP because the activities covered by the proposed HCP are not otherwise lawful if they cause unauthorized take of eagles. If the project proponent proposes to include the bald or golden eagle as a covered non-listed species in the ITP but the minimization and mitigation measures are found not to meet the BGEPA permit issuance criteria an ITP may not be issued in association with the proposed HCP because the permit revocation criterion at 50 CFR 22.11(a) applies when the permitted activity is incompatible with the preservation of the bald eagle or golden eagle.

In addition to the ESA, wind facility project proponents must comply with the Migratory Bird Treaty Act (MBTA). The Migratory Bird Treaty Act (MBTA; 16 USC § 703 *et seq*.) prohibits the taking, hunting, killing, collecting, capture, possession, sale, purchase, transport import, and export of migratory birds, their eggs, parts, and nests, except when authorized by the Department of Interior. Because neither the MBTA nor its permit regulations at 50 CFR Part 21 currently provide a specific mechanism to permit "incidental" take, it is important for project proponents to work proactively with the Service to avoid and minimize take of migratory birds. The Service is actively working to develop guidance for the development of plans specific to migratory birds other than bald and golden eagles, as well as other species listed under the ESA.

The National Environmental Policy Act of 1969 as amended (NEPA) (42 U.S.C. 4321 *et seq.*) 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 related to a project. For actions that may result in applications for or development of programmatic permits, the Service may participate as a cooperating agency to streamline the permitting process.

If no other federal nexus exists, the Service must complete a NEPA analysis before it can issue a permit. The Service will work with the project proponent to conduct a complete NEPA analysis, including assisting with data needs and determining the scope of analysis. Developers should coordinate closely with the Service for projects with no federal nexus other than the eagle permit, and to facilitate timely preparation of NEPA documents, project proponents may provide assistance in accordance with 40 CFR §1506.5. Close coordination between project proponents 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. The NEPA on our permits and the discussion of mitigation in this document follow this system, and in this Draft Eagle Conservation Plan Guidance we refer to (1) – (4) as avoidance and minimization measures, and to (5) as compensatory mitigation. To the extent that the Service acknowledges a developer's commitments to mitigate adverse environmental impacts, the Service will work with the developer to achieve those commitments, monitor how they are implemented, and report on the effectiveness of the mitigation. Additionally, the Service will make generic information on take and mitigation monitoring available to the public.

Eagles are highly significant species in Native American culture and religion (Palmer 1988) and may be viewed as contributing elements to a "traditional cultural property" under Section 106 of the National Historic Preservation Act (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.

Indian tribes have a special status in American law as sovereign nations. Tribes also possess certain rights that are different from the rights of other Americans. Some of the special rights of tribes are based on treaties, some are based on acts of Congress, some are based on actions taken by the Executive Branch of the federal government, and others are clarified by federal court rulings. The Service will consult with tribes on a government-to-government basis as described under Executive Order 13175 and Secretarial Order 3206 during the public comment period on the draft Eagle Conservation Plan Guidance. During the process for bald eagle and golden eagle permitting, the Service will, where appropriate, and to the extent practicable and permissible by law, engage with tribes in open and meaningful communication. Consultation regarding eagle permits under 50 CFR 22 and management of eagle populations will be consistent with overall Service guidance for tribal consultation, but may include additional provisions specific to bald and golden eagles. This draft Guidance changes nothing from the September 2009 regulations concerning eagle take permits in 50 CFR 22.26 and 50 CFR 22.27.

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 statutory and 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 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, as well as to consider operational adjustments at individual projects at regular intervals. The Draft Eagle Conservation Plan Guidance provides the background and information necessary for wind facility project proponents 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. 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 bald and golden eagles in a variety of ways. First, structures such as wind turbines can cause direct mortality through collision (Hunt 2002, Krone 2003, Chamberlain *et al.* 2006). This is the primary threat to eagles from wind facilities, and the monitoring and avoidance and minimization measures advocated in the Draft Eagle Conservation Plan Guidance primarily are aimed at this threat. Second, activities associated with pre-construction, construction, or maintenance of a facility can 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 can 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 areas that are important for roosting or foraging might stress eagles to a degree that leads to reproductive failure or mortality elsewhere; these impacts are of concern as well as they would likely amount to prohibited take. Thus, the Draft Eagle Conservation Plan Guidance addresses both direct mortality and disturbance.

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 maximum degree practicable. Permits for wind-energy development are programmatic in nature 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 even though ACPs are being implemented. 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.”

Where take is unavoidable and when eagle populations at the scale of the eagle management unit (as defined in USFWS 2009b) are not healthy enough to sustain additional mortality over existing levels, applicants must reduce the effect of permitted mortality to a no-net-loss standard, best accomplished through compensatory mitigation. No-net-loss means that additional mortality caused by the permitted activities is offset by compensatory mitigation that reduces another, ongoing form of mortality by an equal or greater amount. Compensatory mitigation may also be necessary to offset substantial effects in other situations as well (USFWS 2009a). The approach described in the Draft Eagle Conservation Plan Guidance is applicable for all land-based wind facility projects within the range of the bald and golden eagle where interactions with wind facility infrastructure are reasonably expected to occur. The Draft Eagle Conservation Plan Guidance is intended to provide a national framework for assessing and mitigating risk through development of ECPs.

As part of the application process for a programmatic eagle take permit, the Service recommends that project proponents should prepare an ECP that outlines the project development process and includes conservation and monitoring plans as described in this Draft Eagle Conservation Plan Guidance. The Draft Eagle Conservation Plan Guidance provides examples of ways that applicants can meet the regulatory standards in the rule, and while other approaches may be acceptable, they will be determined on a case-by-case basis.

B. ASSESSING RISK AND EFFECTS

1. Areas of Importance to Eagles for Consideration When Assessing 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 2009b). Because migration corridors and migration stopover sites provide important foraging areas for eagles during migration (e.g., Restani *et al.* 2001, Mojica 2008), we believe these areas fall within the regulatory definition of important eagle-use areas, and we include them as such in this Draft Eagle Conservation Plan Guidance.

Wind energy projects that overlap important eagle use areas may pose risks to the eagles for reasons described earlier. Project proponents should identify the location and type of all important eagle use areas on and within a 10-mile perimeter of a project footprint (the project footprint is the minimum convex polygon that encompasses the wind facility area inclusive of a 100 meter-radius of all turbines and any associated infrastructure, including utility lines, out-buildings, roads, etc.). The 10-mile perimeter is derived from the definition of project area nesting population in the regulations at 50 CFR 22.26 (see below). Evaluating the spatial area described above for each wind facility 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 facility projects on eagles, and then after the facility begins operating, studies will again be conducted to determine the actual effects. The following sections include descriptions and criteria for identifying important eagle-use areas in these assessments.

a. Nests and Breeding: Implications of the Nesting Territory, Nest Spacing, and Non-Breeding Individuals for Risk Assessment

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. 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). The nesting season home range is, at a most basic level, described as a minimum-convex polygon formed by connecting the outermost occurrences of an eagle or pair of eagles during the nesting season (Mohr 1947).

Size and shape, and distribution of use of bald and golden eagle nesting territories vary with topography, prey availability, region, and between sexes and both species. To adequately describe the nesting territory of an individual eagle or pair of eagles, systematic, direct observation (Walker *et al.* 2005), telemetry (Kenward 2001, Fuller et al. 2005), or a combination of the two (McGrady *et al.* 2002) for at least three years is recommended, and in areas where prey availability is known to vary among years, many years of data may be required to fully account for annual variations in territory size and shape. An eagle's distribution of use within its territory 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). The size and shape of use areas can vary seasonally (Newton 1979), so documentation of spatial use by resident eagles should encompass all seasons.

Spatial disturbance avoidance zones have been prescribed to protect nests and other types of eagle use areas. Recommendations for the size of avoidance zones for nests of bald and golden eagles have 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 four 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 dense bald eagle breeding territories in superior habitat suggest home ranges may be much smaller (Sherrod *et al.* 1976, Hodges and Robards 1982, Anthony 2001). Spatial avoidance recommendations for eagle nests are not accurate throughout the entire range of both species due to marked variation in the size and configuration of nesting territories of both species; spatial avoidance prescriptions have been conservative because site-specific data on territory location and spatial extent are rare in the published and unpublished literature.

Directly determining home-range size and utilization contours of individual eagles requires that birds be captured or marked, usually using radio- or satellite-telemetry. Benefits of this approach are that it can provide information on behavioral responses and spatial use of eagles that is relevant to more than assessing the risk of mortality within the project footprint. This additional information can also be useful in identifying and assessing important prey sources, displacement of eagles, behavioral responses to turbines, and cumulative effects from habitat impacts. However, the down side to this approach is that specific target eagles must be captured, and not all eagles using a wind-facility footprint are equally likely to be captured or provide useful data (e.g., migrants or floaters [adult eagles that have not yet settled on a breeding territory] are not as likely to be captured or monitored). Furthermore, the process of capturing and radio-marking eagles can have behavioral and use-area effects (e.g., Marzluff *et al.* 1997, Gregory *et al.* 2002), and these need to be better understood before widespread use of these techniques can be recommended for wind-facility effect assessments. Despite these caveats, the Service recognizes that telemetry studies can yield considerably more detailed area-use information than observational studies, and as such in specific situations it can inform important pre-construction turbine siting decisions and aid in assessing site risk.

The approach that we recommend as a standard practice in this Draft Eagle Conservation Plan Guidance for evaluating siting options and for assessing disturbance effects of wind facilities on eagles breeding on proximate territories is to determine locations of occupied nests of bald and golden eagles within the project footprint and within 10 miles of the perimeter of the footprint, then for each species calculate the mean nearest neighbor distance between the occupied nests (the project-area inter-nest distance). We use a 10-mile distance because the Service has defined the area nesting population for Golden Eagles to be the "number of pairs of Golden Eagles known to have a nesting attempt during the preceding 12 months within a 10-mile radius of a golden eagle nest" (50 CFR 22.3). To avoid confusion with the regulatory term and definition, we use the term project-area nesting population to describe the eagle population targeted in these surveys.

We also recommend application of this survey approach and scale for bald eagles for the purposes of this Draft Eagle Conservation Plan Guidance. However, where the project area nesting density is high-enough to make the 10-mile perimeter infeasible, we recommend an alternative approach (see Appendix C). The effectiveness of this approach for targeting nest searches will be evaluated through post-construction monitoring and the adaptive management framework described later in this Draft Eagle Conservation Plan Guidance. One-half the inter-nest distance has been widely 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).

For the purposes of this Draft Eagle Conservation Plan Guidance, we use the mean value of the project-area inter-nest distance (project-area inter-nest distance) to delineate which territories and associated breeding and juvenile eagles are likely to be affected by the wind facility, either through injury, mortality, or disturbance. This information is useful in decisions on whether the wind facility might be able to meet permit requirements at 50 CFR 22.26, for evaluating various siting alternatives, and in monitoring for disturbance effects. The advantages of this approach are that it does not require capture and marking of individual eagles, and it weights all territories equally, not just those on which eagles can be captured and marked.

This approach has the disadvantage of not providing the fine scale behavioral and spatial use information that can be helpful in analyses of behavior. Overall, we believe the advantages of this approach outweigh the disadvantages for most wind facility studies. The data used to calculate the project area inter-nest distance should be secured during the initial site specific surveys, as described later in this Draft Eagle Conservation Plan Guidance. If site specific data are lacking, or if nesting habitat is patchily distributed or nests are widely spaced, calculating the project area inter-nest distance can be problematic. We provide alternative suggestions for these circumstances in Appendix H. If information from the literature is adopted, conservative values should be used because nearest neighbor distances vary widely across populations of both species. For example, mean distances to nearest nests were 2.7 to 3.3 miles for golden eagles in Wyoming and in two areas in Idaho (Craig and Craig 1984, Kochert 1972, Phillips et al. 1984), but 13.4 miles for golden eagles in western Arizona (Millsap 1981).

The presence of nesting territories can also be a predictor for the occurrence of eagles that are not nesting. The non-breeding component of eagle populations includes juveniles (fledged that year), subadults, and, in healthy populations, adult "floaters" that have not settled on a breeding territory (Hunt et al. 1995, Hunt 1998). Many non-breeding eagles exist on margins of territories occupied by breeding adults (Watson 1997, Hunt 1998, Caro et al. 2010). Floaters have been shown to be more vulnerable to collision with turbine blades at wind energy projects than locally breeding adults and juveniles (Hunt et al. 1999, 2002). Wind turbines sited proximally to eagle nesting territories may pose significant risks to eagle populations, because population stability hinges on a robust non-breeding cohort, especially surplus adults in the form of floaters, to replace breeding individuals that die. A systematic, observational approach for documenting frequency of eagle use of the project footprint has the substantial advantage of accounting for any eagle regardless of its breeding or residency status. The Draft Eagle Conservation Plan

Guidance recommends such an approach (point count surveys) for the collection of data that will be used to predict eagle fatality rates at wind facilities.

b. Concentration Areas: Communal Roosts and Foraging Concentrations

During the breeding season, some non-breeding individuals, especially bald eagles, roost communally. Outside the breeding season, communal roosts include individuals of all ages and residency status. Bald eagles may roost singly or in small groups but larger communal roosts are common throughout the year (Platt 1976, Mojica *et al.* 2008). Large roosts tend to be associated with nearby foraging areas. Direct, systematic observation in early morning and evening is the most practical means of locating roosts and documenting numbers of eagles 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 has been 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. Migration Corridors and Stopovers

Bald and golden eagles tend to migrate during midday 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 migration being influenced by rising temperatures and favorable winds (Harmata 1984). Bald and golden eagles often hunt during this type of migration flight. Both species of eagle will forage during migration flights, though for bald eagles foraging is often restricted to 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 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 in 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 migration counting protocol as recommended in this Draft Eagle Conservation Plan Guidance as a component of the site-specific surveys.

2. Eagle Risk Factors

Factors known or thought to be associated with increased probability of collisions between eagles and other raptors and wind turbine blades and structures are given in Table 1 (page 18). While some of these factors are not known to affect eagles, because of the similarity of flight behavior between eagles and the other soaring raptors we include them here because they may have applicability for eagles. Evidence across multiple studies suggests three main factors contribute to increased risk of collision by eagles: (1) the interaction of topographic features, season, and wind currents to create favorable conditions for slope soaring or kiting (stationary or near-stationary hovering) in the vicinity of turbines; (2) behavior that distracts eagles and presumably makes them less vigilant (e.g., active foraging or inter- and intra-specific interactions); and (3) residence status, with resident adults and young less vulnerable and dispersers and migrants (especially sub-adults and floating adults) more vulnerable. This latter point should not be taken to undercut the potential severity of the risk to breeding adult eagles and their young, as loses from these segments of the population, especially breeding adults, can have serious consequences to populations.

Table 1. Factors potentially associated with wind turbine collision risk in raptors

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)
Bird Age	Higher risk to subadult and adult Golden Eagles	Hunt (2002)
Bird Residency Status	Mixed findings, higher risk to resident adults in Egyptian vultures (*Neophron percnopterus*), but higher risk to subadults and floating adults and lower risk to resident adults and juveniles in Golden Eagles	Barrios and Rodriguez (2004), Hunt (2002)
Season	Mixed findings, with general consensus that risk is higher in seasons with greater propensity to use slope soaring (fewer thermals) or kiting flight (windy weather) while hunting across a range of species	Barrios and Rodriguez (2004), De Lucas et al. (2008), Hoover and Morrision (2005), Smallwood *et al.* (2009)
Flight Style	High risk associated with slope soaring and kiting flights across a range of species	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hoover and Morrision (2005)
Interaction with Other Birds	Higher risk when interactive behavior is occurring, across a range of species	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)
Turbine Type	Higher risk associated with lattice turbines for Golden Eagles, higher risk with tubular towers for Burrowing Owls (*Athene cunicularia*)	Hunt (2002), Smallwood *et al.* (2007)
Rotor Speed	Higher risk associated with higher blade-tip speed for Golden Eagles	Chamberlain *et al.* (2006)

Perch Availability	Possible higher risk with higher perch availability in the general project area for golden eagles	Chamberlain *et al.* (2006)
Rotor-swept Area	Mixed findings; higher mortality associated with larger rotor-swept area in one study for non-raptors, meta-analysis found no effect	Barclay *et al*. (2007), Chamberlain et al. (2006)
Topography	Several studies show higher risk of collisions with turbines on ridge lines and on slopes where declivity currents facilitate slope soaring and kiting flight of soaring raptors. Also a higher risk in saddles that present low-energy ridge crossing points. Higher risk for Burrowing Owls in canyons.	Barrios and Rodriguez (2004), De Lucas *et al.* (2008), Hoover and Morrission (2005), Smallwood and Thelander (2004), Smallwood *et al.* (2007)
Wind Speed	Mixed findings; general pattern of higher risk in situations that favor slope soaring or kiting (high winds in some locales, low winds in other, likely depending on degree of slope and aspect)	Barrios and Rodriguez (2004), Hoover and Morrision (2005), Smallwood *et al.* (2009)

3. Overview of Process to Assess Risk

The Draft Eagle Conservation Plan Guidance 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 when eagle risk factors are taken into account at each stage. 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, *U.S. Fish and Wildlife Service Draft Land-based Wind Energy Guidelines* 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 are applicable here, but the process for eagles is more defined and falls more into six broadly overlapping, iterative stages: Stage 1 site assessment; Stage 2 site-specific surveys and assessments; Stage 3 predicting eagle fatalities; Stage 4 avoidance and minimization of risk; and Stage 5 post-construction monitoring.

Stage 1 for eagles combines tiers 1 and 2 from the *U.S. Fish and Wildlife Service Draft Land-based Wind Energy Guidelines*, and consists of an **initial site assessment**. In this stage project proponents 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 proponents in identifying potential important eagle use areas and habitat at this stage. To increase the probability of meeting the regulatory requirements for a programmatic permit, Service biological advice should be requested as early as possible in the company's planning process, ideally prior to any financial commitment or finalization of any lease agreements. During Stage 1 the project proponent should gather existing information from publicly available databases and other available information, and use those data to refine 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 assessment** (this is the first component of tier 2 in the *U.S. Fish and Wildlife Service Draft Wind Energy Guidelines*). During Stage 2 the project proponent should collect quantitative data through scientifically rigorous surveys designed to assess the potential risk of the proposed project to eagles at and surrounding the specific site(s) selected in Stage 1.

In **Stage 3**, **the initial fatality prediction stage**, the Service and project proponents 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 a predicted number of fatalities per year. These models can be used to comparatively evaluate alternative siting, construction, and operational scenarios, a useful feature in quantifying the predicted effects of ACPs. We encourage project proponents to use the recommended pre-construction survey protocol in this Draft Eagle Conservation Plan Guidance in Stage 2 to help inform our models in Stage 3. If Service-recommended survey protocols are used, this risk assessment can be greatly facilitated using Excel-based models provided by the Service. If project proponents use other forms of information for the Stage 2 assessment, they will need to employ and fully describe those methods and the analysis approach taken 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 proponent's eagle risk assessment with predictions from our generic, risk-averse models, and if the results differ, we will work with the project proponents to determine if the site specific data collected warrants modification of the Service's predictions. The risk assessments at Stage 2 and Stage 3 are consistent with developing the information necessary to assess the efficacy of ACPs, and to develop the monitoring required by the permit regulations at 50 CFR 22.26(c).

Stage 4 is the **application of ACPs and compensatory mitigation**. Regardless which approach is employed in the Stage 2 assessment, in Stage 4 the information gathered is used by the project proponent and the Service to determine potential ACPs that can be employed to avoid and/or minimize the predicted risks at a given site. The Service will compare the initial predictions of eagle mortality for the project with predictions that take into account proposed and potential ACPs to determine if the project proponent has avoided and minimized risks to the maximum extent achievable, thereby meeting the requirements for programmatic permits in 50 CFR 22.26 that remaining take is unavoidable. This final eagle risk assessment completed at the end of Stage 4 after application of ACPs along with a plan for compensatory mitigation if required (e.g., if unavoidable take exceeds that allowable under calculated take thresholds), will be used by the Service to determine if the applicant has met the regulatory standards for issuance of a programmatic take permit.

If a permit is issued and the project goes forward, **Stage 5** of the process is **risk validation**, equivalent to tiers four and, in part, five in the *U.S. Fish and Wildlife Service Draft Wind Energy Guidelines***.** During this stage, post-construction surveys are conducted to generate empirical data for comparison with the pre-construction risk-assessment predictions. Again, we recommend project proponents use the post-construction survey protocols included in this Eagle Conservation Guidelines for this monitoring, but we will consider other monitoring protocols provided by permit applicants, so long as they meet the permit-condition requirements at 50 CFR 22.26(c)(2). We will use the information from post-construction monitoring will be used in a meta-analysis framework to weight and improve pre-construction predictive models. Additionally, the Service and project proponents will use this data to explore operational changes that might be warranted at a project to reduce observed mortality and ensure that the permit condition requirements at 50 CFR 22.26(c)(7) are met. After implementation of any additional necessary ACPs, project proponents will be eligible for renewal of their eagle take permit. The effectiveness of the additional ACPs will be determined through continued post-construction monitoring.

4. Site Categorization Based on Mortality Risk to Eagles

We recommend project proponents use 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 (Figure 1). A proposed project can be categorized as either: (1) high risk to eagles, little opportunity to minimize effects; (2) high to moderate risk to eagles, but with an opportunity to minimize effects; or (3) minimal risk to eagles. The risk category of a project has the potential to change from one of higher risk to one of lower risk through additional site-specific analyses and application of measures to reduce the risk, as outlined in this document. Distance criteria for evaluating risk should not be considered as protective buffers, but instead as the bounds of zones of proximity to important eagle use areas where more specific data and measures may be necessary to evaluate and reduce risk. If a project cannot practically be placed in one of these categories, the project proponent 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.

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

A project is in this category, as sited and planned, if it is (1) likely to take eagles at a rate greater than is consistent with maintaining stable or increasing populations (taking into account opportunity for reasonable compensatory mitigation), and (2) the effects cannot be minimized to the degree that any take that occurs is unavoidable. In general, prospective project footprints that include important eagle use areas as described previously will fall into category 1. Examples include:

1. For breeding eagles
   a) The project footprint includes or is within half the project area inter-nest distance of an eagle nest or cluster of nests in an occupied territory.

b) Information (e.g., from radio or satellite telemetry) is available to demonstrate that the project footprint is visited regularly by eagles occupying a proximate nesting territory.

2. For non-breeding eagles
   a) The project footprint includes the roost location(s) or a primary foraging area associated with an eagle concentration, or a migration corridor, or stopover area.
3. For all eagles
   a) Based on site-specific survey data collected as part of the Stage 2 site assessment process (described later in this Draft Eagle Conservation Plan Guidance), the estimated eagle fatality rate for the wind facility cannot reasonably be mitigated.

Projects or alternatives in category 1 should be substantially redesigned so that they at least meet the category 2 criteria. If they cannot be redesigned, they should be moved or abandoned; construction of projects at sites in category 1 is not recommended because the project would likely not meet the regulatory requirements for permit issuance. However, when a project has been determined by the Service to be in category 1, Service biologists and Special Agents of the Service's Office of Law Enforcement may consider a detailed re-assessment of risks to eagles posed by the project if it is warranted by additional biological data made available by the project proponent.

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

A project is in this category if, as currently sited and planned, it is (1) reasonably likely to take eagles at a rate greater than is consistent with maintaining stable or increasing populations, but (2) the risk might be minimized to the maximum degree achievable through a combination of conservation measures and reasonable compensatory mitigation, per an effective and verifiable ECP. These projects have a risk of ongoing take of eagles, but this risk can be minimized. For projects in this category an ECP should be prepared following this Draft Eagle Conservation Plan Guidance to assist the applicant in meeting the regulatory requirements for a programmatic permit. For Golden Eagles nationwide, and for bald eagles in the southwest management unit, the conservation measures in the ECP must result in no-net-loss to the breeding population to be compatible with the permit regulations. Examples of likely category 2 situations include:

1. the project as proposed has potential to cause take of eagles in the form of disturbance (e.g., it is within the project area inter-nest distance of a nest), either from the individual project or due to cumulative impacts of the project and other anthropogenic changes in the vicinity; or
2. the project is located where important eagle use areas are present within 10 miles of, but not within, the project footprint; or
3. is based on site-specific survey data collected as part of the Stage 2 site assessment process (described later in this Draft Eagle Conservation Plan Guidance), the estimated eagle fatality rate for the wind facility, after application of all indicated avoidance and minimization measures, can likely be mitigated; or
4. the project is located where important use areas of bald or golden eagles are at least 10 miles from the project footprint but the area within 10 miles contains potential breeding or foraging habitat and the population of eagles in the eagle management

unit (as defined in USFWS 2009b) is increasing or is expected to increase over the lifetime of the project; or

5. in rare circumstances where eagle nests are within or proximate to the project footprint but the project, with strong compensatory mitigation can meet the requirements in 50 CFR 22.27(a)(iv) for take of inactive eagle nests (these situations are not addressed in this Draft Eagle Conservation Plan Guidance, but will be addressed case-by-case basis between the project proponent and the Service).

c. Category 3 – Minimal risk to eagles

A project in this category poses little risk to eagles. A project proponent 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 proponent must contact the Service to discuss ways to avoid take in the future. In general, projects that are unlikely to have or do not currently have important eagle-use areas within 10 miles of the project footprint will fall into category 3.

d. Category 4 – Uncertain risk to eagles

Sites lacking sufficient data to assign them to categories 1 through 3 should be placed in this category. In general, these are sites for which little or no pre-existing data is available to assign them to a category in the Stage 1 assessment. In these cases, assignment to a category (category 1, 2, or 3) should occur no later than Stage 2. It is recommended that project proponents delay making any commitments to sites in this category. After Stage 2 and Stage 3 analyses for the ECP are complete, the project can be put into one of the above risk categories for consideration.

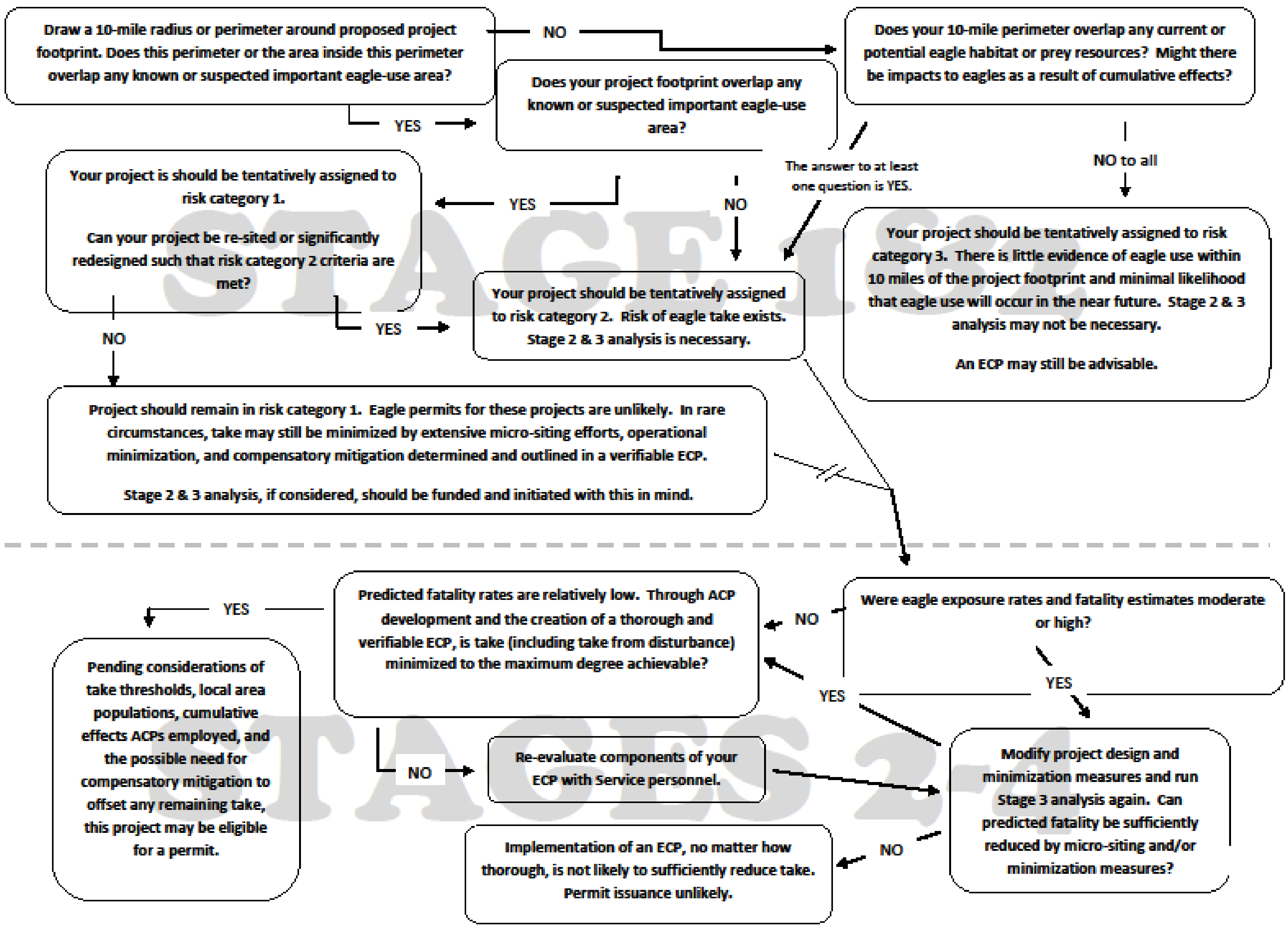

Figure 1. Flow chart for wind-facility site categorization in Stages 1 - 4

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; set suitable boundaries for analysis; 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. Where a permit is sought, a comprehensive cumulative effects analysis at the early planning stage will serve to streamline subsequent steps, including the NEPA process. In addition, considering cumulative effects is essential to developing appropriate ACPs.

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.
8. Triggers and thresholds - fundamental changes in system behavior or structure.

b. Analysis Associated with Permits

The cumulative effects analysis for a wind facility 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 facility projects and associated permits may include greater- and/or lesser- scales than in the FEA, and will be determined by the Service and project proponent on a case-by-case basis.

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. The Service is developing additional specific guidance and recommendations on the scope and scale of cumulative effects analyses associated with programmatic eagle take permits.

C. ADAPTIVE MANAGEMENT

The role of adaptive management with respect to this Draft Eagle Conservation Plan Guidance is to improve our predictive capability relative to likely effects of wind facilities on eagles, and to improve our predictive capabilities relative to effective mitigation measures. There are many sources of uncertainty that can be reduced with better data. Generally, eagle monitoring at the level of the wind-facility site is needed to reduce uncertainty in four categories: (1) exposure risk, (2) rate of mortality, (3) direct and indirect effects on territory occupancy and productivity, and (4) measuring the success of compensatory mitigation. Much of the pre-siting and post-construction monitoring sections of this Draft Eagle Conservation Plan Guidance are devoted to describing advised, standardized monitoring methods that will provide data in a standardized format that will, for example, help us integrate eagle-use data with information on topography, weather, habitat, and prey density to predict, with increasing accuracy, rates of eagle mortality. The ultimate measure of success is a reduction in the number of dead eagles at a site, thus good mortality monitoring is essential to evaluating site risk and the efficacy of the avoidance and minimization measures undertaken by companies to reduce those risks.

Methods for estimating the number of annual eagle fatalities at a site are described in detail, and by comparing fatality rates before and after ACPs are undertaken by companies, we will be able to evaluate the effectiveness of those practices. These evaluations may show that additional ACPs are warranted to address documented problems, but they may also show that ACPs in place are not effective and need not be continued. We will also employ adaptive management to evaluate the effectiveness of compensatory mitigation actions to verify that predicted levels of mortality reduction are achieved. Adaptive management is, therefore, critical to determine the efficacy of applied ACPs and compensatory mitigation measures. This aids the Service in complying with both regulatory permit condition 50 CFR 22.26(c)(7), which determines when the Service may amend, suspend, or revoke a programmatic permit if new information indicates that revised permit conditions are necessary, and permit condition 50 CFR 22.26(c)(2), which requires monitoring after completion of an activity for purposes of adaptive management.

In an adaptive management framework, monitoring that evaluates factors that affect mortality risk, and evaluates the efficacy of measures taken to avoid, minimize, or compensate for mortality, should feed back into planning and operation of wind facilities at the site level with the ultimate goal of a gradual reduction in eagle mortality. Additionally, the data will roll up into population-wide models that incorporate survival, productivity, and population status information from many sources to assess the effects of our permits at the scale of continental eagle populations. By collecting these data in a systematic, unified, stepwise manner, ultimately a clearer picture will ultimately emerge about the nation's eagle populations and the effects that increasing energy developments and other factors have on them. By using adaptive management principles to guide eagle management, the Service in cooperation with our partners and industry can focus its attention on those actions that will most effectively meet our goal of stable or increasing breeding populations of both species of eagle, as established in USFWS (2009b). More information on adaptive management can be found in APPENDIX A.

D. DEVELOPMENT OF AN EAGLE CONSERVATION PLAN

The following sections of this Draft Eagle Conservation Plan Guidance, including attached appendices, provide a descriptive instructional template for developing 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:

1. This Draft Eagle Conservation Plan Guidance offer recommends guidance for project proponents, the Service, and other jurisdictional agency biologists to reference when developing and evaluating ECPs.
2. Using these Draft Eagle Conservation Plan Guidance as a non-binding reference, the Service will work with programmatic take-permit applicants to develop an ECP, which documents how the applicant will 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 applicant comes to us.
3. ECPs should be developed following the five staged approach: (1) initial site assessment; (2) site specific surveys and assessment; (3) initial fatality prediction; (4) application of ACPs that avoid and minimize risk, and a re-assessment of fatality predictions; and (5) post-construction monitoring. During Stages 1 and 2, projects or alternatives should be categorized as either: (1) category 1 – high risk; (2) category 2 – moderate risk; and (3) category 3 – low risk. For projects that fall into category 1 or 2, the Service will either (a) accept an ECP that offers siting, configuration, and an operational alternative that avoids and minimizes take to the point any remaining take is unavoidable and, if required, mitigates that remaining take to meet the statutory preservation standard; or (b) determine that the project cannot be permitted because risk to eagles is too high such that the applicant would be unlikely to meet the regulatory permit requirements. If the Service determines the project can be permitted, the duration of the permit will be no longer than five years, with the expectation that the permit will be renewed if, at that time, all conditions have been satisfactorily met.

4. For permitted projects, the Service and the applicant will use the standardized models developed as part of the adaptive management process to predict unavoidable eagle mortality after implementing the acceptable alternative. These models will rely heavily on pre-construction monitoring by the applicant, ideally following the standardized protocol described in this Draft Eagle Conservation Plan Guidance. If the applicant cannot or chooses not to conduct pre-construction monitoring, the Service will generate a risk-averse estimate of annual mortality using a set of conservative, predictive models.
5. For predicted recurring eagle take that is in excess of calculated take thresholds (i.e., take in excess of the regional thresholds designed to meet the statutory preservation standard as described in USFWS 2009b), the Service will either (a) collect a compensatory mitigation payment from the applicant that will be deposited into a Service-established eagle conservation fund for pooled compensatory mitigation; or (b) approve a compensatory mitigation proposal from the applicant. 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 net of zero. Compensatory mitigation may also be required in other situations where predicted effects to eagle populations are substantial.
6. Systematic, standardized, post-construction monitoring, ideally following protocols established in the Draft Eagle Conservation Plan Guidance, are recommended to derive an estimate of the number of eagle fatalities each year at each permitted wind facility and to document disturbance effects at nearby nests. This monitoring information will be used 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 applicant to identify any project specific additional ACPs that can be implemented to potentially reduce eagle mortalities based on the observed, specific situation at each site. Continued monitoring will determine the effectiveness of any additional ACPs implemented in each situation.

Holders of programmatic eagle take permits will be required to allow Service personnel, or other qualified persons designated by the Service, access to the areas where take is possible, within reasonable hours and with reasonable notice from the Service, for purposes of monitoring eagles at 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)). Typically, these follow-up site visits would be performed by Service employees.

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 proponent 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

a. Stage 1 - Site assessment

The objective of the Stage 1 site assessment is to cast a broad look at the landscape of interest and identify, based on existing information and studies, known or likely important eagle-use areas. Based on that information, project proponents should work with the Service to place potential wind –facility sites in one of the three site categories described in Section B 4 of these Draft Eagle Conservation Plan Guidance. For detailed recommendations on the Stage 1 process, go to APPENDIX B.

b. Stage 2 - Site-specific surveys and assessments

In Stage 2, project proponents collect detailed, site-specific information on eagle use of the specific sites that passed review in Stage 1. The information collected in Stage 2 is used to generate predictions of the annual number of fatalities for a prospective wind facility site and to identify important eagle-use areas likely to be affected by the project. For detailed recommendations on the Stage 2 methods and metrics, go to APPENDIX C.

c. Stage 3 - Predicting eagle fatalities

In this section of the ECP, project proponents should work in coordination with the Service to determine risk factors associated with each turbine in the facility. Then, an annual predicted mortality rate for the project can be calculated by using the estimated annual eagle exposure rate generated from the Stage 2 assessment and Excel-based models. The initial estimate of mortality rate should not take into account possible ACPs; these will be factored in as part of Stage 4. Additionally, any loss of production that may stem from disturbance is not considered in these calculations, but is instead derived from post-construction monitoring as described in Stage 5. Specific elements of the adaptive management process will be further developed as they emerge in actual cases, through coordination with project proponents. Therefore, this stage and Stage 5 of the ECP will require close coordination between the project proponent and the Service. For detailed recommendations on Stage 3 methods and metrics, go to APPENDIX D.

d. Stage 4 - Avoidance and Minimization of Risk using ACPs, and Compensatory Mitigation

Siting of a wind facility is the most important factor when considering potential effects to eagles. Based on information gathered in Stage 2 and analyzed in Stage 3, the project proponent 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 facility has a high eagle exposure rate and presents multiple risk factors, 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 for some rare category 1 sites where there is potential to adequately abate risk, the ECP should next address ACPs that might be employed to minimize or, ideally, avoid eagle mortality and disturbance.

In this section of the ECP, we recommend project proponents re-run models predicting eagle fatality rates *after* implementing the scientifically supportable 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. For detailed recommendations on considerations for the development of ACPs go to APPENDIX E.

Compensatory Mitigation

Compensatory mitigation occurs in the eagle permitting process if ACPs do not remove the potential for take, and projected take exceeds calculated take thresholds for the species or management population affected. Compensatory mitigation may also be required 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. To be consistent with this compensatory mitigation guidance, project proponents must ensure their projects are "compatible with the preservation of the eagle" and "…consistent with the goal of increasing or stable breeding populations" (USFWS 2009a).

For new projects, compensatory mitigation will be required upfront before project operations commence because projects must meet the statutory and regulatory eagle preservation standard before FWS 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. Compensatory mitigation will also be applied in the future, at each permit reissuance or renewal point, so long as it is still necessary to meet the preservation standard at that time. As stated previously in the adaptive management section of this Draft Eagle Conservation Plan Guidance "monitoring that evaluates factors that affect mortality risk; and that evaluate the efficacy of measures taken to avoid, minimize, or compensate for mortality; all should feed back into planning and operation of energy facilities at the site level with the ultimate goal of a gradual reduction in eagle mortality at wind facilities." With this in mind, as new data are made available, the Service will modify the compensatory mitigation process to adapt to any improvements in our knowledge base.

To determine the level of compensatory mitigation required for a proposed or current project, the Service will estimate the quantitative potential for take of all age classes of eagles using informed modeling, as described in Stage 3 of the ECP (APPENDIX D). This fatality prediction will be one of several fundamental variables that will be used to populate a Resource Equivalency Analysis (REA). Economists extended the economic theory from valuation studies and information from scientific models to develop the REA model (based on Unsworth and Bishop 1994; Jones and Pease 1997).

An REA responds to the question, "What, but for the 'take,' would have happened to the eagles?" With REA, the services of the eagles killed are quantified in physical units of *bird-*

years.[1] The selected compensation is "scaled" so that the quantity of replacement bird years equals the quantity of lost bird-years in present value terms to fully compensate the public, accomplishing the stated objective of no-net-loss of birds. For the purposes of this document we refer to an REA as a stepwise replacement model (Sperduto *et al*. 1999, 2003) for eagles that will be taken. The Service will use REA to calculate mitigation offset for a wind facilities' estimated unavoidable take. Application of this model follows other comparable analyses used for white-tailed sea eagles (Cole 2009) and other species (Sperduto *et al*. 1999, 2003, Industrial Economics Inc. 2004).

The use of REA, while relatively new for Service raptor management, is consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Oil Pollution Act (OPA), and Natural Resource Damage Assessment and Restoration (NRDAR) federal regulations, and has been explicitly identified in revised CERCLA regulations (2008). REA calculations using the stepwise replacement model involve wildlife population modeling, including elements of the Leslie matrix and life tables, and include discounting to provide compensatory mitigation costs per unit of take (See APPENDIX F; Cole 2009). The required life history parameters (e.g., survival, fecundity, and longevity) are based on the best available published data to document how individual eagles per age class may be removed from the population during the life of a project and offset through mitigation.

The REA will generate a project level eagle take calculation (debit), expressed in bird-years, as well as an estimate of the quantity of compensatory mitigation (credit) (e.g., power pole retrofits) necessary to offset this take. Compensatory mitigation will then be initiated, subsequently funded per an established rate, and implemented by one of the following mechanisms:

1. Project proponent will directly contract and fund Service-approved compensatory mitigation project; or
2. Project proponent will pay into a Service-established BGEPA account; or
3. Project proponent will pay into a third-party mitigation account identified by the project proponent and approved by the Service.

Effectiveness monitoring of the resulting mitigation projects should be included within the above options using the best scientific and practicable method available. All mitigation projects will be subjected to random inspections by the Service or appointed subcontractors to examine efficacy, accuracy, and reporting rigor.

The Service considered the following compensatory mitigation options to reduce or eliminate factors known or suspected to be negatively affecting eagles of one or both species: (1) improving range management prescriptions to eliminate loss of extant eagle territories; (2) environmental lead abatement; (3) addressing mortality due to collision or drowning; and (4) addressing potential electrocution due to non-APLIC standard powerlines. However, to be

[1] A *bird- year* refers to all services provided by one bird for one year. This measure of services is specific to the type of bird since different birds provide different services. So, e.g., the replacement services for 20 bird-years could be 20 birds for only one year, one bird over 20 years, or anything in between.

effective, any potential compensatory mitigation must have quantifiable adverse impacts and verifiable benefits that can be assessed on a per eagle basis, and have measurable metrics for monitoring.

The Service will focus initial compensatory mitigation efforts towards proactive power pole retrofitting, which is in addition to the reasonable corrective actions required of companies (after implementing ACPs) to avoid the unlawful take of eagles and other migratory birds. We focus mitigation efforts toward eliminating electrocutions because:

1. Utility power poles cause quantifiable adverse impacts to eagles,
2. the 'per eagle' and population effects of utility power pole retrofitting to create safe conditions for eagles are quantifiable and verifiable through accepted practices,
3. success of and subsequent maintenance to retrofitting can be monitored, and
4. electrocution causes a significant amount of eagle mortality and, in most cases, is correctable.

These efforts will be structured to reduce the electrocution hazard from high-risk transmission infrastructure to adult, subadult, and juvenile eagles throughout their range in North America (APLIC 2006, Lehman et al. 2007, Lehman et al. 2010, Millsap et al. 2004). If the benefits can be clearly demonstrated, other forms of compensatory mitigation may also be an option. The Service, in coordination with State and Tribal wildlife agencies, will evaluate and approve the final compensatory mitigation plans for non-power pole efforts. For details on the approach used to calculate appropriate compensatory mitigation values go to APPENDIX F.

e. Stage 5. Post-construction monitoring

In this section of the ECP, the project proponent should describe the proposed post-construction survey methodology for the project. The objective of post-construction monitoring is to estimate (1) the annual number and circumstances of eagle fatalities at operating wind facilities, and (2) disturbance effects in the form of reduced productivity at eagle territories proximate to operating wind facilities. 50 CFR 22.26 requires monitoring as a condition of eagle take permits for ongoing activities like wind facilities for as long as the data are needed to assess effects on eagles. Given the adaptive management framework the Service has adopted and the regulatory conditions at 50 CFR 22.26(c)(2)&(4), this will require wind-facility operators to monitor during construction and for at least three years post construction, to include a minimum of three years of operation, then assess monitoring data to consider whether additional ACPs are appropriate and warranted. If additional or different ACPs are warranted, an additional three years of monitoring data will be required to assess the effectiveness of the new or revised ACPs for at least three years post construction. Detailed recommendations for post-construction monitoring are in APPENDIX H. The Stage 5 post-construction monitoring plan is the final section of the ECP.

Post construction monitoring is essential to identify possible factors associated with eagle fatalities at wind facilities that might warrant additional ACPs or improvement or elimination of ACPs found to be ineffective. Implementation of these additional ACPs and further monitoring following identical (though perhaps more targeted) protocols will help the Service and project proponents rigorously evaluate the effectiveness of conservation measures under different conditions

E. INTERACTION WITH THE SERVICE

As noted throughout this Draft Eagle Conservation Plan Guidance, frequent and through coordination between project proponent and Service and other jurisdictional-agency biologists is crucial to the development of an effective and successful ECP. This is particularly true for the first several wind-facility projects that attempt to obtain programmatic eagle take permits, where many of the operational details of the ECP will be tested through application in the field. 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 this Draft Eagle Conservation Plan Guidance and the recommended methods and metrics will evolve rapidly as the Service and project proponents learn together. The Service will continue to refine this Draft Eagle Conservation Plan Guidance 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 neither excessive nor unduly burdensome.

F. GLOSSARY

Adaptive management – iterative process of decision making considering uncertainty, with the goal of reducing that uncertainty over time.

Advanced conservation practices — scientifically-supportable measures approved by the Service, representing the best-available techniques to reduce eagle disturbance and ongoing mortalities to a level where remaining take is unavoidable.

Adult – an eagle five or more years of age.

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

Area-nesting population – number of pairs of eagles known to have a nesting attempt during the preceding 12 months within a 10-mile radius of an eagle nest.

Avoidance and minimization measures – conservation actions targeted to remove or reduce specific risk factors (e.g., avoiding important eagle-use areas, placing turbines away from ridgelines).

Breeder (resident breeder) – an eagle that is a member of a breeding pair on a 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 during a minute of exposure.

Compensatory mitigation – an action in the eagle permitting process if ACPs do not completely remove the potential for take, and projected take exceeds calculated take thresholds for the species or the eagle management unit management population affected (or in some cases, under other circumstances as described in USFWS 2009a).

Conservation measures – actions that avoid (this is best achieve at the siting stage), minimize, rectify, and reduce or eliminate an effect over time. Determination of which conservation measure or suite of measures, will provide the most benefits to eagles will rely upon a thorough cumulative effects analysis, as well as close coordination with the Service and state and tribal wildlife agencies, and implementation of an adaptive management approach compatible with the process described in the Department of Interior (DoI) Adaptive Management Handbook (Williams *et al.* 2009).

Decorated nest – a nest with fresh whitewash, feathers, or with fresh greenery, all of which are evidence of occupancy.

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 proponent in coordination with the Service that supports issuance of an eagle take permit under 50 CFR 22.26 (or demonstrates that such a permit is unnecessary).

Eagle Management Unit – regional eagle population defined in the FEA (USFWS 2009b). For Golden Eagle's regional management populations follow Bird Conservation Regions (see http://www.nabci-us.org/map.html), whereas for bald eagles they follow U. S. Fish and Wildlife Service regional boundaries.

Eagle exposure rate – a value expressed as eagle exposure minutes (flight minutes) per daylight hour within the footprint of the project, averaged over daylight hours and over the annual cycle.

Eagle territory - an area that contains, or historically contained, one or more nests within the home range of a mated pair of eagles.

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

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

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 (to include as interpreted here migration corridors and migration stopover sites), 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.

Inactive nest (from the regulations**) —** a 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 BGEPA.

Initial site assessment (Stage 1) – where project proponents 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

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.

Juvenile – an eagle less than one year old.

Kiting – stationary or near-stationary hovering by an eagle, usually while searching for prey.

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

Migration corridors - the routes or areas where eagles may concentrate during migration 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.

Monitoring - inventories over intervals of time (repeated observations), using comparable methods to enable comparisons in time or space.

No-net-loss – no net change in the overall eagle population mortality rate after issuance of a permit that authorizes take, because required 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. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current years' 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 facility that changes how that facility operates (e.g., increasing turbine cut in speeds, implementing curtailment of turbines during periods of migration).

Overall collision probability – the cumulative probability across all turbines in a wind facility (i.e., the chance that an eagle will collide with one of the turbines in the facility) of a collision.

Patagial tags – wing markers that are used to individually identify an eagle.

Power analysis – a statistical procedure used to determine the sample size necessary to determine the minimum sample size required to accept the outcome of a statistical test with a particular level of confidence.

Project-area inter-nest distance – the mean 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 10 miles of the project footprint over multiple years.

Project-area nesting population – number of pairs of eagles nesting within the project footprint or within a 10-mile perimeter of the project footprint. In cases where nesting density is very high the perimeter distance can be scaled to equal the project-area inter-nest distance.

Project footprint - the minimum-convex polygon that encompasses the wind-facility area inclusive of a 100 meter-radius of all turbines and any associated utility infrastructure, roads, etc.

Project proponent – any developer that proposes to construct a project.

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

Pylons – tower base of a wind turbine.

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

Risk-averse – a conservative estimate in the face of considerable uncertainty.

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.

Standard kernel analysis - a non-parametric way to smooth estimates of the density of a random variable, where inferences about the population are made based on a limited data. . Used in describing the probabilistic spatial distribution of an animal within its home range.

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 –is used when referring to inventory and monitoring combined.

Unoccupied nest - those nests not selected by raptors for use in the current nesting season.

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

Wind turbine – a machine capable of converting wind energy into electricity by means of a wind-driven generator; usually mounted on a tower structure.

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APPENDIX A

ADAPTIVE MANAGEMENT

Learn by doing. This simple statement is the essence of adaptive management. What is implied is that we take action to achieve a goal, pay attention to the outcome, and apply that learning to our next action. Adaptive management is an iterative process, often conceived of as a continuous loop consisting of four to six sequential steps. They are: Planning - defining and describing goals and objectives and available data; Design - more formally describing management with models; Action - applying management actions; Monitoring - collecting data resulting from the action; Evaluation - analyzing the results and improving the models; and back to planning again to adjust the project design to meet the management goal, but incorporating new information from analyses of monitoring data collected during or after the previous management action (Figure 1). A definition used to describe adaptive waterfowl harvest

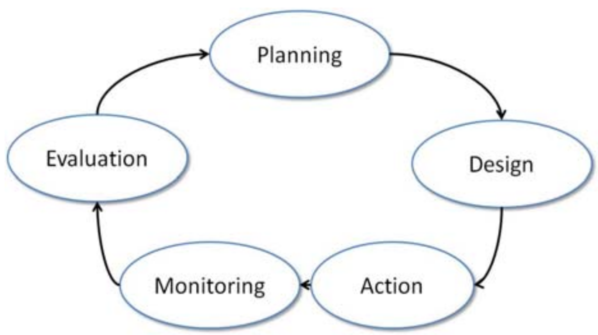


Figure A-1: Essential steps in an adaptive management framework, showing the iterative nature of the process designed to reduce uncertainty around decision making.

management is useful to describe our current task to manage eagle populations, and that is, "…managing in the face of uncertainty, with a focus on its reduction" (Williams and Johnson 1995).

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 a*l. 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 2009b), may be declining in numbers already (Farmer *et al.* 2008), and while we can point to likely causes of those declines we are uncertain about their relative importance or magnitudes. 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 clouded with 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.

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, endangered species, and habitat management at local and landscape scales; and, in the future, landscape management against the threat of climate change (e.g., USFWS 2005). Applying adaptive management to complex resource management issues is promoted throughout the DoI (Williams *et al.* 2009).

Waterfowl harvest management is the classic example of adaptive resource management. Harvest rates are reset each year in the United States and Canada through the application of adaptive management principles (Johnson 2001). The central question in waterfowl management is to what extent is harvest mortality compensated for by reductions in non-harvest mortality or by increases in productivity (Williams et al 1996)? Various population models have been built based on competing hypothetical answers to this question (hypotheses). Every year the Service and its Canadian counterpart monitor waterfowl and environmental conditions to estimate mortality and productivity. Thousands of waterfowl are banded and some are recovered resulting in estimates of hunting mortality rates.

Wings collected from a sample of hunters each year are identified to age and sex, yielding estimates of relative rates of harvest of different age and sex classes within a species. Surveys by air and ground count breeding populations and assess habitat conditions, which yield estimates of productivity. These data feed into the various competing models, and the models are evaluated annually based on how well they predict inter-year 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 (USFWS 2005).

2. Applying Adaptive Management to Eagle Management

At the scale of continental populations, 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 required is a systematic effort to collect information on mortality, breeding, and population status to feed those models. As for waterfowl, 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.

APPENDIX B

STAGE 1 - LANDSCAPE-SCALE SITE ASSESSMENT RECOMMENDATIONS

Eagle use of the landscape varies across large geographic scales. Thus, the first step for project development is to identify sites within a broad geographic area that are both suitable for wind energy and have low potential for effects to eagles through a rigorous, landscape-scale site-assessment process. The initial coarse site assessment should begin before any significant resources have been committed to a particular site. The site assessment should evaluate the suitability of a potential wind energy site within the ecological context of eagles, including considerations for the entire eagle life-cycle (i.e., breeding, migration, dispersal, and wintering.) At this point, the objective is to assess the potential effects to eagles and their habitats from modification at the landscape scale. The primary objective at this stage should be to determine if prospective wind development sites fall within areas used by eagles, and the relative extent and type of eagle use they receive. Areas that receive considerable use by eagles are likely to fall into category 1, and should be avoided if at all possible because the Service likely could not issue a permit that complies with all regulatory requirements for a project in those areas.

To evaluate a site for potential wind-energy development and its ecological relationship to eagle biology, multiple data sources should be consulted. Information gathered should focus on geographic and biological factors that could affect eagle risk from wind energy development. Preliminary site evaluation could begin with a review of publically available data. Good data sources include resource databases such as NatureServe [http://www.natureserve.org/], information from relevant federal, tribal and state agencies, peer-reviewed literature, technical reports, state ornithological societies, and conservation organizations with eagle expertise.

Where data gaps occur, or when beginning to look at sites in more detail, site-level reconnaissance may be necessary. The site assessment should be coordinated with Service staff early in the process to ensure all appropriate information has been included in the evaluation. The specific questions project proponents should be answering at this stage include (but are not necessarily limited to):

1. What information is available in the literature or wildlife occurrence databases on recent or historic nesting and occurrence data for eagles from the project area?
2. What information is available in the literature or raptor migration databases on eagle migration or movement through the project area?
3. What eagle concentration area information (winter [e.g., the midwinter eagle survey at http://ocid.nacse.org/nbii/eagles/] or other) is available for the project area?
4. What vegetation data are available to develop maps of potential eagle habitat?
5. What topographic features are present in the project area that might attract or concentrate eagles?

Using these and other data sources, a series of questions should be answered to help place the project or project alternative into the appropriate risk category. Relevant questions include:

1. Have you contacted the relevant agencies to discuss project development?

2. Does existing or historic data/information indicate that eagles or eagle habitat (including breeding, migration, dispersal, and wintering habitats) may be present within the geographic region under development consideration?
3. Does existing or historic data/information indicate that eagle prey habitat may be present within the geographic region under development consideration?
4. Are there areas of intact eagle habitat in the area of development that would be lost, degraded, or fragmented due to the project?
5. Are their indications the area of interest may be of special importance to eagles, and if so, can those areas of importance be delineated?

The goal of the site assessment is to ultimately select one or more sites that will be the focus of the more detailed site-specific surveys and assessments. We recommend development of a map that, based on the answers to the above questions should allow development of a map that shows broad areas that fall under site category levels 1 through 4, in areas where wind development would pose: (1) a high risk to eagle populations, (2) a moderate risk to eagle populations, (3) a low risk to eagle populations, and (4) areas where the potential effects to eagles are uncertain due to lack of information about the site. In general, sites or alternatives that fall into category 1 should be dropped from consideration, whereas sites that fall into categories 2, 3, and 4 would potentially move on to Stage 2. However, site classification at this stage should be regarded as tentative pending the outcome of the site-specific assessment. Sites in any of the categories could change as more detailed information regarding the sites and eagle populations within or adjacent to them is obtained. For example, a site classified as a category 2 site during the broad geographic assessment could ultimately be dropped from consideration once more site-specific data are collected in the next stage. Conversely, a site deemed high risk due to historical data could become selected if current site-specific data indicate that, based on local factors, it is actually low risk.

APPENDIX C

STAGE 2 – SITE-SPECIFIC ASSESSMENT RECOMMENDED METHODS AND METRICS

Data collected in this stage will be used to generate model-based predictions of annual eagle fatalities for specific potential project sites. The predictions will be generated with models ideally using survey data collected from the project locale following the standardized approach outlined below. Project proponents are free to propose other forms of pre-construction surveys and monitoring, but they should yield data that will satisfy the adaptive management requirements and the regulatory monitoring requirements. Recommended site-specific sampling consists of three components: (1) fixed-radius point counts within the project footprint, (2) characterization of the local-area nesting population, and (3) determination of presence of seasonal eagle concentration areas. Components (1) and (3) provide information useful in predicting potential annual eagle fatality rates from wind facilities, whereas component (2) identifies nesting territories that may be negatively affected by disturbance.

1. Point Counts

The metric that feeds into models used to predict the number of expected eagle fatalities per year is the *eagle exposure rate*, expressed as eagle exposure minutes (flight minutes) per daylight hour within the footprint of the project, averaged over daylight hours and over the annual cycle. The recommended approach for estimating eagle exposure rate for a project is based on 30-minute point count surveys of eagles at 800-m radius plots within and adjacent to the project footprint. Point count surveys of birds on fixed-radius plots were described by Hutto *et al*. (1986). Use of large-plot, long-duration point counts, most typically 20- or 30-minute counts at 800-m radius plots, appears to be standard in pre- and post-construction assessment of use of wind energy projects by large (crow size or greater) species of birds (Hoover and Morrison 1996, Johnson *et al.* 2000, Smallwood *et al.* 2009).

Relative abundance data from point counts (i.e., the mean number of individuals or breeding pairs observed per count) often are used to coarsely predict fatality rates by referencing a regression between like data and associated post-construction fatality results from multiple studies, although this approach is called into question by data from some studies (Orloff and Flannery 1992, DeLucas *et al.* 2008). A common approach to using point count data for assessing risk is to generate a relative index of exposure based on the product of mean abundance from the counts, the proportion of individual birds that were flying when observed, and the proportion of individuals flying at heights within a specified risk zone, usually the rotor-swept zone (Johnson *et al.* 2000). Like comparison with a regression based on many pre- and post-construction data, this coarse index provides a notion of risk relative to other facilities and allows rough comparisons among species within a facility. However, it does not take into account significant factors including species-specific avoidance behavior and site-specific design features other than blade length and hub height of turbines. Point count data can support more detailed risk assessment models (reviewed by Madders and Whitfield 2006), such as recommended in the Draft Eagle Conservation Plan Guidance.

To support our recommended modeling approach, a random or random-systematic approach should be used to distribute points across the project footprint such that all parts of the footprint are represented in proportion to their areal cover. A range of 20-30 point count plots probably represents the maximum number of plots that can be surveyed twice monthly at wind energy projects of moderate (50-100 MW) to large (> 100 MW) capacity. We recommend a sampling frequency targeting a coefficient of variation (ratio of the standard deviation to the mean; CV) for eagle exposure rate of 0.2. Lower sample size and sampling frequency will result in less precise estimates and potentially necessitate use of a more risk-averse approach to predict fatality rates. The two-dimensional area sampled at each 800-m radius plot is $\pi 800^2$ = 201 ha and the total area sampled within the project footprint is the sum of the area sampled across all points. Exposure rate can be estimated based on data from sampling points that are not independent of one another, although points must be separated by at least 1600 m to avoid overlap among the 800-m radius plots that are centered on the points. Observers should use the most efficient, logical route to move among sampling points, changing the starting point with the beginning of each survey cycle such that each point is surveyed during a range of daylight hours.

Likelihood of detecting eagles during point count surveys is low during the first and last 2-3 hours of the day, but increases during midday when the eagles are most active. We recommend use of a temporally stratified sampling approach, allocating most survey effort to the midday period to reduce sampling variance and improve the precision of estimates while maximizing the opportunity for detections. This recommendation is particularly germane to surveys of golden eagles; over the course of a year there may be almost no detections of golden eagles early and late in the day. A pilot study can help validate this and support a power analysis to better ascertain minimum sample sizes. Surveying should be done under all weather conditions except if visibility approaches 0 (blinding snow or fog), or where visibility is less than 800 m horizontally and 200 m vertically. We recommend use of the National Oceanic and Atmospheric Administration's Earth System Research Lab's sunrise-sunset calculator to determine appropriate survey intervals and available daylight hours (http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html).

Every point should be surveyed twice monthly in each of four seasons annually for at least 2 years, and preferably for 3 years. At each survey visit, the observer remains at the point for a set time (20 or 30 minutes is typical, and should be determined based on sampling considerations, ideally after analysis of pilot data from the site) and records the total number of minutes of eagle flight activity within 800 m, except that eagle flight activity more than 175 m above ground is not recorded. Thus, the "plot" actually is three-dimensional, forming a cylinder. As a practical way of documenting eagle exposure, we recommend dividing the total sample interval into 1-minute intervals and then recording the number of birds in flight within the plot in each interval (such that one eagle in flight in the cylinder in a given minute = 1 exposure minute; two eagles in flight in the cylinder in a given minute [or the same eagle in flight continuing into a second minute interval] = 2 exposure minutes, and so on). One exposure minute should be ascribed to an eagle perched within a plot during the entire 30-minute survey, but perched birds should be noted as such so that can be taken into account in the analyses. Because counts will be repeated, each point should be permanently marked. The perimeter of a plot can be temporarily marked in several places to help the observer approximate its location; this also can be done with a rangefinder. Because of the large size of an eagle, we assume a detection probability of about1.0; therefore, no detectability corrections are required. Topography, forest cover, or anthropogenic structures may obstruct views of portions of some plots. In such cases, an observer could estimate the percentage of the plot area that is visible and factor this into the calculation of area surveyed; if an assumption of randomness can be relaxed, the point location could be shifted to the nearest location that provides an unobscured view. Point count surveys for eagles may be conducted in conjunction with other wildlife sampling, provided the sampling frame outlined above (or a suitable alternative) is implemented and that observers are fully qualified to survey eagles. Objectives for using 800-m radius point counts for other large species of birds may require independence among sampling points. If so, the points should be separated by at least 2400 m.

Field data forms should include a large circle representing the point count plot on which the observer can record approximate flight paths and heights of eagles plus ancillary notes on general behavior and activity. Behavior prevalent during each 1-minute interval should be recorded as either soaring flight (circling broadly with wings outstretched), flapping-gliding, kiting-hovering, stooping or diving at prey, stooping or diving in an agonistic context with other eagles or other bird species, being mobbed, undulating/territorial flight, or perched. Observations of eagles outside the plot should also be recorded. Age of each eagle can be categorized as juvenile (recently fledged or fledged the previous year), subadult, adult, or unknown. An eagle's above-ground height should be estimated for each 1-min interval record, using broad categories relevant to the height of the rotor-swept zone and other risk-specific considerations (e.g., 1-20 m, 21-50 m, and so on; Walker *et al.* 2005). The rotor-swept zone (i.e., lowest to highest extent of turbine blades) of a generic 2- to 3-MW wind turbine is 35-135 m high. Weather data also should be recorded: wind direction and speed, extent of cloud cover, precipitation (if any), and temperature.

2. Characterization of the Project-area Nesting Population

The approach that we recommend in this Draft Eagle Conservation Plan Guidance for evaluating siting options and for assessing disturbance effects of wind facilities on eagles breeding on proximate territories is to determine locations of occupied nests of bald and golden eagles within the project footprint and within 10 miles of the perimeter of the footprint, then for each species calculate the mean nearest neighbor distance between the occupied nests (the project-area inter-nest distance). We use a 10-mile distance because the Service has defined the area nesting population for golden eagles to be the "number of pairs of golden eagles known to have a nesting attempt during the preceding 12 months within a 10-mile radius of a golden eagle nest" (50 CFR 22.3). To avoid confusion with the regulatory term and definition we use the term project-area nesting population to describe the eagle population targeted in these surveys. We also recommend application of this survey approach and scale to bald eagles for the purposes of these Draft Eagle Conservation Plan Guidance; however, where the project area nesting density is high-enough to make the 10-mile perimeter infeasible, we suggest considering use of one of the alternative approaches discussed below.

The objective of the project-area nesting population survey is to determine: (1) the number; (2) occupancy status; and (3) productivity of bald and golden eagle nesting pairs within the search area for three or more breeding seasons prior to construction. Where eagle nesting density is especially high and data are available (either from prior studies or a pilot study) to do so, the project-area inter-nest distance can be calculated and used as the width of the perimeter survey area, as the territories immediately adjacent to the footprint are the ones most likely to be affected by the project. This approach is especially appropriate in areas with high densities of nesting bald eagles. The Service strongly encourages that nesting surveys be conducted by experienced biologists with several year's prior experience conducting eagle nest surveys. Recommended approaches for conducting nesting surveys are provided below.

Eagles generally show strong fidelity to the nesting area annually, but not all pairs attempt to breed or successfully breed every year and it is easy to mischaracterize territories where pairs are present but do not breed as unoccupied. Occupancy determination via inventory of all available suitable habitat is the most important goal of nest searches. The project-area nesting population survey should include all potentially suitable eagle-nesting habitat within the project footprint and a 10-mile perimeter (unless a lesser distance is warranted based on factors described previously). A nesting territory or inventoried habitat should be designated as unoccupied by eagles only after ≥ two complete surveys at least 30 days apart in a breeding season. Where ground observations are used, at least two ground observation periods lasting ≥ four hours are necessary to designate an inventoried habitat or territory as unoccupied as long as all potential nest sites and alternate nests are visible and monitored. Dates of starting and continuing inventory and monitoring surveys should be sensitive to local nesting (i.e., laying, incubating, and brooding) chronologies. All surveys should be conducted during weather conditions favorable for survey and/or monitoring from medium to long range distances (> ½ mile).

A 'decorated' nest (a nest with fresh whitewash, feathers, or with fresh greenery) will be sufficient evidence to indicate the probable location of a nesting attempt. If a decorated nest or pair of birds is located, the search in that territory should be continued to locate and map alternate nest sites. Identification and enumeration of alternate nests will help determine the relative value of individual nests to a territory in cases of applications for permits to take 'inactive' nests, and when determining whether abandonment of a particular nest is likely to result in abandonment of a territory.

Helicopters are an accepted and efficient means to monitor large areas of habitat to inventory potential habitat and monitor known territories only if accomplished by competent and experienced observers, and if sufficient aerial time is budgeted for the survey. They can be the primary survey method, or can be combined with follow-up ground monitoring. Effective aerial surveys of woodland habitat for eagle nests may require two- to three-times as much time as aerial surveys for cliff nests. Cliffs should be approached from the front, rather than flying over from behind, or suddenly appearing quickly around corners or buttresses. Inventories should be flown at slow speeds, ca. 30 – 40 knots. All potentially suitable nesting habitats (as identified in coordination with the Service) should be surveyed; multiple passes at several elevation bands may be necessary to provide complete coverage when surveying potential nesting habitat on large cliff complexes, escarpments, or headwalls. Hovering for up to 30 seconds no closer than a horizontal distance of 20 meters from the cliff wall or observed nests may be necessary to discern nest type, document the site with a digital photograph of the nest, and if possible, allow for the observer to read patagial tags, count young, and age young in the nest (Hoechlin 1976). Nest occupancy may be confirmed during later flights at a greater horizontal distance. Aerial surveys may not be appropriate in some areas (e.g., bighorn sheep lambing areas).

Whether inventories are conducted on the ground or aerially, the metrics of interest to the Service for the project-area nesting population area as follows:

1. Number and location of nests within territories with an occupied nest (i.e., an occupied territory).
2. Number and location of likely eagle nests within apparently unoccupied territories (i.e., suspected or previously occupied eagle territories without an occupied nest in the current year).
3. Productivity (number of young surviving to $\geq$51 days of age) in each occupied nest.

Nest location information should be recorded in decimal-degree latitude longitude or UTM coordinates, and the substrate (tree species, cliff, ground, or structure) and nest elevation should be provided. Dates of each nest visit and nest status (occupied, eggs or young present, or failed and abandoned) should also be provided. These data should be provided to the Service in an Appendix to the project proponent's ECP.

3. Eagle Migration and Concentration Area Surveys

Non-breeding bald and golden eagles occasionally use communal roosts and forage communally, and both species can become concentrated on spring and fall migration under particular combinations of weather and topographic conditions. Therefore, pre-development site-specific surveys should be conducted if the Stage 1 site assessments suggest that migratory or transient eagles are likely to be seasonally concentrated in the project area, or if existing biological data are not available to make such a determination. These temporal pulses may be detected by the fixed-radius point counts, however the baseline point-count sampling intensity and sampling intervals may not be sufficient to detect or adequately characterize short-term migration or concentrated non-breeding eagle use. If either migration or non-breeding eagle concentrations are present in the project area, targeted spatio-temporal increases in the frequency of fixed-radius point counts may be advisable to provide more precise measures of the eagle exposure rate.

Migration counts can be used to determine relative numbers of diurnal raptors passing over an established point (Dunn *et al.* 2008), usually a migration concentration site. Migration surveys should be employed using established techniques with appropriate, qualified staffing during primary migration periods if the Stage 1 site assessment suggests the project area may be a migration concentration area. Migration counts may involve staffing observation posts up to 7 days per week during time periods (species and latitude dependent) and weather windows when eagles may be moving.

The Service recommends that project proponents conduct thorough exploratory fall and/or spring migration counts for eagles at possible concentration locations (e.g., north-south oriented ridgelines, peninsulas extending into large water bodies) in the project footprint in the initial site-specific survey year for the duration of the fall/spring passage period (see the Hawk Migration Association of North America's [HMANA] website for information of seasonal passage periods: http://www.hmana.org/index.php, last visited January 2, 2011). If migrating eagles are observed, migration counts should be continued for three years, and project proponents should consult with the Service to determine if increased sampling at fixed-radius points on likely migration flight routes during periods when migration is occurring is warranted. Migration counts should be conducted following standards established HMANA. Migration count data in the form requested by HAMANA should be provided to the Service as an Appendix to the ECP.

As with migration concentrations, the potential for non-breeding (either winter or summer) eagle concentration areas in or near the project footprint should be carefully considered in Stage 1. If seasonal concentration areas are possible, then exploratory aerial surveys (fixed-wing or helicopter) of potential habitat should be conducted in the initial year of site-specific surveys. General guidelines and recommendations for conducting eagle concentration area surveys are provided in Appendix F of the Northern States Bald Eagle Recovery Plan (USFWS 1983: http://www.fws.gov/midwest/eagle/recovery/be_n_recplan.pdf , last visited January 3, 2011). If eagle concentrations are present in the project area, then project proponents should consult with the Service to determine if increased sampling is warranted at fixed-radius points in likely seasonally important use areas.

APPENDIX D

STAGE 3 – RISK ANALYSIS RECOMMENDED METHODS AND METRICS

The objectives of the risk analysis are to predict the number of eagle fatalities to expect for a particular siting and operational configuration at a wind facility. Project proponents should work in coordination with the Service to determine risk-factors associated with each turbine in the facility. Then, an annual predicted mortality rate for the project can be calculated by using the estimated annual eagle exposure rate generated from the Stage 2 assessment and using explicit models with templates possibly supplied in a spreadsheet, such as Excel. The initial estimate of mortality rate should not take into account possible ACPs; these will be factored in as part of Stage 4. Additionally, any loss of production that may stem from disturbance is not considered in these calculations, but is instead derived from post-construction monitoring as described in Stage 5. Specific elements of the adaptive management process will be further developed as they emerge in actual cases, through coordination with project proponents. Therefore, this stage and Stage 5 of the ECP will require close coordination between the project proponent and the Service.

1. Risk-factor Analysis

Risk of collision varies from turbine to turbine in a wind facility based on the presence of one or more risk factors (see Figure 1, also Table 1 in the *Proposed Guidance for Eagle Conservation Plans Module 1. Wind Energy Development*) specific to each turbine. In the risk factor analysis, each turbine is evaluated to determine which of these site-based factors might be present:

1. Topographic features conducive to slope soaring
    a. On or bordering the top of a slope oriented perpendicular to the prevailing wind direction
    b. Near (within 50 meters) of a ridge-crest or cliff edge
2. Topographic features that create potential flight corridors
    a. In a saddle or low point on a ridge line
    b. Near a riparian corridor, at a forest or wetland edge, or near shorelines of large water bodies that eagles are reluctant to traverse
3. Proximate to potential foraging sites
    a. Near perennial or ephemeral water sources that support a robust fishery or harbor concentrations of waterfowl
    b. Near a prairie dog (*Cynomys* spp.) colony or area of high ground squirrel density
    c. Near cover likely to support rabbits or hares
    d. Near concentrations of livestock where carcasses and neonatal stock occur
    e. Near sources of carrion
    f. Near game dumps or landfills
4. Near likely perch structures or roost sites
5. In an area where eagles may frequently engage in territorial interactions
    a. At about one-half of the mean project-area inter-nest distance (based or Stage 2 surveys) from an eagle nest site.
6. Other risk factors not identified above

Because of the importance of factor 3 above, the Service recommends project proponents conduct thorough surveys to document the distribution and availability of eagle food sources within the project footprint to inform the turbine-specific risk-factor analysis. Results of the risk factor analysis for each turbine should be compiled and provided as an appendix to the project proponent's ECP, along with the specific location (decimal-degree latitude longitude or UTM coordinates) of each turbine and its number or other identifier. The permit applicant and the Service will use the information collected to generate predictions of eagle fatality rates as described in the next section, and to facilitate consideration of specific, micro-siting alternatives (ACPs) in Stage 4 that could reduce risk.

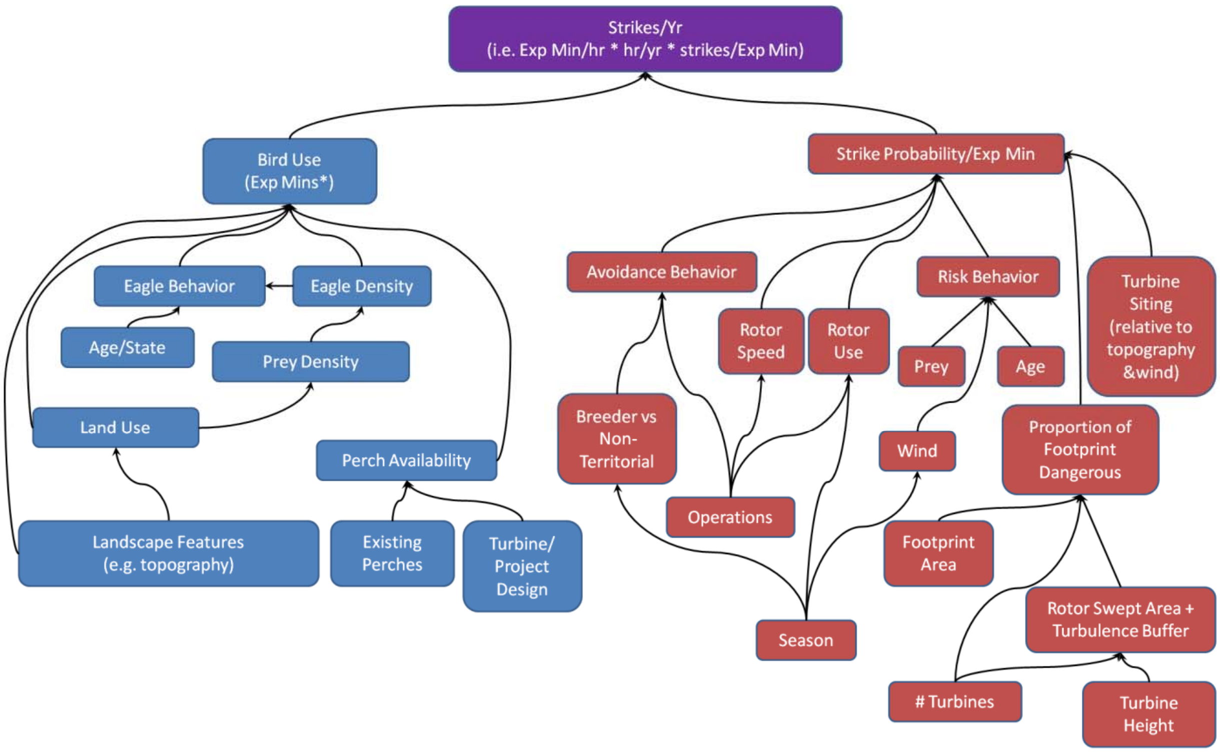
2. Generating an Estimate of Annual Fatality Rate

The predicted number of fatalities per year is estimated from the product of exposure rate and collision probability. Exposure rate is the number of eagle flight minutes in the footprint per minute calculated from point count surveys in Stage 2. Exposure rate is dimensionless (i.e., exposure minutes/observation minutes) and proportional (i.e., each observation is made within a fixed sampling area and the estimate of exposure is scaled up to the footprint of the facility).

Collision probability (risk) is the probability than an eagle will collide with a turbine during a minute of exposure. Collision probability is estimated for the project footprint as a whole based on the risk factor analysis described above, and taking into account the proportion of the project area that represents a collision risk to an eagle (the area within 100 m of the base of a turbine). The overall collision probability is the cumulative probability across all turbines (i.e., the chance that an eagle will collide with one of the turbines in the facility). An assumption is that all collisions result in fatality. A general description of the approach with an example is provided in Table D-1, and a flow chart showing elements of the model is provided in Figure D-1.

Ideally, all parameters on the left (blue) side of Figure D-1 will not have to be estimated because the metric of eagle use is determined empirically through the point count surveys. However, the Service is developing predictive models that will include risk-averse estimates for parameters associated with eagle exposure rate so that conservative estimates of the eagle exposure rate can be generated where appropriate survey data are not available. The last term of the model defines the probability of collision during a minute of exposure. Collision risk is predicted using the collision part of the model (Figure 2), and is a function of its compliment, a basic avoidance rate (e.g., ~1% [Whitfield 2009]), adjusted downward based on the presence of one or more risk factors.

The actual number of fatalities per year is estimated using standardized line-transect surveys of carcasses in the footprint of the facility, corrected to account for imperfect detection, carcass scavenging, and carcass decay as described in Stage 5 (Buckland et al. 2001, 2004; Laing et al. 2003; Rivera-Milán et al. 2004). Updating the collision model using these Stage 5 monitoring data will lead to improved decision-making through adaptation (Nichols and Williams 2006). In addition, data collected across wind-power facilities in a state or region will be used for meta-analysis to better understand cumulative impacts of wind facilities on eagle populations.



*Exp min = exposure minutes (time eagles are within the project footprint)

Figure D-1. Flow chart showing structure of the model used to predict annual eagle fatality rate at a wind facility. The proportion of the footprint that is dangerous is that within 100 meters of the base of a wind turbine.

Stage 2 and 3 Exposure Survey and Take Model Predictions Example

The predicted number of annual fatalities is estimated from three terms: (1) a measure of eagle use of the project area, (2) the proportion of the project area that is dangerous, and (3) the rate of collisions per minute in the danger zone based on the various site and turbine features. Eagle use (exposure) of the project area is determined from preconstruction surveys or estimated when survey data are insufficient or unavailable. The proportion of the project area that is dangerous (danger zone) is a direct calculation of hazardous areas relative to the total project area. The risk of a strike fatality is first determined from quantifying the risk of relevant turbine siting, model, and operating characteristics at first determined from expert elicitation and refined by applying a statistical model to results of Stage 5 carcass surveys. The product of these becomes the estimate of fatalities. To illustrate this, we use a simple, hypothetical example of what would be, by today's standards, an extensive wind energy facility, but which may also represent multiple adjoining facilities.

A wind facility has a planned foot print of A=1,000 km^2 (3183 turbines). A pre-construction survey was run for a year to estimate eagle exposure (minutes) relative to total daylight minutes (262,980). The facility conducted a systematic sample of n = 300 fixed radius (800m) points with $r = 5$ visits for each point i. (For this example, no observations were missing, but missing replicates are easily accommodated by allowing r to vary among points with the notation, r_i.) Areas ($a_i^{Sample} = \pi \times 0.8^2 = 2.01 \text{ km}^2$) around each point were observed for t_{Sample} = 20 minutes and the time eagles were observed in the sample area recorded (eagle flight minutes). Although in this example all sample areas are complete, in practice observable area may be limited by topography or other features, and area a_i^{Sample} may vary among points.

Eagle Exposure

The example exposure per km^2 (eagle flight min/min/km^2) is obtained in 2 steps:

Let y_{ij} be the observed rate of exposure (eagle flight min per 20 minute sample period) at sample point i (i = 1 to n) and replicate observation j (j = 1 to r_i). First, the means at each sample point (i) are taken from all the replicate observations and standardized by the area sampled,

$$\bar{y}_i = \frac{\sum_{j=1}^{r_i} y_{ij}}{r_i a_i^{Sample}} = \frac{\sum_{j=1}^{r} y_{ij}}{r a^{Sample}}$$

(The right part of the equation is a simplified version when no observations are missing and all points have a_i = 0.8 km^2 sample area.)

Second, the average of the sample point means is calculated

$$E_{\text{km}^2} = \frac{\sum_i^n \bar{y}_i}{n} \qquad SD\left(E_{\text{km}^2}\right) = \frac{\sum_i^n \left(\bar{y}_i - E_{\text{km}^2}\right)^2}{n-1}.$$

In the example, this results in: $E_{\text{km}^2} = 5.53\times10^{-3}\ \frac{\text{eagle flight min}}{\text{daylight min}\times\text{km}^2}\ \left(\text{SD} = 2.072\times10^{-3}\right)$.

To get the exposure minutes for the project, multiply by project area, *A*, and the number of daylight minutes per year,

$$\text{Exposure}_{\text{Minutes}} = T_{\text{Min}} \times A \times E_{\text{km}^2} = 1,453 \text{ minutes}$$

$$\text{SE}\left(\text{Exposure}_{\text{Minutes}}\right) = \text{T}_{\text{Min}} \times \text{A} \times \frac{\text{SD}\left(\text{E}_{\text{km}^2}\right)}{\sqrt{\text{n}}} = 545$$

$\text{Exposure}_{\text{Minutes}}$ has a CV of 38 percent $\left(\text{CV} = \text{SE}\left(\text{Exposure}_{\text{Minutes}}\right)/\text{Mean}\left(\text{Exposure}_{\text{Minutes}}\right).\right)$

Danger Zone

This is the portion of the project footprint that is in the danger zone, D, where eagles are in danger from the turbines, power lines, or other project hazards. For wind turbines, the zone includes 100 m buffers placed around each turbine, $D = {n_{\text{Turbine}} \times \pi \times 0.1^2}/{A}$. In our example, the danger zone is ten percent of total area (3183 turbines).

Collision Rate

The rate of strikes per minute of eagle flight in the danger zone is determined turbine by turbine, depending on associated risk factors, c_{ij}. The levels of the factors j are assigned a risk for each turbine i. A unspecified function, $\text{f}_{\text{Collision Rate}}$, uses the factors to determine the turbine specific risk,

$$C_i^{\text{Turbine}} = \text{f}_{\text{Collision Rate}}\left(c_{i1},\cdots,c_{iJ}\right) = \exp\left(\sum_j \log\left(c_{ij}\right)\right)$$

An example function that keeps the rates positive might be a multiplicative function, exponentiating the sum of the logs.

The per turbine rates are averaged to get the overall collision rate.

$$C = {\sum_i^{n_{\text{Turbine}}} C_i^{\text{Turbine}}} \Big/ {n_{\text{Turbine}}}.$$

In this example, let the overall collision rate be 0.0259.

The number of annual fatalities is the product of the three terms: exposure minutes, the proportion of the footprint in the danger zone, and the overall collision rate,

$$\text{Fatalities}_{\text{Project,Year}} = \text{Exposure}_{\text{Minutes}} \times D \times C$$

$$= \left(1453 \text{ minutes}\right) \times 0.10 \times \left(0.0259 \tfrac{\text{strikes}}{\text{minute}}\right).$$

Finally, the example eagle fatalities per year is 2.9. Because the only variation here is from the exposure survey the SE is 1.09.

To keep this example simple, exposure was not stratified into areas and times of the year thought to influence eagle use of habitat. With experience and data from projects, other parts of the model will be further refined, e.g., in Stage 3, the collision rate, C, will be updated in Stage 5 using data from the carcass surveys. Also, with data from multiple projects, the relationships among exposure, collision rate, and fatalities will be better understood and incorporated into the model.

APPENDIX E

STAGE 4 – DEVELOPMENT OF ADVANCED CONSERVATION PRACTICES

Siting of a wind facility is the most important factor when considering potential effects to eagles. Based on information gathered in Stage 2 and analyzed in Stage 3, the project proponent 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 facility has a high eagle exposure rate and presents multiple risk factors (e.g., is proximate to an important eagle-use area and Stage 2 data suggest eagles frequently use the proposed wind-facility 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 for some rare category 1 sites where there is potential to adequately abate risk, the ECP should next address Advanced Conservation Practices (ACPs) that might be employed to minimize or, ideally, avoid eagle mortality and disturbance.

In this section of the ECP, we recommend project proponents re-run models predicting eagle fatality rates *after* implementing the scientifically supportable 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 the unavoidable eagle mortality. 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.

1. Examples of ACPs Applicable Before and During Project Construction

Examples of avoidance and minimization measures that should 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 activities, such as monitoring and site reconnaissance, as well as during construction.
2. Consider undertaking real-time monitoring of proximate occupied nest sites, and curtailing activity if eagles exhibit signs of distress.
3. Prioritize locating development on disturbed lands that provide minimal eagle use potential.
4. Utilize existing transmission corridors and roads.
5. Avoid vegetation removal and construction during the breeding season.
6. Design project layout to reduce collision and electrocution:
    a. Site turbines in groups rather than spreading them widely but avoid areas where eagles concentrate which could result in high-risk rows of turbines (Smallwood and Thelander 2004).
    b. Consider using pylons at the ends of turbine rows, place pylons in ridge dips or leave dips undeveloped.

c. Set turbines back from ridge edges at least 100 m where soaring is/will likely take place.
d. Site structures away from high avian use areas and the flight zones between them.
e. Dismantle nonoperational turbines and meteorological towers.
f. Bury powerlines when feasible to reduce avian collision and electrocution.
g. Follow the Avian Power Line Interaction Committee (APLIC) guidance on power line construction (APLIC 2006) and power line siting (APLIC 1994).
h. Develop a transportation plan, including road design, locations and speed limits to minimize habitat fragmentation and wildlife collisions and minimize noise effects.
i. Minimize the extent of the road network.

7. Select project features that minimize effects to eagles:
    a. Avoid use of lattice or structures that are attractive to birds for perching.
    b. 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).
    c. Minimize lighting at facilities (see *U.S. Fish and Wildlife Service Draft Land-based Wind Energy Guidelines* for detailed recommendations). Require that all security lighting be motion- or heat-activated, not left "on" overnight, and down-shield all security and related infrastructure lights.
    d. During construction, implement spatial and seasonal buffers to protect individual nest sites/territories and/or roost sites, including:
        i. Maintaining a buffer between activities and nest/communal roost sites;
        ii. Keep natural areas between the project footprint and the nest site or communal roost by avoiding disturbance to natural landscapes.
    e. Avoid activities that may disturb eagles.
8. Avoid siting turbines in areas where eagle prey are abundant and conduct practices that do not enhance prey availability at the project site.
9. Consider use of pylons to divert eagle flight paths away from risk zones.
10. Avoid areas with high concentrations of ponds, streams, or wetlands.

With respect to item 6d, buffers can help ensure nesting or roosting eagles are not disturbed by construction or maintenance because they serve to minimize visual and auditory effects associated with human activities. Our understanding of how to design effective buffers is limited at the present time, but it seems likely that the size and shape of effective buffers vary depending on the topography and other ecological characteristics surrounding the important eagle-use area. In open areas where there are little or no forested or topographic features to serve as buffers, distance alone must serve as the buffer. Effective use of buffers is one of the key areas where we hope to reduce uncertainty through the adaptive management process.

2. Examples of ACPS Applicable During Project Operations

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

1. Maintain facilities to minimize eagle effects:
    a. If rodents and rabbits are attracted to project facilities, identify and eliminate activities that may be attracting them (do not control for native wildlife without contacting the appropriate regulatory agencies). Coordinate in advance with the Service if poisons or lead-based ammunitions are contemplated for control purposes.
    a. Avoid management that indirectly results in attracting raptors to turbines, such as seeding forbs or maintaining rock piles that attract rabbits and rodents.
    b. Move stored parts and equipment, which may be utilized by small mammals for cover, away from wind turbines.
    c. If fossorial mammals burrow near tower footprints, where feasible on a case-by-case basis fill holes and surround pad with gravel at least 2 inches deep and out to a perimeter of at least 5 feet.
    d. Immediately remove carcasses (other than those applicable to post-construction fatality monitoring; see below) that have the potential to attract raptors from roadways and from areas where eagles could collide with wind turbines.
2. Ensure responsible livestock husbandry (e.g. removing carcasses, fencing out livestock) is practiced if grazing occurs around turbines.
3. Reduce vehicle collision risk to wildlife:
    a. Instruct project personnel and visitors to drive at low speeds (< 25 mph), and be alert for wildlife, especially in low visibility conditions.
    b. Plow roads during winter so as not to impede ungulate movement. Snow banks can cause ungulates to run along roads resulting in them colliding with vehicles. Roadside carcasses attract eagles, subjecting them to collision as well.
4. Follow procedures that reduce risk to wildlife:
    a. Instruct employees, contractors, and visitors to avoid disturbing wildlife, especially during breeding seasons and periods of winter stress.
    b. Reduce fire hazards from vehicles and human activities (e.g., use spark arrestors on power equipment, avoid driving vehicles off road).
    c. Follow federal and state measures for handling toxic substances.
    d. Minimize effects to wetlands and water resources by following provisions of the Clean Water Act (33 USC 1251-1387).

3. Additional ACPs

The project proponent and the Service at this point should consider additional scientifically supportable ACPs that might reduce predicted mortality even further. However, to date, few additional practices have been implemented and monitored sufficiently to be demonstrably effective in reducing eagle mortality at wind facilities. Therefore, unless compelling evidence suggests additional practices are warranted up-front, the Service may authorize permits for category 2 and category 3 projects without additional ACPs initially, but with a permit condition that post-construction monitoring data be evaluated to identify potential operational modifications that might be implemented experimentally in the future to the reduce mortality rates (e.g., if observed mortalities are limited to a single turbine in a single season, shutting down that turbine in that season would be a potential additional ACP). Permit renewal may be contingent on implementing and monitoring these empirically derived ACPs, as a component of the adaptive management process.

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

1. Seasonal or daily 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) or turbine relocation or removal.
2. Retro-fit existing horizontal turbines with new designs (e.g., vertical axis wind turbines).
3. Placing visual and/or auditory bird flight diverters in critical locations.
4. Hazing big game off property, specifically under turbines (coordinate in advance with the Service and state or tribal wildlife authorities).
5. Prey-base enhancements and/or land acquisition and management to draw eagles out of a project footprint.
6. Retro-fitting tower pads to prevent fossorial mammals from burrowing;
7. Removal of artificial and/or natural habitats attracting prey.
8. Limiting domestic livestock grazing within the project area (e.g., under turbines).
9. Adjusting turbine cut in speeds.
10. Painting blades to reduce visual “smear” (also painting with UV paint or applying different patterns).
11. Installing sound devices to disorient eagles either by having intermittent but frequent emissions, or emissions triggered by remote sensors or radar (Orloff and Flannery 1992).

APPENDIX F

USING RESOURCE EQUIVALENCY ANALYSIS TO DEVELOP A FRAMEWORK OF COMPENSATORY MITIGATION FOR POTENTIAL TAKES OF GOLDEN EAGLES FROM WIND ENERGY DEVELOPMENT

Introduction

When birds are killed—whether from oil spills, hazardous substance releases, permitted or illegal takes—their value can be difficult to quantify in ecological and economic terms. Exactly how much are they worth to an ecosystem, as well as to the public? How much compensation is enough to offset that 'take' or loss of that bird's contribution to the population? The field of resource economics has experienced tremendous advances in the development of tools to measure ecosystem services[1] since the mid 1990's. In particular, economists have extended the economic theory from valuation studies and information from scientific models to develop an alternative approach to economic valuation called resource equivalency analysis (REA) (based on Unsworth and Bishop 1994; Jones and Pease 1997). An REA responds to the question, "What, but for the event, would have happened to the injured species?" With REA, the services of the birds killed are quantified in physical units of *bird-years*.[2] The selected compensation is *scaled* so that the quantity of replacement bird-years equals the quantity of lost bird-years in present value terms to fully compensate the public for depletion of that individual or groups of individuals from the public trust, i.e., no net loss of birds.

REA is referenced in Interior's natural resource damage assessment (NRDA) regulations (2008) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); National Oceanic and Atmospheric Association's Oil Pollution Act (OPA) guidance documents; and is commonly used in NRDA cases (see, e.g., Sperduto *et al*. 1999, 2003; Natural Resource Trustees 2006; Skrabis 2005). The model has also been applied to Federal Energy Regulatory Commission (FERC) licensing, Endangered Species Act (ESA) permitted takes (see, e.g., Skrabis 2004, 2007), and enforcement actions for illegal takes. Internationally, the European Union adopted the US' REA methods for addressing environmental liabilities (Cole & Kriström 2008), and REA was used to estimate the avoided losses of sea eagles from electric

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[1] Although the fields of ecology and economics do not have a standard definition and measurement of ecosystem services, they are generally understood to be the benefits of nature to individuals, communities, and economies. Ecologists' general classification of provisioning, regulating, cultural, and supporting services aligns with the economic concepts of use and non-use values. In economics, direct use involves human physical involvement with natural resources (e.g., logging, fishing, cultural, and tourism); indirect use values resources that support humans or what humans directly use, e.g., climate regulation, flood control, animal/fish refugia, pollination, waste assimilation; and non-use does not involve physical interaction (i.e., bequest and option values).

[2] A *bird- year* refers to all services provided by one bird for one year. This measure of services is specific to the type of bird since different birds provide different services. So, e.g., the replacement services for 20 bird-years could be 20 birds for only one year, one bird over 20 years, or anything in between.

pole retrofitting as compensation for sea eagle mortalities from collisions with a wind farm in Norway (Cole 2009). With established methods and other comparable analyses, REA may be considered "informed modeling," as described in Stage 3 of the Eagle Conservation Plan, and thus an appropriate tool for estimating the required quantity of mitigation offset for estimated allowable or pre-permitted take of Golden Eagles from wind energy development.

For the purposes of the Draft Eagle Conservation Plan Guidance, the Service's Eagle Compensatory Mitigation Team (ECMT) has developed an REA example to calculate compensatory mitigation for the loss of golden eagles caused by wind power. The remainder of this paper provides a summary of the golden eagle REA results using the following scenario from the ECMT:

> **Example 1:** An annual take of five golden eagles over a five-year renewable permit, starting in 2011. Projected compensatory mitigation involves retrofitting electric power poles that pose a high likelihood of causing eagle mortality[3]. This power pole retrofit would occur in calendar year 2011, thus avoiding the potential loss of golden eagles from electrocution. Proper operation and maintenance (O&M) by the utility company of all retrofitted poles is an assumption; hereafter required for the 30-year life cycle of the wind power project. 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 25 golden eagles (5 eagles annually over five years). The cost of the retrofit of the power poles may then be converted to an estimated minimum total cost of compensatory mitigation funded by the project proponent/ applicant.

An overview of REA methods, inputs, analysis, and references is also provided below.

Summary of Results

To expedite the REA for purposes of this draft guidance module on wind energy development, the best available peer-reviewed, published data and information from North American golden eagle experts were used.[4] It should be noted that additional modeling work within the REA may be needed, particularly on issues related to migration, super producers, adult female survivorship, natal dispersal, age at first breeding, and male-female productivity and population sex ratio, as identified and documented by experts.

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[3] Companies responsible for power poles and infrastructure are also responsible for taking all reasonable and prudent measures to ensure their equipment does not kill eagles, which includes immediately retrofitting poles that have killed an eagle, and proactively retrofitting poles that are likely to kill eagles in the future. This mitigation is intended to speed up the process of proactively retrofitting power poles, and does not absolve any utility company of liability associated with eagle or other migratory bird mortalities.

[4] Dr. Jim Watson, Pete Bloom, and Karen Steenhof, personal communications to the National Golden Eagle Compensatory Mitigation Team, 12/22/10.

As a *framework* for compensatory mitigation, it needs to be clear that the following results are an illustration of how the REA works given the *current* understanding of the Golden Eagle life history inputs, effectiveness of retrofitting lethal electric poles, the expected annual take, and the timing of both the permitting and mitigation. As would be expected, smaller or larger annual takes lead to a smaller or larger number of poles to be retrofitted. The lengths of permits affect the number of retrofitted poles. Delays in retrofitting would lead to more retrofitted poles owed. As permits are being renewed, new information on changes in the level of take, understanding of the eagle life history, or effectiveness of retrofitting would be expected to change the number of retrofitted poles required for compensation. Finally, while only electric pole retrofitting is considered in this REA, the metric of bird-years lends itself to consideration of other compensatory mitigation options used to achieve the no-net loss standard in the future. With enough reliable information, any mitigation that directly leads to an increased number of Golden Eagles (e.g., habitat restoration) or the avoided loss of golden eagles (e.g., reducing vehicle/eagle collisions, retrofitting livestock water tanks, lead ammunition abatement, etc.) could be considered for compensation within the context of the REA.

The language of REA, which is described in greater detail later, includes:

- The **direct loss** of golden eagles from the take (first part of the *debit* in bird-years);
- The **lost reproduction** over two generations that is foregone because of the take (second part of the *debit* in bird-years);
- The **relative productivity** of retrofitting lethal power poles, which is the effectiveness in avoiding the loss of golden eagles by electrocution as a mitigation offset (measured in total bird-years per pole for 30 years); and
- The **mitigation owed**, with is the total debit divided by the relative productivity (*scaling*) to identify the number of lethal power poles that need retrofitting to completely offset the take of golden eagles.

Using the scenario described above, Table F-1 provides a summary of the results:

Table F-1
Mitigation Owed for a 5-Year Permitted Take of 25 Golden Eagles
(5 Eagles Annually)

Total Debit	485.74	PV bird-years for 5 years of Golden Eagle take
÷ Relative Productivity of Electric Pole Retrofitting	÷4.20	Avoided loss of PV bird-years per retrofitted pole
= Mitigation owed	=115.61	Poles to be retrofitted to achieve no net loss

PV=Present Value

If *all* of the REA inputs remain the same when the permit is renewed, then the estimated 116 poles may be multiplied by the expected number of renewals to provide an estimate of the total number of poles that would eventually be retrofitted. For example, for the 30-year life cycle of an average wind project, 115.6 poles would be multiplied by 6 permit renewals to equal approximately **694 lethal power poles** to be retrofitted as mitigation for the take of 150 Golden

Eagles over 30 years (5 eagles annually). Proper O&M of these poles would need to be conducted to ensure the expected effectiveness of the mitigation is achieved.

REA Methods

Deciding to Conduct a REA

There are two basic approaches to measuring the compensation for injuries to natural resources. The "consumer valuation approach" focuses on the demand side; the "replacement cost" approach focuses on the supply side. The former seeks to determine how much the public demands the services of natural resources (e.g., using a survey method like contingent valuation). The latter seeks to measure how much it costs to replace the natural resource services that the public loses as a result of the injury (i.e., how much it costs to supply natural resource services). The REA model focuses on the supply side of compensation for natural resource injuries, i.e., the "replacement cost" approach, as a variation of habitat equivalency analysis (HEA) (based on Unsworth & Bishop 1994, and Jones & Pease 1997).

At the US Department of the Interior, REA generally refers to a stepwise replacement model[5] for killed or injured species, which was first used in the North Cape NRDA case (Sperduto *et al*. 1999, 2003). As discussed above, this approach is consistent with both the CERCLA and OPA NRDA regulations, and is explicitly identified in the revised CERCLA regulations (2008). The model has also been applied in other US settings and internationally adopted by the European Union for addressing a full range of environmental liabilities (Cole & Kriström 2008). REA calculations using the stepwise replacement model involve basic population modeling, including elements of the Leslie matrix and associated life tables, with appropriate discounting to provide the final results in present value. This approach documents how individuals are lost by age class over time in a stepwise fashion based on survival rates and longevity, and seeks to measure how much it costs to replace the natural resource services that the public lost as a result of the injury.

Interior currently uses REA extensively in NRDA cases to measure the losses associated with individuals, not population-level effects.[6] NRDA case teams typically decide to use the REA model because of its: (1) appropriate focus on individuals killed and their replacement, (2) relatively reliable results that are transparent and reproducible, and (3) cost-effectiveness. More specifically, the current state-of-the-art REA has:

1. **Appropriate Focus.** As noted across the REA literature, the number of individuals killed in an incident can be counted or estimated. Although lost individual-years (e.g.,

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[5] Term coined by Hampton & Zafonte in the *Luckenbach Final DARP*, Appendix C, 2003, which appropriately describes how lost bird-years are calculated by the age classes over time in a stepwise fashion (i.e., # in age class (0-1) (Year 1) * survival rate = # in age class (1-2) (Year 2) * survival rate = # in age class (2-3) (Year 3), etc.). The stepwise concept reflects the Leslie Matrix used by biologists/ecologists. Similar terms are seen in the economics and political science literature to describe various trajectories over time.

[6] There have been some limited efforts to model population effects by NRDA consultants (e.g., Tank Barge Bouchard No. 120) and the State of California (e.g., M/V Kure oil spill, SS Jacob Luckenbach).

bird-years, fish-years) can be difficult to observe, simulations and arguments in the literature suggest that removing even a small number of individuals from a population can produce persistent impacts (e.g., Sperduto *et al.* 1999, Zafonte & Hampton 2005). Thus, it seems reasonable to focus on individuals killed using REA when quantifying appropriate compensation

2. **Relatively Reliable Results.** The reality is that the public's valuation of a resource is not necessarily equal to the total replacement cost identified in a REA, particularly in the case of unique and scarce resources. Zafonte & Hampton (2007) conducted experiments to explore the degree to which violations of REA assumptions can result in either under-compensation or over-compensation of the public. Specifically, they looked at whether the results of compensatory restoration diverged from monetized settlements. They found that a traditional REA is consistent with a monetized approach except in cases where the demand for resources is inelastic (i.e., no substitutes) and the impact to local resources is severe (public values are likely affected). Zafonte & Hampton (2007) believe their results suggest "the welfare biases intrinsic to a traditional REA methodology are probably minor for many NRDA cases" (p. 10). In sum, REA applies basic ecological concepts in a standard economic framework to provide relatively reliable estimates of compensation.

3. **Cost-Effective Assessment.** REA can be run and reviewed by all stakeholders, often using existing literature. Certain species require more local study, so even REAs can become more expensive in those situations. "However, because it is easier and less costly to measure the total replacement cost than the total public value, REA has an advantage over other methods, especially for small to medium-sized incidents with minimal impact on rare species" (Kure Final DARP 2008: C-2).

While the same basic REA model is being used in a variety of settings, there is some variation on the number of generations to include in the assessment. According to Zafonte and Hampton (2005), "[i]t is difficult, however, to construct a rationale that links population recovery to a specific number of entirely lost future generations (i.e., if one full generation of offspring is lost, why not the next?)" (pp. 9-10). Instead, recovery can be quantified by focusing on the production of juveniles from the remaining live birds rather than what was foregone from the dead birds (e.g., SS Jacob Luckenbach, Tank Barge Bouchard No. 120). Population models provide flexibility to specify recovery mechanisms that are based upon individuals remaining in the population. Specifying these types of mechanisms may be helpful for guiding calculations when full juvenile replacement is not expected. "The same flexibility that makes population modeling attractive can also work against it. Even simple population models may require (or imply) the specification of parameters and relationships that may not be needed when doing direct calculations of lost individuals. On one hand, specifying these relationships may help place the analysis in a broader context (e.g., by helping calibrate appropriate modeling inputs). However, it may also introduce additional uncertainty. Addition of model complexity should be done with care" (pp. 10-11).

Given the current state of the art in the REA modeling, the extensive bird expertise in the US Fish and Wildlife Service and many state agencies, and the analysis of uncertainty in more advanced population modeling by Zafonte & Hampton (2005), DOI NRDA cases typically have decided to apply zero to two generations. Most often two generations of reproductive losses are estimated based on the site-specific bird injuries. All of these factors seem relevant to any context that REA would be applied, including Golden Eagle mitigation.

Background on Conducting a Stepwise Replacement Approach REA

The stepwise replacement model is commonly used for bird kills. The basic conceptual approach to measuring losses in bird-years for one year of a take is provided in Figure F-1.

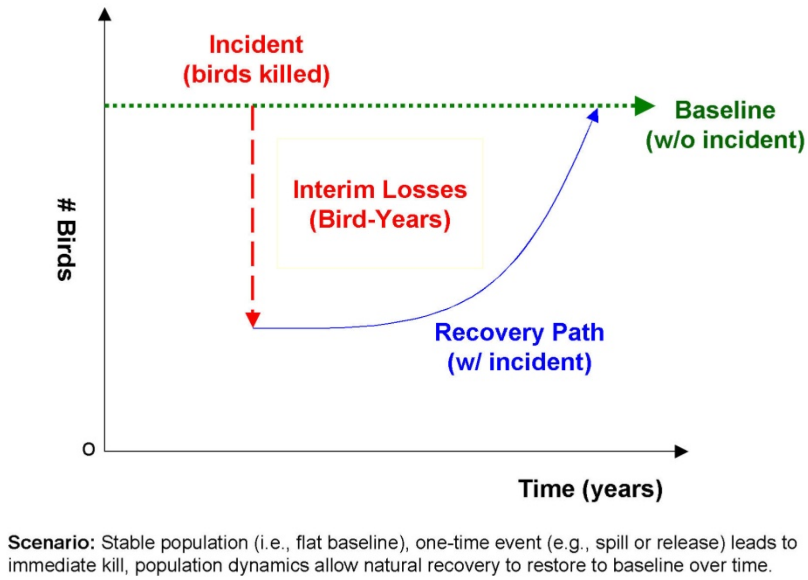

Figure F-2. Conceptually Measuring Lost Bird-Years in an REA

Mathematically, the stepwise replacement model approach is calculated as:

$$I = \sum_{t=o} [(NB_t - N_t) \div (1+r)^t] \qquad (1)$$

where *I* is the injury in lost bird-years, *NBt* and *Nt* represent the number of individuals in the population (at time *t*) under existing baseline and take scenarios, respectively, *t* indexes time (usually years, but could be adjusted for months or days for short-lived and/or quick recovering species), and *r* is the annual discount rate (which can be adjusted for months or days depending on the units of *t*) (see, e.g., Sperduto *et al.* 1999, Zafonte and Hampton 2005).

REA using the stepwise replacement model is based upon the assumptions provided in Table F-2. These assumptions are necessary to obtain a static perspective of take and mitigation for compensation, which allows a reasonable simplification of the analysis by focusing on the dead birds and associated lost bird years (measuring injury (*I*) directly).

Table F-2 REA Assumptions

Assumption 1	Incident-related mortality is distributed across the various age classes of the injured population (unless an average age is assumed).
Assumption 2	The juvenile and adult survival rates are constant before and after the incident.
Assumption 3	The baseline and mitigated/restored populations are roughly constant in size and stable in age-distribution, as determined by demographic characteristics of the species (specifically survival rates and fecundity).
Assumption 4	There is a maximum age beyond which no individuals live that is constant before and after the incident.
Assumption 5	Reproductive rates by surviving individuals are unchanged by the incident (e.g., the number of post-spill nests equals the number of baseline nests).
Assumption 6	The real discount rate is 3%. Figures presented in *current value* have no discounting; the number presented is the actual number expected to occur in the year it appears. In contrast, figures reported in *present value* have been discounted, such that the number reported reflects its value today.

Sources: See, e.g., Sperduto *et al*. 2003; Natural Resource Trustees, SS Jacob Luckenbach 2006.

There are 16 steps in conducting any REA. There are 13 total steps involved in calculating the injury side (debit) of an REA, and three additional steps involved in estimating compensatory mitigation owed (credit).

On the injury side, the first five steps measure direct losses of birds, i.e., bird-years lost from the take of Golden Eagles by wind energy development.

Step 1: Identify how many eagles by age class should have been alive "but for" the take (REAs may use the % age distribution from a Leslie model, average age, or calculated age). The Eagle Compensatory Mitigation Team and supporting national eagle experts provided an age distribution of eagles killed. A Leslie model came up with similar results. A review of Cole (2009) showed an average age for the sea eagle used in the Norwegian wind power electrocution case study. Through personal communications, the author noted that the use of an average age was a "simplification based on a lack of data" (which has also been necessitated in some NRDA cases) and is making current efforts to "improve our estimates -- both the age of a collided bird and the age of an electrocuted bird" (1/12/11).

Step 2: Multiply the relevant survival rates by the lost birds per age class at the time of the incident (from Step 1), and identify the midpoint. The midpoint provides average bird-services for the year instead of overvaluing at the beginning of the year or undervaluing at the end of the year.

Step 3: For each subsequent year, multiply the number of birds progressing through each age class by the relevant annual survival rates for the remaining lifespan of the species.

Step 4: Total the lost bird-years across age classes and for each year of remaining lifespan to estimate the total direct loss in bird-years. Multiply by the discount factor to calculate the total lost bird-years in present value.

Step 5: Identify the subset of birds that are of reproducing age (i.e., Reproducing Subset).

The next three steps involve calculating the expected losses associated with the foregone production of one (dead) bird.

Step 6: Calculate the expected value in bird-years associated with one first-generation bird in the first year as the product of the annual survival rates over the expected lifespan.

Step 7: Multiply by the relevant discount factor to convert to present value.

Step 8: Extrapolate the results from Step 7 into future years using the 3% discount rate. Although some minor rounding error is introduced, the quickest and easiest way to adjust the future values is to continuously reduce the values by 3% by multiplying the previous year by 0.97.

The next five steps measure lost reproduction in bird-years.

Step 9: Using the Reproducing Subset identified in Step 5, calculate how many of the reproducing adults are females that would actually reproduce [# reproducing age (from Step 5) x proportion female x reproductive rate of females].

Step 10: Multiply the number of reproducing females (from Step 9) by the average number of young to estimate the total number of lost first-generation birds.

Step 11: Multiply the total number of lost first-generation birds (from Step 10) by the present value bird-years associated with their lifespan (from Steps 6-8).

Step 12: To calculate the number of lost second-generation birds, identify the total number of lost first-generation birds and follow Steps 2 through 5 to calculate the reproducing subset.

Step 13: Finally, to calculate the total second-generation reproductive losses, take the reproducing subset from Step 5 and repeat Steps 9 through 11.

Finally, there are three additional steps involved for scaling mitigation options to estimate the amount of compensatory mitigation required to offset the take of Golden Eagles.

Step 14: Identify the mitigation option(s). See the Eagle Compensatory Mitigation Team's mitigation option described above, which is based on the retrofitting of lethal electric poles.

Step 15: Identify the relative productivity of the mitigation. In this case, it is the number of bird-years per retrofitted electric pole over 30 years with proper O&M to ensure the relative productivity.

Step 16: Scale the mitigation project(s) by dividing the total lost bird-years (direct and reproductive losses) by the relative productivity of the mitigation option(s) to identify the size of the mitigation project (quantity of mitigation owed). Alternatively, a project of known size could be evaluated in terms of potential bird-years as an offset to the debit. This helps decision-makers understand whether they need to identify additional projects (not enough offset) or reduce the proposed mitigation project (too much offset).

Golden Eagle REA Inputs

Table F-3 provides a summary of the Golden Eagle life history inputs and assumptions used in this REA. As discussed above, to expedite the REA for purposes of this draft guidance module on wind energy development, the best available peer-reviewed, published data and information from North American Golden Eagle experts were used.

Table F-3
REA Inputs to Develop a Framework of Compensatory Mitigation for Potential Takes of Golden Eagles from Wind Energy Development

Parameter	REA Input	Reference
Start year of permit	2011	Test run of model
Length of permit	5 years	Can test with other permit lengths
Estimated take	5 birds annually	Test run of model
Maximum lifespan	30 years	28 years, 3 months, Bird Banding Lab. Consistent with Cole (2009) approach.
Age distribution of birds killed	(0-1) 20% (1-2) 11.67% (2-3) 11.67% (3-4) 11.67% (4-5) 1.73% (5-6) 1.73% (6-7) 1.73% (7-8) 1.73% (8-9) 1.73% (9-10) 1.73% (10-11) 1.73% (11-12) 1.73% (13-14) 1.73% (14-15) 1.73% (15-16) 1.73% (16-17) 1.73% (17-18) 1.73% (18-19) 1.73% (19-20) 1.73% (20-21) 1.73% (21-22) 1.73% (22-23) 1.73% (23-24) 1.73% (24-25) 1.73% (25-26) 1.73% (26-27) 1.73% (27-28) 1.73% (28-29) 1.73% (29-30) 1.73%	• 20% juveniles; age class (0-1) • 35% sub-adults; age classes (1-2) through 3-4) —Dr. Jim Watson, Pete Bloom, Karen Steenhof, 12/22/10 • 45% adults; age classes (4-5) through (29-30) Assume distributed evenly over time. The Leslie model produces a very similar population distribution for the maximum lifespan: • 19.6% juveniles; age class (0-1) • 33.5% sub-adults; age classes (1-2) through 3-4) • 46.9% adults; age classes (4-5) through (29-30)
Age start reproducing	Age 5 [age class (5-6)]	Jim Watson, Pete Bloom, Karen Steenhof, 12/22/10
Expected years of reproduction	25 years	Maximum lifespan – Age start reproducing
% of adult females that reproduce	80%	Jim Watson (82%), Karen Steenhof (79%) 12/22/10
# eggs/nest	2	Jim Watson (2), Pete Bloom (1.5-1.8), Karen Steenhof (2; 1.6 brood size), 12/22/10
Nesting success—the proportion of nesting or laying pairs that	50%	Jim Watson, Pete Bloom, 12/22/10

Parameter	REA Input	Reference
raise young to the age of **fledging** (i.e., the age when a fully-feathered offspring voluntarily leaves the nest for the first time)(Steenhof & Newton (2007): 184)		
year 0-1 survival	61%	Division of Migratory Bird Management, US Fish and Wildlife Service, *Final Environmental Assessment: Proposal to Permit Take as Provided Under the Bald and Golden Eagle Protection Act*, April 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	0.0102 eagle electrocutions per pole per year over 30 years	R. Harness, R. Lehman, EDM International, Fort Collins, CO, unpublished. Mitigation involves retrofitting of electric power poles, thus avoiding the loss of Golden Eagles from electrocution. Proper operation and maintenance (O&M) of the retrofitted poles is required for the 30-year life of the wind power project to achieve this relative productivity.
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)
Additional factors		Migration in model, superproducer, natal dispersion, age at first breeding. Jim Watson, Pete Bloom, Karen Steenhof, 12/22/10

Golden Eagle REA

Tables F-4 through F-11 provide the results of the 16 steps of the Golden Eagle REA. The discount factor for a 3% discount rate is calculated as $(1+r)^{P-t}$, where *r* is the discount rate, *P* is the present time period, and *t* is the time period of lost services. In 2011, for example, the discount factor is 1.0, because any number raised to the zero power equals 1.0 ($1.03^{(2011-2011=0)} = 1.0$). Readers should be aware that more than the usual one or two significant digits are shown for the computed values. This choice is not intended to convey an excessive level of confidence in the calculations. Rather, the decision was made to provide sufficient information to maximize the transparency and reproducibility of the results.

Table F-4
Golden Eagle REA Debit: Direct Loss from a Take in 2011*
(REA Steps 1-5)

Year	Discount Factor	Age Class (0-1)	(1-2)	(2-3)	(3-4)	(4-5)	(5-6)	(6-7)	(7-8)	(8-9)	(9-10)
2011	1.00	1.000	0.583	0.583	0.583	0.087	0.087	0.087	0.087	0.087	0.087
2012	0.97		0.895	0.522	0.522	0.557	0.083	0.083	0.083	0.083	0.083
2013	0.94			0.707	0.412	0.475	0.506	0.075	0.075	0.075	0.075
2014	0.92				0.559	0.375	0.431	0.460	0.068	0.068	0.068
2015	0.89					0.508	0.341	0.392	0.418	0.062	0.062
2016	0.86						0.462	0.310	0.356	0.380	0.056
2017	0.84							0.420	0.282	0.324	0.346
2018	0.81								0.381	0.256	0.295
2019	0.79									0.347	0.233
2020	0.77										0.315

Year	Discount Factor	(10-11)	(11-12)	(12-13)	(13-14)	(14-15)	(15-16)	(16-17)	(17-18)	(18-19)	(19-20)
2011	1.00	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
2012	0.97	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
2013	0.94	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
2014	0.92	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
2015	0.89	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
2016	0.86	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
2017	0.84	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
2018	0.81	0.314	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
2019	0.79	0.268	0.286	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
2020	0.77	0.212	0.243	0.260	0.039	0.039	0.039	0.039	0.039	0.039	0.039
2021	0.74	0.286	0.192	0.221	0.236	0.035	0.035	0.035	0.035	0.035	0.035
2022	0.72		0.260	0.175	0.201	0.214	0.032	0.032	0.032	0.032	0.032
2023	0.70			0.237	0.159	0.183	0.195	0.029	0.029	0.029	0.029
2024	0.68				0.215	0.144	0.166	0.177	0.026	0.026	0.026
2025	0.66					0.196	0.131	0.151	0.161	0.024	0.024
2026	0.64						0.178	0.119	0.137	0.146	0.022
2027	0.62							0.162	0.108	0.125	0.133
2028	0.61								0.147	0.099	0.113
2029	0.59									0.134	0.090
2030	0.57										0.121

Table F-4 (continued)
Golden Eagle REA Debit: Direct Loss from a Take in 2011
(REA Steps 1-5)

Year	Discount Factor	(20-21)	(21-22)	(22-23)	(23-24)	(24-25)	(25-26)	(26-27)	(27-28)	(28-29)	(29-30)	Total Direct Bird-Years	Total Lost Bird-Years in PV	Reproducing Subset
2011	1.00	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	5.000	--	2.163
2012	0.97	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	4.561	4.428	2.065
2013	0.94	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	3.902	3.678	2.308
2014	0.92	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	3.395	3.107	2.461
2015	0.89	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	3.024	2.687	2.516
2016	0.86	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	2.692	2.322	2.692
2017	0.84	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	2.396	2.007	2.396
2018	0.81	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	2.131	1.733	2.131
2019	0.79	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	1.895	1.496	1.895
2020	0.77	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	1.684	1.291	1.684
2021	0.74	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	1.496	1.113	1.496
2022	0.72	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	1.328	0.959	1.328
2023	0.70	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	1.178	0.826	1.178
2024	0.68	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	1.045	0.711	1.045
2025	0.66	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.926	0.612	0.926
2026	0.64	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.820	0.526	0.820
2027	0.62	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.725	0.452	0.725
2028	0.61	0.121	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.641	0.388	0.641
2029	0.59	0.103	0.110	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.567	0.333	0.567
2030	0.57	0.081	0.094	0.100	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.500	0.285	0.500
2031	0.55	0.110	0.074	0.085	0.091	0.013	0.013	0.013	0.013	0.013	0.013	0.441	0.244	0.441
2032	0.54		0.100	0.067	0.077	0.083	0.012	0.012	0.012	0.012	0.012	0.389	0.209	0.389
2033	0.52			0.091	0.061	0.070	0.075	0.011	0.011	0.011	0.011	0.342	0.179	0.342
2034	0.51				0.083	0.056	0.064	0.068	0.010	0.010	0.010	0.301	0.153	0.301
2035	0.49					0.075	0.051	0.058	0.062	0.009	0.009	0.264	0.130	0.264
2036	0.48						0.068	0.046	0.053	0.056	0.008	0.232	0.111	0.232
2037	0.46							0.062	0.042	0.048	0.051	0.203	0.094	0.203
2038	0.45								0.057	0.038	0.044	0.138	0.062	0.138
2039	0.44									0.051	0.035	0.086	0.038	0.086
2040	0.42										0.047	0.047	0.020	0.047
Total													**30.194**	33.983

PV=Present Value

Table F-5
Golden Eagle REA Debit: Statistical Lifespan of One Eagle Fledgling Produced in 2011 (Services Start in 2012)
(REA Steps 6-7)

Year	Discount Factor		Bird-Years/ Fledgling		Bird-Years/ Fledgling in PV
2012	0.97		0.610		0.592
2013	0.94		0.482		0.454
2014	0.92		0.381		0.348
2015	0.89		0.301		0.267
2016	0.86		0.273		0.236
2017	0.84		0.249		0.208
2018	0.81		0.226		0.184
2019	0.79		0.205		0.162
2020	0.77		0.187		0.143
2021	0.74		0.170		0.126
2022	0.72		0.154		0.111
2023	0.70		0.140		0.098
2024	0.68		0.127		0.087
2025	0.66	x	0.116	=	0.077
2026	0.64		0.105		0.068
2027	0.62		0.096		0.060
2028	0.61		0.087		0.053
2029	0.59		0.079		0.046
2030	0.57		0.072		0.041
2031	0.55		0.065		0.036
2032	0.54		0.059		0.032
2033	0.52		0.054		0.028
2034	0.51		0.049		0.025
2035	0.49		0.045		0.022
2036	0.48		0.041		0.019
2037	0.46		0.037		0.017
2038	0.45		0.034		0.015
2039	0.44		0.030		0.013
2040	0.42		0.028		0.012
2041	0.41		0.025		0.010
					3.592

PV= Present Value

Table F-6
Golden Eagle REA Debit: 1st Generation Reproductive Losses from a Take in 2011
(REA Steps 8-11)

Year	Discount Factor	Total # Birds--Reproducing Age	# Reproducing Females	Total # 1st Gen Fledglings	Bird-Years/ Fledgling in PV	1st Gen Lost Bird-Years Total in PV
2011	1.00	2.163	0.865	0.865	3.592	3.108
2012	0.97	2.065	0.826	0.826	3.484	2.878
2013	0.94	2.308	0.923	0.923	3.379	3.120
2014	0.92	2.461	0.984	0.984	3.278	3.227
2015	0.89	2.516	1.006	1.006	3.180	3.200
2016	0.86	2.692	1.077	1.077	3.084	3.321
2017	0.84	2.396	0.958	0.958	2.992	2.867
2018	0.81	2.131	0.853	0.853	2.902	2.474
2019	0.79	1.895	0.758	0.758	2.815	2.134
2020	0.77	1.684	0.674	0.674	2.730	1.839
2021	0.74	1.496	0.598	0.598	2.649	1.585
2022	0.72	1.328	0.531	0.531	2.569	1.365
2023	0.70	1.178	0.471	0.471	2.492	1.174
2024	0.68	1.045	0.418	0.418	2.417	1.010
2025	0.66	0.926	0.370	0.370	2.345	0.868
2026	0.64	0.820	0.328	0.328	2.274	0.746
2027	0.62	0.725	0.290	0.290	2.206	0.640
2028	0.61	0.641	0.257	0.257	2.140	0.549
2029	0.59	0.567	0.227	0.227	2.076	0.471
2030	0.57	0.500	0.200	0.200	2.014	0.403
2031	0.55	0.441	0.177	0.177	1.953	0.345
2032	0.54	0.389	0.156	0.156	1.895	0.295
2033	0.52	0.342	0.137	0.137	1.838	0.252
2034	0.51	0.301	0.120	0.120	1.783	0.215
2035	0.49	0.264	0.106	0.106	1.729	0.183
2036	0.48	0.232	0.093	0.093	1.677	0.156
2037	0.46	0.203	0.081	0.081	1.627	0.132
2038	0.45	0.138	0.055	0.055	1.578	0.087
2039	0.44	0.086	0.034	0.034	1.531	0.053
2040	0.42	0.047	0.019	0.019	1.485	0.028
Total		33.983	13.593	13.593		**38.723**

PV= Present Value

Table F-7
Golden Eagle REA Debit: 2nd Generation Reproductive Losses from a Take in 2011
(REA Steps 12-13)

		Age Classes									
Year	0	(0-1)	(1-2)	(2-3)	(3-4)	(4-5)	(5-6)	(6-7)	(7-8)	(8-9)	(9-10)
2011	0.865										
2012	0.826	0.697									
2013	0.923	0.665	0.550								
2014	0.984	0.743	0.525	0.435							
2015	1.006	0.793	0.587	0.415	0.343						
2016	1.077	0.810	0.626	0.464	0.328	0.312					
2017	0.958	0.867	0.640	0.495	0.366	0.298	0.284				
2018	0.853	0.771	0.685	0.506	0.391	0.333	0.271	0.258			
2019	0.758	0.686	0.609	0.541	0.399	0.355	0.303	0.246	0.234		
2020	0.674	0.610	0.542	0.481	0.427	0.363	0.323	0.275	0.224	0.213	
2021	0.598	0.542	0.482	0.428	0.380	0.389	0.330	0.293	0.250	0.203	0.194
2022	0.531	0.482	0.428	0.381	0.338	0.346	0.353	0.300	0.267	0.227	0.185
2023	0.471	0.428	0.381	0.338	0.301	0.308	0.314	0.321	0.273	0.242	0.207
2024	0.418	0.379	0.338	0.301	0.267	0.273	0.280	0.286	0.292	0.248	0.220
2025	0.370	0.336	0.300	0.267	0.237	0.243	0.249	0.254	0.260	0.265	0.225
2026	0.328	0.298	0.266	0.237	0.211	0.216	0.221	0.226	0.231	0.236	0.241
2027	0.290	0.264	0.235	0.210	0.187	0.192	0.196	0.201	0.205	0.210	0.215
2028	0.257	0.234	0.209	0.186	0.166	0.170	0.174	0.178	0.183	0.187	0.191
2029	0.227	0.207	0.185	0.165	0.147	0.151	0.155	0.158	0.162	0.166	0.170
2030	0.200	0.182	0.163	0.146	0.130	0.134	0.137	0.140	0.144	0.147	0.151
2031	0.177	0.161	0.144	0.129	0.115	0.118	0.121	0.125	0.128	0.131	0.134
2032	0.156	0.142	0.127	0.114	0.102	0.105	0.108	0.110	0.113	0.116	0.119
2033	0.137	0.125	0.112	0.101	0.090	0.093	0.095	0.098	0.100	0.103	0.106
2034	0.120	0.110	0.099	0.089	0.079	0.082	0.084	0.086	0.089	0.091	0.094
2035	0.106	0.097	0.087	0.078	0.070	0.072	0.074	0.076	0.079	0.081	0.083
2036	0.093	0.085	0.077	0.069	0.062	0.064	0.066	0.068	0.070	0.071	0.073
2037	0.081	0.075	0.067	0.061	0.054	0.056	0.058	0.060	0.061	0.063	0.065
2038	0.055	0.065	0.059	0.053	0.048	0.049	0.051	0.053	0.054	0.056	0.057
2039	0.034	0.045	0.052	0.047	0.042	0.043	0.045	0.046	0.048	0.049	0.051
2040	0.019	0.028	0.035	0.041	0.037	0.038	0.039	0.041	0.042	0.043	0.045
2041	0.000	0.015	0.022	0.028	0.032	0.033	0.035	0.036	0.037	0.038	0.040
2042	0.000	0.000	0.012	0.017	0.022	0.029	0.030	0.032	0.033	0.034	0.035
2043	0.000	0.000	0.000	0.009	0.014	0.020	0.027	0.028	0.029	0.030	0.031
2044	0.000	0.000	0.000	0.000	0.007	0.012	0.018	0.024	0.025	0.026	0.027
2045	0.000	0.000	0.000	0.000	0.000	0.007	0.011	0.016	0.022	0.023	0.024
2046	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.010	0.015	0.020	0.021
2047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.009	0.014	0.018
2048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.008	0.012
2049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.008
2050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004

Table F-7 (continued)
Golden Eagle REA Debit: 2^{nd} Generation Reproductive Losses from a Take in 2011
(REA Steps 12-13)

Year	(10-11)	(11-12)	(12-13)	(13-14)	(14-15)	(15-16)	(16-17)	(17-18)	(18-19)	(19-20)
2022	0.176									
2023	0.168	0.160								
2024	0.188	0.153	0.146							
2025	0.200	0.171	0.139	0.132						
2026	0.205	0.182	0.155	0.126	0.120					
2027	0.219	0.186	0.166	0.141	0.115	0.109				
2028	0.195	0.199	0.169	0.150	0.128	0.104	0.099			
2029	0.174	0.177	0.181	0.154	0.137	0.117	0.095	0.090		
2030	0.154	0.158	0.161	0.165	0.140	0.124	0.106	0.086	0.082	
2031	0.137	0.140	0.143	0.147	0.150	0.127	0.113	0.096	0.078	0.075
2032	0.122	0.125	0.127	0.130	0.133	0.136	0.116	0.103	0.088	0.071
2033	0.108	0.111	0.113	0.116	0.118	0.121	0.124	0.105	0.093	0.080
2034	0.096	0.098	0.101	0.103	0.105	0.108	0.110	0.112	0.095	0.085
2035	0.085	0.087	0.089	0.091	0.094	0.096	0.098	0.100	0.102	0.087
2036	0.075	0.077	0.079	0.081	0.083	0.085	0.087	0.089	0.091	0.093
2037	0.067	0.069	0.070	0.072	0.074	0.076	0.077	0.079	0.081	0.083
2038	0.059	0.061	0.062	0.064	0.065	0.067	0.069	0.070	0.072	0.074
2039	0.052	0.054	0.055	0.057	0.058	0.060	0.061	0.062	0.064	0.065
2040	0.046	0.047	0.049	0.050	0.051	0.053	0.054	0.055	0.057	0.058
2041	0.041	0.042	0.043	0.044	0.046	0.047	0.048	0.049	0.050	0.052
2042	0.036	0.037	0.038	0.039	0.040	0.041	0.043	0.044	0.045	0.046
2043	0.032	0.033	0.034	0.035	0.036	0.037	0.038	0.039	0.040	0.041
2044	0.028	0.029	0.030	0.031	0.032	0.032	0.033	0.034	0.035	0.036
2045	0.025	0.025	0.026	0.027	0.028	0.029	0.029	0.030	0.031	0.032
2046	0.022	0.022	0.023	0.024	0.025	0.025	0.026	0.027	0.028	0.028
2047	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.024	0.025
2048	0.017	0.017	0.018	0.018	0.019	0.020	0.020	0.021	0.022	0.022
2049	0.011	0.015	0.016	0.016	0.017	0.017	0.018	0.018	0.019	0.020
2050	0.007	0.010	0.014	0.014	0.015	0.015	0.016	0.016	0.017	0.017
2051	0.004	0.006	0.009	0.012	0.013	0.013	0.014	0.014	0.015	0.015
2052	0.000	0.003	0.006	0.008	0.011	0.012	0.012	0.013	0.013	0.013
2053	0.000	0.000	0.003	0.005	0.008	0.010	0.011	0.011	0.011	0.012
2054	0.000	0.000	0.000	0.003	0.005	0.007	0.009	0.010	0.010	0.010
2055	0.000	0.000	0.000	0.000	0.003	0.004	0.006	0.008	0.009	0.009
2056	0.000	0.000	0.000	0.000	0.000	0.002	0.004	0.006	0.008	0.008
2057	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.004	0.005	0.007
2058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.005
2059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003
2060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002

Table F-7 (continued)
Golden Eagle REA Debit: 2nd Generation Reproductive Losses from a Take in 2011
(REA Steps 12-13)

Year	(20-21)	(21-22)	(22-23)	(23-24)	(24-25)	(25-26)	(26-27)	(27-28)	(28-29)	(29-30)	Subset Total
2032	0.068										1.785
2033	0.065	0.062									1.717
2034	0.072	0.059	0.056								1.645
2035	0.077	0.066	0.054	0.051							1.570
2036	0.079	0.070	0.060	0.049	0.046						1.493
2037	0.084	0.072	0.064	0.054	0.044	0.042					1.415
2038	0.075	0.077	0.065	0.058	0.049	0.040	0.038				1.337
2039	0.067	0.068	0.070	0.059	0.053	0.045	0.037	0.035			1.260
2040	0.059	0.061	0.062	0.063	0.054	0.048	0.041	0.033	0.032		1.185
2041	0.053	0.054	0.055	0.056	0.058	0.049	0.044	0.037	0.030	0.029	1.112
2042	0.047	0.048	0.049	0.050	0.051	0.052	0.045	0.040	0.034	0.027	1.015
2043	0.042	0.043	0.044	0.045	0.046	0.047	0.048	0.040	0.036	0.031	0.924
2044	0.037	0.038	0.039	0.040	0.041	0.041	0.042	0.043	0.037	0.033	0.830
2045	0.033	0.034	0.034	0.035	0.036	0.037	0.038	0.039	0.039	0.033	0.736
2046	0.029	0.030	0.031	0.031	0.032	0.033	0.034	0.034	0.035	0.036	0.645
2047	0.026	0.026	0.027	0.028	0.028	0.029	0.030	0.030	0.031	0.032	0.554
2048	0.023	0.023	0.024	0.025	0.025	0.026	0.026	0.027	0.028	0.028	0.475
2049	0.020	0.021	0.021	0.022	0.022	0.023	0.023	0.024	0.025	0.025	0.406
2050	0.018	0.018	0.019	0.019	0.020	0.020	0.021	0.021	0.022	0.022	0.346
2051	0.016	0.016	0.017	0.017	0.018	0.018	0.018	0.019	0.019	0.020	0.294
2052	0.014	0.014	0.015	0.015	0.016	0.016	0.016	0.017	0.017	0.018	0.249
2053	0.012	0.013	0.013	0.013	0.014	0.014	0.015	0.015	0.015	0.016	0.211
2054	0.011	0.011	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.014	0.177
2055	0.009	0.010	0.010	0.010	0.011	0.011	0.011	0.012	0.012	0.012	0.148
2056	0.008	0.009	0.009	0.009	0.009	0.010	0.010	0.010	0.011	0.011	0.124
2057	0.007	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.010	0.103
2058	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.008	0.009	0.084
2059	0.004	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.069
2060	0.003	0.004	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.007	0.056
2061	0.001	0.002	0.004	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.045
2062	0.000	0.001	0.002	0.003	0.004	0.005	0.005	0.005	0.005	0.005	0.035
2063	0.000	0.000	0.001	0.002	0.003	0.004	0.004	0.004	0.004	0.005	0.027
2064	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.004	0.004	0.004	0.021
2065	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.003	0.003	0.004	0.015
2066	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.003	0.003	0.011
2067	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.007
2068	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.004
2069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002
2070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Total:											**44.477**

Table F-7 (continued)
Golden Eagle REA Debit: 2nd Generation Reproductive Losses from a Take in 2011
(REA Steps 12-13)

Year	Discount Factor	Total # Birds-- 1st Gen-- Reproducing Age**	# Reproducing Females	Total # 2nd Gen Fledglings	Bird-Years/ Fledgling in PV	2nd Gen Lost Bird-Years Total in PV
2017	0.84	0.284	0.114	0.114	2.992	0.340
2018	0.81	0.529	0.212	0.212	2.902	0.614
2019	0.79	0.784	0.313	0.313	2.815	0.882
2020	0.77	1.035	0.414	0.414	2.730	1.130
2021	0.74	1.271	0.508	0.508	2.649	1.346
2022	0.72	1.508	0.603	0.603	2.569	1.550
2023	0.70	1.685	0.674	0.674	2.492	1.680
2024	0.68	1.812	0.725	0.725	2.417	1.752
2025	0.66	1.895	0.758	0.758	2.345	1.778
2026	0.64	1.944	0.778	0.778	2.274	1.768
2027	0.62	1.963	0.785	0.785	2.206	1.732
2028	0.61	1.959	0.783	0.783	2.140	1.677
2029	0.59	1.935	0.774	0.774	2.076	1.607
2030	0.57	1.896	0.758	0.758	2.014	1.527
2031	0.55	1.845	0.738	0.738	1.953	1.441
2032	0.54	1.785	0.714	0.714	1.895	1.352
2033	0.52	1.717	0.687	0.687	1.838	1.262
2034	0.51	1.645	0.658	0.658	1.783	1.173
2035	0.49	1.570	0.628	0.628	1.729	1.086
2036	0.48	1.493	0.597	0.597	1.677	1.001
2037	0.46	1.415	0.566	0.566	1.627	0.921
2038	0.45	1.337	0.535	0.535	1.578	0.844
2039	0.44	1.260	0.504	0.504	1.531	0.772
2040	0.42	1.185	0.474	0.474	1.485	0.704
2041	0.41	1.112	0.445	0.445	1.440	0.641
2042	0.40	1.015	0.406	0.406	1.397	0.567
2043	0.39	0.924	0.370	0.370	1.355	0.501
2044	0.38	0.830	0.332	0.332	1.314	0.437
2045	0.37	0.736	0.295	0.295	1.275	0.376
2046	0.36	0.645	0.258	0.258	1.237	0.319
2047	0.35	0.554	0.222	0.222	1.200	0.266
2048	0.33	0.475	0.190	0.190	1.164	0.221
2049	0.33	0.406	0.162	0.162	1.129	0.183
2050	0.32	0.346	0.138	0.138	1.095	0.151
2051	0.31	0.294	0.118	0.118	1.062	0.125
2052	0.30	0.249	0.100	0.100	1.030	0.103
2053	0.29	0.211	0.084	0.084	0.999	0.084
2054	0.28	0.177	0.071	0.071	0.969	0.069
2055	0.27	0.148	0.059	0.059	0.940	0.056
2056	0.26	0.124	0.049	0.049	0.912	0.045
2057	0.26	0.103	0.041	0.041	0.885	0.036
2058	0.25	0.084	0.034	0.034	0.858	0.029
2059	0.24	0.069	0.028	0.028	0.832	0.023
2060	0.23	0.056	0.022	0.022	0.807	0.018
2061	0.23	0.045	0.018	0.018	0.783	0.014
2062	0.22	0.035	0.014	0.014	0.760	0.011
2063	0.22	0.027	0.011	0.011	0.737	0.008
2064	0.21	0.021	0.008	0.008	0.715	0.006

Table F-7 (continued)
Golden Eagle REA Debit: 2nd Generation Reproductive Losses from a Take in 2011
(REA Steps 12-13)

2065	0.20	0.015	0.006	0.006	0.693	0.004
2066	0.20	0.011	0.004	0.004	0.673	0.003
2067	0.19	0.007	0.003	0.003	0.652	0.002
2068	0.19	0.004	0.002	0.002	0.633	0.001
2069	0.18	0.002	0.001	0.001	0.614	0.000
2070	0.17	0.001	0.000	0.000	0.595	0.000
Total		44.477	17.791	17.791		**34.238**

Table F-8
Golden Eagle REA Debit: Extrapolation of the Debit from a Take in 2011
to the Total Debit for a Five-Year Renewable Permit

Year	PV Bird-Years
2011	103.155
2012	100.061
2013	97.059
2014	94.147
2015	91.323
Total PV Bird-Years	485.745

Table F-9
Golden Eagle REA Mitigation: Lethal Electric Power Pole Retrofitting;
The Avoided Loss of Direct and Reproductive Bird-Years Associated with
The Relative Productivity of 0.0102 Bird-Years per Pole in 2011
(REA Steps 14-15)

Source of Bird-Years	PV Bird-Years
Avoided Direct Loss of Eagles:	0.06
Avoided Loss--1st Gen	0.08
Avoided Loss--2nd Gen	0.07
Avoided Loss of Eagle Reproduction:	0.15
Relative Productivity (Direct+ Reproductive):	**0.21**

PV= Present Value